**BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL**
**(SOUTHERN ZONE) CHENNAI.**

**O.A.No.19 of 2013,**
**O.A.No.248 of 2016 and**
**O.A.No.224 of 2016**

Meenavargal Mempattu Sangam ..Applicant

-Vs-

The Chief Secretary,
Government of Tamil Nadu,
Chennai and others ..Respondents

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Dated at Chennai on this the 17th day of July, 2021.

Certified that all the above are true copies of their respective originals.

**COUNSEL FOR RESPONDENTS**

M/S. MPL - Unit-I Page No. 1

ANNEXURE - 1 (A')

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 141/2014–15 Dated : 22.09.2014

Name of the Sender : DEE/Ambattur
Nature and Number of sample and Time : One number of sample
Date and Time of Collection : 26.08.2014 at 4.50 PM
Date and Time of Receipt : 27.08.2014 at 10.15 AM
Code No. & Point of Collection : 1. 5497 – ETP outlet into sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.35 |
| 2. | Total Suspended Solids | mg/L | 62 |
| 3. | Total Dissolved Solids | mg/L | 56780 |
| 4. | Chlorides | mg/L | 33500 |
| 5. | Sulphates | mg/L | 267 |
| 6. | Oils & Grease | mg/L | 2.8 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 12 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 22 |
| 10. | Zinc | mg/L | 0.22 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 8256 |
| 18. | Sulphide | mg/L | - |
| 19. | Lead | mg/L | <0.02 |
| 20. | Copper | mg/L | <0.002 |
| 21. | Nickel | mg/L | - |
| 22. | Cadmium | mg/L | <0.01 |

Note: ** –Parameter could not be ascertained due to interference during analysis.

28/09/14
Deputy CSO (L)
DEL, Manali

8/+
2919

M/s. MPL - Plant-I

2

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 155/2014–15 Dated : 15.10.2014

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 05.09.2014 at 1.45 PM
Date and Time of Receipt : 08.09.2014 at 10.15 AM
Code No. & Point of Collection : 1. 5519 – ETP outlet into sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.11 |
| 2. | Total Suspended Solids | mg/L | 68 |
| 3. | Total Dissolved Solids | mg/L | 49154 |
| 4. | Chlorides | mg/L | 25000 |
| 5. | Sulphates | mg/L | 295 |
| 6. | Oils & Grease | mg/L | 3.2 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 22 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 22 |
| 10. | Zinc | mg/L | 0.04 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 633 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

Note: ** –Parameter could not be ascertained due to interference during analysis.

Deputy CSO (L) 17/10.
DEL, Manali

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17/10

M/s. MPL - Unit-I

3

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.178/2014–15 Dated : 21.11.2014

Name of the Sender : DEE/Ambattur
Nature and Number of sample and Time : One number of sample
Date and Time of Collection : 20.10.2014 at 4.50 PM
Date and Time of Receipt : 21.10.2014 at 10.45 PM
Code No. & Point of Collection : 1. 5580 - ETP Outlet into sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 8.41 |
| 2. | Total Suspended Solids | mg/L | 54 |
| 3. | Total Dissolved Solids | mg/L | 26880 |
| 4. | Chlorides | mg/L | 13000 |
| 5. | Sulphates | mg/L | 53 |
| 6. | Oils & Grease | mg/L | 2.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 16 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 7.3 |
| 10 | Zinc | mg/L | 0.11 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 9379 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

Deputy CSO (L)
DEL, Manali

27/11

M/s MPL Unit-I

4

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.213/2014–15 Dated : 11.12.2014

Name of the Sender : DEE/Ambattur
Nature and Number of sample and Time : One number of sample
Date and Time of Collection : 25.11.2014 at 11.30 AM
Date and Time of Receipt : 26.11.2014 at 10.00 AM
Code No. & Point of Collection : 1. 5626 - ETP Outlet into sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 4.14 |
| 2. | Total Suspended Solids | mg/L | 72 |
| 3. | Total Dissolved Solids | mg/L | 28428 |
| 4. | Chlorides | mg/L | 16996 |
| 5. | Sulphates | mg/L | 194 |
| 6. | Oils & Grease | mg/L | 2.4 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 61 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 31 |
| 10 | Zinc | mg/L | 0.15 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 7816 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

15/12/14

Deputy CSO (L)
DEL, Manali

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15/12

M/S. MPL - Unit I

5

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 262/2014–15 Dated : 11.02.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample and Time : One number of sample
Date and Time of Collection : 23.01.2015 at 2.40 PM
Date and Time of Receipt : 23.01.2015 at 5.45 PM
Code No. & Point of Collection : 1. 5752 - ETP Outlet in to sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 6.09 |
| 2. | Total Suspended Solids | mg/L | 40 |
| 3. | Total Dissolved Solids | mg/L | 38432 |
| 4. | Chlorides | mg/L | 20000 |
| 5. | Sulphates | mg/L | 32 |
| 6. | Oils & Grease | mg/L | 2.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 13 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 6.44 |
| 10 | Zinc | mg/L | 0.047 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 9218 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

13/02/15
Deputy CSO (L)
DEL, Manali

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M/s. MPL-I

6

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 307/2014–15 Dated : 10.04.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 26.03.2015 at 10.45 AM
Date and Time of Receipt : 26.03.2015 at 5.40 PM
Code No. & Point of Collection : 1. 5863 - ETP Outlet in to sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.18 |
| 2. | Total Suspended Solids | mg/L | 72.0 |
| 3. | Total Dissolved Solids | mg/L | 41580 |
| 4. | Chlorides | mg/L | 25250 |
| 5. | Sulphates | mg/L | 12 |
| 6. | Oils & Grease | mg/L | <1.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 66 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 1.33 |
| 10 | Zinc | mg/L | <0.002 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 7856 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

Deputy CSO (L)
DEL, Manali

M/s. MPL - Unit I

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 6/2015–16 Dated : 18.05.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 20.04.2015 at 3.10 PM
Date and Time of Receipt : 20.04.2015 at 5.30 PM
Code No. & Point of Collection : 1. 5923 - ETP Outlet in to sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.15 |
| 2. | Total Suspended Solids | mg/L | 84 |
| 3. | Total Dissolved Solids | mg/L | 32560 |
| 4. | Chlorides | mg/L | 18000 |
| 5. | Sulphates | mg/L | 12 |
| 6. | Oils & Grease | mg/L | 2.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 28 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 6.7 |
| 10 | Zinc | mg/L | 0.07 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | ** |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

Deputy CSO (L)
DEL, Manali

8A
19/5

M/s. MPL – Unit I

8

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.42/2015–16 Dated : 04.06.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 26.05.2015 at 3.10 PM
Date and Time of Receipt : 26.05.2015 at 5.30 PM
Code No. & Point of Collection : 1. 6011 - ETP Outlet into sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.12 |
| 2. | Total Suspended Solids | mg/L | 48 |
| 3. | Total Dissolved Solids | mg/L | 37060 |
| 4. | Chlorides | mg/L | 22500 |
| 5. | Sulphates | mg/L | 77 |
| 6. | Oils & Grease | mg/L | 2.8 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 19 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 4.9 |
| 10 | Zinc | mg/L | 0.18 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 48 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

for Deputy CSO (L) 08/06
DEL, Manali

5/6

M/s. MPL - Unit I

9

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 74/2015–16 Dated : 20.07.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 29.06.2015 at 11.50 AM
Date and Time of Receipt : 29.06.2015 at 5.00 PM
Code No. & Point of Collection : 1. 8016 - ETP Outlet in to sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.45 |
| 2. | Total Suspended Solids | mg/L | 48 |
| 3. | Total Dissolved Solids | mg/L | 30898 |
| 4. | Chlorides | mg/L | 18500 |
| 5. | Sulphates | mg/L | 43 |
| 6. | Oils & Grease | mg/L | 1.2 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 14 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 4.6 |
| 10 | Zinc | mg/L | 0.30 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | ** |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

20/07/15
Deputy CSO (L)
DEL, Manali

M/s. MPL - Unit I

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.94/2015–16 Dated : 10.08.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 20.07.2015 at 2.15 PM
Date and Time of Receipt : 20.07.2015 at 4.30 PM

Code No. & Point of Collection : 1. 8058 - ETP Outlet into sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.37 |
| 2. | Total Suspended Solids | mg/L | 52 |
| 3. | Total Dissolved Solids | mg/L | 34280 |
| 4. | Chlorides | mg/L | 20492 |
| 5. | Sulphates | mg/L | 95 |
| 6. | Oils & Grease | mg/L | 2.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 21 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 4.7 |
| 10 | Zinc | mg/L | 0.42 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | ** |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | 0.12 |

** Note: Parameters could not be ascertained due to interferences during analysis

10/8/15
Deputy CSO (L)
DEL, Manali

8/4
10/8

M/s. MPL - I.

PT

**TAMILNADU POLLUTION CONTROL BOARD**
**District Environmental Laboratory, Ambattur.**
**Report of Analysis**

**ROA No:1378/2015-2016** **Dated:19/10/2015**

**1. Nature and No. of Sample(s)** : Two Numbers of Effluent Samples

**2. Date of Collection** : 25/09/2015

**3. Code Number(s) and Point of Collection** : 8139-Ennore Rama krishna nager before sea disposal-Treated
8140- ETP Outlet into sea- Treated

| Sl.No. | Parameter | DEE Code NO. | 8139 | 8140 |
|---|---|---|---|---|
| | | Lab Code No. | 1378 | 1379 |
| | | Unit | 1 | 2 |
| 1 | pH | | 5.72 | 6.48 |
| 2 | Conductivity | | -- | -- |
| 3 | Total Suspended Solids | mg/L | 28 | 12 |
| 4 | Total Dissolved Solids | mg/L | 37916 | 35528 |
| 5 | Chlorides | mg/L | 23093 | 19444 |
| 6 | Sulphates | mg/L | 198 | 2214 |
| 7 | Oil and Grease | mg/L | <1 | <1 |
| 8 | B O D at 27*C for 3 Days | mg/L | 3 | 4 |
| 9 | C O D | mg/L | ** | ** |
| 10 | Percentage Sodium | % | - | - |
| 11 | Total Phosphate | mg/L | 0.025 | 0.034 |
| 12 | Total Chromium | mg/L | 0.064 | 0.048 |
| 13 | Zinc | mg/L | 0.127 | 0.082 |
| 14 | Copper | mg/L | <0.0015 | <0.0015 |
| 15 | Lead | mg/L | <0.015 | <0.015 |
| 16 | Nickel | mg/L | <0.006 | -- |
| 17 | Cadmium | mg/L | <0.0008 | <0.0008 |
| 18 | Cyanide | mg/L | <0.005 | <0.005 |
| 19 | Fluoride | mg/L | <0.1 | <0.1 |
| 20 | Sulphide | mg/L | <1 | - |
| 21 | Total Iron | mg/L | 0.036 | - |
| 22 | Calcium | mg/L | 7455 | 7735 |
| 23 | Total kjeldhal Nitrogen | mg/L | 3.9 | - |
| 24 | Total Residual Chloride | mg/L | <1 | <1 |
| 25 | Hexavalent Chromium | mg/L | <0.01 | <0.01 |
| 26 | Phenolic compounds | mg/L | <0.0005 | <0.0005 |
| 27 | Ammonical Nitrogen | mg/L | 2.2 | - |
| 28 | Mercury | mg/L | FNA | - |

**- Parameter Could not be asscrtained due to high interference during the analysis

FNA - Facility not available

28/11/2015

CHIEF SCIENTIFIC OFFICER (LAB)
DEL,AMBATTUR

M/s. MPC-I 12

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.207 / 2015-16 Dated : 22.02.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 28.12.2015 at 3.55 PM
Date and Time of Receipt : 29.12.2015 at 12.30 PM

Code No. & Point of Collection : 1. VA34/12/15 ETP Outlet - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.98 |
| 2. | Total Suspended Solids | mg/L | 52 |
| 3. | Total Dissolved Solids | mg/L | 36468 |
| 4. | Chlorides | mg/L | 19994 |
| 5. | Sulphates | mg/L | 1885 |
| 6. | Oils & Grease | mg/L | 5.2 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 15 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Zinc | mg/L | 0.18 |
| 10. | TRC | mg/L | <1.0 |
| 11. | Cyanide | mg/L | <0.001 |
| 12. | Total Chromium | mg/L | <0.01 |
| 13. | Hexavalent Chromium | mg/L | <0.01 |
| 14. | Phenolic Compounds | mg/L | <0.01 |
| 15. | Calcium | mg/L | 14830 |
| 16. | Copper | mg/L | <0.002 |
| 17. | Cadmium | mg/L | <0.01 |
| 18. | Lead | mg/L | <0.02 |
| 19. | Ammoniacal Nitrogen | mg/L | <0.05 |

** Parameter could not be ascertained due to interferences during analysis.

S. Hemalatha
Deputy CSO (L) 29/2
DEL, Manali

M/s. MPL - I 13

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.219 / 2015-16 Dated : 22.02.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 27.01.2016 at 2.30 PM
Date and Time of Receipt : 27.01.2016 at 6.30 PM

Code No. & Point of Collection : 1. VA37/1/2016 ETP Outlet - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 6.09 |
| 2. | Total Suspended Solids | mg/L | 32 |
| 3. | Total Dissolved Solids | mg/L | 20826 |
| 4. | Chlorides | mg/L | 10500 |
| 5. | Sulphates | mg/L | 32 |
| 6. | Oils & Grease | mg/L | 6.8 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 10 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 0.40 |
| 10. | Zinc | mg/L | 0.65 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 80 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 21. | Lead | mg/L | <0.02 |

** Note: Parameter could not be ascertained due to interferences during analysis.

Deputy CSO (L)
DEL, Manali

M/s. MPL-I 14

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 235/2015–16 Dated : 20.04.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 22.02.2016 at 3.00 PM
Date and Time of Receipt : 22.02.2016 at 5.30 PM

Code No. & Point of Collection : 1. 9022 – Sea water sample near the outlet of The marine disposal diffuser

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 6.94 |
| 2. | Total Suspended Solids | mg/L | 46 |
| 3. | Total Dissolved Solids | mg/L | 31046 |
| 4. | Chlorides | mg/L | 23500 |
| 5. | Sulphates | mg/L | 3290 |
| 6. | Oils & Grease | mg/L | 8.8 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 21 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 0.08 |
| 10. | Zinc | mg/L | 0.3 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Calcium | mg/L | 8096 |
| 17. | Sulphide | mg/L | <1.0 |
| 18. | Copper | mg/L | 0.1 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | 0.3 |
| 21. | Total Iron | mg/L | <0.01 |

** Note: Parameters could not be ascertained due to interferences during analysis

Deputy CSO (L)
DEL, Manali

M/s. MPL-I 15

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 249/2015–16 Dated : 20.04.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 17.03.2016 at 12.50 PM
Date and Time of Receipt : 17.03.2016 at 5.30 PM

Code No. & Point of Collection : 1. 9060 - ETP Outlet in to sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.55 |
| 2. | Total Suspended Solids | mg/L | 104 |
| 3. | Total Dissolved Solids | mg/L | 26492 |
| 4. | Chlorides | mg/L | 15395 |
| 5. | Sulphates | mg/L | 186 |
| 6. | Oils & Grease | mg/L | 4.8 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 153 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 1.5 |
| 10 | Zinc | mg/L | 0.2 |
| 11. | TRC | mg/L | <1 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 914 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

Deputy CSO (L)
DEL, Manali

M/s. MPL-I 16

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 44/2016–17 Dated : 09.08.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 23.06.2016 at 6.15 PM
Date and Time of Receipt : 24.06.2016 at 11.00 AM

Code No. & Point of Collection : 1. 9011 ETP outlet into sea - T

| Sl.No. | Parameters | Unit | 3 |
|---|---|---|---|
| 1. | pH | Number | 5.53 |
| 2. | Total Suspended Solids | mg/L | 96 |
| 3. | Total Dissolved Solids | mg/L | 38416 |
| 4. | Chlorides | mg/L | 22093 |
| 5. | Sulphates | mg/L | 510 |
| 6. | Oils & Grease | mg/L | 7.6 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 35 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 2 |
| 10. | Zinc | mg/L | 0.37 |
| 11. | TRC | mg/L | <1 |
| 12. | Cyanide | mg/L | <0.005 |
| 13. | Total Chromium | mg/L | <0.003 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.005 |
| 16. | Fluoride | mg/L | <1 |
| 17. | Calcium | mg/L | 12810 |
| 18. | Copper | mg/L | <0.0015 |
| 19. | Cadmium | mg/L | <0.008 |
| 20. | Lead | mg/L | <0.015 |

** Note: Parameters could not be ascertained due to interferences during analysis

09/16

Deputy CSO (L)
DEL, Manali

M/s. MPL-I.
17

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 72/2016–17 Dated : 06.09.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 26.07.2016 at 11.00 AM
Date and Time of Receipt : 27.07.2016 at 12.15 PM

Code No. & Point of Collection : 1.7000 – ETP outlet - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.73 |
| 2. | Total Suspended Solids | mg/L | 12 |
| 3. | Total Dissolved Solids | mg/L | 31442 |
| 4. | Chlorides | mg/L | 16495 |
| 5. | Sulphates | mg/L | 31 |
| 6. | Oils & Grease | mg/L | 7.2 |
| 7. | BOD for 3 days at $27^0$C | mg/L | 2 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 0.7 |
| 10. | Zinc | mg/L | 0.24 |
| 11. | TKN | mg/L | <5 |
| 13. | Cyanide | mg/L | <0.005 |
| 14. | Total Chromium | mg/L | <0.003 |
| 15. | Hexavalent Chromium | mg/L | <0.01 |
| 16. | Phenolic Compounds | mg/L | <0.005 |
| 17. | Sulphide | mg/L | <1 |
| 18. | Copper | mg/L | <0.0015 |
| 19. | Nickel | mg/L | <0.006 |
| 20. | Cadmium | mg/L | <0.008 |
| 21. | Lead | mg/L | 0.09 |
| 22. | Ammonical Nitrogen | mg/L | <5 |

** Note: Parameters could not be ascertained due to interferences during analysis

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Deputy CSO (L)
DEL, Manali

M/s. MPL - I
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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 72/2016–17 Dated : 06.09.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 26.07.2016 at 10.30 AM
Date and Time of Receipt : 27.07.2016 at 12.15 PM

Code No. & Point of Collection:
1. 7003 - ETP Treated water deliver line to sea sampling point Near Ramakrishna Nagar Board- NA
2. 7004 - ETP Treated water deliver line to sea sampling point Near TPL gate- NA
3. 7005 - ETP Treated water deliver line to sea sampling point Near MOL -2 gate - NA

| Sl.No. | Parameters | Unit | 1 | 2 | 3 |
|---|---|---|---|---|---|
| 1. | pH | Number | 6.43 | 6.54 | 6.34 |
| 2. | Total Suspended Solids | mg/L | 28 | 18 | 14 |
| 3. | Total Dissolved Solids | mg/L | 31234 | 32948 | 33126 |
| 4. | Chlorides | mg/L | 17245 | 15595 | 17495 |
| 5. | Sulphates | mg/L | 32 | 24 | 27 |
| 6. | Oils & Grease | mg/L | 8.4 | 8.0 | 8.8 |
| 7. | BOD for 3 days at 27$^0$C | mg/L | 2 | 1 | 1 |
| 8. | Chemical Oxygen Demand | mg/L | ** | ** | ** |
| 9. | Phosphate | mg/L | 0.4 | 0.3 | 0.3 |
| 10. | Zinc | mg/L | 0.22 | 0.3 | 0.36 |
| 11. | TRC | mg/L | <1 | <1 | <1 |
| 12. | Cyanide | mg/L | <0.005 | <0.005 | <0.005 |
| 13. | Total Chromium | mg/L | <0.003 | <0.003 | <0.003 |
| 14. | Hexavalent Chromium | mg/L | <0.01 | <0.01 | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.005 | <0.005 | <0.005 |
| 16. | Sulphide | mg/L | <1 | <1 | <1 |
| 17. | Calcium | mg/L | 12400 | 10800 | 12720 |
| 18. | Copper | mg/L | <0.0015 | <0.0015 | <0.0015 |
| 19. | Cadmium | mg/L | <0.008 | <0.008 | <0.008 |
| 20. | Lead | mg/L | <0.015 | <0.015 | <0.015 |
| 21. | Total Iron | mg/L | <0.01 | <0.01 | <0.01 |

** Note: Parameters could not be ascertained due to interferences during analysis

06/09/16
Deputy CSO (L)
DEL, Manali

M/s. MPL-I 19

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.92/2016–17 Dated : 03.10.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 18.08.2016 at 12.30 PM
Date and Time of Receipt : 18.08.2016 at 5.00 PM

Code No. & Point of Collection : 1. 7086 - ETP Outlet into Sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.62 |
| 2. | Total Suspended Solids | mg/L | 28 |
| 3. | Total Dissolved Solids | mg/L | 27532 |
| 4. | Chlorides | mg/L | 15995 |
| 5. | Sulphates | mg/L | 101 |
| 6. | Oils & Grease | mg/L | 8.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 5 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | <0.15 |
| 10. | Zinc | mg/L | 0.1 |
| 11. | TRC | mg/L | <1 |
| 12. | Cyanide | mg/L | <0.005 |
| 13. | Total Chromium | mg/L | <0.003 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.005 |
| 16. | Fluoride | mg/L | <1 |
| 17. | Calcium | mg/L | 11600 |
| 18. | Copper | mg/L | <0.0015 |
| 19. | Cadmium | mg/L | <0.008 |
| 20. | Lead | mg/L | <0.015 |

** Note: Parameters could not be ascertained due to interferences during analysis.

Deputy CSO (L)
DEL, Manali

M/s. MPL – II & I

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 92/2016–17 Dated : 03.10.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 18.08.2016 at 2.10 PM
Date and Time of Receipt : 18.08.2016 at 5.00 PM

Code No. & Point of Collection:
1. 7089 - ETP Treated water deliver line to sea sampling point Near Ramakrishna Nagar Board- NA
2. 7088 - ETP Treated water deliver line to sea sampling point Near TPL gate- NA
3. 7087 - ETP Treated water deliver line to sea sampling point Near MOL -2 gate - NA

| Sl.No. | Parameters | Unit | 1 | 2 | 3 |
|---|---|---|---|---|---|
| 1. | pH | Number | 5.84 | 5.82 | 5.89 |
| 2. | Total Suspended Solids | mg/L | 32 | 26 | 42 |
| 3. | Total Dissolved Solids | mg/L | 25370 | 28526 | 28918 |
| 4. | Chlorides | mg/L | 14495 | 15745 | 16894 |
| 5. | Sulphates | mg/L | 50 | 47 | 47 |
| 6. | Oils & Grease | mg/L | 5.2 | 4.4 | 4.8 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 6 | 2 | 6 |
| 8. | Chemical Oxygen Demand | mg/L | ** | ** | ** |
| 9. | Phosphate | mg/L | 0.5 | 0.05 | 0.51 |
| 10. | Zinc | mg/L | 0.15 | 0.22 | 0.16 |
| 11. | TRC | mg/L | <1 | <1 | <1 |
| 12. | Cyanide | mg/L | <0.005 | <0.005 | <0.005 |
| 13. | Total Chromium | mg/L | <0.003 | <0.003 | <0.003 |
| 14. | Hexavalent Chromium | mg/L | <0.01 | <0.01 | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.005 | <0.005 | <0.005 |
| 16. | Sulphide | mg/L | <1 | <1 | <1 |
| 17. | Calcium | mg/L | 10400 | 11200 | 11600 |
| 18. | Copper | mg/L | 0.01 | 0.01 | <0.0015 |
| 19. | Cadmium | mg/L | <0.008 | <0.008 | <0.008 |
| 20. | Lead | mg/L | <0.015 | <0.015 | <0.015 |
| 21. | Total Iron | mg/L | <0.01 | <0.01 | <0.01 |

** Note: Parameters could not be ascertained due to interferences during analysis

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Deputy CSO (L)
DEL, Manali

M/s. MPL – I
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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 140/2016–17 Dated : 23.12.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Three number of samples
Date and Time of Collection : 20.10.2016 at 3.45 PM
Date and Time of Receipt : 21.10.2016 at 10.00 AM

Code No. & Point of Collection : 1. KU-93- ETP outlet into sea - T
2. KU-94 -Near TPL gate – T
3. KU-95 -Near Sea Shore-T

| Sl.No | Parameters | Unit | 1 | 2 | 3 |
|---|---|---|---|---|---|
| 1. | pH | Number | 5.85 | 6.07 | 6.01 |
| 2. | Total Suspended Solids | mg/L | 24 | 30 | 28 |
| 3. | Total Dissolved Solids | mg/L | 29742 | 30860 | 28520 |
| 4. | Chlorides | mg/L | 15395 | 16594 | 15245 |
| 5. | Sulphates | mg/L | 87 | 69 | 75 |
| 6. | Oils & Grease | mg/L | 7.2 | 6.8 | 7.2 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 2 | 2 | 2 |
| 8. | Chemical Oxygen Demand | mg/L | ** | ** | ** |
| 9. | Phosphate | mg/L | 0.57 | 0.62 | 0.05 |
| 10. | Cyanide | mg/L | <0.005 | <0.005 | <0.005 |
| 11. | Phenolic Compounds | mg/L | <0.005 | <0.005 | <0.005 |
| 12. | Fluoride | mg/L | <1 | <1 | <1 |
| 13. | TRC | mg/L | <1 | <1 | <1 |
| 14. | Calcium | mg/L | 12480 | 13000 | 11920 |
| 15. | Total Chromium | mg/L | <0.003 | <0.003 | <0.003 |
| 16. | Hexavalent Chromium | mg/L | <0.01 | <0.01 | <0.01 |
| 17. | Copper | mg/L | <0.0015 | <0.0015 | <0.0015 |
| 18. | Zinc | mg/L | 0.27 | 0.26 | 0.49 |
| 19. | Lead | mg/L | <0.015 | <0.015 | <0.015 |
| 20. | Cadmium | mg/L | <0.008 | <0.008 | <0.008 |

** Note: Parameters could not be ascertained due to interferences during analysis

Deputy CSO (L)
DEL, Manali

M/s-MPR-I 22

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 181/2016–17 Dated : 28.02.2017

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Three number of samples
Date and Time of Collection : 19.12.2016 at 12.50 PM
Date and Time of Receipt : 20.12.2016 at 10.45 AM

Code No. & Point of Collection : 1. KUD-44- ETP outlet into sea - T
2. KUD-45 -Near TPL gate – T
3. KUD-46 -Near Sea Shore-T

| Sl.No | Parameters | Unit | 1 | 2 | 3 |
|---|---|---|---|---|---|
| 1. | pH | Number | 6.21 | 6.29 | 6.12 |
| 2. | Total Suspended Solids | mg/L | 268 | 250 | 260 |
| 3. | Total Dissolved Solids | mg/L | 29624 | 28756 | 28542 |
| 4. | Chlorides | mg/L | 16795 | 16595 | 16145 |
| 5. | Sulphates | mg/L | 216 | 16 | 14 |
| 6. | Oils & Grease | mg/L | 1.6 | 1.6 | 1.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 3 | 4 | 2 |
| 8. | Chemical Oxygen Demand | mg/L | ** | ** | ** |
| 9. | Phosphate | mg/L | <0.15 | <0.15 | <0.15 |
| 10. | Cyanide | mg/L | <0.005 | <0.005 | <0.005 |
| 11. | Phenolic Compounds | mg/L | <0.005 | <0.005 | <0.005 |
| 12. | Fluoride | mg/L | <1 | <1 | <1 |
| 13. | TRC | mg/L | <1 | <1 | <1 |
| 14. | Calcium | mg/L | 13360 | 12480 | 11920 |
| 15. | Total Chromium | mg/L | <0.003 | <0.003 | <0.003 |
| 16. | Hexavalent Chromium | mg/L | <0.01 | <0.01 | <0.01 |
| 17. | Copper | mg/L | 0.07 | 0.12 | 0.04 |
| 18. | Zinc | mg/L | 0.15 | 0.21 | 0.16 |
| 19. | Lead | mg/L | 1.1 | 1.3 | 1.1 |
| 20. | Cadmium | mg/L | <0.008 | <0.008 | <0.008 |

** Note: Parameters could not be ascertained due to interferences during analysis

Deputy CSO (L)
DEL, Manali

M/s. Manali Petrochemicals Ltd, Plant-II 23 (B)

ANNEXURE - 1

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 250/2013–14 Dated : 04.03.2014

Name of the Sender : DEE/Ambattur
Nature and Number of sample and Time : One number of samples
Date and Time of Collection : 20.02.2014 at 1.50 PM
Date and Time of Receipt : 21.02.2014 at 10.00 AM
Code No. & Point of Collection : 1. 5213 - ETP Outlet into sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 6.19 |
| 2. | Total Suspended Solids | mg/L | 60 |
| 3. | Total Dissolved Solids | mg/L | 53960 |
| 4. | Chlorides | mg/L | 30500 |
| 5. | Sulphates | mg/L | 2502 |
| 6. | Oils & Grease | mg/L | 2.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 20 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 3.1 |
| 10 | Zinc | mg/L | 0.11 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 16834 |
| 18. | Sulphide | mg/L | - |
| 19. | Copper | mg/L | <0.002 |
| 20. | Cadmium | mg/L | <0.01 |
| 21. | Nickel | mg/L | - |
| 22. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

03/14

Deputy CSO (L)
DEL, Manali

M/s. MPL- Unit II

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 213/2014–15 Dated : 11.12.2014

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 25.11.2014 at 3.10 PM
Date and Time of Receipt : 26.11.2014 at 10.00 AM
Code No. & Point of Collection : 1. 5643 - ETP outlet into sea - Treated

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.88 |
| 2. | Total Suspended Solids | mg/L | 76 |
| 3. | Total Dissolved Solids | mg/L | 37988 |
| 4. | Chlorides | mg/L | 22993 |
| 5. | Sulphates | mg/L | 21 |
| 6. | Oils & Grease | mg/L | 2.8 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 13 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | <0.01 |
| 10. | Zinc | mg/L | 0.03 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Fluoride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 13627 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Nickel | mg/L | - |
| 20. | Cadmium | mg/L | <0.01 |
| 21. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

Deputy CSO (L)
DEL, Manali

15/12

M/s. MPL - Unit-II

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.256/2014–15 Dated : 19.01.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample and Time : One number of sample
Date and Time of Collection : 30.12.2014 at 3.10 PM
Date and Time of Receipt : 30.12.2014 at 5.45 PM
Code No. & Point of Collection : 1. 5727 - ETP Outlet into sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.57 |
| 2. | Total Suspended Solids | mg/L | 54 |
| 3. | Total Dissolved Solids | mg/L | ** |
| 4. | Chlorides | mg/L | 43000 |
| 5. | Sulphates | mg/L | 654 |
| 6. | Oils & Grease | mg/L | 2.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 20 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 6.9 |
| 10 | Zinc | mg/L | 0.26 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 16433 |
| 18. | Copper | mg/L | 0.02 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

for Deputy CSO (L) 21/01
DEL, Manali

8th/21/1

M/s. MPL - II

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 264/2014–15 Dated : 16.02.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 28.01.2015 at 12.30 PM
Date and Time of Receipt : 28.01.2015 at 5.50 PM
Code No. & Point of Collection : 1. 5768 - ETP outlet into sea - Treated

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 6.07 |
| 2. | Total Suspended Solids | mg/L | 48 |
| 3. | Total Dissolved Solids | mg/L | 38946 |
| 4. | Chlorides | mg/L | 23000 |
| 5. | Sulphates | mg/L | 139 |
| 6. | Oils & Grease | mg/L | 2.4 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 15 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 7.24 |
| 10. | Zinc | mg/L | <0.002 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Fluoride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 14028 |
| 18. | Sulphide | mg/L | - |
| 19. | Copper | mg/L | <0.002 |
| 20. | Nickel | mg/L | - |
| 21. | Cadmium | mg/L | <0.01 |
| 22. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

16/02/15
Deputy CSO (L)
DEL, Manali

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 282/2014–15 Dated : 12.03.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 23.02.2015 at 2.15 PM
Date and Time of Receipt : 24.02.2015 at 10.00 AM
Code No. & Point of Collection : 1. 5831 - ETP Outlet in to sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.24 |
| 2. | Total Suspended Solids | mg/L | 48 |
| 3. | Total Dissolved Solids | mg/L | 52568 |
| 4. | Chlorides | mg/L | 33000 |
| 5. | Sulphates | mg/L | 60 |
| 6. | Oils & Grease | mg/L | 2.8 |
| 7. | BOD for 3 days at 27$^0$ C | mg/L | 14 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 1.61 |
| 10 | Zinc | mg/L | 0.13 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 10822 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

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Deputy CSO (L)
DEL, Manali

877
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M/s. MPL - II

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 307/2014–15 Dated : 10.04.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 26.03.2015 at 10.45 AM
Date and Time of Receipt : 26.03.2015 at 5.40 PM
Code No. & Point of Collection : 1. 5856 - ETP Outlet in to sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.32 |
| 2. | Total Suspended Solids | mg/L | 42 |
| 3. | Total Dissolved Solids | mg/L | 22784 |
| 4. | Chlorides | mg/L | 13500 |
| 5. | Sulphates | mg/L | 141 |
| 6. | Oils & Grease | mg/L | 2.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 20 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 1.33 |
| 10 | Zinc | mg/L | 0.05 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 2886 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

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Deputy CSO (L)
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M/s. MPL - Unit - II

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 6/2015–16 Dated : 18.05.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 20.04.2015 at 4.20 PM
Date and Time of Receipt : 20.04.2015 at 5.30 PM
Code No. & Point of Collection : 1. 5929 - ETP Outlet in to sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.55 |
| 2. | Total Suspended Solids | mg/L | 56 |
| 3. | Total Dissolved Solids | mg/L | 29528 |
| 4. | Chlorides | mg/L | 17750 |
| 5. | Sulphates | mg/L | 161 |
| 6. | Oils & Grease | mg/L | 2.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 34 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 5.0 |
| 10 | Zinc | mg/L | 0.07 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | ** |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

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Deputy CSO (L)
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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.42/2015–16 Dated : 03.06.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 26.05.2015 at 4.10 PM
Date and Time of Receipt : 26.05.2015 at 5.30 PM
Code No. & Point of Collection : 1. 6017 - ETP Outlet into sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.38 |
| 2. | Total Suspended Solids | mg/L | 48 |
| 3. | Total Dissolved Solids | mg/L | 20858 |
| 4. | Chlorides | mg/L | 11500 |
| 5. | Sulphates | mg/L | 44 |
| 6. | Oils & Grease | mg/L | 2.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 14 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 1.3 |
| 10 | Zinc | mg/L | 0.47 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 9218 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

Deputy CSO (L)
DEL, Manali

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.74/2015–16 Dated : 16.07.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 29.06.2015 at 12.35 PM
Date and Time of Receipt : 29.06.2015 at 5.00 PM
Code No. & Point of Collect : 1. 8022 - ETP outlet into sea - Treated

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.08 |
| 2. | Total Suspended Solids | mg/L | 58 |
| 3. | Total Dissolved Solids | mg/L | 38756 |
| 4. | Chlorides | mg/L | 20500 |
| 5. | Sulphates | mg/L | 7 |
| 6. | Oils & Grease | mg/L | 2.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 14 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 7.6 |
| 10. | Zinc | mg/L | 0.52 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Fluoride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 2084 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

20/07/15
Deputy CSO (L)
DEL, Manali

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.94/2015–16 Dated : 10.08.2015

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 20.07.2015 at 3.10 PM
Date and Time of Receipt : 20.07.2015 at 4.30 PM

Code No. & Point of Collection : 1. 8063 - ETP Outlet into sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.11 |
| 2. | Total Suspended Solids | mg/L | 46 |
| 3. | Total Dissolved Solids | mg/L | 34168 |
| 4. | Chlorides | mg/L | 19992 |
| 5. | Sulphates | mg/L | 93 |
| 6. | Oils & Grease | mg/L | 1.2 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 15 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 6.1 |
| 10 | Zinc | mg/L | 0.42 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | ** |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

10/08/15

Deputy CSO (L)
DEL, Manali

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M/s. NPL - II

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**TAMILNADU POLLUTION CONTROL BOARD**
**District Environmental Laboratory, Ambattur.**
**Report of Analysis**

**ROA No:1380/2015-2016** Dated:08/10/2015

**1. Nature and No. of Sample(s)** : One No of Water Sample

**2. Date of Collection** : 25/09/2015

**3. Code Number(s) and Point of Collection** : 8141 - ETP outlet into sea - T

| Sl.No. | Parameter | DEE Code NO. | 8141 |
|---|---|---|---|
| | | Lab Code No. | 1380 |
| | | Unit | 1 |
| 1 | pH | | 6.94 |
| 2 | Total Suspended Solids | mg/L | 14 |
| 3 | Total Dissolved Solids | mg/L | 25598 |
| 4 | Chlorides (as Cl) | mg/L | 14894 |
| 5 | Sulphates (as $SO_4$) | mg/L | 576 |
| 6 | Oil and Grease | mg/L | <1 |
| 7 | BOD for 3 days at 27°C | mg/L | 5 |
| 8 | Chemical Oxygen Demand | mg/L | ** |
| 9 | Total Phosphate | mg/L | 0.042 |
| 10 | Zinc | mg/L | 0.129 |
| 11 | Total Residual Chlorine | mg/L | <1 |
| 12 | Cyanide | mg/L | <0.005 |
| 13 | Hexavelent Chromium | mg/L | <0.01 |
| 14 | Total Chromium | mg/L | 0.032 |
| 15 | Phenolic Compounds | mg/L | <0.0005 |
| 16 | Fluoride | mg/L | <0.01 |
| 17 | Calcium | mg/L | 8216 |
| 18 | Lead | mg/L | <0.015 |
| 19 | Copper | mg/L | <0.0015 |
| 20 | Cadmium | mg/l | <0.0008 |

** Parameter could not be ascertained due to interference during the analysis.

23/10/2015

**CHIEF SCIENTIFIC OFFICER (LAB)**
**DEL,AMBATTUR**

23/10/15

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.207 / 2015-16 Dated : 22.02.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 28.12.2015 at 4.10 PM
Date and Time of Receipt : 29.12.2015 at 12.30 PM

Code No. & Point of Collection : 1. VA35/12/15 ETP Outlet - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.72 |
| 2. | Total Suspended Solids | mg/L | 56 |
| 3. | Total Dissolved Solids | mg/L | 46784 |
| 4. | Chlorides | mg/L | 26592 |
| 5. | Sulphates | mg/L | 1909 |
| 6. | Oils & Grease | mg/L | 5.2 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 4 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Zinc | mg/L | 0.26 |
| 10. | TRC | mg/L | <1.0 |
| 11. | Cyanide | mg/L | <0.001 |
| 12. | Total Chromium | mg/L | <0.01 |
| 13. | Hexavalent Chromium | mg/L | <0.01 |
| 14. | Phenolic Compounds | mg/L | <0.01 |
| 15. | Copper | mg/L | <0.002 |
| 16. | Cadmium | mg/L | <0.01 |
| 17. | Lead | mg/L | <0.02 |
| 18. | Ammoniacal Nitrogen | mg/L | <0.05 |

** Parameter could not be ascertained due to interferences during analysis.

S. Hemalatha
Deputy CSO (L) 29/2
DEL, Manali

M/s. MPC – II

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.219 / 2015-16 Dated : 22.02.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 27.01.2016 at 2.50 PM
Date and Time of Receipt : 27.01.2016 at 6.30 PM

Code No. & Point of Collection : 1. VA38/1/2016 ETP Outlet - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 6.26 |
| 2. | Total Suspended Solids | mg/L | 28 |
| 3. | Total Dissolved Solids | mg/L | 29440 |
| 4. | Chlorides | mg/L | 18500 |
| 5. | Sulphates | mg/L | 30 |
| 6. | Oils & Grease | mg/L | 6.4 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 9 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 0.25 |
| 10. | Zinc | mg/L | 0.30 |
| 11. | TRC | mg/L | <1.0 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Flouride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 44 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 21. | Lead | mg/L | <0.02 |

** Note: Parameter could not be ascertained due to interferences during analysis.

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Deputy CSO (L)
DEL, Manali

M/s. MPL - II
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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.249/2015–16 Dated : 20.04.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 17.03.2016 at 1.40 PM
Date and Time of Receipt : 17.03.2016 at 5.30 PM

Code No. & Point of Collection : 1. 9064 - ETP Outlet into Sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.66 |
| 2. | Total Suspended Solids | mg/L | 40 |
| 3. | Total Dissolved Solids | mg/L | 39252 |
| 4. | Chlorides | mg/L | 24193 |
| 5. | Sulphates | mg/L | 172 |
| 6. | Oils & Grease | mg/L | 6.4 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 19 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 2.6 |
| 10. | Zinc | mg/L | 0.1 |
| 11. | TRC | mg/L | <1 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Fluoride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 7375 |
| 18. | Lead | mg/L | <0.02 |
| 19. | Copper | mg/L | <0.002 |
| 20. | Cadmium | mg/L | <0.01 |

** Note: Parameters could not be ascertained due to interferences during analysis

Deputy CSO (L)
DEL, Manali

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.9/2016–17 Dated : 30.05.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 27.04.2016 at 1.00 PM
Date and Time of Receipt : 27.04.2016 at 4.00 PM

Code No. & Point of Collection : 1. 9021 - ETP Outlet into Sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.44 |
| 2. | Total Suspended Solids | mg/L | 28 |
| 3. | Total Dissolved Solids | mg/L | 23916 |
| 4. | Chlorides | mg/L | 13621 |
| 5. | Sulphates | mg/L | 258 |
| 6. | Oils & Grease | mg/L | 5.2 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 12 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 1.6 |
| 10. | Zinc | mg/L | 0.7 |
| 11. | TRC | mg/L | <1 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.01 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Fluoride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 6800 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

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Deputy CSO (L)
DEL, Manali

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 28/2016–17 Dated : 15.07.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 27.05.2016 at 12.45 PM
Date and Time of Receipt : 27.05.2016 at 5.00 PM

Code No. & Point of Collection : 1. 9083 ETP outlet into sea - T

| Sl.No. | Parameters | Unit | 3 |
|---|---|---|---|
| 1. | pH | Number | 6.45 |
| 2. | Total Suspended Solids | mg/L | 112 |
| 3. | Total Dissolved Solids | mg/L | 39110 |
| 4. | Chlorides | mg/L | 23993 |
| 5. | Sulphates | mg/L | 428 |
| 6. | Oils & Grease | mg/L | 5.2 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 70 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 0.7 |
| 10. | Zinc | mg/L | 0.3 |
| 11. | TRC | mg/L | <1 |
| 12. | Cyanide | mg/L | <0.001 |
| 13. | Total Chromium | mg/L | <0.003 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.01 |
| 16. | Fluoride | mg/L | <0.05 |
| 17. | Calcium | mg/L | 10000 |
| 18. | Copper | mg/L | <0.002 |
| 19. | Cadmium | mg/L | <0.01 |
| 20. | Lead | mg/L | <0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

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Deputy CSO (L)
DEL, Manali

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 44/2016–17 Dated : 09.08.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 23.06.2016 at 6.35 PM
Date and Time of Receipt : 24.06.2016 at 11.00 AM

Code No. & Point of Collection : 1. 9013 ETP outlet into sea - T

| Sl.No. | Parameters | Unit | 3 |
|---|---|---|---|
| 1. | pH | Number | 4.88 |
| 2. | Total Suspended Solids | mg/L | 112 |
| 3. | Total Dissolved Solids | mg/L | 34280 |
| 4. | Chlorides | mg/L | 20094 |
| 5. | Sulphates | mg/L | 242 |
| 6. | Oils & Grease | mg/L | 7.6 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 34 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 2 |
| 10. | Zinc | mg/L | 0.37 |
| 11. | TRC | mg/L | <1 |
| 12. | Cyanide | mg/L | <0.005 |
| 13. | Total Chromium | mg/L | <0.003 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.005 |
| 16. | Fluoride | mg/L | <1 |
| 17. | Calcium | mg/L | 10720 |
| 18. | Copper | mg/L | <0.0015 |
| 19. | Cadmium | mg/L | <0.008 |
| 20. | Lead | mg/L | 0.02 |

** Note: Parameters could not be ascertained due to interferences during analysis

09/16

Deputy CSO (L)
DEL, Manali

M/s MPL - II

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 72/2016–17 Dated : 06.09.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 26.07.2016 at 11.05 AM
Date and Time of Receipt : 27.07.2016 at 12.15 PM

Code No. & Point of Collection : 1.7001 – ETP outlet - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.74 |
| 2. | Total Suspended Solids | mg/L | 14 |
| 3. | Total Dissolved Solids | mg/L | 30820 |
| 4. | Chlorides | mg/L | 15745 |
| 5. | Sulphates | mg/L | 23 |
| 6. | Oils & Grease | mg/L | 8.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 1 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 0.5 |
| 10. | Zinc | mg/L | 0.38 |
| 11. | TKN | mg/L | <5 |
| 13. | Cyanide | mg/L | <0.005 |
| 14. | Total Chromium | mg/L | <0.003 |
| 15. | Hexavalent Chromium | mg/L | <0.01 |
| 16. | Phenolic Compounds | mg/L | <0.005 |
| 17. | Sulphide | mg/L | <1 |
| 18. | Copper | mg/L | <0.0015 |
| 19. | Nickel | mg/L | <0.006 |
| 20. | Cadmium | mg/L | <0.008 |
| 21. | Lead | mg/L | <0.015 |
| 22. | Ammonical Nitrogen | mg/L | <5 |

** Note: Parameters could not be ascertained due to interferences during analysis

06/09/16

Deputy CSO (L)
DEL, Manali

M/s. MP2 – II
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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No.92/2016–17 Dated : 03.10.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 18.08.2016 at 12.40 PM
Date and Time of Receipt : 18.08.2016 at 5.00 PM

Code No. & Point of Collection : 1. 7089 - ETP Outlet into Sea - T

| Sl.No. | Parameters | Unit | 1 |
|---|---|---|---|
| 1. | pH | Number | 5.75 |
| 2. | Total Suspended Solids | mg/L | 20 |
| 3. | Total Dissolved Solids | mg/L | 27876 |
| 4. | Chlorides | mg/L | 15495 |
| 5. | Sulphates | mg/L | 53 |
| 6. | Oils & Grease | mg/L | 5.2 |
| 7. | BOD for 3 days at 27$^0$C | mg/L | 4 |
| 8. | Chemical Oxygen Demand | mg/L | ** |
| 9. | Phosphate | mg/L | 0.23 |
| 10. | Zinc | mg/L | 0.18 |
| 11. | TRC | mg/L | <1 |
| 12. | Cyanide | mg/L | <0.005 |
| 13. | Total Chromium | mg/L | <0.003 |
| 14. | Hexavalent Chromium | mg/L | <0.01 |
| 15. | Phenolic Compounds | mg/L | <0.005 |
| 16. | Fluoride | mg/L | <1 |
| 17. | Calcium | mg/L | 12400 |
| 18. | Copper | mg/L | <0.0015 |
| 19. | Cadmium | mg/L | <0.008 |
| 20. | Lead | mg/L | <0.015 |

** Note: Parameters could not be ascertained due to interferences during analysis

10/16

Deputy CSO (L)
DEL, Manali

N/& MPL - T
42

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 140/2016–17 Dated : 23.12.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Two number of samples
Date and Time of Collection : 20.10.2016 at 4.00 PM
Date and Time of Receipt : 21.10.2016 at 10.00 AM

Code No. & Point of Collection : 1. KU-96 - ETP outlet into sea - T
2. KU-97 - Near Kothari collection point – T

| Sl.No | Parameters | Unit | 1 | 2 |
|---|---|---|---|---|
| 1. | pH | Number | 5.97 | 6.67 |
| 2. | Total Suspended Solids | mg/L | 18 | 28 |
| 3. | Total Dissolved Solids | mg/L | 31810 | 29536 |
| 4. | Chlorides | mg/L | 17495 | 15995 |
| 5. | Sulphates | mg/L | 73 | 76 |
| 6. | Oils & Grease | mg/L | 104 | 8.8 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 1 | 2 |
| 8. | Chemical Oxygen Demand | mg/L | ** | ** |
| 9. | Phosphate | mg/L | 0.04 | 0.38 |
| 10. | Cyanide | mg/L | <0.005 | <0.005 |
| 11. | Phenolic Compounds | mg/L | <0.005 | <0.005 |
| 12. | Fluoride | mg/L | <1 | <1 |
| 13. | TRC | mg/L | <1 | <1 |
| 14. | Calcium | mg/L | 12700 | 11400 |
| 15. | Total Chromium | mg/L | <0.003 | <0.003 |
| 16. | Hexavalent Chromium | mg/L | <0.01 | <0.01 |
| 17. | Copper | mg/L | <0.0015 | 0.35 |
| 18. | Zinc | mg/L | 0.45 | <0.0015 |
| 19. | Lead | mg/L | <0.015 | <0.015 |
| 20. | Cadmium | mg/L | <0.008 | <0.008 |

** Note: Parameters could not be ascertained due to interferences during analysis

01/12/17

Deputy CSO (L)
DEL, Manali

M/s. MPL - II
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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 151/2016–17 Dated : 09.01.2017

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Two number of samples
Date and Time of Collection : 08.11.2016 at 3.40 PM
Date and Time of Receipt : 09.11.2016 at 10.00 AM

Code No. & Point of Collection : 1. KUN-63 - ETP outlet into sea - T
2. KUN-64 - Near Kothari collection point – T

| Sl.No | Parameters | Unit | 1 | 2 |
|---|---|---|---|---|
| 1. | pH | Number | 6.01 | 6.03 |
| 2. | Total Suspended Solids | mg/L | 906 | 590 |
| 3. | Total Dissolved Solids | mg/L | 29240 | 28960 |
| 4. | Chlorides | mg/L | 17045 | 16745 |
| 5. | Sulphates | mg/L | 5 | 6 |
| 6. | Oils & Grease | mg/L | 2.4 | 2.0 |
| 7. | BOD for 3 days at $27^0$ C | mg/L | 2 | 2 |
| 8. | Chemical Oxygen Demand | mg/L | ** | ** |
| 9. | Phosphate | mg/L | <0.15 | 0.13 |
| 10. | Cyanide | mg/L | <0.005 | <0.005 |
| 11. | Phenolic Compounds | mg/L | <0.005 | <0.005 |
| 12. | Fluoride | mg/L | <1 | <1 |
| 13. | TRC | mg/L | <1 | <1 |
| 14. | Calcium | mg/L | 11200 | 10800 |
| 15. | Total Chromium | mg/L | <0.003 | <0.003 |
| 16. | Hexavalent Chromium | mg/L | <0.01 | <0.01 |
| 17. | Copper | mg/L | <0.0015 | <0.0015 |
| 18. | Zinc | mg/L | 0.27 | 0.20 |
| 19. | Lead | mg/L | <0.015 | <0.015 |
| 20. | Cadmium | mg/L | <0.008 | <0.008 |

** Note: Parameters could not be ascertained due to interferences during analysis

Deputy CSO (L)
DEL, Manali

M/s. MPL - II

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY – MANALI

REPORT OF ANALYSIS

ROA No. 181/2016–17 Dated : 28.02.2017

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Two numbers of samples
Date and Time of Collection : 19.12.2016 at 1.30 PM
Date and Time of Receipt : 20.12.2016 at 10.45 AM

Code No. & Point of Collection : 1. KUD-47 - ETP outlet to Sea - T
2. KUD-48 – Near Kothari connecting point-T

| Sl.No | Parameters | Unit | 1 | 2 |
|---|---|---|---|---|
| 1. | pH | Number | 6.31 | 6.56 |
| 2. | Total Suspended Solids | mg/L | 270 | 316 |
| 3. | Total Dissolved Solids | mg/L | 30412 | 29736 |
| 4. | Chlorides | mg/L | 17154 | 16890 |
| 5. | Sulphates | mg/L | 13 | 70 |
| 6. | Oils & Grease | mg/L | 2.0 | 2.4 |
| 7. | BOD for 3 days at 27$^0$C | mg/L | 3 | 4 |
| 8. | Chemical Oxygen Demand | mg/L | ** | ** |
| 9. | Phosphate | mg/L | <0.15 | <0.15 |
| 10. | Cyanide | mg/L | <0.005 | <0.005 |
| 11. | Phenolic Compounds | mg/L | <0.005 | <0.005 |
| 12. | Fluoride | mg/L | <1 | <1 |
| 13. | TRC | mg/L | <1 | <1 |
| 14. | Calcium | mg/L | 14160 | 12360 |
| 15. | Total Chromium | mg/L | <0.003 | <0.003 |
| 16. | Hexavalent Chromium | mg/L | <0.01 | <0.01 |
| 17. | Copper | mg/L | 0.02 | 0.06 |
| 18. | Zinc | mg/L | 0.16 | 0.08 |
| 19. | Lead | mg/L | 1.4 | 1.5 |
| 20. | Cadmium | mg/L | <0.008 | <0.008 |

** Note: Parameters could not be ascertained due to interferences during analysis

Deputy CSO (L)
DEL, Manali

ANNEXURE-1

# Test Report

SAMPLE NOT DRAWN BY SGS INDIA PVT. LTD.

Print Date : 30/11/2016

Report No : CE16-006244.001

JOE No : CE16-006244

Report Control No : CER0000119770

Sample Described by Customer as : MPL TREATED EFFLUENT FOR TOXICITY STUDY

| | |
|---|---|
| Client Name | : MANALI PETROCHEMICALS LTD |
| Client Address | : PONNERI HIGH ROAD, |
| | : MANALI, |
| City | : CHENNAI |
| State | : TAMIL NADU |
| Country | : INDIA |
| Sample Type | : MPL TREATED EFFLUENT FOR TOXICITY STUDY |
| Received | : 21/11/2016 |
| Sample Qty. Recd. | : 5L |
| Test Start/End Date | : 21/11/2016 - 30/11/2016 |

| Analysis | Method | Result | Unit | Requirement/Limit As per CPCB (Inland Surface Waters) | |
|---|---|---|---|---|---|
| | | | | Min | Max |
| Colour | APHA 2120 B | 2 | Hazen | - | - |
| Odour | APHA 2150 B | Agreeable | - | - | - |
| Total suspended solids | APHA 2540 D | 42.6 | mg/L | - | 100 |
| pH at 25 °C | APHA 4500 B | 7.44 | - | 5.5 | 9.0 |
| Temperature | APHA 2550 B | 25.9 | °C | - | 5° |
| Oil & Grease | APHA 5520 B | BDL(DL:1) | mg/L | - | 10 |
| Total available residual chlorine as Cl2 | APHA 4500 B | BDL(DL:1) | mg/L | - | 1.0 |
| Kjeldahl nitrogen as N | APHA 4500 B | BDL(DL:1) | mg/L | - | 100 |
| Free ammonia as NH3 | APHA 4500 C | BDL(DL:0.5) | mg/L | - | 5.0 |
| COD as O2 | APHA 5220 B | 24.0 | mg/L | - | 250 |
| Arsenic as As | APHA 3126 B | 0.080 | mg/L | - | 0.2 |
| Mercury as Hg | APHA 3125 B | 0.015 | mg/L | - | 0.01 |
| Lead as Pb | APHA 3125 B | BDL(DL:0.005) | mg/L | - | 0.1 |
| Cadmium as Cd | APHA 3125 B | 0.001 | mg/L | - | 2.0 |
| Total chromium as Cr | APHA 3125 B | 0.011 | mg/L | - | 2.0 |
| Copper as Cu | APHA 3125 B | BDL(DL:0.005) | mg/L | - | 3.0 |
| Selenium as Se | APHA 3125 B | 0.008 | mg/L | - | 0.05 |
| Nickel as Ni | APHA 3125 B | BDL(DL:0.005) | mg/L | - | 3.0 |
| Manganese as Mn | APHA 3125 B | BDL(DL:0.005) | mg/L | - | 2.0 |
| Vanadium as V | APHA 3125 B | 0.02 | mg/L | - | 0.2 |



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# Test Report

Print Date : 30/11/2016

SAMPLE NOT DRAWN BY SGS INDIA PVT. LTD.

Report No : CE16-006244.001

JOE No : CE16-006244

Report Control No : CER0000119770

| Analysis | Method | Result | Unit | Requirement/Limit As per CPCB (Inland Surface Waters) | |
|---|---|---|---|---|---|
| | | | | Min | Max |
| Total iron as Fe | APHA 3120 B | BDL(DL:0.04) | mg/L | - | 3.0 |
| Zinc as Zn | APHA 3120 B | BDL(DL:0.04) | mg/L | - | 5.0 |
| Hexavalent chromium as Cr | APHA 3500 B | BDL(DL:0.02) | mg/L | - | 0.1 |
| Cyanide as CN | APHA 4500 F | BDL(DL:0.01) | mg/L | - | 0.2 |
| Fluoride as F | APHA 4500 C | BDL(DL:0.1) | mg/L | - | 2.0 |
| Dissolved phosphates as P | APHA 4500 D | BDL(DL:0.02) | mg/L | - | 5.0 |
| Sulphide as S | APHA 4500 F | BDL(DL:0.1) | mg/L | - | 2.0 |
| Phenolic compounds as C6H5OH | APHA 5530 C | BDL(DL:0.001) | mg/L | - | 1.0 |
| Nitrate nitrogen as NO3 | IS 3025 (Part 34) : 1988 | <2.0 | mg/L | - | 10 |
| Ammonical nitrogen as N | APHA 4500 C | BDL(DL:0.5) | mg/L | - | 50 |
| BOD at 27 °C for 3 days | IS 3025 (Part 44) : 1993 | 7.0 | mg/L | - | 30 |

Remark : BDL: Below detection limit, DL: Detection limit
*Shall not exceed above the receiving water temperature

Per pro SGS India Private Ltd

M_ELLAPPAN
Senior executive
Authorized Signatory

****End of Report****



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# INVOICE

PAN:AAACS 5514 Q STC:AAACS5514QST002
CIN: U74990MH1950PTC008117

Invoice No: CHN/2016/34D/005170
Invoice Date: 01-12-2016

Client Code: 1600M01462
Client Name: Manali Petrochemical Limited
Address: PONNERI HIGH ROAD,
MANALI,
CHENNAI
Postcode:
Country: INDIA
Pan No: AAACM3404D
Purchase Order No:

Sales Person : DIRECT

Contact Name: T.BALAGURU
Contact No: 09444047828
Email ID: balaguru@manalipetro.com

| Job No. | Particulars | Units | Unit rate | Amount in INR |
|---|---|---|---|---|
| CE16-006244 | EFFLUENT WATER | 1 | 12,000.00 | 12,000.00 |
| | | | Total Amount | 12,000.00 |
| | | | Service Tax @ 14.00% | 1,680.00 |
| | | | Swachh Bharat Cess @ 0.50% | 60.00 |
| | | | Krishi Kalyan Cess@ 0.50 % | 60.00 |
| | | | Total Service tax addition | 1,800.00 |
| | | | Total Amount Payable | **13,800.00** |

**In Words:** Rupees Thirteen Thousand Eight Hundred Only

Category:1.Technical Inspection & Certification, 2. Technical Testing & Analysis, 3. Commercial Training & Coaching Services, 4. Cleaning Services, 5. Storage & Warehouse Service

**Payment Options :**
- Wire transfer Domestic, please remit to:
  - Bank Name: CITIBANK N.A., Fort House, 4th Floor, Unit No.1, 224,Dr. D.N.Road, Fort, Mumbai-400001 -India;
  - Account # 0341283019;
  - IFSC / NEFT Code: CITI0100000;
- Cheque / Draft to be made in favour of SGS INDIA PRIVATE LIMITED

**Made a payment? Please send us at payment.india@sgs.com :**
- Payment advice containing SGS invoice details (and TDS details,if any)
- For short payment / retention for any invoice, kindly specify
- For advance payments, kindly specify the proforma invoice details / job number
- Please add this email ID to master record of SGS India Pvt. Ltd. in your accounting system

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For SGS India Private Ltd.

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ANNEXURE - 2 A8

MD Seen

MD

Report filed in the Court CPCB

BEFORE THE NATIONAL GREEN TRIBUNAL (SOUTHERN ZONE) CHENNAI

APPLICATION NO. 19 OF 2013

M.A. NO. 173 Of 2015

IN THE MATTER OF:

M/s Meenavargal Membattu Sangam .....APPLICANT

Vs

The Government of Tamilnadu and Ors. .....RESPONDENTS

**JOINT INSPECTION REPORT FILED ON BEHALF OF CENTRAL POLLUTION CONTROL BOARD (CPCB) WITH REGARD TO HON'BLE TRIBUNAL ORDER DATED MARCH 31, 2016**

I, S. Suresh, Son of S.R. Sathyanarayana, Hindu, aged about 54 years, having office at the Zonal Office, Central Pollution Control Board, 1st& 2nd Floors, Nisarga Bhavan, A- Block, Thimmaiah Main Road, 7th D Cross, Shivanagar, Bengaluru – 560 079 do hereby solemnly affirm and sincerely state as follows:-

2. That I am presently working as Scientist 'D' & In-charge, Zonal Office (South), Central Pollution Control Board (hereafter called as CPCB), Bengaluru and have been authorized to file the present report. I am fully conversant with the facts of the case and hence, competent and authorized to depose and swear the present report as under:

3. That the Hon'ble National Green Tribunal (Southern Zone), Chennai in Application No. 19 of 2013 & M.A. No. 173 of 2015 ordered on March 31, 2016 to conduct a joint inspection along with the Tamil Nadu State Pollution Control Board (TNPCB) as per the recommendation of the Expert Committee dated 19.09.2014 and file a status report, accordingly joint inspection was carried out during April 11-13, 2016 and the report is enclosed as Appendix 1.

S. Suresh 30/4/2016

DEPONENT

S. SURESH
ZONAL OFFICER
CENTRAL POLLUTION CONTROL BOARD
MIN. OF ENV. & FORESTS, GOVT. OF INDIA
SOUTH ZONAL OFFICE
NISARGA BHAVANA
BENGALURU – 560 010
MOB: 9480672128

**VERIFICATION**

It is verified that the content of this report which is based on official record and information available in the office are true and correct. Nothing has been concealed therein.

Signed and verified on this 30th day of April 2016 at Bengaluru

COUNSEL FOR CPCB

S. Suresh 30/4/2016

DEPONENT

S. SURESH
ZONAL OFFICER
CENTRAL POLLUTION CONTROL BOARD
MIN. OF ENV. & FORESTS, GOVT. OF INDIA
SOUTH ZONAL OFFICE
NISARGA BHAVANA
BENGALURU – 560 010
MOB: 9480672128

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# Joint Inspection Report on

## M/s Meenavargal Membattu Sangam

## Vs

## The Government of Tamilnadu and Others

## In

## Application no.19 of 2013

## M.A. No. 173 0f 2015

**Submitted to**

**Before the National Green Tribunal**
**South Zone, Chennai**

**Central Pollution Control Board**
**South Zonal Office, Bengaluru**
**May 02, 2016**

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**JOINT INSPECTION REPORT OF CENTRAL POLLUTION CONTROL BOARD (CPCB) IN THE MATTER OF APPLICATION NO. 19 OF 2013 (SZ) (THC) & M.A.NO. 173 OF 2015 (SZ), M/s MEENAVARGAL MEMBATTU SANGAM VS THE GOVERNMNET OF TAMILNADU AND OTHERS SUBMITTED BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL, SOUTHERN ZONE, CHENNAI AS PER ORDER DATED MARCH 31, 2016**

**1.0. Preamble**

In the matter of Application no. 19 of 2013 (SZ) (THC) & M.A. No. 173 of 2015 (SZ), M/s Meenavargal Membattu Sangam Vs The Government of Tamilnadu and others, the National Green Tribunal (NGT), South Zone has directed the Central Pollution Control Board (CPCB) vide its order dated March 31, 2016 to "Conduct a joint inspection along with the Tamil Nadu State Pollution Control Board (TNPCB) as per the recommendation of the Expert Committee dated 19.09.2014 and file a status report before this Tribunal by the next hearing i.e. May 02, 2016".

In compliance to above mentioned order, CPCB, South Zonal Office deputed officials and informed to Tamilnadu Pollution Control Board vide letter dated March 07, 2016 **(Annexure -1)** regarding schedule of inspection and also requested to co-ordinate with CPCB team during visit. A team comprising of following officials from CPCB, South Zonal Office, Bengaluru and Tamilnadu Pollution Control Board (TNPCB), District Environmental Engineer Office, Ambattur carried out joint inspection during **April 11-13, 2016** and the entire inspection work was supervised by Mrs. H. D. Varalaxmi, Sr. Env. Engineer, CPCB, Bengaluru.

| Central Pollution Control Board, Zonal Office, Bengaluru | Tamil Nadu Pollution Control Board, District Envrionmental Office, Ambattur |
|---|---|
| 1. Mrs. H.D. Varalaxmi, SEE/Sci. D | 1. Mr. D. Vasudevan, DEE |
| 2. Mr. A. Gnanavelu, Scientist B | 2. Mrs. S. Vasuki, AEE |
| | 3. Mr. G. Manivasagan, AE |

**Representatives from Industries**

1. Mr. Balaguru, Safety Officer, MPL
2. Mr. Shanmuganathan, Quality Assurance, MPL
3. Mr. A.R. Ashokkumar, Deputy General Manager, Kothari Petrochemicals
4. Mr. D. Senthilkumar, Director - Operation, TPL
5. Mr. T. Muthukumarasamy, AGM - Operation, TPL
6. Mr. A. Rajkumar, DM – Safety, TPL

**2.0. About marine disposal system**

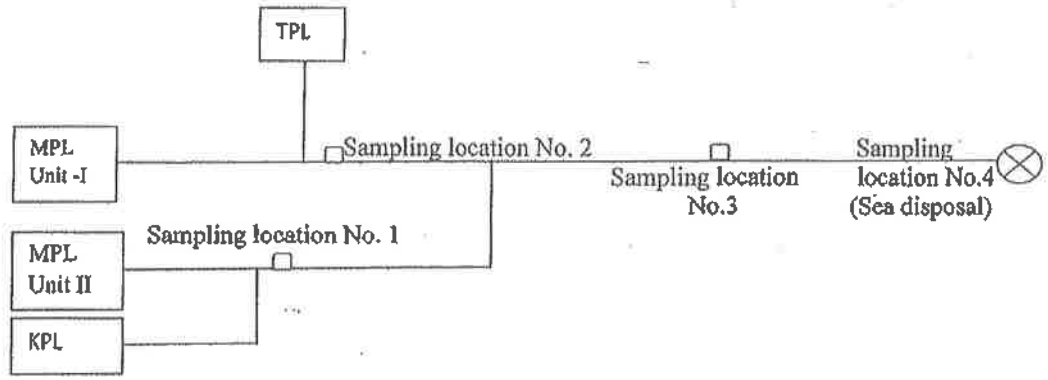
During visit, CPCB team obtained first-hand information about existing marine disposal system from Mr. D. Vasudevan, DEE, TNPCB, Ambattur and made preliminary survey of pipeline carrying effluent from different industries viz. M/s Manali Petro Chemicals Ltd., (MPL) Plant - I & II, M/s Tamilnadu Petro Products Ltd – Heavy Chemicals Division (TPL) and M/s Kothari Petrochemicals Ltd., (KPL) to marine out fall and common points where provisions

H.D. Vara

made to collect samples from this pipe line. It was informed that the existing pipeline was laid in the year 2011 and total length of pipeline is 10.6 km (2.2 + 4.0+ 3.7 + 0.7 = 10.6 km) with HDPE material (PE 100 Grade PN6). The details of pipe length and sampling locations are given below in table as well as in line diagram.

**Details of Pumping (Discharge) Line**

| Sl. No. | From | To | Size of pipe (outer dia) in mm | Length of pipe (Meters) |
|---|---|---|---|---|
| 1 | MPL – I | TPL | 280 | 800 |
| 2 | TPL | Sathyamurthy Nagar | 315 | 1400 |
| 3 | MPL -2 | Sathyamurthy Nagar | 280 | 4000 |
| 4 | Sathyamurthy Nagar | Seashore | 400 | 3700 |
| 5 | Seashore | Diffuser | 400 | 700 |




**Pipe Line Diagram showing the Sampling Locations**

As per the Hon'ble NGT order, the team collected samples from the discharge line carrying treated effluent into sea disposal at following points to ascertain the quality of effluent discharged into sea:

| Sampling location no. | Location Identification | Date and Time of collection | Remarks |
|---|---|---|---|
| 1 | Inside the MPL – II premises (after confluence of MPL plant –II & KPL plant effluent) | 12.04.16 at 15.20 PM | It was informed that no effluent was pumped from KPL, the effluent taken in the point represents the effluent of MPL plant -II only |
| 2 | In front of Tamilnadu Petro products Ltd., (after confluence of MPL plant –I effluent and TPL plant effluent) | 12.04.16 at 9.50 AM | It was informed that no effluent was pumped from TPL; the effluent taken in the point represents the effluent of MPL plant -I only. |
| 3 | Near to junction road of Manali Express highway and Ramakrishna Nagar 3rd main road before sea disposal | 12.04.16 at 14.00 PM | After confluence of all 4 units effluent, during sampling no effluent from MPL –I, KPL & TPL being pumped. The effluent taken in the point represents the effluent of both MPL – II only. |
| 4 | In the sea (where Marine disposal system exist) | 12.04.16 at 16.40 PM | Taken two samples, one from sea surface and other from the 5m depth. |

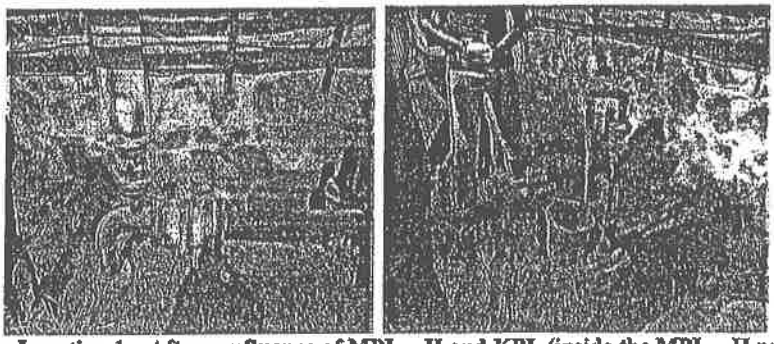
The samples from above mentioned points were collected in the presence of TNPCB officials and industry representatives. The samples were analysed in the CPCB, South Zonal Office Laboratory, Bengaluru & analysis results are tabulated below:

**Analysis Results of samples collected at the outlet**

| Sl. No. | Parameters | Marine disposal standards | Sampling Locations | | | | |
|---|---|---|---|---|---|---|---|
| | | | Sampling location 1 | Sampling location 2 | Sampling location 3 | Sampling location 4 | |
| | | | | | | At surface | At 5m depth |
| 1 | pH | 5.5 -9.0 | 6.7 | 6.8 | 6.3 | 7.8 | 7.9 |
| 2 | Conductivity (µs/cm) | - | 46920 | 52800 | 39800 | 57000 | 57100 |
| 3 | Total Suspended Solids (mg/L) | 100 | 104 | 88 | 68 | BDL | 3 |
| 4 | Total Dissolved Solids (mg/L) | - | 27218 | 34716 | 26060 | 37521 | 37664 |
| 5 | $BOD_3$ at 27°C 3days | 100 | 629 | 1310 | 656 | 1.3 | 2.5 |
| 6 | COD (mg/L) | 250 | 1102 | 1728 | 960 | 90 | 150 |
| 7 | Oil & Grease (mg/L) | 20 | BDL | BDL | BDL | BDL | BDL |
| 8 | Dissolved Oxygen (mg/L) | - | - | - | - | 7.4 | 6.6 |
| 9 | Alkalinity (mg/L) | - | 144 | 190 | 196 | 122 | 124 |
| 10 | Calcium (mg/L) | - | 8955 | 11626 | 8484 | 440 | 440 |
| 11 | Chloride (mg/L) | --- | 15850 | 21525 | 15655 | 19960 | 19568 |
| 12 | Sulphate (mg/L) | - | 224 | 327 | 209 | 29.5 | 28.3 |
| 13 | Fluoride (mg/L) | 15 | 1.22 | 1.04 | 0.38 | - | - |
| 14 | Hexavalent Chromium (mg/L) | 1.0 | 0.02 | 0.06 | 0.02 | BDL | BDL |
| 15 | Phenol (mg/L) | 5.0 | BDL | 0.01 | BDL | BDL | BDL |
| 16 | Sulphide (mg/L) | 5.0 | BDL | BDL | BDL | - | - |
| 17 | Cadmium (mg/L) | 2.0 | BDL | BDL | BDL | BDL | BDL |
| 18 | Total Chromium (mg/L) | 2.0 | BDL | 0.7 | BDL | BDL | BDL |
| 19 | Nickel (mg/L) | 5.0 | BDL | BDL | BDL | BDL | BDL |
| 20 | Lead (mg/L) | 1.0 | BDL | BDL | BDL | BDL | BDL |
| 21 | Zinc (mg/L) | 15 | BDL | 0.13 | BDL | BDL | BDL |

**Field observations and interpretation of analysis results:**

**Location 1:**



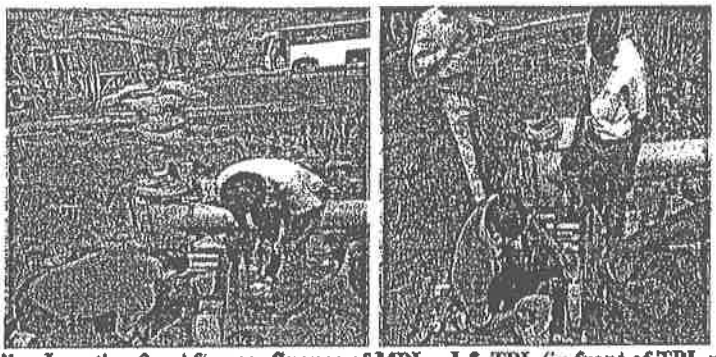
**Sampling Location 1 – After confluence of MPL – II and KPL (inside the MPL – II premises)**

- During inspection, it was observed that sampling location no. 1 existing inside the premises of M/s Manali Petrochemicals Plant- II is accessible without any interference to the team for collection of sample.
- It was informed, this location represents the effluents from both MPL – II and Kothari petrochemicals and both the plants pumps their effluent simultaneously. ***However, during***

***inspection /sampling, no effluent was pumped from Kothari petrochemicals; the effluent collected at this point represents the effluent from MPL –II only.***

- From the analysis results, it is observed that ***the concentration of BOD (629 mg/L) exceeding more than 6 folds and COD (1102 mg/L) exceeding 4.4 folds than marine disposal standards).*** Total Chromium and Zinc were found within the norms of marine disposal standards. No traces of heavy metals were found.

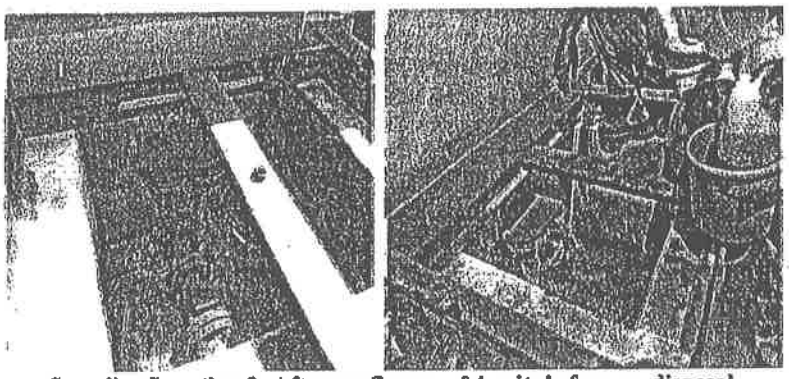
**Location 2:**



**Sampling Location 2 – After confluence of MPL – I & TPL (in front of TPL plant)**

- ✓ During inspection, it was observed that sampling location no. 2, located in front of M/s TPL plant found accessible without any interference for collection of samples.
- ✓ It was informed that, this location represents the combination of effluent from MPL – I and M/s TPL plant & both plants pumps their effluent simultaneously. However, during sampling no effluent was pumped from TPL, the effluent collected at this point represents the effluent from MPL –I only.
- ✓ The analysis results reveals that ***the concentration of BOD (1310 mg/L) exceeding more than 13 folds and COD (1728 mg/L) exceeding 6.9 folds than marine disposal standards.*** Total chromium and Zinc concentrations were found within the norms of marine disposal standards.

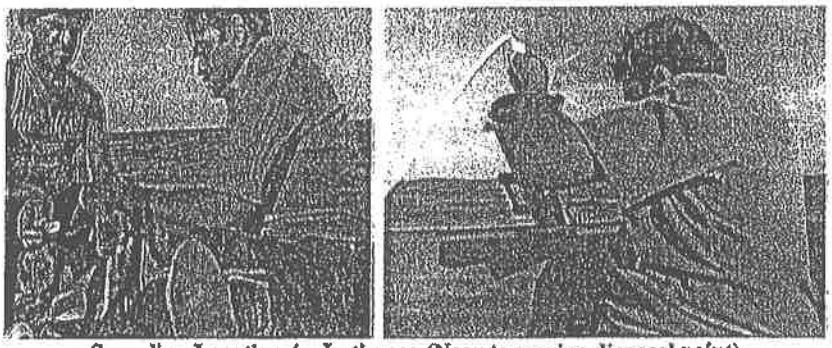
**Location 3:**



**Sampling Location 3: After confluence of 4 units before sea disposal (Junction of Manali Express highway and Ramakrishna Nagar 3rd main road)**

- During inspection, it was observed that sampling location no. 3 is located near to junction road of Manali Express Highway and Ramakrishna Nagar 3rd main road before sea disposal. MPL has provided valve before this tapping point; however this valve key was not made available in the field. After informing to MPL, representatives from MPL plant provided the key for opening of valve for collection of sample.
- It was informed that, this location represents the downstream point of confluence of effluents from MPL – I & II, TPL and KPL, in a situation where all four plants are pumping their effluent simultaneously. ***However, during sampling no effluent was pumped from TPL KPL and MPL – I; the effluent collected at this point represents the effluent from MPL – II only.***
- The analysis results reveals that ***the concentration of BOD (656 mg/L) exceeding more than 6 folds and COD (960 mg/L) exceeding 3.8 folds than marine disposal standards.*** No traces of heavy metals were found.

**Location 4:**



**Sampling Location 4 – In the sea (Near to marine disposal point)**

- During inspection, team also monitored the marine out fall, however no identification/ floaters were found to trace the exact point of out fall diffuser system. Industry representatives informed that floaters were provided to trace the diffuser and the same have been stolen. As per the information and location traced by the industry representatives, team took two samples in the periphery of out fall system; one is at surface of sea and other one from 5 m depth (it was informed that diffuser is installed at 10 m depth).
- During sample collection, **no difference in appearance or colour of water observed in the sea.**
- From the analysis results, **it is observed that Dissolved Oxygen (7.4 & 6.6 mg/L) at both points of sampling locations observed to be good.** No traces of heavy metals were found.

**3.0 Status of treatment system provided by industries discharging their effluent into sea through marine disposal system**

As per records of TNPCB four industries viz. (i) M/s Manali Petrochemicals Ltd. Plant – I, (ii) M/s Manali Petrochemical Ltd., Plant – II, (iii) M/s Kothari Petrochemicals Ltd and (iv) M/s Tamilnadu Petro Products Ltd., are discharging their treated effluent into sea through marine disposal system. The team visited all four units and obtained required information from the individual units, which are depicted below:

**3.1 M/s Manali Petrochemicals Ltd., Plant –I**

The industry is engaged in manufacturing of Propylene Oxide (1000 MT/month), Propyline Glycol (520 MT/month), Polyol (500MT/month) and Propylene Glycol Mono Methyl Ether (225 MT/month) and by product of DCP – Dichloro Propane (120 MT/month), Dipropylene Glycol (40 MT/month) and Di Prooylen Glycol MonoMethyle Ether (15 MT/month) by using raw materials viz. Propylene, Chlorine and Lime. During inspection the industry was in operation at full capacity and also poses consent to operate under Water Act 1974 and Air Act 1981 & the ***validity of the consents is up to March 31, 2017.***

The industry informed that , they are procuring water from three sources i.e. (i) M/s Madras Fertiliser Ltd. (MFL), (RO reject of 600- 900 $m^3$/day), (ii) Treated sewage from Kodungaiyur STP (500 - 900 $m^3$/day) and (iii) Fresh water from Chennai Metro Water Supply (CMWS) (800 -2300 $m^3$/day). The unit has flow meters to quantify the raw water received from CMWS and not provided flow meter to quantify the effluent generated from different sections and the same is estimated based on the pumping rate. As per the records the water consumption and effluent generated from different sections are as follows;

| Sl. No. | Details | Water consumption ($m^3$/day) | Effluent generation ($m^3$/day) |
|---|---|---|---|
| 1 | Manufacturing process | 2235 | 2235 |
| 2. | Cooling tower / Utility | 300 | 30 |
| 3. | Domestic use | 65 | 15 |

The industry is claiming that its effluent generation is 2265 $m^3$/day, which is within the consented quantity of 3400 $m^3$/day needs to be cross checked after installation of flow meters in the respective sections. The unit is having ETP comprising of High rate thickener, rotary drum filter, cooling tower, pH correction tank, six bio reactors and treated effluent tank, the ETP flow diagram is given below:

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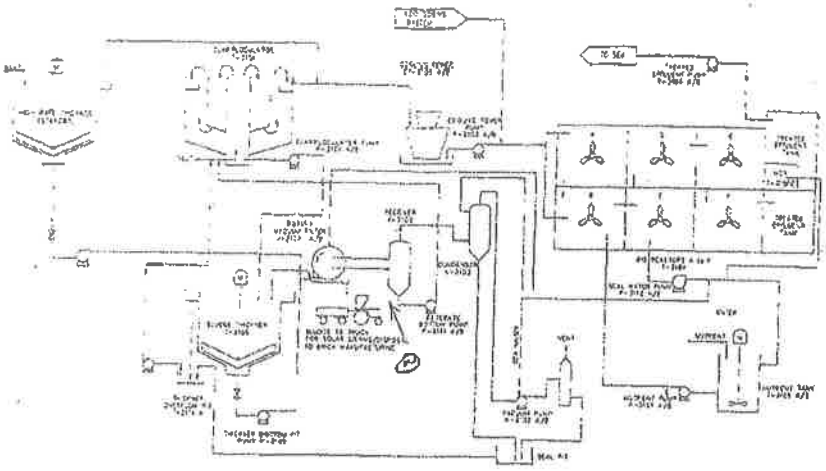


**ETP flow Diagram of MPL – I**

The effluent from the different sections are taken to high rate thickener to allow to settle the sludge, the settled lime sludge taken to rotary drum filter for dewatering, the over flow from high rate thickener taken to cooling tower to reduce temperature from 70 °C to ambient temperature, after reducing temperature the effluent taken to pH correction tank to reduce pH from 10.5 – 11 to 6.5-8.5. After pH correction the effluent is treated in the bio reactor by adding DAP as a nutrient, then the treated effluent is stored in the treated water tank and the same is pumped to marine outfall pipeline for discharging into sea.

To verify the adequacy of effluent treatment facility the team collected the samples from inlet and outlet of ETP & also collected raw water samples to verify the quality of water used since the industry is claiming that they are using major quantity of water is treated effluent from other sources (MFL and STP). The analysis results of raw water as well as untreated and treated effluent are depicted below:-

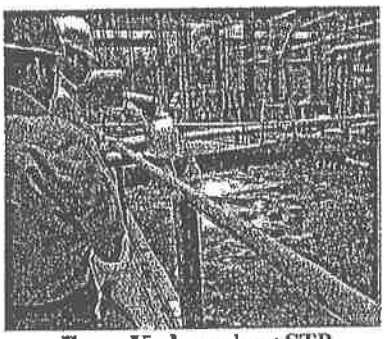
**Analysis Results of Samples collected at M/s Manali Petrochemicals Ltd., Plant –I**

| Sl. No. | Parameters | Raw water Quality used in process | | Effluent Quality | | Marine disposal standards |
|---|---|---|---|---|---|---|
| | | Treated sewage from STP (Kodungaiyur) | RO reject received from MFL plant | Inlet to ETP | Out let of ETP | |
| 1 | pH | 7.6 | 6.8 | 11.1 | 6.5 | 5.5 -9.0 |
| 2 | Conductivity (µs/cm) | 6800 | 6500 | 61000 | 61200 | - |
| 3 | Total Suspended Solids (mg/L) | BDL | 3 | 3 | 14 | 100 |
| 4 | Total Dissolved Solids (mg/L) | 3982 | 4192 | 48634 | 46310 | - |
| 5 | $BOD_3$ at 27°C 3days (mg/L) | 4.3 | 18 | 1463. | 1258 | 100 |
| 6 | COD (mg/L) | 67 | 192 | 1744 | 1536 | 250 |
| 7 | Oil & Grease (mg/L) | BDL | BDL | BDL | BDL | 20 |
| 8 | Alkalinity (mg/L) | - | - | 1292 | 72 | - |
| 9 | Calcium (mg/L) | - | - | 13669 | 13669 | - |
| 10 | Chloride (mg/L) | - | - | 24461 | 25048 | - |
| 11 | Sulphates (mg/L) | 512 | 444 | 484 | 341 | - |
| 12 | Fluoride (mg/L) | - | - | 1.54 | 1.74 | 15 |

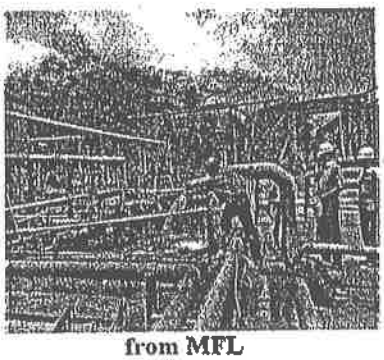
| Sl. No. | Parameters | Raw water Quality used in process | | Effluent Quality | | Marine disposal |
|---|---|---|---|---|---|---|
| | | Treated sewage from STP (Kodungaiyur) | RO reject received from MFL plant | Inlet to ETP | Out let of ETP | |
| 13 | Hexavalent Chromium (mg/L) | - | - | BDL | BDL | 1.0 |
| 14 | Phenol (mg/L) | - | - | BDL | 0.02 | 5.0 |
| 15 | Sulphide (mg/L) | - | - | BDL | BDL | 5.0 |
| 16 | Cadmium (mg/L) | - | - | BDL | BDL | 2.0 |
| 17 | Total Chromium (mg/L) | - | - | BDL | BDL | 2.0 |
| 18 | Nickle (mg/L) | - | - | BDL | BDL | 5.0 |
| 19 | Lead (mg/L) | - | - | BDL | BDL | 1.0 |
| 20 | Zinc (mg/L) | - | - | 6.08 | 1.61 | 15 |

### 3.1.1. Field observations and interpretation of analysis results

- During inspection it was observed that the industry is receiving raw water from Kodungaiyur STP as well as from RO reject from MFL and having TDS of 3982 & 4192 mg/L respectively.

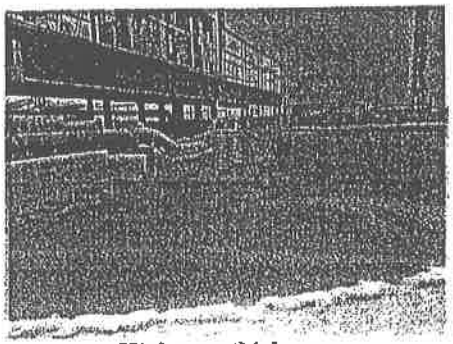


From Kodungaiyur STP



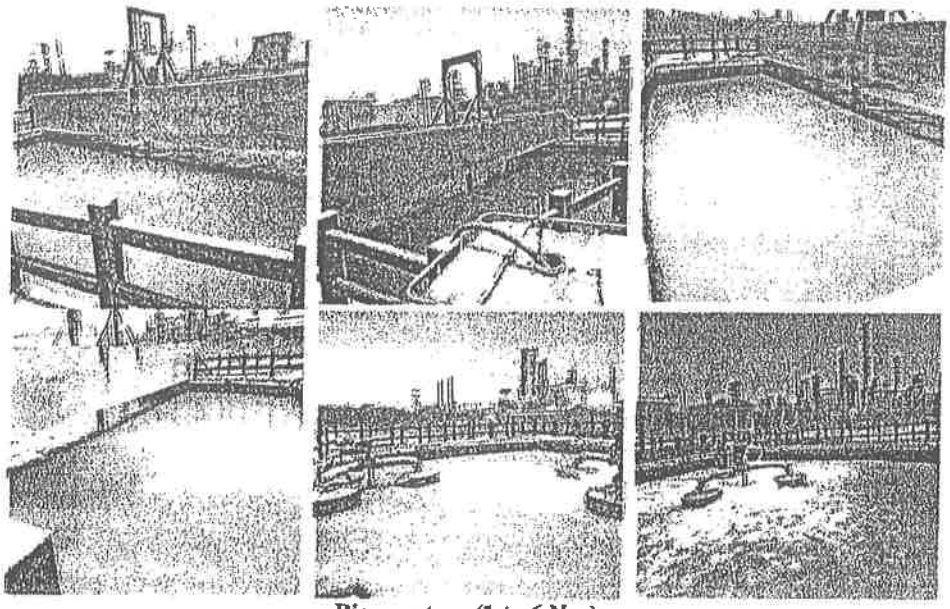
from MFL

- It was observed that the weirs of High rate thickener at the ETP found clogged due to accumulation of lime sludge.



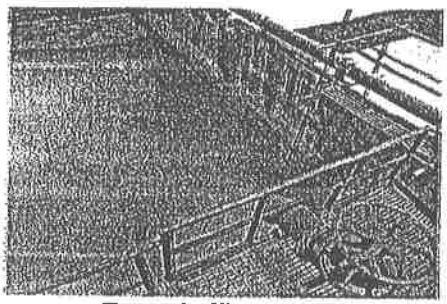
High rate thickener

- Out of six bio reactors, bio-mass found in only one bio reactor where DAP is added and other five bio reactors, no bio- mass was found which indicates the poor operation of bio reactors, the same is explained below. ***The analysis results reveals that the efficiency of ETP was found very less w.r.t BOD (14 %) and COD (11.9%) removal, which indicates the poor operation of bio reactors.***



**Bio reactors (1 to 6 Nos)**

- The treated effluent from bio reactor is stored in treated effluent tank, after attaining required water level in the tank; the treated effluent is pumped to marine disposal system for discharging the same into sea. During inspection very lean flow was observed at out let of bio reactors. The treated effluent tank is shown below. ***No water level indicator is provided in the treated effluent storage tank to assess the quantity of treated effluent stored and pumped to marine disposal system.***



**Treated effluent tank**

- Online measurement system for flow and pH are installed in the pumping main lines. It was informed that treated effluent pumping is not continuous, whenever it attains required level in the tank, pump will be operated. During inspection no pumping of treated effluent was in operation hence the efficiency and functioning of online monitoring system could not be verified.

H.D.

G. Ramesh

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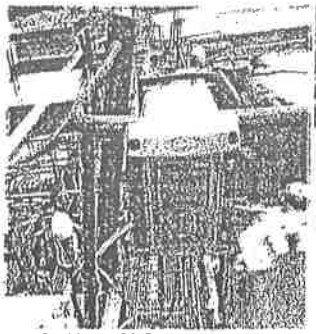
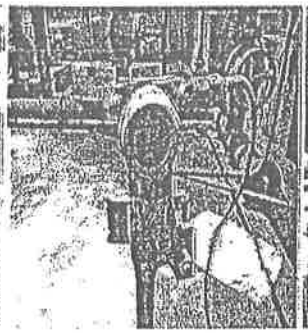
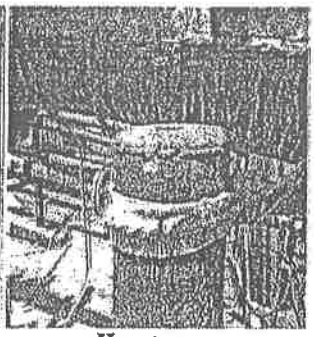


Online TSS meter



Flow meter



pH meter

- ***It is also observed that the effluent having BOD of 1258 mg/L, COD of 1744 mg/L was being discharged into marine disposal by violating the prescribed standards of TNPCB (BOD of 100 mg/L and COD of 250 mg/L).***
- It was informed that the dewatered sludge is sent to brick manufacturing unit.
- ***The overall housekeeping in the ETP was poor.***

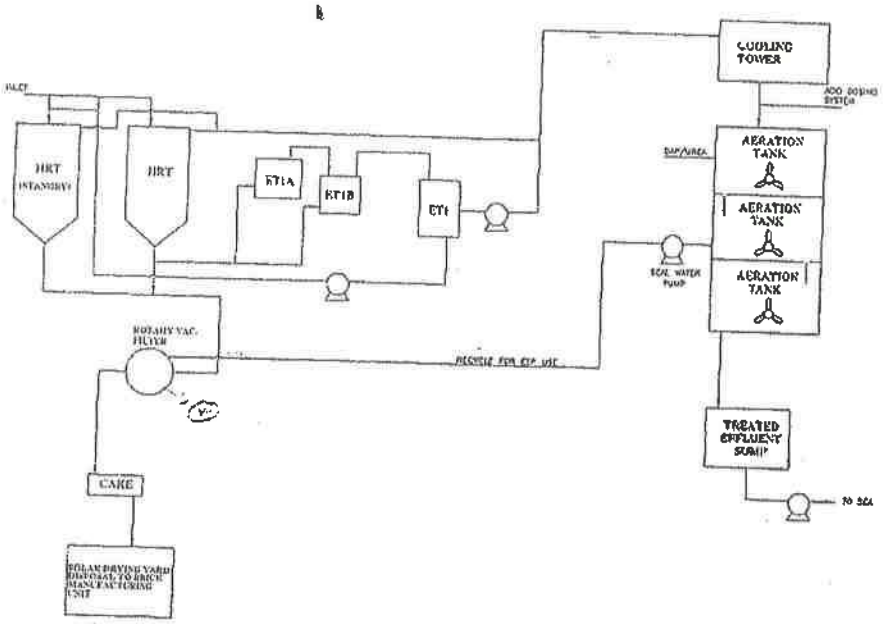
### 3.2 M/s Manali Petrochemicals Ltd., Plant –II

The industry is engaged in manufacturing of Propylene Oxide (1000 MT/month), Propyline Glycol (650 MT/month) and Polyol (1000MT/month) and by product of DCP – Dichloro Propane (175 MT/month), Dipropylene Glycol (80 MT/month) and Tri Propylene Glycol (10 MT/month) by using raw materials viz. Propylene, Chlorine and Lime. During inspection the industry was in operation at full capacity and also having consent to operate under Water Act 1974 and Air Act 1981, ***the validity of the consents is up to March 31, 2017.***

The industry is procuring water from three sources viz. (i) Chennai Petrochemical Ltd., (RO reject of 200- 500 $m^3$/day), (ii) Treated effluent from Kodungaiyur STP (460 - 1340 $m^3$/day) and (iii) Fresh water from Chennai Metro water supply (1050 -1680 $m^3$/day). The industry is having flow meters to quantify the raw water received from CMWS and has **not provided any flow meter to quantify the effluent generated from different sections;** it is quantified based on the pumping record. As per the records the water consumption and effluent generation from different sections are as follows. The industry is claiming that their effluent generation is 2045 $m^3$/day which is within the consented quantity of 4500 $m^3$/day; however it needs to be crossing verified after installation of flow meters in the respective section.

| Sl. No. | Details | Water consumption ($m^3$/day) | Effluent generation ($m^3$/day) |
|---|---|---|---|
| 1 | Manufacturing process | 2000 | 2000 |
| 2. | Cooling tower / Utility | 300 | 30 |
| 3. | Domestic use | 65 | 15 |

The industry is having ETP, comprising of High rate thickener, rotary drum filter, cooling tower, pH correction tank, three bio reactors and treated effluent tank; the ETP flow diagram is given below:




**ETP flow Diagram of MPL – II**

The effluent from different sections are taken to high rate thickener to allow to settle the sludge, the settled lime sludge is taken to rotary drum filter for dewatering, the over flow from high rate thickener is taken to cooling tower to reduce temperature from 70 °C to ambient temperature, after reducing temperature the effluent is taken to pH correction tank to reduce pH from 10.5 – 11 to 6.5-8.5. After pH correction the effluent is treated in bio reactor by adding DAP as nutrient, the treated effluent is stored in the treated water tank and the same is pumped to marine pipeline for discharging into sea.

To verify the adequacy of effluent treatment facility, the team collected the samples from inlet and outlet of ETP & also collected the raw water samples to verify the quality of water used; since the industry is claiming that the major quantity of water used is treated effluent from other sources (MFL and STP). The analysis results of raw water as well as untreated and treated effluent are depicted below:

**Analysis Results of Samples collected at M/s Manali Petrochemicals Ltd., Plant –II**

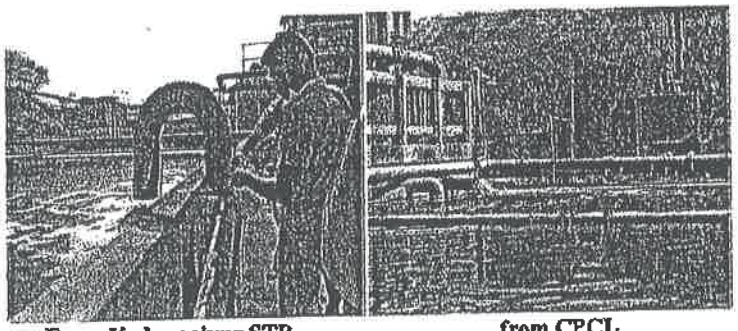
| Sl. No. | Parameters | Raw water Quality used in process | | Effluent Quality | | Marine disposal standards |
|---|---|---|---|---|---|---|
| | | Treated sewage from STP (Kodungaiyur) | RO reject received from CPCL plant | Inlet to ETP | Out let of ETP | |
| 1 | pH | 8 | 7.2 | 8.2 | 7.7 | 5.5 -9.0 |
| 2 | Conductivity (µs/cm) | 1826 | 8440 | 72880 | 60750 | - |
| 3 | Total Suspended Solids (mg/L) | 3 | 12 | BDL | 113 | 100 |
| 4 | Total Dissolved Solids (mg/L) | 996 | 5390 | 43730 | 41920 | - |
| 5 | $BOD_3$ at 27°C 3days (mg/L) | 21 | 22 | * | 1068 | 100 |
| 6 | COD (mg/L) | 20 | 192 | 2960 | 1344 | 250 |
| 7 | Oil & Grease (mg/L) | BDL | BDL | BDL | BDL | 20 |

| Sl. No. | Parameters | Raw water Quality used in process | | Effluent Quality | | Marine disposal standards |
|---|---|---|---|---|---|---|
| | | Treated sewage from STP (Kodungaiyur) | RO reject received from CPCL plant | Inlet to ETP | Out let of ETP | |
| 8 | Alkalinity (mg/L) | - | | 60 | 62 | - |
| 9 | Calcium (mg/L) | | | 12883 | 12726 | - |
| 10 | Chloride (mg/L) | - | - | 23322 | 23482 | - |
| 11 | Sulphates (mg/L) | - | - | 468 | 335 | - |
| 12 | Fluoride (mg/L) | - | - | 1.49 | 1.44 | 15 |
| 13 | Hexavalent Chromium (mg/L) | - | - | BDL | 0.02 | 1.0 |
| 14 | Phenol (mg/L) | - | - | BDL | 0.01 | 5.0 |
| 15 | Sulphide (mg/L) | - | - | BDL | BDL | 5.0 |
| 16 | Cadmium (mg/L) | - | - | BDL | BDL | 2.0 |
| 17 | Total Chromium (mg/L) | - | - | BDL | BDL | 2.0 |
| 18 | Nickle (mg/L) | - | - | BDL | BDL | 5.0 |
| 19 | Lead (mg/L) | - | - | BDL | BDL | 1.0 |
| 20 | Zinc (mg/L) | - | - | 3.31 | 0.115 | 15 |

**Note: * Parameter could not be analysed due to interference during analysis**

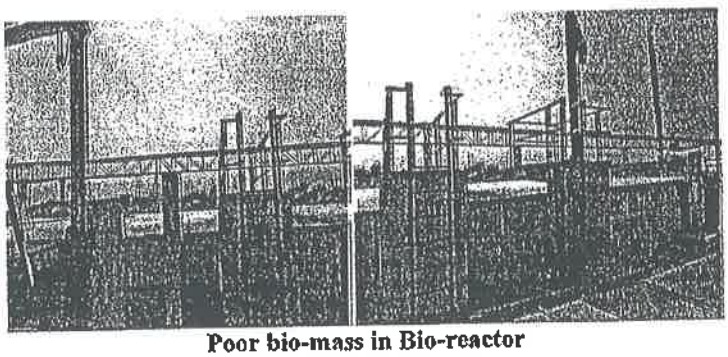
### 3.2.1 Field Observations of Team and interpretation of analysis results:

- During inspection it was s observed that industry is receiving raw water from Kodungaiyur STP as well as from RO reject from CPCL having TDS of 996 & 5390 mg/L respectively.



**From Kodungaiyur STP** **from CPCL**

- Very poor bio mass is observed in the bio reactor which indicates the poor operation of bio reactor. ***The analysis results reveals that the efficiency of ETP was found less w.r.t COD removal (54.5%) which indicates the poor operation of bio reactors.***



**Poor bio-mass in Bio-reactor**

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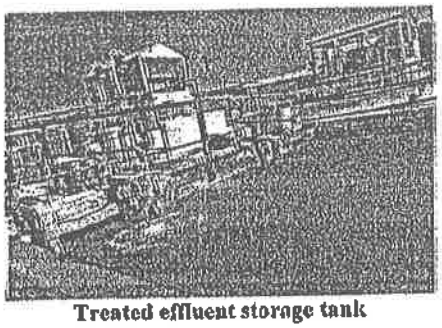
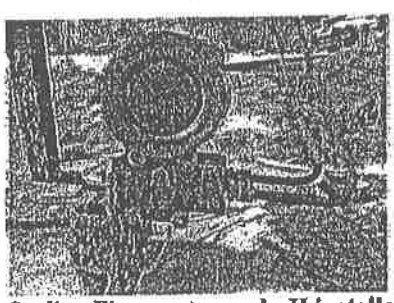
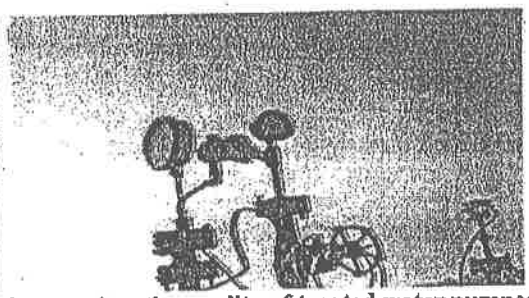
- No water level indicator is provided in the treated effluent storage tank to assess the quantity of treated effluent stored and pumped to marine disposal system.



**Treated effluent storage tank**

- Online measurement system for flow and pH are installed in the pumping main and it was informed that pumping of treated effluent is continuous. Online flow meter display was not visible to verify the same.





**On line Flow meter and pH installed to monitor the quality of treated water pumped to marine disposal system**

- ***From the analysis results, it is observed that the effluent having BOD of 1068 mg/L and COD of 1344 mg/L is discharged into marine disposal by violating the prescribed standards of TNPCB (BOD of 100 mg/L and COD of 250 mg/L).***

- Hexavalent chromium and Zinc concentrations are found within the norms of marine disposal standards.

- It is informed that the dewatered sludge is sent to brick manufacturing unit.

- ***The overall housekeeping in the ETP is poor.***

### 3.3 M/s Kothari Petrochemicals Ltd

The industry is engaged in manufacturing of Polybutane (2000 MT/month), Light Polymer (240 MT/month) and by product of dilute caustic (120 MT/month) and Intermediate product of Intermediate polymer (10 MT/month). During inspection the industry was in operation at 80% of consented capacity i.e. at 1700 – 1800 MT/month and also having consent to operate under Water Act 1974 and Air Act 1981, the ***validity of the consents is expired on March 31, 2016***. It was informed that they have applied for renewal of consent.

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D. Lada

The industry informed that they are procuring water from Chennai Metro water supply (400 $m^3$/day) and partly meeting with its own RO permeate of 120 $m^3$/day. As per records the water consumption and effluent generation from different section are as follows. The industry is claiming that its effluent generation is 180 $m^3$/day out of which 150 $m^3$/day is recovered as RO permeate and the same is utilised as process water and remaining quantity of 30 $m^3$/day is discharged into sea. The domestic sewage is treated in its STP.

| Sl. No. | Details | Water consumption ($m^3$/day) | Effluent generation ($m^3$/day) |
|---|---|---|---|
| 1 | Manufacturing process | 110 | 110 |
| 2. | Boiler &Cooling tower/Utility | 450 | 70 |
| 3. | Domestic use | 32 | 22 |

The industry is having ETP, comprising of collection tank, clarifloculator, clear water tank, dual filter media, and Ultra filtration and RO system. The effluent from the different section is collected in collection tank, the effluent from collection tank is taken to chemical dosage tank and allowed for precipitation in clarifloculator, the clarified effluent is treated through dual filter media followed by ultra filtration to reduce suspended solids before feeding to RO system. After treating through RO, 150 $m^3$/day is recovered as RO permeate and the same is utilised as process water and remaining quantity of 30 $m^3$/day as RO reject is discharged into sea. To verify the adequacy of effluent treatment facility the team collected the samples from inlet and outlet of ETP. The analysis results of untreated and treated effluent are depicted below:

**Analysis Results of Samples collected at M/s Kothari Petrochemicals Ltd**

| Sl. No. | Parameters in mg/l | Inlet of ETP | Out let of ETP | Marine disposal standards |
|---|---|---|---|---|
| 1 | pH | 9.7 | 8.5 | 5.5 -9.0 |
| 2 | Conductivity (µs/cm) | 2460 | 917 | - |
| 3 | Total Suspended Solids (mg/L) | 2252 | BDL | 100 |
| 4 | Total Dissolved Solids (mg/l) | 1276 | 584 | - |
| 5 | $BOD_3$ at 27°C 3days | 43 | * | 100 |
| 6 | COD (mg/L) | 192 | BDL | 250 |
| 7 | Oil & Grease (mg/L) | BDL | BDL | 20 |
| 8 | Alkalinity (mg/L) | 234 | 58 | - |
| 9 | Calcium (mg/L) | 35 | 102 | - |
| 10 | Chloride (mg/L) | 646 | 157 | - |
| 11 | Sulphates (mg/L) | 169 | 219 | - |
| 12 | Fluoride (mg/L) | 0.78 | 0.73 | 15 |
| 13 | Hexavalent Chromium (mg/L) | 0.1 | 0.08 | 1.0 |
| 14 | Phenol (mg/L) | 0.007 | BDL | 5.0 |
| 15 | Sulphide (mg/L) | 0.27 | BDL | 5.0 |
| 16 | Cadmium (mg/L) | - | - | 2.0 |
| 17 | Total Chromium (mg/L) | - | - | 2.0 |
| 18 | Nickle (mg/L) | - | - | 5.0 |
| 19 | Lead (mg/L) | - | - | 1.0 |
| 20 | Zinc (mg/L) | - | - | 15 |

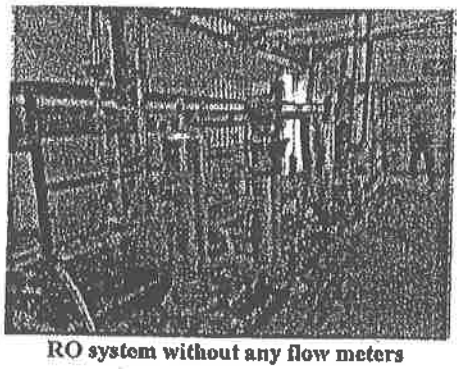
**Note: * BOD not carried out; hence the COD is BDL (less than 20 mg/L)**

### 3.3.1 Field Observations of Team and interpretation of analysis results:

- The maintenance of raw effluent collection tank was observed to be very poor; ***TSS (2252 mg/L)***

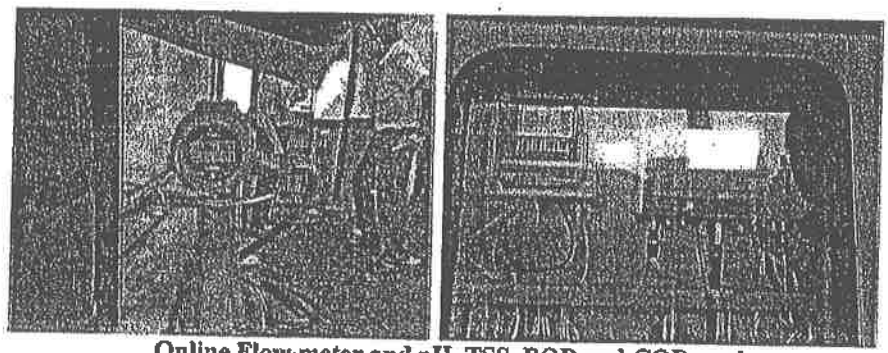
**Raw effluent collection tank**

- ***No flow meters are installed in RO system to quantify the effluent feed to RO, permeate recovered and RO reject generated.***



**RO system without any flow meters**

- The industry has installed online flow meter, pH meter and TSS, BOD COD Analyser, and the same is connected to TNPCB / CPCB servers for real time monitoring. The industry was asked to produce on line data but same was not made available to team.



**Online Flow meter and pH, TSS, BOD and COD analyser**

- It was informed that the RO reject is stored and pumped to marine disposal system when ever required level attains.
- ***The analysis results reveal that the treated effluent (RO reject) pumped to marine disposal system meeting with TNPCB norms w.r.t BOD and COD.***

N.D.

### 3.4 M/s Tamilnadu Petro Products Ltd.

The industry is engaged in manufacturing of Caustic Soda (6875 MT/month), Liquid Chlorinet (4166 MT/month), Hydrochloric Acid (4125 MT/month) and Ammonium Chloride (1788 MT/month) by using Sodium chloride and Ammonia as raw material. During inspection the industry was in operation at 50% of consented capacity and having consent to operate under Water Act 1974 and Air Act 1981. ***The validity of the consents had expired on 31.12.2013.*** It is informed that ***consent fee is paid to TNPCB every year.***

The industry informed that they are procuring water from Chennai Metro water supply (700 -800 $m^3$/day). As per records the water consumption and effluent generation from different sections are as follows; and the unit is claiming that its effluent generation is 170 $m^3$/day against the consented quantity of 310 $m^3$/day.

| Sl. No. | Details | Water consumption ($m^3$/day) | Effluent generation ($m^3$/day) |
|---|---|---|---|
| 1 | Manufacturing process | 630 | 170 (anion and cation regeneration section and Cooling tower & boiler Blow down) |
| 2. | Boiler &Cooling tower/Utility | 160 | |
| 3. | Domestic use | 10 | 7 |

The industry is having ETP comprising of collection tank, neutralisation tank and treated effluent collection tank. The effluent from the different section is collected in collection tank, the effluent is neutralised by mixing acidic and alkaline effluent from different section and neutralised effluent is stored in the treated effluent sump (exist in ECH plant) and the same is discharged into sea through marine disposal system.

To verify the adequacy of effluent treatment facility the team collected the samples from inlet and outlet of ETP. The analysis results of untreated and treated effluent are depicted below;

**Analysis Results of Samples collected at M/s Tamilnadu Petro Products Ltd**

| Sl. No | Parameters in mg/l | Inlet of ETP | Out let of ETP | Marine disposal standards |
|---|---|---|---|---|
| 1 | pH | 10.1 | 9.5 | 5.5 -9.0 |
| 2 | Conductivity (µs/cm) | 64850 | 14600 | - |
| 3 | Total Suspended Solids (mg/L) | 12 | 04 | 100 |
| 4 | Total Dissolved Solids (mg/l) | 38252 | 9730 | - |
| 5 | $BOD_3$ at 27°C 3days | * | 131 | 100 |
| 6 | COD (mg/L) | BDL | 1152 | 250 |
| 7 | Oil & Grease (mg/L) | BDL | BDL | 20 |
| 8 | Alkalinity (mg/L) | 282 | 58 | - |
| 9 | Calcium (mg/L) | 39 | 39 | - |
| 10 | Chloride (mg/L) | 21917 | 5518 | - |
| 11 | Sulphates (mg/L) | 2952 | 436 | - |
| 12 | Fluoride (mg/L) | BDL | 1.5 | 15 |
| 13 | Hexavalent Chromium (mg/L) | 0.04 | 0.1 | 1.0 |
| 14 | Phenol (mg/L) | BDL | BDL | 5.0 |
| 15 | Sulphide (mg/L) | BDL | BDL | 5.0 |
| 16 | Cadmium (mg/L) | BDL | BDL | 2.0 |

| Sl. No | Parameters in mg/l | Inlet of ETP | Out let of ETP | Marine disposal standards |
|---|---|---|---|---|
| 17 | Total Chromium (mg/L) | BDL | BDL | 2.0 |
| 18 | Nickle (mg/L) | BDL | BDL | 5.0 |
| 19 | Lead (mg/L) | BDL | BDL | 1.0 |
| 20 | Zinc (mg/L) | 2.0 | BDL | 15 |

Note: * BOD not carried out; hence the COD is BDL (less than 20 mg/L)

**3.4.1 Field observations of team and interpretation of analysis results:**

- The industry has not provided separate neutralisation tank; The acidic and alkaline effluent from cation & anion regeneration plant and boiler & Cooling tower blown down are mixed in the collection tank itself, after achieving pH of 6.5-8.5, the effluent is pumped to treated effluent collection tank existing in its sister concerned industry in other premises (M/s TPL, ECH plant).

**Collection cum neutralisation tank**

**Treated effluent storage tank (ECH plant)**

- It was informed that they are discharging effluent twice in a week through marine disposal system since effluent quantity (170 $m^3$/day) is less.

- ***The analysis results reveals that the COD in the inlet is less than 20 mg/l but in out let COD& BOD found high this may be due to non homogeneuosity in the inlet storage tank. However, from the analysis results, effluent having BOD of 131mg/L and COD of 1152 mg/L was discharged into marine disposal by violating the prescribed standards of TNPCB (BOD of 100 mg/L and COD of 250 mg/L).***

- The industry has installed on line flow meter, pH meter & TSS and the same is connected to TNPCB monitoring Centre.

**4.0 Overall Findings of Joint Monitoring Team:**

(a) As per the observations of joint monitoring team, ***maintenance and operation of ETPs in MPL – I & II plants are not satisfactory. Since effluent has High TDS, the existing biological treatment system is not adequate to meet the prescribed standards of marine disposal.***

(b) The analysis results of ETP outlet samples taken from MPL – I & II as well as TPL have shown the high concentration w.r.t BOD (1258, 1068 & 131 mg/L) and COD (1536,

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1344 & 1152 mg/L) **confirms the inadequate treatment system.** As per Expert committee recommendation the industries required to improve treatment facility to achieve the marine discharge standards. The above mentioned analysis results also confirms the same.

(c) None of the industries have planned any fixed schedule of pumping of treated effluent into marine disposal system. On the day of sampling at downstream of confluence point of all four industries (Location 3), there was no discharge from M/s MPL- I, M/s TPL and M/s KPL. This is due to intermittent discharge from each industry.

(d) None of the industries have installed water level indicators in raw effluent collection tank or in treated effluent storage tanks. Also there is no proper record / log book for accountability of effluent generated, treated and quantity of treated effluent disposed.

(e) As per records of industries and based on the analysis results of samples collected , the BOD and COD load discharged into sea are as below;

| Parameters | MPL – I | MPL – II | KPL- I | TPL |
|---|---|---|---|---|
| Quantity of effluent discharged into sea ($m^3$/day) | 2280 | 2045 | 30 | 170 |
| Concentration of BOD in treated effluent ( mg/L) | 1258 | 1068 | BDL | 131 |
| BOD load in kg/day | *2868.24* | *2184.06* | --- | *22.27* |
| Concentration of COD (mg/L) | 1536 | 1344 | BDL | 1152 |
| COD load ( kg/day) | *3502.08* | *2748.48* | ---- | *195.84* |

From the above table it clearly indicates that MPL – I is discharging effluent around 2280 $m^3$/day with BOD load of 2868.24 kg/day & COD load of 3502.02 kg/day. Subsequently MPL –II is discharging effluent around 2045 $m^3$/day with BOD load of 2184.24 kg/day & COD load of 2748.48 kg/day. **From this, it is confirmed that major pollution contribution is from MPL – I & II.**

(f) M/s MPL – I & II have installed online pH, Temperature, and flow meters in the pipeline in which the treated effluent is pumped into marine disposal system and the same is connected to TNPCB monitoring center. The installation of online monitoring system for parameters TSS, BOD & COD is under process.

(g) M/s KPL has installed online monitoring system for pH, TSS, BOD, COD and flow meters in the pipeline in which the treated effluent is pumped into marine disposal system and the same is connected to TNPCB as well as CPCB monitoring center.

(h)M/s TPL has installed online monitoring system for pH & TSS and flow meters in the pipeline in which the treated effluent is pumped into marine disposal system and the same is connected to TNPCB monitoring center.

(i) As per the analysis results of samples of all four industries, hexavalent chromium and zinc found within the prescribed limits and other heavy metals found below detectable limits.

(j) The industries informed that the marine disposal pipeline is inspected manually to verify the leaks if any. The marine pipeline route is marked by putting mile stones in the interval of 400 – 500 mts and these stones are painted with yellow and green colour.

(k) No flow meters are installed in the marine disposal pipe line carrying the treated effluent from four industries to assess the quantity of effluent pumped and quantity of effluent discharged. Since total length of pipe line is 10.6 km and passing below ground level, in case of any leakages in pipe lines, the flow meter give immediate indication and accordingly remedial action can be taken up.

(l) The BOD & COD concentrations observed at different points of marine disposal system are as below;

| Name of location / Parameter | Location No. 1 (after confluence of MPL –II and KPL only) | Location No. 2 (after confluence of MPL – I and TPL only) | Location no. 3 (after confluence of all 4 units, before sea disposal) |
|---|---|---|---|
| BOD in mg/ L | 629 | 1310 | 656 |
| COD in mg/L | 1102 | 1728 | 960 |

The results confirm that the effluent discharged is not meeting the marine disposal standards. During sampling at location no. 1, no effluent was pumped from KPL, the sample taken in this location at that particular time was representing the MPL- II effluent, however as per analysis results, the BOD (629 mg/l) & COD (1102 mg/l) concentrations at this point was found much lesser than the MPL-II outlet (BOD – 1068 mg/l & COD – 1344 mg/l) concentrations, this indicates the dilution of effluent which requires further detailed investigations.

At the time of sample collection at Location no 2, no effluent was pumped from TPL, the sample taken in this location represent the MPL – I effluent, as per the analysis results BOD (1258 mg/L) & COD (1536 mg/l) concentration at MPL -I outlet and location no 2 (BOD- 1310 mg/l & COD 1728 mg/l) was found around 5-12 % higher than the MPL –I outlet.

It is observed that during sampling at Location no.3, no effluent was pumped from MPL – I, TPL and KPL, the sample taken from this location represent the MPL – II effluent, as per the analysis result BOD (656 mg/L) & COD (960 mg/l) concentration at Location no. 3 found much lesser than the MPL- II outlet (BOD – 1068 mg/l & COD – 1344 mg/l) concentrations, this also confirms the dilution of effluents which requires the further detailed investigations to find out exact cause.

(m) As per the analysis results of samples taken from three points of marine disposal, cobalt and zinc found within the prescribed limit and other heavy metals found below detectable limit.

(n) As per the expert committee recommendations, industries are required to make necessary arrangement for sample collection and same may be covered and locked. One set of key to be kept with industry for maintenance and another set be available with TNPCB for sample collection. ***During inspection, team observed that all three common points were accessible without any lock and key arrangements and also the*** sampling location no. 3, situated near to junction road of Manali Express Highway and Ramakrishna Nagar 3rd main road before sea disposal is provided with valve arrangement before tapping point, however this valve key was not made available in the field. After informing to MPL, representatives from MPL provided the key for opening of valve for collecting the sample ***indicates the noncompliance of expert committee recommendation***.

(o) The joint inspection team found very difficult to trace the exact points of diffusers in the sea due to non-availability of any identification or floaters to trace the same. The team travelled around 750 – 850 meters distance from sea shore to inside the sea but found no clear land marks. As per the information and location traced by the industry representatives, the team collected the samples.

(p) During samples collection, no difference in appearance or colour of water found in the sea, the dissolved oxygen found is good (7.4 & 6.6 mg/L).

**5.0 Views of Joint monitoring committee w.r.t specific observations made during visit:**

i. All industries are required to install flow meters to maintain proper records of water consumption, effluent generation from different section of process along with material balance and water balance and the records needs to be furnished to TNPCB/CPCB during inspection.

ii. Existing ETPs of MPL – I & II and TPL found inadequate, hence it is suggested to take up treatability study to identify the suitable treatment technology to meet the prescribed standards of marine disposal system.

iii. All four industries have to prepare planned schedule of pumping of treated effluent into marine disposal system and to ensure the quality of effluent meeting standards before discharging into sea.

iv. All four industries have to install water level indicators in raw effluent collection tank as well as in treated effluent storage tanks, to assess the quantity of effluent received treated, recycled and discharged into marine disposal system. They have to maintain proper

records / logbook for effluent generated, treated and quantity of treated effluent discharged in to marine disposal system on daily basis.

v. All industries have to install at least three intermediate flow meters in the marine disposal pipeline where provisions are made to collect samples to assess the quantity of effluent pumped and discharged. This will also help in finding of any leaks in the pipeline. These flow meters shall connect to TNPCB/CPCB monitoring center.

vi. All sampling points are found accessible to public and this issue needs to be looked into; these sampling locations have to be provided with lock and key arrangements and one set of key as well as valve operating devices shall be given to TNPCB to access at any point of time.

vii. M/s MPL I & II have to install online BOD, COD analyzer in the marine disposal pipeline and to be connected to TNPCB/ CPCB monitoring center.

viii. The industry shall provide advanced leak detection system along with manual verification for quick identification of leak in the marine disposal pipeline for immediate repair of the same to prevent the soil and ground water contamination in the surrounding area.

ix. A detailed marine study shall be taken up considering the actual quality and quantity of effluent discharged into sea to assess the dilution factor to verify the impact on marine species by an expert agency.

x. The floaters have to be installed to identify the actual point of location of diffusers inside the sea. Without any proper identification it is very difficult to locate exact point of diffuser for collection of samples from disposal points otherwise the samples collected may not be true representative of actual pollution load.

xi. All industries are required to conduct toxicity studies for their effluents and also for combined discharge of effluents. The results shall be submitted to TNPCB including species used for the study to assess the actual situation.

H. D. Varalaxmi

(H.D. Varalaxmi, SEE/Sci. D)
Central Pollution Control Board
South Zonal Office, Bengaluru

D. Vasu

(D. Vasudevan, DEE)
Tamilnadu Pollution Control Board
Ambattur, Chennai

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**Annexure 1**

F.No.Tech-/39/Legal(NGT)/TN/ZO(S)/2016-17/ 75-77 April 7, 2016

To

The Member Secretary
Tamil Nadu Pollution Control Board
No. 76, Mount Salai, Guindy
Chennai - 600032

Subject: M/s Meenavargal Membattu Sangam, Royapuram V/s The Chief Secretary Government of Tamil Nadu and 4 others in the matter of NGT Application no. 19 of 2013(SZ)(THC) and M.A. No. 175 of 2015 (SZ) regarding disappearance of marine species due to discharge of effluent from M/s Manali Petrochemical Ltd.,

Sir,

Please find enclosed herewith a copy of the Hon'ble National Green Tribunal, Southern Zone bench, Chennai, order dated March 21, 2016 in the matter of above cited petition. The contents of the order are self-explanatory. In compliance of above said order, zonal office is deputing a team of officials lead by Smt.H.D.Varalaxmi, SEE for surprise joint monitoring of M/s Manali Petrochemical Ltd., and its marine discharge system during April 11-13, 2016 to verify the pollution control measures taken by the unit before discharging into marine water body. It is therefore requested to depute concerned officer for joint monitoring and to extend necessary co-operation to the team during inspection.

Yours faithfully

S. Suresh 7/4/2016
(S. Suresh)
Zonal Officer

Encl: As above

Copy to:

The District Environmental Engineer, Tamilnadu Pollution Control Board, 77-A, South Avenue road, Ambattur Taluk, Thiruvallur District, Chennai - 600053

} With request to depute concerned officer for surprise joint monitoring of the unit please

S. Suresh 7/4/2016
(S. Suresh)
Zonal Officer

c/c

DESPATCHED
No.: 76-77
Date: 7/4/16
Signature:

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BEFORE THE NATIONAL GREEN TRIBUNAL (SOUTHERN ZONE) CHENNAI

APPLICATION NO. 19 OF 2013

M.A. No. 173 of 2015

Meenavargal Membattu Sangam

APPLICANT

VERSUS

The Government of Tamilnadu & Others

RESPONDENTS

JOINT INSPECTION REPORT FILED ON BEHALF OF CENTRAL POLLUTION CONTROL BOARD

Advocate D. S. Ekambram

&

Advocate P. Jayalakshmi

COUNSELS FOR CPCB

ANNEXURE - 3
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# REPORT

# Development of an analytical method for determining Chemical Oxygen Demand of high chloride containing wastewater generated during the synthesis of propylene oxide at M/s Manali Petrochemicals Limited, Chennai, T.N.

***Sponsor***

**M/s Manali Petrochemicals Ltd., Chennai**

MANALI PETROCHEMICALS

**CSIR-National Environmental Engineering Research Institute,**
**Nagpur - 440020**

NEERI

October 2019

# Executive Summary

Chemical Oxygen Demand (COD) is a regulated parameter prescribed globally by regulatory agencies. The potassium dichromate open reflux method is the most widely followed method for determination of COD in aqueous samples as is prescribed by American Public Health Association (APHA) and also by US Environmental Protection Agency (USEPA). The measurement of COD in high chloride containing samples, suffers from high false positive error as chloride is also oxidized along with the organics. Chloride interference can be overcome largely, but not completely, by complexing with mercuric (II) sulphate before the refluxing procedure. As per the method prescribed by APHA, an amount of 1g mercuric (II) sulphate or less is specified for 50 mL sample for chloride concentration ≤2000 mg/L as long as 10:1 weight ratio of mercuric (II) sulphate to chloride is maintained. Addition of larger quantities of mercuric (II) sulphate is not recommended as mercury is an environmental hazard. Hence, highly saline samples including marine samples and water samples from estuaries having chloride concentrations ≥2000 mg/L are subjected to very high errors in estimation of COD.

USEPA also prescribes a potassium dichromate method (Method 410.3) for estimation of COD under high saline conditions (Revision, 1978) but the minimum detection limit of this method is 250 mg/L of COD for chloride concentrations of >1000 mg/L. Apart from USEPA, some countries like China, Japan, Korea follow alkaline potassium permanganate method for estimating COD of marine samples with very low concentration of COD (<50 mg/L). Thus, the existing methods for saline samples are either suitable for < 50 mg/L of COD or > 250 mg/L of COD. Hence, there is an immediate need to establish a suitable method for estimating COD of saline samples with minimum COD of 50 mg/L to at least maximum of 250 mg/L.

M/s Manali Petrochemicals Limited (MPL), Chennai generates effluents with very high concentration of chloride (28,000-33,000 mg/L) as calcium chloride. The COD concentration of the treated effluent which is expected to be in the range 50-150 mg/L was grossly overestimated due to high chloride interference. This resulted in non-compliance of the parameter COD in the treated effluent. Hence, MPL approached CSIR-NEERI, Nagpur for recommending a suitable method for estimation of COD in presence of high concentration of chlorides.

Extensive experiments were carried out at CSIR-NEERI using the methods available for COD estimation. And consequently, a corrected potassium dichromate method ($COD_{Cr\text{-}corrected}$) was developed by CSIR-NEERI for determining COD of saline samples with chloride concentrations between 2000-37,000 mg/L and COD between 50 to 1400 mg/L. This method of COD estimation does not exceed the prescribed dose of mercuric (II) sulphate and is mostly similar the open-reflux method of APHA.

The alkaline potassium permanganate method ($COD_{OH}$) was also tested for the MPL samples and were found to be effective in accurately estimating COD of both the influent and treated effluent. Since both the methods ($COD_{Cr\text{-}corrected}$ and $COD_{OH}$) studied in this report are capable of accurately estimating the COD of the samples with chloride concentrations in the range 2000 mg/L-37,000 mg/L, CSIR-NEERI recommends both the methods for COD estimation.

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NEERI

*Final Report*

# Development of an analytical method for determining Chemical Oxygen Demand of high chloride containing wastewater generated during the synthesis of propylene oxide at M/s Manali Petrochemicals Limited, Chennai, T.N.

## 1.0 Preamble

Manali Petrochemicals Limited (MPL) located in Chennai, Tamil Nadu, established since 1986 manufactures an array of chemical compounds like propylene oxide, propylene glycols, polyols, and many customized chemical formulations for different industries such as appliances, automotive, bedding, food & fragrances, furniture, footwear, paints and coatings, and pharmaceuticals.

Propylene Oxide (PO), an important bulk chemical intermediate, is widely used for manufacturing of polyurethane, unsaturated resins, surfactants and other products. PO is traditionally produced by two routes, namely the chlorohydrin and Halcon (hydroperoxide) processes. MPL manufactures PO through the chlorohydrin route. In the chlorohydrin process, propylene is reacted with chlorine, and water in the first step to form chlorohydrin, which is then saponified with milk of lime or calcium hydroxide to generate PO and chlorinated by-products such as dichloropropane and $CaCl_2$ as per the following reaction.

$$Cl_2 + H_2O \rightarrow HCL + ClOH \quad (1)$$

$$ClOH + C_3H_6 \rightarrow ClC_3H_6OH \quad (2)$$

$$2ClOHC_3H_6 + Ca(OH)_2 \rightarrow 2C_3H_6O + CaCl_2 + 2H_2O \quad (3)$$

PO thus formed is used for the manufacture of propylene glycol and Polyether Polyols.

## 2.0 Origin of the problem

The wastewater generated from PO manufacturing process yields wastewater with chloride concentration of around 28,000 to 33,000 mg/L. The measurement of COD in samples with very high concentration of chloride results in severe false positive errors due to interference of chloride oxidation. The 23rd Edition of Standard Methods for Examination of Water and Wastewater (APHA, 2017) points out chloride ion as the most common interferent in the determination of Chemical Oxygen Demand (COD) (method: APHA 5220 A). Chloride ion interferes with the estimation of COD by reacting with silver ion and thus inhibits the catalytic activity of silver in the COD digestion. Chloride also undergoes oxidation during vigorous acid digestion and reduces $Cr^{6+}$ to $Cr^{3+}$ to form chlorine as follows:

$$Cr_2O_7^{2-} + 6Cl^- + 14H^+ \rightarrow 3Cl_2 + 2Cr^{3+} + 7H_2O \quad (4)$$

Thus, the reaction (oxidation) of chloride with dichromate results in a higher positive error in the COD analysis. The Standard Methods for Examination of Water and Wastewater (APHA, 2017) prescribes the use of ten parts by weight of mercuric chloride salt for every part by weight of chloride salt (10:1, w/w) for masking the interfering effects of chloride during measurement of COD. However, the procedure prescribed by APHA for overcoming chloride interference is applicable for samples with a chloride concentration of less than 2000 mg/L. While the total error in COD determination of effluents with less than 2000 mg/L of chloride is generally about 10-12%, this could go up to >50-80% in the presence of very high chloride concentrations. Moreover, in the presence of high concentrations of chloride, the organics present in the sample also may undergo incomplete oxidation further enhancing the error.

Since the wastewater samples of M/s. Manali Petrochemicals Limited (MPL) contains a high concentration of chloride salts, accurate measurement of COD has become a

major hurdle for MPL in complying the prescribed discharged standards for COD. Hence to develop a method for determining COD of high chloride containing wastewater samples, the management of M/s. MPL has approached CSIR-NEERI seeking CSIR-NEERI's advice and intervention in this matter.

**3.0 Scope of the study**

Accordingly, CSIR-NEERI proposed to carry out a detailed study with the following scope of work:

- Characterisation of the effluent stream water in terms of major physicochemical parameters
- Identification and quantification of parameters in the effluent that interfere both false positively and negatively in the COD estimation of the sample by APHA method 5220 B
- Development of an alternative method for COD analysis with the removal of identified interferents
- Validation of method developed on synthetic wastewater samples at different concentration of interferents
- Submission of Interim & Final Report

**4.0 A brief review of the literature**

Oxygen demand is an important parameter for assessing the concentration of organic contaminants in wastewater. Since the degradation of organic compounds requires oxygen, their concentrations can be estimated by the amount of oxygen required to oxidise the compound, either chemically or biologically. The chemical oxygen demand (COD), biological oxygen demand (BOD) and total organic carbon (TOC) are three main indices used to assess the level of organic pollution in aqueous systems. Values measured by COD and BOD methods are used as environmental and effluent criteria in most of the countries in the world. Although TOC analysis is valid for organic compounds and the BOD reflects the biodegradable part of the pollutants, COD represents the pollution load of most wastewater discharges. As a pollution monitoring

parameter, COD has the advantage of speed and simplicity over BOD and requires less equipment compared to TOC determination. Thus, COD is preferred for estimating organic pollution.

COD is defined as the amount of an oxidant (expressed in terms of oxygen equivalence), that is consumed during the oxidation of organic compounds by strong oxidizing agents, such as dichromate (E0 = 1.36 V), permanganate (E0 = 1.51 V), or cerium (E0 = 1.44 V), where E0 is the standard reduction potential (25 °C vs. Normal Hydrogen Electrode, pH = 0). ISO 6060 states that the accepted definition of COD (chemical oxygen demand) is the mass concentration of oxygen that is equivalent to the amount of dichromate consumed by dissolved and suspended matter when a (water or sludge) sample is treated with that oxidant under defined conditions (ISO 6060, Determination of the Chemical Oxygen Demand, International Organization for Standardization, Geneve, Switzerland, 1989).

The earliest methods to determine COD were developed approximately 150 years ago and involved the observation of colour changes of a permanganate solution mixed with water samples (Miller et al., 2001). The first attempts to use dichromate to oxidize organic matter were during the period from 1925 to 1930 and were not very promising (Geerdink et al., 2017). In 1949, Moore et al., applied the dichromate procedure to wastewater analysis. Quantitative oxidation of compounds was obtained by refluxing the sample for 2 h with dichromate in a 50% sulphuric acid solution at 145-150°C. Using this procedure, approximately 90% of the organic matter present and most of the chloride were oxidized, but a correction was required for the chloride (Moore et al., 1949). In 1951, Moore et al., introduced a small amount of silver sulphate to a mixture to catalyze the oxidation, and this resulted in nearly quantitative results even with several relatively inert compounds, such as carboxylic acids and aliphatic alcohols. In

1963, Dobbs and Williams demonstrated that chloride oxidation during COD digestion was reduced substantially by the addition of mercuric sulphate to the sulphuric acid/dichromate reagent, which meant that a separate chloride determination was no longer necessary. However, the work of Dobbs and Williams (1963) was limited only to samples with chloride concentrations of 2000 mg/L or less.

After Dobbs and Williams work on masking chloride in 1963, many researchers have attempted to establish methods with various degrees of success to eliminate the interference of chloride in COD estimation using various approaches and have even tried to develop a completely new method of estimation of COD for chloride concentrations > 2000 mg/L. Recently, photo-electrocatalytic COD determination using $TiO_2$ was introduced, and it may have a great future for dissolved COD. In the commercially available PeCOD® system, the chloride tolerance is approximately 350 mg/L, and some authors report a chloride tolerance up to approximately 2000 mg/L with a modified system. As outlined above, the current COD determination methods are not satisfactory because of the use of highly toxic substances such as Cr (VI), Hg and Ag. This is true even when considering the possibility of strongly reducing or completely recycling the spent chemicals. In the literature, there are few procedures that advocate an environmentally friendly method for COD determination, and the chance of successfully introducing such a method is slim as long as the use of the current COD methods are embedded in legislation and taxation.

### 4.1 Chloride Interference

Chloride is the most common interference in a COD analysis. It is oxidized in acidic solutions by dichromate, but natural processes do not oxidize chloride in the

environment. In the presence of sulphuric acid, however, chromyl chloride ($CrO_2Cl_2$) is formed:

$$K_2Cr_2O_7^{2-} + 4NaCl + 6H_2SO_4 \leftrightharpoons 2KHSO_4 + 4NaHSO_4 + 2CrO_2Cl_2 + 3H_2O \quad (5)$$

During the two h of dichromate oxidation of organic compounds at 148° C, chloride is oxidized quantitatively to chlorine

$$Cr_2O_7^{2-} + 6Cl^- + 12H^+ \leftrightharpoons 3Cl_2 + 2Cr^{3+} + 7H_2O \quad (6)$$

While Moore et al. (1949) stressed upon the fact that quantitative estimation of COD depended upon the accurate determination of chloride, amount of dichromate present and acid concentration, Baumann, 1974 argued that degree of oxidation of chloride is not predictable under practical conditions. This unpredictability caused determination of the small amount of COD in the presence of a high concentration of chloride unreliable (Baumann, 1974). Significant errors (20%-500%) have been reported in samples containing low COD (up to 500 mg/L) and high chloride (up to 6000 mg/L) concentrations (Belkin et al., 1992). There also some reports that the variation in COD analysis varies with the organic composition of the sample that influences the extent of chloride oxidation (Ballinger et al., 1982).

The interference of chloride can be mitigated by adding mercury (II) sulphate:

$$Hg^{2+} + 2Cl^- \leftrightharpoons HgCl_2 \quad (7)$$

In standard procedure prescribed by APHA, interference in the estimation of COD due to oxidation of chloride ion is largely prevented by addition of mercuric (II) sulphate by maintaining a mercuric (II) sulphate to chloride weight ratio of 10:1. The complexing method, as currently practised is expected to yield satisfactory

results up to 2000 mg/L and recommended the use of 0.75 g of silver sulphate as the catalyst and mercuric (II) sulphate as a masking agent in the weight ratio of 5:1 for chlorides (Dobbs and Williams, 1963). The method developed by Dobbs and Williams (1963) is widely adopted with some modifications and has formed the basis of modern standard practise of COD estimation by dichromate method. The ISO method for COD estimation (2nd edition) limits the concentration of chloride in samples to <1000 mg/L and the method for masking chloride is by adding mercury (II) sulphate in a weight ratio of 10:1 for samples with chloride content of 2000 mg/L or less. Beyond chloride concentration of 2000 mg/L, the dose of mercuric (II) sulphate needs to be increased proportionately. However, mercury being an environmental hazard, its indiscriminate use in COD estimation is not desirable. As per the method prescribed by APHA, an amount of 1g mercuric (II) sulphate or less is specified for 50 mL sample, where sample chloride concentration is known to be less than 2000 mg/L as long as 10:1 weight ratio of mercuric (II) sulphate to chloride is maintained.

### 4.2 Established methods of COD estimation in highly saline samples

Since chloride is the most common interference in a COD analysis, it is oxidized in acidic solutions by dichromate, but it is not oxidized by natural processes in the environment (Miller et al., 2001). Additives such as $HgSO_4$, $AgNO_3$ and Cr (III), or their combinations, minimize chloride interference but not completely remove it (Axen and Morrison, 1995). At high temperatures, the masking of chloride is insufficient even with mercury sulphate. Moreover, the addition of mercuric sulphate could mask chloride interference to some extent but not completely and hence necessitates the need for a chloride correction in the standard method for COD estimation (Crips and Jenkins, 1964)

Hence, in some countries like Korea (KIOST, MOF 2013-230), Malaysia (Goh and Lim, 2008), Japan (JIS Handbook of Pollution Part 1993) and China (Administration of Quality and Technical Supervision of the People's Republic of China, 1999), another method based on alkaline digestion by potassium permanganate is practiced for determining COD of saline waters with very low organics like that in oceanic samples (COD<50 mg/L).

On the other hand, in other parts of the world, especially in US, Europe and in developing countries like India, United States Environmental Protection Agency (USEPA) prescribes a potassium dichromate method (Method 410.3) with method correction (based on the studies made by Burns and Marshall (1965), for estimating COD of saline waters (Revision,1978). The method correction used in the mercuric sulphate addition method prescribed by USEPA 410.3 (Revision,1978) accounts for the non-linearity of chloride interference with increasing chloride concentration using the following formula for calculation of corrected COD:

$$\text{mg/L, COD} = \frac{\{[(A-B)\times C\times 8000]-50D}{mL\ of\ sample} \times 1.2 \qquad (8)$$

where,

A = mL, ferrous ammonium sulphate for blank;
B = mL, ferrous ammonium sulphate for sample;
C = normality of ferrous ammonium sulphate
D = chloride correction from curve (refer to step 7.9 of Annexure A)
1.2 = compensation factor to account for the extent of chloride oxidation which is dissimilar in systems containing organic and non-organic material

Some of the prominent features of the USEPA 410.3 method are:

- The method is prescribed for samples containing a minimum COD concentration of 250 mg/L and chloride concentrations higher than 1000 mg/L.

- Sample volume is 50 mL
- If COD concentrations exceed 800 mg/L, smaller aliquots should be taken. However, the volume should be readjusted to 50 ml using distilled water, having chloride concentrations equal to that in the sample.

The USEPA method which is based on a study carried by Burns and Marshall et al., (1965) is also limited to COD concentration of ≥250 mg/L, which means samples with high concentration of chloride (>1000 mg/L) and low concentration of COD (<250 mg/L) cannot be estimated with reliability using this method. Similarly, the method adopted by Japan and China is limited to a very low concentration of organics (COD <50 mg/L) in the presence of high concentrations of chloride (~33,000 mg/L). Hence, some study is warranted to determine a robust method for determination of COD of highly saline samples (with > 2000 mg Cl/L) having COD concentrations between 50 to 250 mg/L.

## 5.0 Approach and methodology

Raw and treated effluent samples collected from the effluent treatment plant (ETP) of M/s MPL were characterized for both COD (COD open reflux method: APHA 5220B) and chloride concentrations (Argentometric titration method: APHA 4500B). After determining the concentration of chloride in raw and treated effluents, it was decided first to determine the quantity of COD exerted by chloride alone and by chloride in the presence of the organics. For COD estimation, we have followed the potassium dichromate acid digestion method (USEPA 410.3, 1978) and alkaline potassium permanganate method (Administration of Quality and Technical Supervision of the People's Republic of China, 1999).

First, a series of experiments were carried out in the laboratory to determine the quantity of false COD (COD-Cl) exerted by varying the concentration of chloride.

For that, a range of standard chloride solution were prepared in the laboratory by mixing the calculated amount of calcium chloride in distilled water. The chloride concentration in the standard calcium chloride solutions prepared in laboratory varied in the range of nil to 37,000 mg/L.

Secondly, a series of known concentrations of potassium hydrogen phthalate (KHP) and/or glucose solutions were prepared to have two ranges of standard COD solutions, one for the raw influent (range 500 mg/L to 1400 mg/L) and another for the treated effluent (range 50 mg/L to 500 mg/L). The effect of varying chloride concentration on the estimation of standard solutions of COD was determined by both dichromate method (with 10:1 ratio of mercury (II) sulphate) and by alkaline potassium permanganate method. Based on the observed deviations in COD due to chloride, correction factors were applied suitably to eliminate the deviation. The detailed step-wise method development is delineated in the following sections.

## 6.0 Method Development

The wastewater samples from MPL had pH in the range 5.6-6.7, and chloride concentration between 27580-29785 mg/L. The COD estimated using APHA method 5220B yielded values in the range of 350 to 400 mg/L. Very likely, the true value of COD of the treated effluent has been overestimated due to the presence of >25,000 mg/L of chloride. The following steps were followed to develop a robust method for the determination of COD in the presence of a high concentration of chloride.

## 6.1 Method A: The potassium dichromate, open reflux method

### a. *Principle*

Under acid digestion, potassium dichromate can quantitatively oxidise organics present in the sample, and the remaining dichromate is estimated by a redox titration using ferrous ammonium sulphate. This method can also quantitatively oxidise chloride if it is also present in the sample along with the organics.

### b. *Determination of COD contributed by chloride ($COD_{Cr}$-Cl) & preparation of a standard curve of $COD_{Cr}$-Cl*

At first, a graph was plotted for COD (mg/L) concentrations contributed by standard calcium chloride solutions ($COD_{Cr}$-Cl) both in presence and absence of mercuric (II) sulphate (10:1, w/w). The following Figure 1 shows concentrations of $COD_{Cr}$-Cl both in the absence and presence of 10:1 mercuric (II) sulphate. In absence of mercuric (II) sulphate, $COD_{Cr}$-Cl (depicted with blue solid circles) increased linearly and was around 2700 mg/L at 20,000 mg Cl/L while, when mercuric (II) sulphate was used in weight ratio of 10:1 to chloride, the $COD_{Cr}$-Cl concentrations at 20,000 mg Cl/L (solid red circles) were around 107 mg/L. Though the COD values (solid red circles) drastically reduced when mercuric (II) sulphate was used; there was still a false positive error of around 100 mg/L at 20,000 mg Cl/L which can be significantly high for a low COD sample.

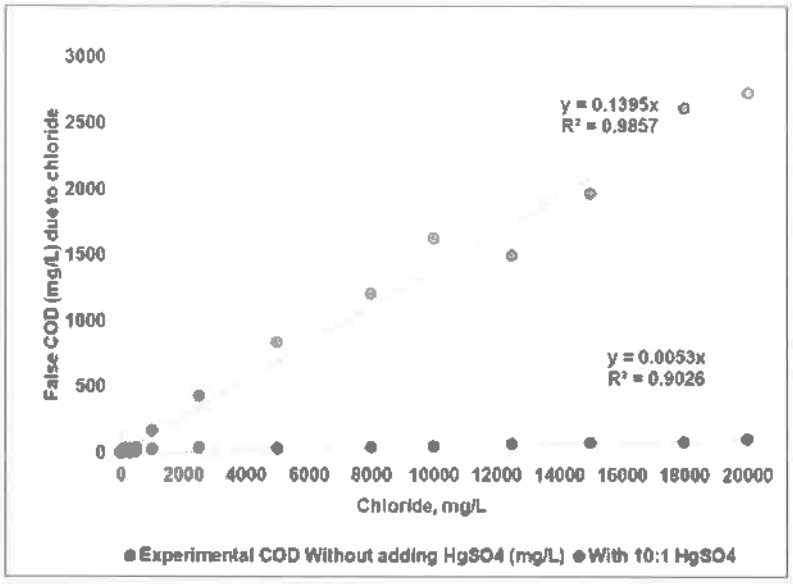


**Figure 1: False COD ($COD_{Cr}$-Cl) due to standard chloride solutions in the presence and absence of 10:1 (w/w) $HgSO_4$: Cl (data generated at CSIR-NEER, Nagpur)**

A linear trendline (red dotted line) plotted for the COD values obtained with mercuric (II) sulphate and the slope (m) of the equation (y=mx) of the linear line is determined. The slope m is then used to determine the COD due to chloride interference in the subsequent analysis.

For example, if any sample has chloride concentration of around 18,000 mg/L, then COD due to chloride ($COD_{Cr}$-Cl) can be determined using the equation (y=0.0053x) where x is to be replaced by 18,000 mg/L.

It is important to mention that a separate standard $COD_{Cr}$-Cl curve must be plotted every time a fresh reagent is prepared, and the slope of the curve might vary from lab to lab and from individual to individual. Hence the curve must be plotted separately by every person and/or laboratory. Moreover, extrapolation of the curve should not be done under any case. For plotting the curve, a minimum chloride interval of 4000 mg/L is essential up to

chloride concentration of 20,000 mg/L, and for higher concentration, the curve should be determined with lesser intervals of chloride (e.g. 1000 mg/L).

In the case of MPL, the effluent samples have chloride concentration in the range 25,000 to 28, 000 mg/L. Hence, MPL laboratory has plotted the following calibration curve in chloride range of nil to 32,000 mg/L (Figure 2). The slope value for MPL laboratory is 0.0027.

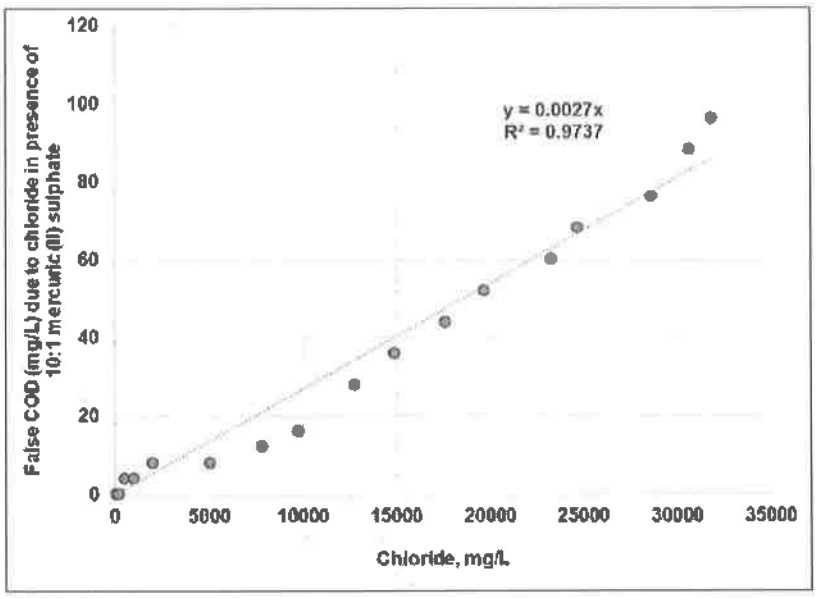


**Figure 2: False COD ($COD_{Cr}$-Cl) contributed by standard calcium chloride solutions in the presence of 10:1 (w/w) $HgSO_4$: Cl (data generated by MPL)**

***c. Effect of standard chloride concentrations on standard organic solutions (standard potassium hydrogen phthalate)***

After plotting the standard $COD_{Cr}$-Cl graph with calcium chloride standard solutions, the effect of increasing chloride concentration on $COD_{Cr}$ estimation of standard potassium hydrogen phthalate (KHP) solutions (in range 50 mg/L to 500 mg/L) was determined. The relative standard error (RSE, %) in the estimation of $COD_{Cr}$-Std due to increasing chloride concentration is shown in Figure 3. The highest deviation in estimated

$COD_{Cr}$-Std because of chloride interference was observed in samples with lower $COD_{Cr}$ strength.

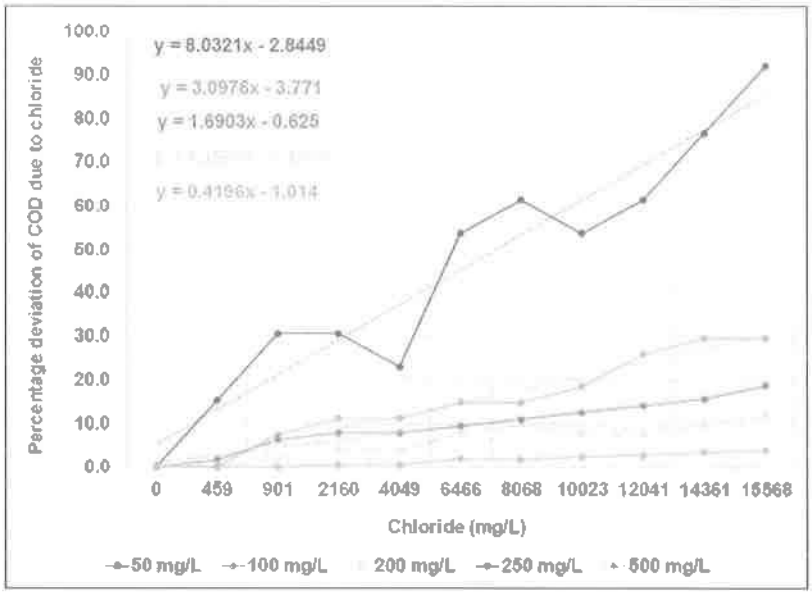


**Figure 3: Deviation of $COD_{Cr}$-Std from the true value in the presence of increasing chloride concentrations**

### *d. Incorporation of chloride correction*

Logically, if chloride oxidation has caused false-positive errors in the estimation of the standard $COD_{Cr}$, then the corrected $COD_{Cr}$ of standard solutions (corrected $COD_{Cr}$-Std) values could be obtained by subtracting the $COD_{Cr}$-Cl from the experimental $COD_{Cr}$. However, a careful analysis of the data revealed that up to a certain chloride concentration (2000 to 4000 mg/L), subtracting $COD_{Cr}$-Cl from the experimental $COD_{Cr}$ fetched acceptable results of corrected $COD_{Cr}$-Std. However, at higher chloride concentration, the subtraction method fetched increasingly lower $COD_{Cr}$-Std values than expected. The blue line in the Figures (4 to 8) represents the net COD after subtracting the $COD_{Cr}$-Cl (green line) from the experimental COD (Exp $COD_{Cr}$, orange line).

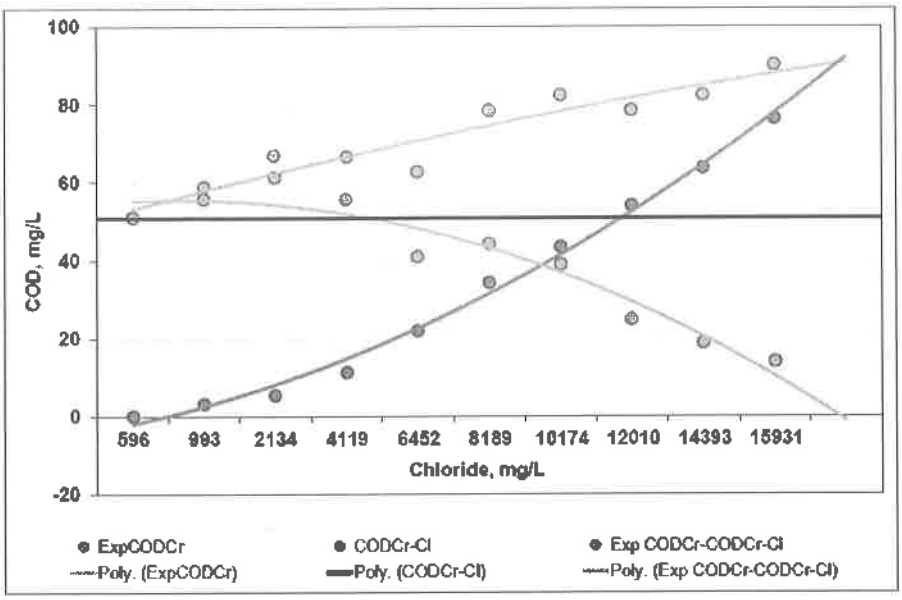


**Figure 4: The deviation of the net $COD_{Cr}$ (blue line) from the true value (horizontal line). The net COD is obtained after subtracting $COD_{Cr}$-Cl from the Exp $COD_{Cr}$ (50 mg/L standard solution)**

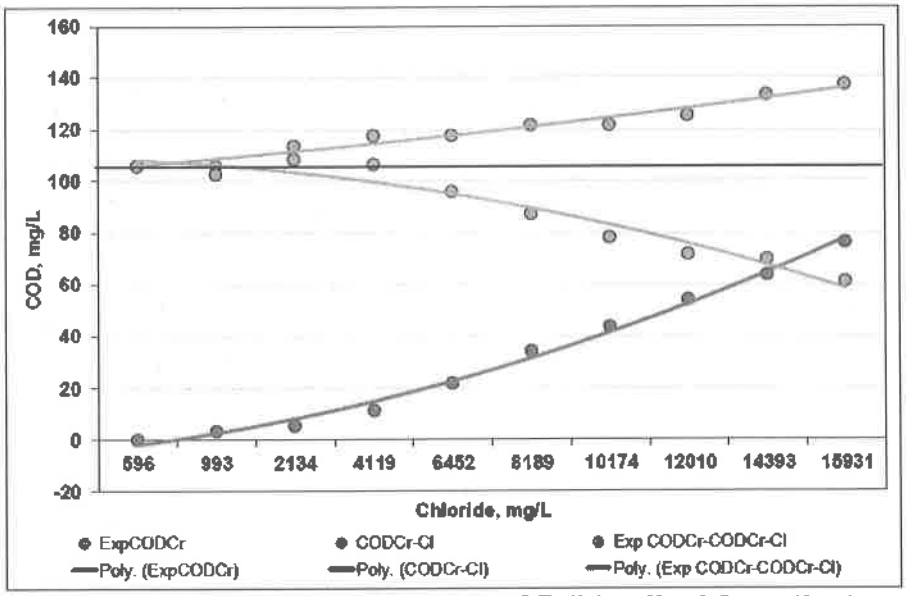


**Figure 5: The deviation of the net COD (blue line) from the true value (horizontal line). The net COD is obtained after subtracting $COD_{Cr}$-Cl from the experimental COD (100 mg/L standard solution)**

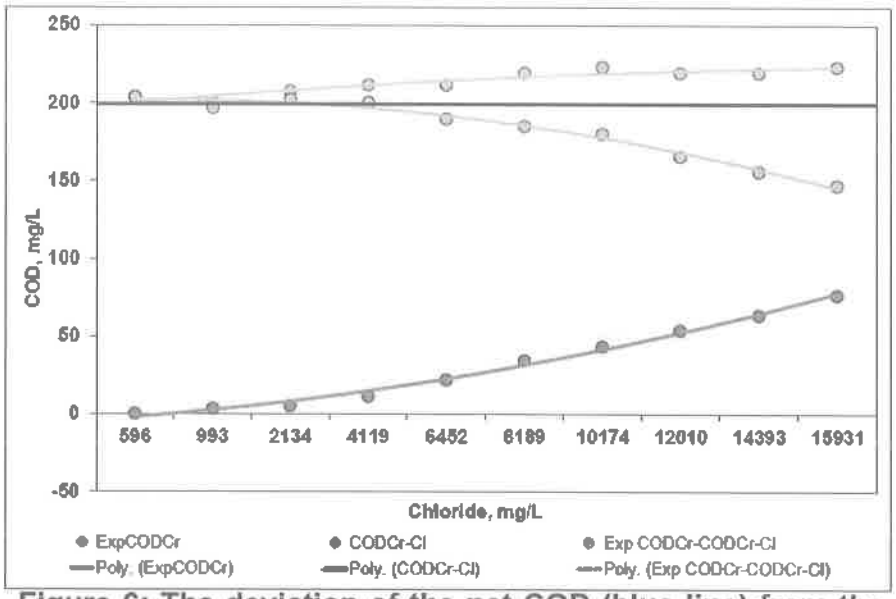


**Figure 6: The deviation of the net COD (blue line) from the true value (horizontal line). The net COD is obtained after subtracting $COD_{Cr}$-Cl from the experimental COD (200 mg/L standard solution)**

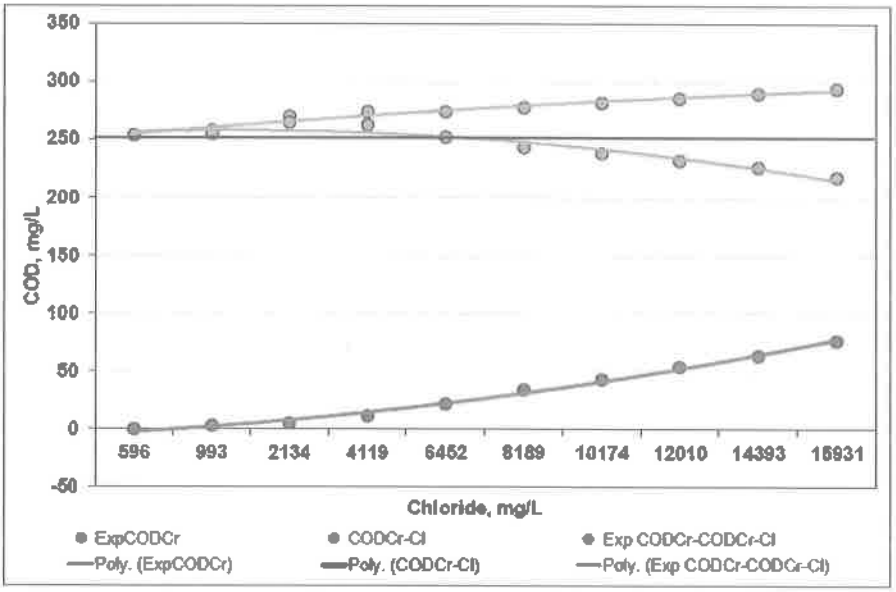


**Figure 7: The deviation of the net COD (blue line) from the true value (horizontal line). The net COD is obtained after subtracting $COD_{Cr}$-Cl from the experimental COD (250 mg/L standard solution)**

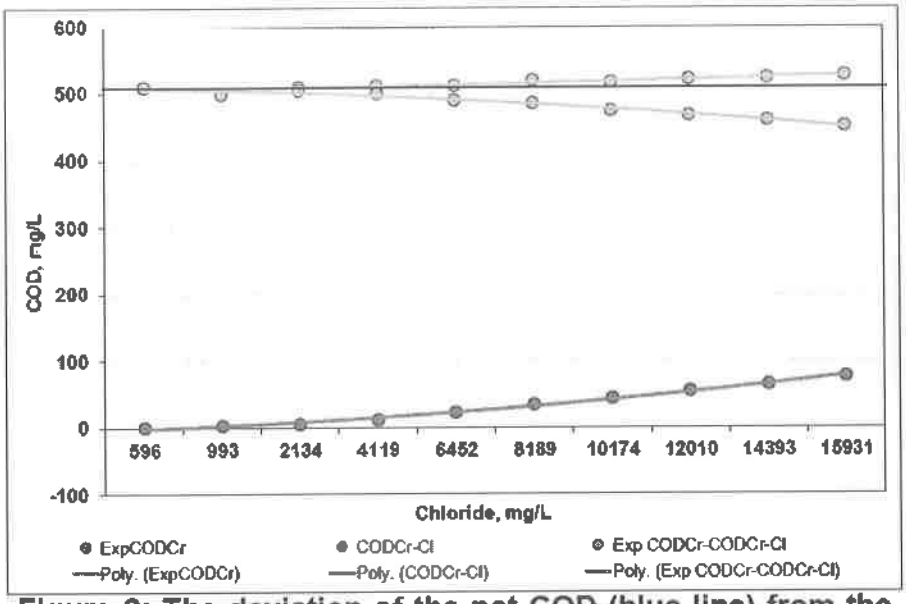


**Figure 8: The deviation of the net COD (blue line) from the true value (horizontal line). The net COD is obtained after subtracting $COD_{Cr}$-Cl from the experimental COD (500 mg/L standard solution)**

This deviation of the corrected $COD_{Cr}$ values from the true value (represented as black horizontal line in Figure 4-8) can be seen in all the experiments conducted with known concentration of $COD_{Cr}$ (50mg/L, 100 mg/L, 200 mg/L, 250 mg/L and 500 mg/L).

As can be seen, the deviation of corrected $COD_{Cr}$ (blue line) from the true value (black horizontal line) becomes more evident at higher chloride concentrations and for lower concentrations of COD (Figure 4). There appears to be seemingly preferential oxidation of KHP over chloride at higher concentrations of organics (KHP) where the availability of $Cr^{6+}$ limits the oxidation of chloride at higher theoretical COD and higher chloride concentrations. However, when the concentration of KHP is low (as in 50 and 100 mg $COD_{Cr}$/L), chloride oxidation appears to be complete and preferred over organics (KHP). Hence, for the given experiments, the

following method for calculating corrected $COD_{Cr}$ ($COD_{Cr\text{-}corrected}$) can be used for chloride concentrations higher than 2,500 mg/L:

$$COD_{Cr\text{-}corrected}\ mg/L = \frac{[(A-B)C \times 8{,}000]}{mL\ of\ sample} - 50\%\ of\ D \qquad (9)$$

where:

A = mL $Fe(NH_4)_2(SO_4)_2$ for blank;

B = mL $Fe(NH_4)_2(SO_4)_2$ for sample;

C = normality of $Fe(NH_4)_2(SO_4)_2$;

D= $COD_{Cr}$-Cl derived from the chloride correction curve (Section 6.1b)

The calculation for deriving corrected COD is different from that prescribed by USEPA 410.3 and hence, the equation (9) shall be hereafter referred to as CSIR-NEERI's $COD_{Cr\text{-}corrected}$ correction method.

***Optional compensation factor of 1.2***

An optional compensation factor of 1.2 may be multiplied to the result obtained in equation (9) to account for the extent of chloride oxidation which is dissimilar in systems containing organic and non-organic material. This compensation factor is as per the USEPA 410.3 method and may be used if needed. After applying the above formula, the corrected $COD_{Cr}$-Std under the varying concentrations of chloride is as follows:

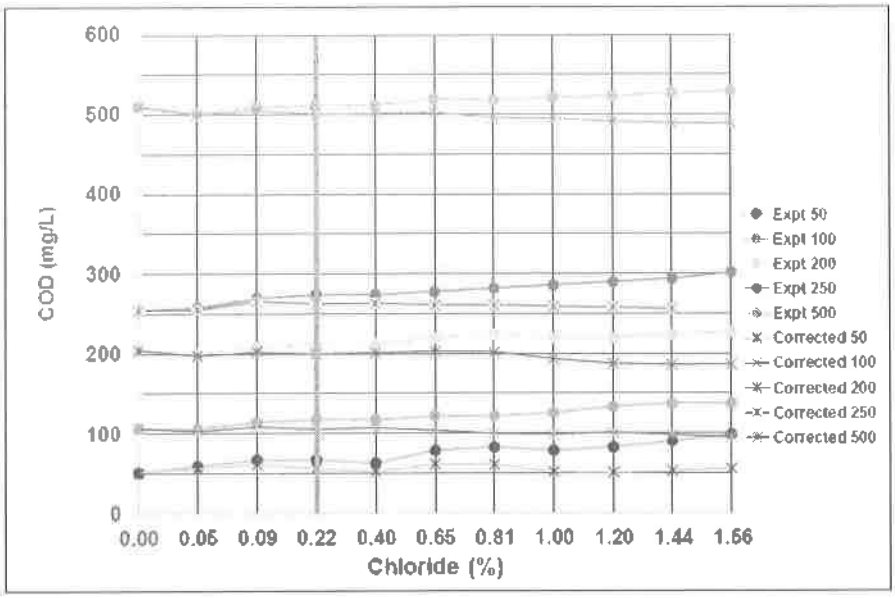


**Figure 9: The corrected and the uncorrected $COD_{Cr}$-Std**

***e. Effect of mixing***

A study was also conducted to evaluate the effect of mixing of mercuric (II) sulphate with the sample before dichromate digestion on masking of chloride. In the first set of experiments (noted as 'set I'), the mercuric (II) sulphate was added in one go into the sample as is normally done in open reflux method while in the second set of experiments (noted as 'set II'), mercuric (II) sulphate was added very slowly into the sample slowly over a period of two to three minutes while swirling the vessel/flask, followed by a waiting period of at least five minutes during which the flask was mixed thoroughly using a magnetic stirrer and magnetic stirring bar. After this step, the rest of the procedure of open reflux method of potassium dichromate was followed as normally practised.

The $COD_{Cr}$-Cl of standard chloride solutions determined by two procedures (I & II), as mentioned above, is shown below:

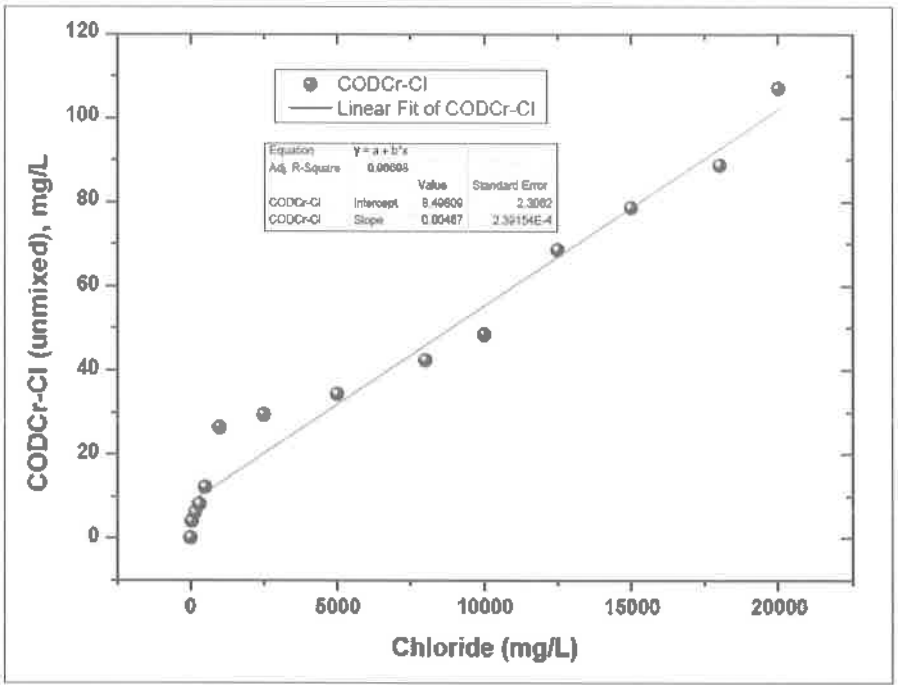


**Figure 10: $COD_{Cr}$-Cl obtained in experiment set I (normal procedure with no additional mixing)**

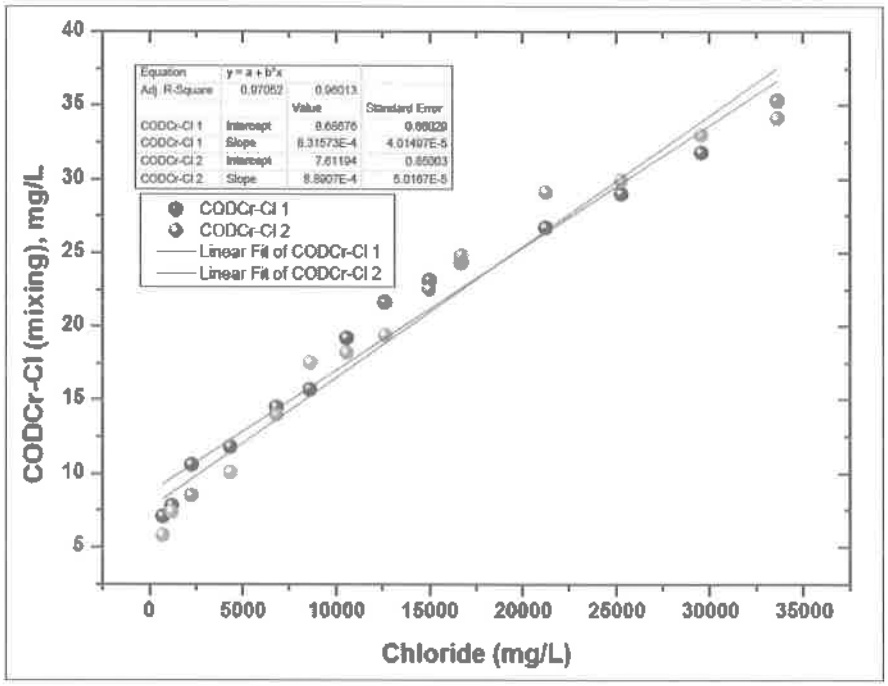


**Figure 11: $COD_{Cr}$-Cl obtained in experiment set II (slow addition of $HgSO_4$ with thorough mixing)**

The experimental set II (mixed) was carried out in duplicates, and as can be seen from Figure 11 above, there was good replicability in the results obtained.

A straight-line equation plotted for the data obtained by both the methods fetched the following results:

**Table 1: Straight line fitting of CODCr-Cl obtained in experimental sets I & II**

| Sr. No. | Experimental set | Equation y=mx+c | Standard Error for Slope | Standard Error for Intercept | Regression coefficient ($R^2$) |
|---|---|---|---|---|---|
| 1 | I | y=0.005x+8.5 | 0.00024 | 2.3 | 0.97 |
| 2 | II | y= 0.00083x + 8.7 | 0.00004 | 0.68 | 0.97 |
| 3 | II | y= 0.00088x + 7.6 | 0.00005 | 0.85 | 0.96 |

Using the equations obtained, a chloride solution of 20,000 mg/L yielded $COD_{Cr}$-Cl of 107 mg/L and 25.43 mg/L in the first set and second set of experiments, respectively. From this study, it was observed that a good mixing of mercuric (II) sulphate with chloride-containing sample before digestion with dichromate did minimize the interfering action of chloride in the COD estimation by almost 4 times.

The effect of increasing chloride solution on standard $COD_{Cr}$ was also studied by both the methods. The data obtained by method I is already explained in details in the sections 6.1a to 6.1d. Figure 3 is reproduced again below in Figure 12a for comparison with that obtained in method II (Figure 12b).

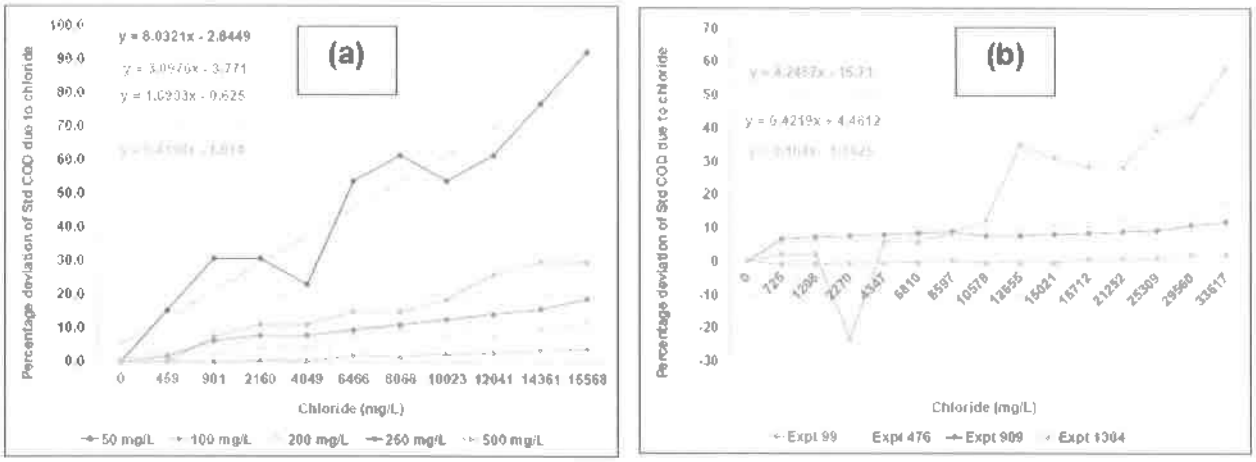


**Figure 12: Relative Standard Deviation (%) of standard COD solutions ($COD_{Cr}$-Std) from the true value due to chloride interference. (a) Data obtained from experimental set I (b) data obtained in the experiment set II (slow addition of $HgSO_4$ with thorough mixing)**

From Figure 12, it can be deduced that the interference of chloride in $COD_{Cr}$ is reduced to some extent, but not completely, if vigorous mixing of mercuric (II) chloride with chloride-containing sample is carried out before the digestion process. The interfering effect of chloride on estimation of $COD_{Cr}$ at lower COD concentrations (<100 mg/L) is very pronounced even after thorough mixing. Hence a correction in the calculation of $COD_{Cr}$ is necessary at high concentration of chlorides and low concentrations of COD.

### *f. Quality control and statistical analysis*

We have seen in Figure 9 that after applying the correction (equation 9), the corrected $COD_{Cr}$ of the standard KHP is close to the theoretical COD values. After vigorous mixing of mercuric (II) sulphate with chlorides present in the sample (as per method II of Section 6.2e above), the corrected $COD_{Cr}$ derived from equation (9) is presented as follows:

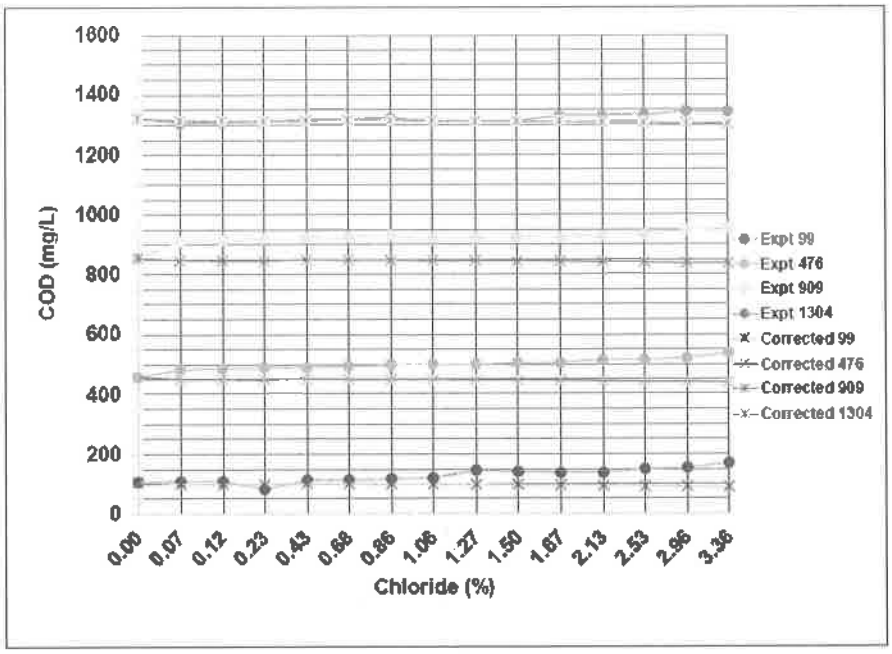


**Figure 13: Uncorrected and corrected $COD_{Cr}$ data obtained in the experiment set II (slow addition of $HgSO_4$ with thorough mixing)**

The per cent deviation of corrected $COD_{Cr}$ from the true value which was carried using normal procedure was found to be within ±10% relative error (except for 50 mg/L COD sample) (Figure 14a). The deviation for 50 mg/L standard KHP solution is highest, and it is because of the limitation of the open reflux dichromate method for estimation of $COD_{Cr}$ in samples less than or equal to 50 mg/L (APHA, 2017). Similarly, the per cent deviation of corrected $COD_{Cr}$ obtained by thorough mixing of $HgSO_4$ with the chloride-containing sample yielded results within ±5% relative error for $COD_{Cr}$ >100 mg/L (Figure 14b). At 100 mg/L of $COD_{Cr}$, the relative error was within 10% for chloride concentrations up to 20,000 mg/L.

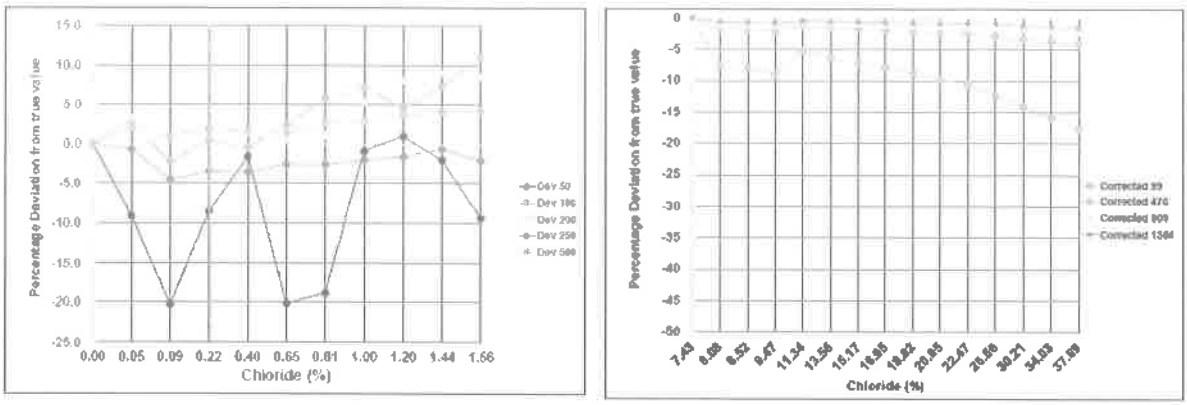


**Figure 14: Percent deviation of corrected COD from the true value (a) data obtained in experimental set I and (b) data obtained in experiment set II: slow addition of $HgSO_4$ with thorough mixing**

Here it must be noted that about ±10.8% coefficient of variation in the estimation of COD has been reported by Standard Methods (APHA, 2017) for standard KHP solution with a COD of 160 mg/L and 100 mg Cl /L. Hence, considering the limitation of the open reflux method of dichromate at lower COD concentrations, a maximum relative error of corrected $COD_{Cr}$ of up to ± 20% for COD concentrations between ≥50 mg/L to ≤100 mg/L can be reasonably accepted.

Quality control was also carried out to evaluate the robustness of the method. For this, four standard COD solutions of known concentrations (100 mg/L, 476 mg/L, 909 mg/L and 1304 mg/L) were prepared, and then they were spiked in the influent and effluent samples received from the ETP of MPL. The results of the analysis are presented in Table (2) below:

**Table 2: Estimated $COD_{Cr}$, Corrected COD ($COD_{Cr\text{-}Corrected}$) and percentage recovery**

| Sr. No. | Sample Name | Theoretical $COD_{Cr}$ | Estimated $COD_{Cr}$ 1 | Estimated $COD_{Cr}$ 2 | Mean | $COD_{Cr}$-Corrected* | % Recovery |
|---|---|---|---|---|---|---|---|
| 1 | Std 1 | 100 | 107 | 107 | 107±0.1 | - | - |
| 2 | Std 2 | 476 | 457 | 487 | 472±15 | - | - |
| 3 | Std 3 | 909 | 855 | 919 | 887±32 | - | - |
| 4 | Std 4 | 1304 | 1267 | 1322 | 1244.5±27 | - | - |
| 5 | Outlet# | UK | 55 | 55 | 55±0.1 | 37.2±0.1 | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | Outlet + Std 1 | UK+100 | 151 | 159 | 155±4 | 137.2±4 | 93.5 |
| 7 | Outlet + Std 2 | UK+476 | 530 | 526 | 528±2 | 510.2±2 | 100.2 |
| 8 | Outlet + Std 3 | UK+909 | 959 | 959 | 959±0.1 | 941.2±0.1 | 101.9 |
| 9 | Outlet + Std 4 | UK+1304 | 1353 | 1350 | 1351.5±2 | 1333.7±2 | 104.2 |
| 10 | Inlet# | UK | 1356 | 1317 | 1336.5±19 | 1319.9±19 | - |
| 11 | Inlet + Std 1 | UK+100 | 1417 | 1463 | 1440±23 | 1423.4±23 | 96.7 |
| 12 | Inlet + Std 2 | UK+476 | 1714 | 1706 | 1710±4 | 1693.4±4 | 79.1 |
| 13 | Inlet + Std 3 | UK+909 | 1942 | 1981 | 1961.5±19 | 1944.9±19 | 70.5 |
| 14 | Inlet + Std 4 | UK+1304 | 2368 | 2355 | 2261.5±6.5 | 2344.9±6.5 | 79.2 |

UK- unknown value; *calculated as per equation 9 (CSIR-NEERI method); #Chloride concentration in inlet and outlet samples is 27,594 mg/L and 29,713 mg/L, respectively; Estimated $COD_{Cr}$ 1 & $COD_{Cr}$ 2- duplicate analysis; - Not applicable

As can be seen in the above table, the treated effluent (outlet) having estimated $COD_{Cr}$ of 55 mg/L and corrected $COD_{Cr}$ of 37.2 mg/L, when spiked with known $COD_{Cr}$ standards solutions of 100 mg/L, 476 mg/L, 909 mg/L and 1304 mg/L fetched recoveries of 93.5%, 100.2%, 101.9% and 104.2% respectively. The inlet sample having estimated $COD_{Cr}$ 1336.5 mg/L and corrected $COD_{Cr}$ of 1320 mg/L fetched recoveries of 96.7%, 79.1%, 70.5% and 79.2%, when spiked with standards COD solutions of 100 mg/L, 476 mg/L, 909 mg/L and 1304 mg/L, respectively.

Thus, the method developed exhibited very good recovery of spiked standards for the low strength 'treated effluent' (outlet) samples. For higher-strength of COD, spiking with 100 g/L of standard COD solution yielded very good recovery (96.7%). However, as the strength of the standard COD solution increased, lower recoveries were obtained for high strength influent samples indicating the need for taking lower aliquots of the sample. USEPA

method (410.3) recommends aliquoting for samples with COD >800 mg/L and chloride > 1000 mg/L. However, satisfactory results were obtained in this study with COD concentrations as high as 1423.4±23 mg/L without any need for aliquoting.

### *g. Method limitation and conclusion*

The following correction method determines corrected COD of samples with chloride > 2000 mg/L by potassium dichromate method with $HgSO_4$: Cl weight ratio of 10:1

$$COD_{Cr\text{-}corrected},\ mg/L = \frac{[(A-B)C \times 8{,}000]}{mL\ of\ sample} - 50\%\ of\ D \qquad (9)$$

where:

A = mL $Fe(NH_4)_2(SO_4)_2$ for blank;
B = mL $Fe(NH_4)_2(SO_4)_2$ for sample;
C = normality of $Fe(NH_4)_2(SO_4)_2$;
D= $COD_{Cr}$-Cl chloride correction from curve (step 1)

Method correction can be eliminated for chloride concentrations ≤2000 mg/L. The mercuric sulphate masking in potassium dichromate method of COD can be carried out in two ways:

a. By normal way of adding mercuric (II) chloride added in $HgSO_4$: Cl weight ratio of 10:1
b. By slowly adding stoichiometric amounts of mercuric (II) chloride (in $HgSO_4$:Cl weight ratio of 10:1) to the sample over a period of two to three minutes while swirling the vessel/flask, followed by a waiting period of at least five minutes during which the flask was mixed thoroughly using a magnetic stirrer and magnetic stirring bar

Both the methods yield corrected COD values with varying relative standard errors under the limiting conditions as explained in Table (3) below:

Table 3: Limiting conditions for estimation of COD by CSIR-NEERI's $COD_{Cr\text{-}corrected}$ method

| $HgSO_4$ addition in CSIR-NEERI's $COD_{Cr\text{-}corrected}$ method* | Chloride range (mg/L) | COD range (mg/L) | Relative standard error (RSE) |
|---|---|---|---|
| Normal | 2000 mg/L to 15,000 mg/L | ≥100 mg/L to ≤500 mg/L | ≤12 % |
| | 2000 mg/L to 15,000 mg/L | ≥50 mg/L to ≤ 100 mg/L | ≤20 % |
| Slow addition of $HgSO_4$ with vigorous mixing | 2000 mg/L to 20,000 mg/L | ≥100 mg/L to ≤14,000 mg/L | ≤12 % |
| | 20,000 mg/L to 37,000 mg/L | ≥100 mg/L to ≤500 mg/L | ≤20 % |
| | 2,000 mg/L to 37,000 mg/L | ≥500mg/L to ≤14,000 mg/L | ≤5 % |

*Mercuric (II) sulphate added in $HgSO_4$: Cl weight ratio of 10:1

The limit of detection (LOD) of the above method using both the mixing methods of mercuric sulphate is 100 mg/L. The slow addition of mercuric (II) sulphate with vigorous mixing method has yielded better results at higher chloride concentrations than normal addition of mercuric (II) sulphate. Hence, our study recommends a slow addition of mercuric (II) sulphate with vigorous mixing with the sample containing chloride before acid digestion. The method of estimating COD of samples by this method is delineated in Annexure A.

## 6.2 Method B: The Alkaline Potassium Permanganate Method

The steps followed in the potassium dichromate method for determination of COD ($COD_{Cr}$) were also followed in determining the effect of chloride on COD obtained due to alkaline permanganate ($COD_{OH}$) method.

a. ***Determining COD of standard calcium chloride solution***

At first, $COD_{OH}$ of standard calcium chloride solutions were determined using alkaline potassium permanganate method. The effect of increasing calcium chloride strength on $COD_{OH}$ values were found to be non-significant as shown in the following figure (Figure 15).

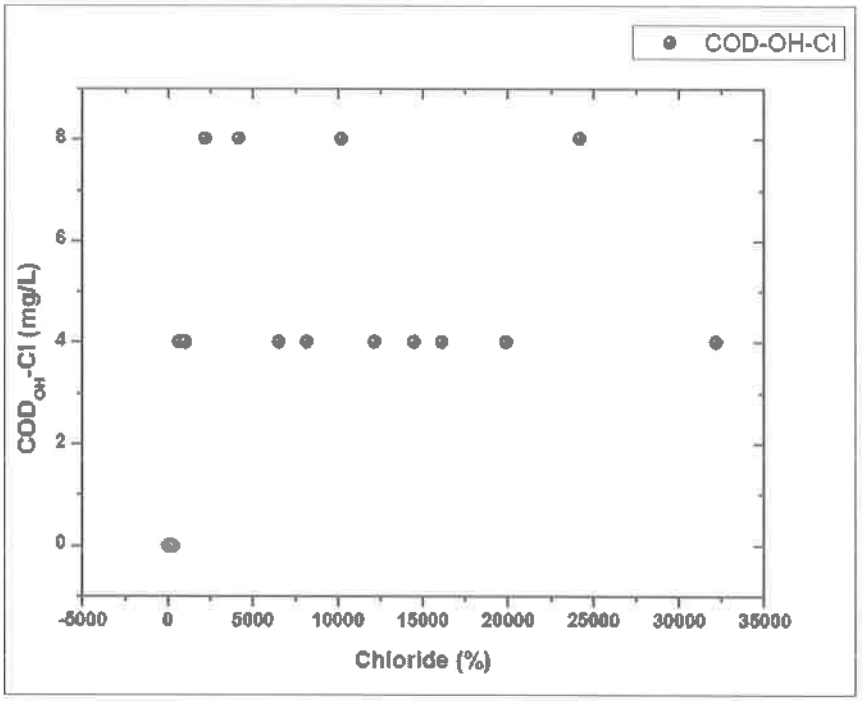


**Figure 15: COD ($COD_{OH}$-Cl) contributed by standard calcium chloride solutions**

The results are in concurrence with studies reported by other researchers where alkaline permanganate method is used to determine COD of oceanic samples or highly saline samples with low organic strength (Shiqiang and Changsong, 2007, Goh and Lim, 2008, Rho et al. 2018). However, it would be interesting to see whether the COD results are influenced in presence of organic contaminants.

***b. Determining influence of chloride on $COD_{OH}$ of standard organic solution***

As described in the previous section, standard solutions of glucose were prepared with theoretical $COD_{Cr}$ in the range 50 to 500 mg/L. In the presence of varying concentrations of calcium chloride, the influence of chloride on the $COD_{OH}$ was determined. The results are presented as below:

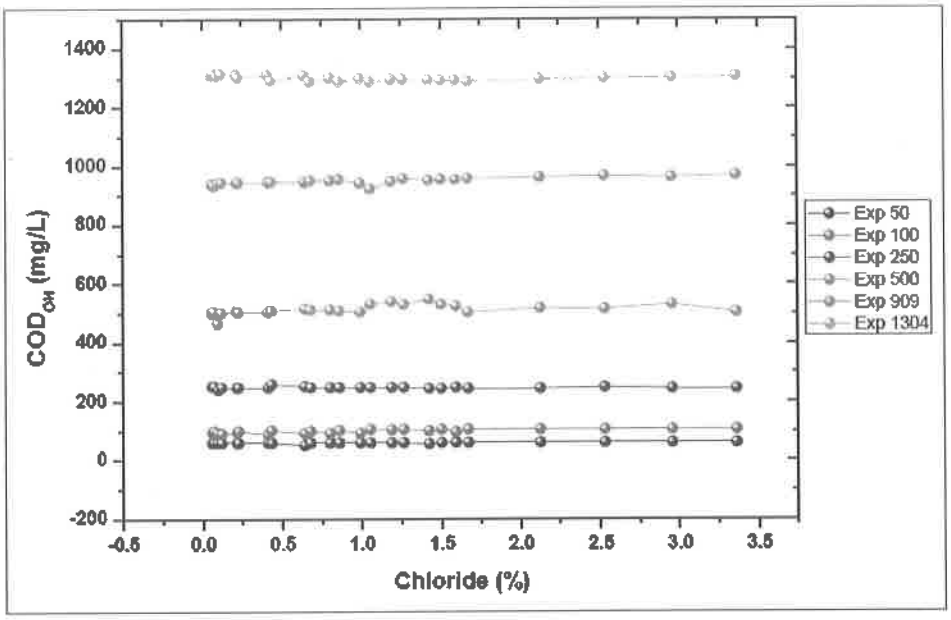


**Figure 16: Influence of increasing chloride concentrations on experimental COD ($COD_{OH}$) of standard glucose solutions**

Figure 16 shows almost nil influence of increasing chloride concentration on the estimation of $COD_{OH}$.

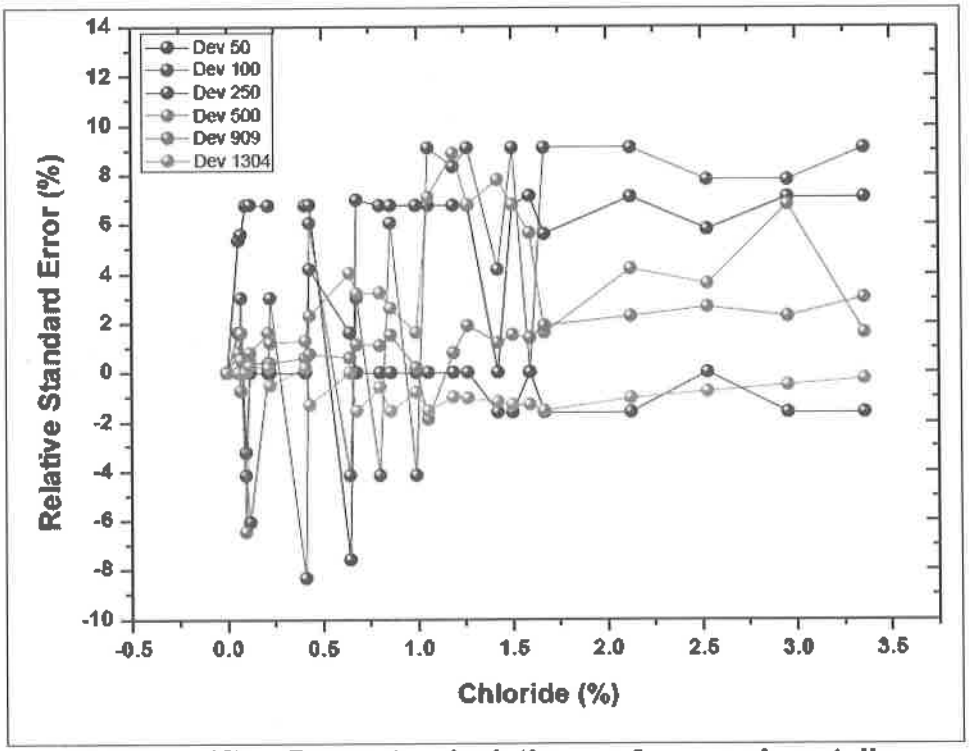


**Figure 17: Percent deviation of experimentally determined values of $COD_{OH}$ from the true value**

As can be seen in Figure 18, the effect of chloride on $COD_{OH}$ was found to be minimal with ≤ 10% deviation.

### c. *Calculation of $COD_{OH}$*

No correction is needed in the calculation as the RSE is within ± 10%. Hence, $COD_{OH}$ can be calculated as per the usual procedure given below:

$$COD_{OH}\ mg/L = \frac{[(A-B)C \times 8{,}000]}{mL\ of\ sample}$$

where:

A = mL standard sodium thiosulphate for blank;

B = mL standard sodium thiosulphate for sample;

C = normality of standard sodium thiosulphate;

The protocol of estimating COD by this method detailed in Rho et al., (2018).

### d. *Quality control and statistical analysis*

A quality control was also carried out to evaluate the robustness of the method. For this, two standard COD solutions of known concentrations (100 mg/L and 909 mg/L) were prepared and then they were spiked in the influent and effluent samples received from the ETP of MPL. The results of the analysis are presented below in Table (4):

Table 4: Estimated $COD_{OH}$, and percentage recovery

| Sr. No. | Sample Name | Theoretical $COD_{OH}$ | Estimated $COD_{OH}$ 1 | Estimated $COD_{OH}$ 2 | Mean $COD_{OH}$ | % Recovery |
|---|---|---|---|---|---|---|
| 1 | Std 1 | 100 | 99 | 96 | 97.5±1.5 | - |
| 2 | Std 2 | 909 | 856 | 851 | 853.5±2.5 | - |
| 3 | Outlet# | UK | 36 | 40 | 38±2.0 | - |
| 4 | Outlet + Std 1 | UK+100 | 135 | 131 | 133±2 | 93.4 |
| 5 | Outlet + Std 3 | UK+909 | 894 | 898 | 896±2.0 | 111.8 |
| 6 | Inlet# | UK | 1404 | 1404 | 1404±0.0 | - |
| 7 | Inlet + Std 1 | UK+100 | 1469 | 1473 | 1471±2.0 | 97.8 |
| 8 | Inlet + Std 3 | UK+909 | 2138 | 2135 | 2136.5±1.5 | 91.4 |

UK- unknown value; #Chloride concentration in inlet and outlet samples is 27,594 mg/L and 29,713 mg/L, respectively; Estimated COD 1&2 are measured in duplicates; - Not applicable

As can be seen in the above Table, the treated effluent (outlet) was estimated to have a $COD_{OH}$ having estimated COD of 38 mg/L. When spiked with known COD standards solutions of 100 mg/L and 909 mg/L fetched recoveries of 93.4% and 111.8%, respectively. The inlet sample having estimated COD 1404 mg/L fetched recoveries of 97.8% and 91.4%, when spiked with standards COD solutions of 100 mg/L, and 909 mg/L, respectively.

Thus, the method studied, exhibited very good recovery of spiked standards for the low strength 'treated effluent' (outlet) samples. For higher strength of COD, spiking with 100 g/L of standard yielded very good recovery (96.7%). However, as the strength of the standard solution increased, lower recoveries (91.4%) were obtained.

***e. Method limitation and conclusion***

Alkaline permanganate digestion method is usually recommended for sample with very low concentration of organic and high concentrations of chloride. The method was found to have not much interference due to chlorides (upto 3.5%) and our study with glucose standards has shown good recoveries upto 1400 mg/L. However, alkaline permanganate digestion method is not recommended for complex organics usually found in raw industrial effluents. Hence, this method can be recommended for estimation of COD of only treated effluents with $COD_{OH}$ <250 mg/L.

## 7.0 Estimation of $COD_{Cr\text{-}Corrected}$ and $COD_{OH}$ in wastewater samples

The methods discussed (methods A and B) discussed in this report were presented and discussed with MPL management team on 27th March 2019. Thereafter the laboratory of MPL carried out COD analysis of their ETP samples

and the data obtained by MPL laboratory during 2nd April to 12th April 2019 is presented herewith in Table (5):

**Table 5: COD values of estimated by MPL using both the methods: CSIR-NEERI's $COD_{Cr\text{-}Corrected}$ and $COD_{OH}$**

| Sr. No. | Sample description* | date of analysis | Chloride (mg/L) | Uncorrected $COD_{Cr}$ | CSIR-NEERI's $COD_{Cr\text{-}Corrected}$ | $COD_{OH}$ |
|---|---|---|---|---|---|---|
| 1 | RE 1 | 02.04.2019 | 28640 | 1540 | 1464 | 1415 |
| | TE 1 | | 29150 | 165 | 89 | 83 |
| | RE 2 | | 28453 | 1655 | 1579 | 1496 |
| | TE 2 | | 28616 | 142 | 66 | 74 |
| 2 | RE 1 | 03.04.2019 | 29564 | 1489 | 1413 | 1486 |
| | TE 1 | | 29140 | 148 | 72 | 69 |
| | RE 2 | | 29230 | 1564 | 1488 | 1510 |
| | TE 2 | | 29156 | 157 | 81 | 77 |
| 3 | RE 1 | 04.04.2019 | 29880 | 1512 | 1436 | 1412 |
| | TE 1 | | 28960 | 153 | 77 | 71 |
| | RE 2 | | 28790 | 1568 | 1492 | 1536 |
| | TE 2 | | 29410 | 155 | 79 | 84 |
| 4 | RE 1 | 05.04.2019 | 29456 | 1456 | 1380 | 1424 |
| | TE 1 | | 28978 | 146 | 70 | 66 |
| | RE 2 | | 29658 | 1614 | 1538 | 1488 |
| | TE 2 | | 28548 | 159 | 83 | 73 |
| 5 | RE 1 | 06.04.2019 | 29410 | 1562 | 1486 | 1510 |
| | TE 1 | | 29540 | 145 | 69 | 69 |
| | RE 2 | | 28657 | 1488 | 1412 | 1454 |
| | TE 2 | | 28321 | 154 | 78 | 72 |
| 6 | RE 1 | 08.04.2019 | 28961 | 1368 | 1284 | 1320 |
| | TE 1 | | 29154 | 159 | 83 | 76 |
| | RE 2 | | 28654 | 1496 | 1420 | 1389 |
| | TE 2 | | 28860 | 145 | 69 | 73 |
| 7 | RE 1 | 09.04.2019 | 29412 | 1398 | 1322 | 1368 |
| | TE 1 | | 29451 | 168 | 92 | 86 |
| | RE 2 | | 28654 | 1456 | 1380 | 1365 |
| | TE 2 | | 28687 | 182 | 106 | 99 |
| 8 | RE 1 | 10.04.2019 | 28740 | 1355 | 1279 | 1254 |
| | TE 1 | | 28564 | 135 | 59 | 61 |
| | RE 2 | | 28356 | 1398 | 1322 | 1340 |
| | TE 2 | | 28954 | 142 | 66 | 68 |
| 9 | RE 1 | 11.04.2019 | 28312 | 1396 | 1320 | 1352 |
| | TE 1 | | 28541 | 159 | 83 | 74 |
| | RE 2 | | 28658 | 1453 | 1377 | 1352 |
| | TE 2 | | 28563 | 161 | 85 | 79 |
| 10 | RE 1 | 12.04.2019 | 29541 | 1456 | 1380 | 1345 |
| | TE 1 | | 28654 | 145 | 69 | 62 |
| | RE 2 | | 28531 | 1389 | 1313 | 1354 |
| | TE 2 | | 28657 | 136 | 60 | 56 |

* RE- Raw Effluent, TE-Treated Effluent; 1 & 2 represents two treatment schemes at MPL

A two-tailed student's t-test conducted on the series of results obtained under the column $COD_{Cr}$ and $COD_{OH}$ is shown as follows:

| | N | Mean | Standard Deviation | Mean |
|---|---|---|---|---|
| $COD_{Cr\text{-}Corrected}$ | 40 | 741 | 675 | 107 |
| $COD_{OH}$ | 40 | 741 | 678 | 107 |
| Difference | 40 | -0.53 | 30.03 | 4.75 |

95% Confidence Interval (CI) for mean difference: (-10.13, 9.08)
T-Test of mean difference = 0 (vs not = 0):

T-Value = -0.11
P-Value = 0.913

Since the p value is 0.913 (i.e, $p>0.05$), we accept the null hypothesis that the two series are similar with 95% confidence. This also means that COD values obtained by both the developed methods yield very similar values and are unaffected by the effects of high concentration of both chlorides and organics.

## 8.0 Conclusion

M/s Manali Petrochemicals Ltd., Chennai generates effluents with very high concentrations of chloride (28,000 to 33,000 mg/L) as $CaCl_2$. High concentrations of chloride pose a serious challenge in accurately estimating chemical oxygen demand (COD) of wastewater samples as chloride also gets oxidized and leads to overestimation of COD values. This is in particular, a very serious issue in samples with low COD concentrations such as the treated effluent where the COD concentrations are expected to be less than 250 mg/L. The existing methods of COD analysis (22nd Edition APHA, 2012) using mercuric (II) sulphate masking are limited to chloride concentration of ≤ 2000 mg/L.

At present, there are two internationally accepted methods for estimation of COD under high saline conditions: (i) the potassium dichromate method of USEPA 410.3 (Revision, 1978) and (ii) the alkaline potassium permanganate method of China's Standard Method (Administration of Quality and Technical Supervision of the People's Republic of China, 1999). The USEPA method is applicable for $COD_{Cr}$ > 250 mg/L while the alkaline potassium permanganate is applicable for $COD_{OH}$ < 50 mg/L, respectively, Hence, both the methods were tested for their applicability in wastewater samples generated at MPL that were having COD in the range 50-150 mg/L in the treated effluent. After detailed study and experimentations, the

USEPA method was modified appropriately and referred to as $COD_{Cr\text{-}Corrected}$ while the China's Standard Method referred to as $COD_{OH}$ was used as defined. Both the methods ($COD_{Cr\text{-}Corrected}$ and $COD_{OH}$), have been tested for their robustness and repeatability and have been found to be satisfactory within the limitations given below (Table 6):

**Table 6: Method limitation and Relative Standard Error (%)**

| Method | Mercuric (II) Sulphate addition method | Chloride range (mg/L) | COD range (mg/L) | Relative standard error (RSE, %) |
|---|---|---|---|---|
| CSIR-NEERI's $COD_{Cr\text{-}Corrected}$ | Normal | 2000 - 15,000 mg/L | ≥100 mg/L to ≤500 mg/L | ≤12 % |
| | | 2000 - 15,000 mg/L | ≥50 mg/L to ≤ 100 mg/L | ≤20 % |
| | Slow addition of $HgSO_4$ with vigorous mixing | 2000 - 20,000 mg/L | ≥100 mg/L to ≤14,000 mg/L | ≤12 % |
| | | 20,000 - 37,000 mg/L | ≥100 mg/L to ≤500 mg/L | ≤20 % |
| | | 2,000 - 37,000 mg/L | ≥500mg/L to ≤14,000 mg/L | ≤5 % |
| $COD_{OH}$ | Not required | 2,000 - 37,000 mg/L | ≤ 250 mg/L | ≤10 % |

Hence both the methods, namely, the potassium dichromate modified method developed by CSIR-NEERI ($COD_{Cr\text{-}Corrected}$) and the alkaline permanganate method ($COD_{OH}$) of China's Standard Method are recommended for use and MPL can chose their method of choice as per their convenience.

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**Annexure A**

**TITLE:** Determination of Chemical Oxygen Demand of High Chloride Containing Aqueous Sample Using Open Reflux Potassium Dichromate Oxidation in Acidic Condition ($COD_{Cr\text{-}Corrected}$)

**ANALYTE:** Chemical Oxygen Demand ($COD_{Cr\text{-}Corrected}$)

**INSTRUMENTATION:** Reflux/ Digester & Titration Assembly

1.0 Scope and Application

1.1 When chloride level exceeds 2000 mg/L COD values are highly questionable because of the high chloride correction which must be made.

2.0 Summary of Method

2.1 Organic and oxidizable inorganic substances (such as Chloride) in an aqueous sample are oxidized by potassium dichromate solution in 50 percent (by volume) sulfuric acid solution. The excess dichromate is titrated with standard ferrous ammonium sulfate using orthophenanthroline ferrous complex (ferroin) as an indicator. Mercuric sulphate is used to complex the chloride, and silver sulphate is used as the oxidation catalyst.

Test results on samples containing chloride will be corrected with test results on the samples containing known amounts of chloride and no organics using a.

3.0 Sample Handling and Preservation

3.1 Collect the samples in glass bottles, if possible. Use of plastic containers is permissible if it is known that no organic contaminants are present in the containers.

3.2 Biologically active samples should be tested as soon as possible. Samples containing settleable material should be well mixed, preferably homogenized, to permit removal of representative aliquots.

3.3 Samples should be preserved with sulfuric acid to a pH < 2 and maintained at 4°C until analysis.

4.0 Interferences

4.1 Traces of organic material either from the glassware or atmosphere may cause a gross, positive error.

4.1.1 Extreme care should be exercised to avoid inclusion of organic materials in the distilled water used for reagent preparation or sample dilution.

4.1.2 Glassware used in the test should be conditioned by running blank procedures to eliminate traces of organic material.

4.2 Volatile materials may be lost when the sample temperature rises during the sulfuric acid addition step.

4.3 Chlorides are quantitatively oxidized by dichromate and represent a positive interference. A chloride correction is made using the procedure outlined in 7.7 of this method.

5.0 Apparatus

5.1 Reflux apparatus: Glassware should consist of a 500 mL Erlenmeyer flask or a 300 mL round bottom flask made of heat-resistant glass connected to an Allihn condenser by means of a ground glass joint. Alternatively, any commercially available equivalent reflux apparatus consisting programmed heating block and heat-resistant glass made digestion vessels and condenser may be used provided the digestions vessels are at least of 250 mL capacity.

6.0 Reagents

6.1 Standard potassium dichromate solution, (0.25 N): Dissolve 12.2588 g of $K_2Cr_2O_7$, primary standard grade, previously dried for 2 hours at 103°C in water and dilute to 1000 mL.

6.2 Sulfuric acid silver sulfate reagent: Conc. $H_2SO_4$ containing 23.5 g silver sulfate, $Ag_2SO_4$, per 4.09 kg. bottle. (With continuous stirring, the silver sulfate may be dissolved in about 30 minutes.)

6.3 Standard ferrous ammonium sulfate solution, 0.250 N: Dissolve 98 g of $Fe(NH_4)_2(SO_4)_2$ $6H_2O$ in distilled water. Add 20 mL of conc. $H_2SO_4$, (6.7), cool and dilute to 1 liter. This solution must be standardized against the standard potassium dichromate solution (6.1) daily.

6.3.1 Standardization: Dilute 25.0 mL of standard dichromate solution (6.1) to about 250 mL with distilled water. Add 20 mL conc. sulfuric acid (6.7). Cool, then titrate with ferrous ammonium sulfate titrant (6.3), using 10 drops of ferroin indicator (6.5).

Normality = [(mL $K_2Cr_2O_7$)(0.25)] / [mL $Fe(NH_4)_2(SO_4)_2$]

6.4 Mercuric sulfate: Powdered $HgSO_4$.

6.5 Phenanthroline ferrous sulfate (ferroin) indicator solution: Dissolve 1.48 g of 1-10-(ortho) phenanthroline monohydrate, together with 0.70 g of $FeSO_4.7H_2O$ in 100 mL of water. This indicator may be purchased already prepared.

6.6 Silver sulfate: Powdered $Ag_2SO_4$.

6.7 Sulfuric acid (sp. gr. 1.84): Concentrated $H_2SO_4$.

7.0 Procedure

7.1 For best results pipet a 20.0 mL aliquot of the sample into a digestion vessel. Add mercuric sulphate in the ratio of 10 mg to 1 mg chloride, based upon the mg of chloride in the sample aliquot. $HgSO_4$ should be added slowly over a period of two to three minutes while swirling the vessel/flask, followed

by a five minutes waiting period during which the flask should be swirled thoroughly or the mixture should be mixed thoroughly using a magnetic stirrer and magnetic stirring bar. Sulfuric acid-silver sulfate solution should be added next. The digestion vessel should be place in ice water/ cold water, and carefully add 30 mL of sulfuric acid-silver sulfate solution and gently swirl until the solution is thoroughly mixed. Sulphuric acid should be added slowly enough to prevent appreciable solution heating. The potassium dichromate solution will be added last. Add 10.0 mL of 0.25N $K_2Cr_2O_7$. Glass beads should be added to the reflux mixture to prevent bumping, which can be severe and dangerous.

**CAUTION:**
The reflux mixture must be thoroughly mixed before heat is applied. If this is not done, local heating occurs in the bottom of the flask, and the mixture may be blown out of the condenser.

7.1.1 If volatile organics are present in the sample, use an Allihn condenser and add the sulfuric acid-silver sulfate solution through the condenser, while cooling the flask, to reduce loss by volatilization.

7.2 Attach condenser to digestion vessel and carry out the test as in the standard procedure (APHA). Reflux the mixture for two hours.

7.3 Cool, and wash down the interior of the condenser with 25-30 mL of distilled water. Disconnect the condenser and wash the digestion vessel and condenser joint with 25-30 mL of distilled water. Cool to room temperature.

7.4 Titrate with standard ferrous ammonium sulfate using 10 drops of ferroin indicator. (This amount must not vary from blank, sample and standardization.) The color change is sharp, going from blue-green to reddish-brown and should be taken as the end point although the blue-green color may reappear within minutes.

7.5 A blank must be run, using 20 mL of distilled water in place of the sample together with all reagents and subsequent treatment.

7.6 For very high COD values, sample may be diluted with distilled water and resulting chloride concentration of the diluted sample must be calculated/ determined.

7.7 Use standard calculation to calculate uncorrected COD of sample ($COD_{Cr\text{-}S}$) as

$$COD_{Cr-S}\,(mg/L) = \frac{[(A-B)C \times 8{,}000]}{mL\ of\ sample}$$

where:
A = mL $Fe(NH_4)_2(SO_4)_2$ for blank;
B = mL $Fe(NH_4)_2(SO_4)_2$ for sample;
C = normality of $Fe(NH_4)_2(SO_4)_2$;

7.8 ***Chloride correction for COD due to Chloride Oxidation***: Chloride corrections of typical pure system (prepared by adding sodium chloride or calcium chloride $CaCl_2$) in terms of COD units should be plotted (**Plot # 1**) for

variations in chloride content at 10:1 mercuric sulphate to chloride weight ratios. Known amounts of calcium chloride (or sodium chloride) and mercuric sulphate will be added and 20 mL of water replaces the usual like size sample. The standard calculation is to be used to determine the COD value of each mixture without regard for a chloride correction. The chloride interval, as a maximum should be 3000 mg/L up to 20,000 mg/L chloride. Lesser intervals of greater concentrations must be run as per the requirements of the data, but extrapolation must not be used in any case.

7.9 **Chloride Correction Factor**: Prepare a working chloride correction curve of COD (due to chloride) versus mg/L of chloride, from the above plot (Plot # 1) for chloride contents as high as 20000 mg/L or more by fitting the data points with a linear trendline passing through origin and derive the linear equation (y=mx). Chloride Correction Factor for given chloride concentration will be determined from the slope (m) of this curve.

The Chloride Correction Factor (D) or COD due to chloride ($COD_{Cr\text{-}Cl}$) in the sample is to be calculated as:

$$COD_{Cr-Cl}(mg/L) = m \times [Cl^-] = D$$

Where:

m = slope of the linear chloride correction curve

$[Cl^-]$ = chloride concentration in the sample in mg/L

**NOTE:** Separate chloride correction curve must be established by each laboratory for its own equipment and reagents. Extrapolation of the curve must not be used in any case.

8.0 Calculation of Corrected COD of the sample ($COD_{cr}$): For chloride concentrations >2000 mg/L, uncorrected sample COD ($COD_{Cr}$-S) should be corrected to get the corrected COD vale ($COD_{Cr\text{-}Corrected}$) as follows:

$$COD_{Cr-corrected}(mg/L) = COD_{Cr-S} - COD_{Cr-Cl} \times 50\%$$

or

$$COD_{Cr-corrected}(mg/L) = COD_{Cr-S} - D \times 0.5$$

# Disclaimer

The results presented and the conclusion drawn in this report are based on independent studies carried out at CSIR-NEERI, Nagpur. The premise of the study was to suggest a robust method for estimation of COD for high chloride (in the form of calcium chloride) containing samples generated from M/s Manali Petrochemicals Ltd., Chennai (MPL) and to minimise the interference of chloride in COD estimation. The conclusions derived in the report do not however, circumvent the internationally established methods of COD estimation. M/s MPL shall exercise due diligence in following the results of the report.

ANNEXURE - 4 /20

केन्द्रीय प्रदूषण नियंत्रण बोर्ड
CENTRAL POLLUTION CONTROL BOARD
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE, GOVT. OF INDIA

CPCB/RLB/2019-20/ 235

9th May, 2019

To
Mr. C. Subash Chandra Bose
Whole Time Director (Works)
M/s. Manali Petrochemicals Limited
Ponneri High Road, Manali
CHENNAI – 600068

**Sub: Development of methodology for determination of COD for samples with high calcium chloride content**

**Ref: 1. Participation in COD analysis in RD(S) Laboratory on 29.4.19 and 30.4.19**
**2. Your mail dated 2.5.2019**

Sir

With reference to subject cited above, CPCB appreciates the steps taken by M/s. MPL, Chennai, for determination of COD with samples having high calcium chloride content. As per the method, chloride to mercuric sulphate is maintained at 1: 10 ratio, as given in APHA, 23rd edition. Only change encountered is proper mixing of the mixture for 10-15 minutes by using magnetic stirrer instead of shaking by hand for uncontrolled time. The reason stated by M/s. MPL is the reaction time taking between calcium chloride and mercuric sulphate. Since the reaction between calcium chloride and mercuric sulphate is slow, proper mixing of the mixture for a prolonged period is mandatory. This is achieved by mixing the mixture for fixed time at fixed speed. This ensures the proper mixing and eradicates the interference of chloride in COD analysis.

On 29.4.2019 and 30.4.2019, many trails were conducted in CPCB, Regional Laboratory, Bengaluru, Jointly by CPCB and MPL laboratory staff by varying sample volume, using different type of stirrers and by varying quantity of mercuric sulphate. While scrutinizing the results it is noted that the method developed by M/s. MPL, gives consistent results, when compared to other methods.

Hence the method developed by M/s. MPL, could be followed by maintaining 1: 10 ratio and stirring the mixture for 10-15 minutes in magnetic stirrer and carrying out the analysis.

Contd.....

क्षेत्रीय निदेशालय (दक्षिण) : निसर्ग भवन, ए-ब्लाक, प्रथम एवं द्वितीय तल, तिम्मय्या रोड, 7-डी मैन, शिवनगर, बेंगलूरु - ५६० ०७९.
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However, when an existing method is modified to meet special requirements, validation is required. Once the method is validated and published, the procedure could be followed by all PCBs and other industries that are generating effluent containing high calcium chloride. Effort made to find a suitable method for samples with high calcium chloride will become more authentic when it is validated. Hence it is advised to initiate steps for validation of the developed method.

It is advised to make a team comprising of members from CPCB, RD(S), Bengaluru and M/s. MPL, Chennai, to work on this project. The team members will initiate all required actions that are necessary to validate the method within a stipulated time.

Let us work together towards developing a new method as a part of research and development of both the organisations.

Wishing you all the best

Yours faithfully

S. Suresh
10/5/2019

(S.Suresh)
Regional Director

ANNEXURE - 5 122

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Dr. S. Mohan, M.E., Ph.D., F.N.A.E
Professor & Charted Engineer (I)

21st October 2019

To
C. Subash Chandra Bose
Director Works
Manali Petrochemicals Limited
Chennai – 600 068.

Manali Petrochemicals Limited (MPL), Chennai approached IIT Madras to carry out the analysis of Chemical Oxygen Demand (COD) using modified APHA standard method for effluent having high concentration of calcium chloride concentration. CPCB has advised MPL to validate the modified procedure before implementing the same for future analysis of COD. In this connection, COD analysis was carried out jointly with MPL officials on 12th September 2019 at Environmental and Water Resources Engineering laboratory, Department of Civil Engineering, IIT Madras. COD analysis was carried out in Open reflux apparatus following the protocol as specified in 23rd edition of APHA standards Part. 5220, Open reflux Method Vol. 5, pp. 18-19 with the except that mercuric sulphate of 1:10 ratio was used for suppressing chloride interferences in the COD estimation. The overall sample preparation and analysis is given below.

Take 20 ml of sample
↓
Add 6 gm of $HgSO_4$
↓
Add 5 ml of $H_2SO_4$
↓
20 mins of stirring with magnetic stirrer
↓
Add 10 ml of $K_2Cr_2O_7$
↓
Add 25 ml of $H_2SO_4$
↓
2 hour open reflux digestion
↓
Titration of sample with Ferrous Ammonium Sulphate after required cooling

The end point is taken as colour change from Pale Yellow/green colour to wine red colour and the COD was estimated using the formula.

$$COD\ (mg/L) = \frac{(a-b) \times N \times 8000}{mL\ of\ sample}$$

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Where:

A – mL of Fe $(NH_4)_2(SO_4)_2$ required for the blank

B - mL of Fe $(NH_4)2(SO_4)_2$ required for the sample

N – Normality of Fe $(NH_4)_2(SO_4)_2$

A total of two samples with triplicates each were analysed during the COD analysis such as synthetic samples having 4.5% calcium chloride (samples 4 – 6) and influent samples from Effluent Treatment plant (samples 7 – 9).

| Sl No | Sample ID | Titrated Value | COD mg/L |
|---|---|---|---|
| 1. | Blank 1 | 25.7 | - |
| 2. | Blank 2 | 25.6 | - |
| 3. | COD Standard – 150 ppm | 22.0 | 144.7 |
| 4. | 4.5 % $CaCl_2$ sample 1 | 19.8 | 230 |
| 5. | 4.5% $CaCl_2$ sample 2 | 21.5 | 164.3 |
| 6. | 4.5% $CaCl_2$ sample 3 | 21.5 | 164.3 |
| 7. | TET sample 1 | 21 | 183.9 |
| 8. | TET sample 2 | 21.1 | 180 |
| 9. | TET sample 3 | 21 | 183.9 |

For calculation purposes, out of the two Blank values, the value of 25.7 (Blank 1) is taken as the representative blank value for COD analysis.

From the above table, we observed that based on the method used by MPL, it was found that the COD estimation were found to be consistent during all the trails except in trail 1 of 4.5% $CaCl_2$ (sample 4). Since sample 5 & 6 resulted in concomitant values, the sample 4 has been discarded and the value of COD estimated in this case was taken as 164.3 mg/L. Also, we observed that 1:10 ratio of Mercuric Sulphate and Chloride found to be working well by reducing the chloride interferences which is shown in consistency results of COD analysis.

(Dr. S. Mohan)

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**Dr. S. KANMANI**, B.E., M.E., Ph.D.
*Professor & Director*


1/24

Lr.No. 0109/CES/DIR/MPL/2019-20 Dt. 21.10.2019

To
Manali Petrochemicals Limited
Ponneri High Road, Manali,
Chennai -600068

Sample Description: Water Received On: 13.09.2019
Sample Parameter: CODCommenced On: 13.09.2019
Date of report: 14.10.2019

Ref: Letter No: MPL / CES/2019., Dt: 04.09.2019

| SNO | SAMPLE ID | PROTOCOL | UNITS | RESULTS |
|---|---|---|---|---|
| 1 | TET | MPL Method | mg/L | Trail -1 =141<br>Trail -2 =149<br>Trail -3 =156 |
| 2 | 150ppm COD standard in 4.5% Cacl2 solution | MPL Method | mg/L | Trail -1 =160<br>Trail -2 =153<br>Trail -3 =164 |

Note: Analysis was carried out in the presence of MPL representative.

Yours faithfully

21/10/19

DIRECTOR

Dr. S. KANMANI
Director
Centre for Environmental Studies
Department of Civil Engineering
Anna University
Chennai-600 025

M.V.

(M.VANCHINATHAN)
21.10.19

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# CSIR - Central Leather Research Institute
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Dr. S. SWARNALATHA
Scientist
Environmental Science and Engineering Division


To

**Manali Petrochemicals Limited (MPL)**
Ponneri High Road, Manali, Chennai- 600 068

Sample description: water
Sample Parameter: COD

Received on: 13/09/2019
Commenced on: 13/09/2019
Date of report:04/10/2019

| S.No | Sample ID | Protocol | Unit | Results |
|---|---|---|---|---|
| 1 | TET* | MPL method# | mg/L | Trial-1=159<br>Trial-2=163<br>Trial-3=167 |
| 2 | STD150PPM in 4.5% $CaCl_2$* | MPL method# | mg/L | Trial-1=175<br>Trial-2=171<br>Trial-3=163 |

* CLRI is not responsible for sample collection or preparation.

#As provided by MPL, copy of the method used for analysis is attached here with signatureof the undersigned for the reference.

Note: Analysis was carried out in the presence of MPL representatives.

S. Swarnalatha

**(Dr. S. Swarnalatha)**

डॉ. एस. स्वर्णलता Dr. S. SWARNALATHA
वैज्ञानिक Scientist
पर्यावरण विज्ञान एवं अभियांत्रिकी प्रभाग
Environmental Science & Engineering Division
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CSIR - Central Leather Research Institute
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| MANALI PETROCHEMICALS LIMITED. | | | |
|---|---|---|---|
| R&D/QA | DETERMINATION OF CHEMICAL OXYGEN DEMAND IN WATER SAMPLES | SHEET | 1 |
| MTM-01 | | REV | 1 |
| SECTION – 241 | | DATE | 05.08.2019 |

**1.0 TITLE**

DETERMINATION OF CHEMICAL OXYGEN DEMAND (COD)

**2.0 PURPOSE**

The purpose is to determine chemical oxygen demand in water and waste water

**3.0 PRINCIPLE**

The chemical oxygen demand is the amount of oxygen required for chemical oxidation of organic matter using a strong chemical oxidant such as potassium dichromate under by refluxing the sample for two hours at 150C .most of the organic matter is oxidized when boiled with a mixture of potassium dichromate and sulphuric acid producing carbon dioxide and water. A sample is refluxed with a known amount of potassium dichromate in sulphuric acid medium and the excess of unreduced dichromate remaining after the reaction is back titrated against standard ferrous ammonium sulphate. The amount of dichromate consumed is proportional to the oxygen to the required to oxidize the oxidsable organic matter present in the sample.

**4.0 SCOPE**

This method is a chemical method applicable for measurement of organic load in water and waste water.

**5.0 INTEREFERENCE**

Straight chain alipathic compounds, aromatic hydrocarbons, fatty acids, chlorides, nitrites, and iron, are the main interfering radicals. The interference caused by chlorides can be eliminated by the addition of mercuric sulphate to the sample prior to addition of other reagents. About 0.4 mg of Hgso4 is adequate to complex 40mg of CL ions in the form of poorly ionized HgCL.

**6.0 APPARATUS**

**6.1 Reflux *Apparatus*:** Consisting of a flat bottom 150 to 250 ml capacity tubes with ground glass joint and long air condensers.

**6.2 Burner *or Hot Plate*:** it is convenient to have a digester block on which series of refluxing sets are connected to have uniform heating to all the tubes.

—S. Sivamalatha

| MANALI PETROCHEMICALS LIMITED. | | | |
|---|---|---|---|
| R&D/QA | DETERMINATION OF CHEMICAL OXYGEN DEMAND IN WATER SAMPLES | SHEET | 2 |
| MTM-01 | | REV | 1 |
| SECTION – 241 | | DATE | 05.08.2019 |

**7.0 REAGENTS**

**7.1** ***Standard Potassium dichromate*** **(0.25N)** 12.259g potassium dichromate previously dried at 103C for 24 hours in distilled water and dilute to 1000ml.

**7.2 Sulphuric *Acid*:** Add 22g silver sulphate to 4 kg conc.H2SO4 bottle or 1g to 100ml of H2SO4

Keep overnight for dissolution. Shake well after dissolution.

**7.3** ***Standard Ferrous ammonium sulphate*** **(0.1N)** Dissolve 39g of Fe (NH4)2 (SO4)2 6H20 in distilled water. Add 20ml conc.H2so4 cool and dilute to 1 liter. Standardize this solution daily against the standard K2CR2O7 of 0.25 N .

**7.4** ***Ferroin Indicator:*** Dissolve 1.485g 1.10 phenanthroline monohydrate and 605mg Fe SO4.7H2O in water and dilute to 100ml. This indicator solution **could be also purchased already prepared.**

**7.5** ***Mercuric Sulphate*****:** HgSO4 crystals.

**7.6 Standardization: Dilute 10ml standard K2CR2O7 of 0.25 N** solution to about 100ml with distilled water. Add 30ml conc. H2SO4 and cool. Add 3-4 drops of ferrion indicator and titrate with Ferrous Ammonium sulphate of 0.1N of till the color change to wine red.

**Normality of ferrous ammonium sulphate** = 10 x 0.25/ml Fe(NH4)2 (SO4)2 consumed.

J. Sreenalatha

| MANALI PETROCHEMICALS LIMITED. | | | |
|---|---|---|---|
| R&D/QA | DETERMINATION OF CHEMICAL OXYGEN DEMAND IN WATER SAMPLES | SHEET | 3 |
| MTM-01 | | REV | 1 |
| SECTION – 241 | | DATE | 05.08.2019 |

PROCEDURE

Estimate the chloride content of the sample by Argentometric method. (Approximately chloride content is 30000ppm so 1:10 ratio of $Cl^-$ : $HgSO_4$ is 6 grams for 20 ml of sample). Take 20 ml of the sample in a reflux tube and add 6gram of $HgSO_4$ and 5ml of $H_2SO_4$ at cool condition and stir for 15 min in magnetic stirrer or 25 min by vigorous shaking by hand so that chlorides are converted into poorly ionized mercuric chloride. (Allow to stand for few minutes and observe the solution white precipitate at the bottom and clear liquid at the top indicates complete masking of chlorides if hazy or turbid appears further stirring required) Add 10 ml. Standard 0.25N $k_2Cr_2O_7$ followed by very slow addition of 25ml sulphuric acid at ice cool condition (sulphuric acid which already contains silver sulphate)

Connect the tube to condenser and reflux for 2hrs at 150°C temperature. Cool and wash down the condensers with 30 ml quantity of distilled water. Remove the flask and add about 30ml distilled water. Cool and titrate against 0.1N ferrous ammonium sulfate using ferroin as indicator. Color changes sharply from green blue to wine red.

Reflux the reagent black under identical conditions, preferably simultaneously with the sample.

CALCULATION

$$mg/L\ COD = (a-b) \times N \times 8000 / ml\ sample$$

Where:

a – mL of $Fe(NH_4)_2(SO_4)_2$ required for the blank

b – mL of $Fe(NH_4)_2(SO_4)_2$ required for the sample

N – Normality of $Fe(NH_4)_2(SO_4)_2$

EXPRESSION OF RESULTS

A. Results are expressed as mg/L of $O_2$

B. Report to the nearest whole number

—S. Sivamalatha

| MANALI PETROCHEMICALS LIMITED. | | | |
|---|---|---|---|
| R&D/QA | DETERMINATION OF CHEMICAL OXYGEN DEMAND IN WATER SAMPLES | SHEET | 4 |
| MTM-01 | | REV | 1 |
| SECTION – 241 | | DATE | 05.08.2019 |

PRECISION AND ACCURACY

Precision and accuracy both depends upon COD values and accuracy up to 10% is expected to an good analyst

Neutralization of chloride content with mercuric sulphate takes long time so the magnetic stirrer will help in 100% neutralization compared with manual shaking. Especial for 4.5% calcium chloride effluent samples

The accuracy of this method is still not known. For most organic compounds get oxidation is 95 - 100% of theoretical value.

PRECAUTIONS

1. The strength of sulfuric acid in final solution should be 18 N i.e. 50%( during digestion )
2. The trend of making mixture should be sample (swirl) , $HgSO_4$,$H_2SO_4$, $K_2Cr_2O_7$ and conc. $H_2SO_4$ ( with silver sulphate)
3. As far as possible, reflux blank and the samples simultaneously.
4. Ensure very slow addition of sulphuric acid in the tube at ice cool condition
5. After refluxing, cool, use required amount of distilled water for washing the container. Ensure cooling and then titrate.
6. Magnetic stirrer RPM 500 to 700 to be maintained for proper mixing and to avoid flash over of Hgso4 in the walls of the reactor

REFERENCE

1. APHA ( American public health association), (1998) : Standard Method for examination of water wastewater (20th edition) , Washington, D.C ., USA , p .5.12- 5.14

S. Sivaramakrishna

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# ALAGAPPA COLLEGE OF TECHNOLOGY
## ANNA UNIVERSITY
CHENNAI-600 025, INDIA

Phone : +91 – 44 – 2235 9166

**Dr. S. SIVANESAN**
Professor
Department of Applied Science and Technology

E-mail : siva@annauniv.edu
sivanesh1963@gmail.com


## Test Report

| | | | |
|---|---|---|---|
| Costomer Name & Address : | Manali Petrochemicals Limited<br>Ponneri High Road,<br>Manali,<br>Chennai - 600068 | Received On<br>Test Commenced On<br>Test Report Issuing Date | :13.09.2019<br>:13.09.2019<br>:04.10.2019 |
| Sample Description<br>Sample Parameter | | : Water<br>: COD | |

| S.No | Sample ID | Protocol | Unit | Results |
|---|---|---|---|---|
| 1 | TET | MPL method | Mg/L | Trial -1=162<br>Trial -2=162<br>Trial -3=158 |
| 2 | STD150PPM in 4.5% $CaCl_2$ | MPL method | Mg/L | Trial -1=170<br>Trial -2=168<br>Trial -3=168 |

Note : Analysis was carried out in the presence of MPL representatives .

**.....End of Report .....**

Verified by

Sivanesan

(S. Sivanesan) 04/10/19

Dr. S. SIVANESAN
Professor
Department of Applied Science and Technology
Alagappa College of Technology
Anna University, Chennai-600 025.

TAMILNADU POLLUTION CONTROL BOARD
ADVANCED ENVIRONMENTAL LABORATORY
NO. 76, MOUNT SALAI, GUINDY,
CHENNAI -32
TEST REPORT

NABL

DBS

OHSAS 18001:2007

ULR-TC687319000000197F

ROA NO. September-751 – September-758/ 2019-20 dated: 16.09.2019

| | | | | |
|---|---|---|---|---|
| Name and address of the sender | | M/s. Manali Petrochemicals Ltd., Ponneri High Road, Manali, Chennai – 600 068. | | |
| Nature and number of samples. | : | 8 numbers of Water Samples | Sample quantity 250 ml | Sealed and fastened in 250ml polythene container |
| Date and time of sample collection | | 12.09.2019, | Date and time of samples received at the lab | 12.09.2019, 10.30 AM |
| Point of Collection | 1 | MPL Treated Effluent tank sample (TET) | | |
| | 2 | 150ppm COD standard in 4.5% $Cacl_2$ solution | | |
| Analysis Starting date | : | 12.09.2019 | Analysis Completion date | : 16.09.2019 |

| S. No | Code no / Lab Code no / Parameters | Unit | Blank | KHP STD | MPL Treated Effluent tank sample (TET) | | | 150ppm COD standard in 4.5% $Cacl_2$ solution | | | Test Method |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Trail-1 | Trail-2 | Trail-3 | Trail-1 | Trail-2 | Trail-3 | |
| | | | Sep-751 | Sep-752 | Sep-753 | Sep-754 | Sep-755 | Sep-756 | Sep-757 | Sep-758 | |
| 1. | COD | mg/L | 25.7 | 145 | 137 | 149 | 145 | 145 | 157 | 161 | MPL Method |

16/9/19

Authorized Signatory
[AD(Lv) Dy.CSO]
[Sankara Subramanian, B. Helen Mary]

******End of Report******

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Web : www.mettexlab.com
Phone : 044-22323163, 42179490, 91
Fax : 044-22311034

# CHENNAI METTEX LAB PRIVATE LIMITED

Jothi Complex, 83, M.K.N. Road, Guindy, Chennai - 600 032.

(Approved/Recognized by APEDA, AGMARK, GAFTA, EIC, FSSAI, BIS & MoEF)

## TEST REPORT



ISSUED TO : M/s.Manali Petrochemicals Limited,
Ponneri High Road,
Manali, Chennai - 600 068.

T.C Date : 11.09.2019

T.C No : CML/19-20/34162

Date Of Receipt : 11.09.2019

Cust. Ref : SRF Dated : 11.09.19.

Analysis Commenced On : 11.09.2019

Lab No : 2038863

Analysis Completed On : 11.09.2019

Sample Description : TET Water.

| S.No | Test Parameters | Protocol | Results | | |
|---|---|---|---|---|---|
| | | | Trial - I | Trial - II | Trial - III |
| 1 | COD | MPL Method | 156 | 152 | 160 |

Note: MPL - Manali Petrochemical Limited.

End of Report

For Chennai Mettex Lab Private Limited

P. KAVITHA
Technical Manager

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(Approved/Recognized by APEDA, AGMARK, GAFTA, EIC, FSSAI, BIS & MoEF)

## TEST REPORT



ISSUED TO : M/s.Manali Petrochemicals Limited,
Ponneri High Road,
Manali, Chennai - 600 068.

T.C Date : 11.09.2019

T.C No : CML/19-20/34163

Date Of Receipt : 11.09.2019

Cust. Ref : SRF Dated : 11.09.19.

Analysis Commenced On : 11.09.2019

Lab No : 2038864

Analysis Completed On : 11.09.2019

Sample Description : **150ppm COD Standard in 4.5% CaCl2.**

| S.No | Test Parameters | Protocol | Results | | |
|---|---|---|---|---|---|
| | | | Trial - I | Trial - II | Trial - III |
| 1 | COD | MPL Method | 164 | 160 | 160 |

Note: MPL - Manali Petrochemical Limited.

*End of Report*

For Chennai Mettex Lab Private Limited

P. KAVITHA
Technical Manager

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## TEST REPORT



ISSUED TO : M/s.Manali Petrochemicals Limited,
Ponneri High Road,
Manali, Chennai - 600 068.

T.C Date : 11.09.2019

T.C No : CML/19-20/34164

Date Of Receipt : 11.09.2019

Cust. Ref : SRF Dated : 11.09.19.

Analysis Commenced On : 11.09.2019

Lab No : 2038865

Analysis Completed On : 11.09.2019

Sample Description : COD Standard.

| S.No | Test Parameters | Protocol | Results |
|---|---|---|---|
| 1 | COD | MPL Method | 148 |
| Note: MPL - Manali Petrochemical Limited. | | | |

End of Report

For Chennai Mettex Lab Private Limited

P. KAVITHA
Technical Manager

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SINCE 1989

# OMEGA INSPECTION & ANALYTICAL LABORATORY

T.S. No. 57,58 & 35, 36 GUINDY INDUSTRIAL ESTATE, GUINDY, CHENNAI - 600 032,TN,INDIA.

*Chemical Analysis by Spectrometer, Mechanical Test, NDT, Water, Etc.,*
*Our Esteemed Customers : HYUNDAI, FORD, BHEL, BV, IBR, IRS, EIL, NLC, BIS, RITES, CPWD, Etc.,*

## Test Report



Report Date : 12-09-2019

Customer:
M/S MANALI PETROCHEMICALS LIMITED
Ponneri High Road
Manali
Chennai - 600068

TR.No. : OIAL/2019/09-7972

Sample Details :
ETP Waste Water Sample
Sample ID : TEI

Our Ref. TOCR No : 19-3521 Dt.11.09.2019
Party's Ref : Letter Dt.11.09.2019
Nature of Test : Water Analysis
Test Method : As per customer request

Sample Drawn By : Customer
Test Started On : 11-09-2019
Test Completed On : 11-09-2019

## Test Results

| SL.NO. | TEST PARAMETERS | PROTOCOL | RESULTS |
|---|---|---|---|
| 1. | COD | MPL METHOD | TRIAL-1 = 152 mg/L<br>TRIAL-2 = 160 mg/L<br>TRIAL-3 = 160 mg/L |

NOTE :- MPL METHOD (MANALI PETROCHEMICALS LIMITED - METHOD)

==========CONCLUDED==========

M. SENTHIL KUMAR
Chemist
Tested / Verified By

P. DHANASEKARAN
Deputy Quality Manager
Authorised Signatory

Note : Certified that the test enumerated above have been carried out in conformity with standard Testing procedures and relevant specifications. The Certificate refers ONLY to the particular sample(s) submitted for Test. Sample description is not verified in all cases and is given as described by Customer. All Complaints about this should be communicated in writing within 15 days from the date of issue of this report. The report shall not be reproduced in part /full,without the approval of OIAL.

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# OMEGA INSPECTION & ANALYTICAL LABORATORY

T.S. No. 57,58 & 35, 36 GUINDY INDUSTRIAL ESTATE, GUINDY, CHENNAI - 600 032,TN,INDIA.

*Chemical Analysis by Spectrometer, Mechanical Test, NDT, Water, Etc.,*
*Our Esteemed Customers : HYUNDAI, FORD, BHEL, BV, IBR, IRS, EIL, NLC, BIS, RITES, CPWD, Etc.,*

## Test Report



Report Date : 12-09-2019

| | |
|---|---|
| Customer:<br>M/S MANALI PETROCHEMICALS LIMITED<br>Ponneri High Road<br>Manali<br>Chennai - 600068 | TR.No. : OIAL/2019/09-7973<br>Sample Details :<br>ETP Waste Water Sample<br>Sample ID : 4.5% CaCl2 + Standard 150rpm Standard Solution |
| Our Ref. TOCR No : 19-3521 Dt.11.09.2019<br>Party's Ref : Letter Dt.11.09.2019<br>Nature Of Test : Water Analysis<br>Test Method : As per customer request | Sample Drawn By : Customer<br>Test Started On : 11-09-2019<br>Test Completed On : 11-09-2019 |

## Test Results

| SL.NO. | TEST PARAMETERS | PROTOCOL | RESULTS |
|---|---|---|---|
| 1. | COD | MPL METHOD | TRIAL-1 = 160 mg/L<br>TRIAL-2 = 168 mg/L<br>TRIAL-3 = 164 mg/L |

NOTE :- MPL METHOD (MANALI PETROCHEMICALS LIMITED - METHOD)

==========CONCLUDED==========

M. SENTHIL KUMAR
Chemist
Tested / Verified By

P. DHANASEKARAN
Deputy Quality Manager
Authorised Signatory

Note : Certified that the test enumerated above have been carried out in conformity with standard Testing procedures and relevant specifications. The Certificate refers ONLY to the particular sample(s) submitted for Test. Sample description is not verified in all cases and is given as described by Customer. All Complaints about this should be communicated in writing within 15 days from the date of issue of this report. The report shall not be reproduced in part /full,without the approval of OIAL.

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# Test Report

SAMPLE NOT DRAWN BY SGS INDIA PVT. LTD.

**Report No** : CE19-003989.001 **Print Date** : 13/09/2019

**JOE No** : CE19-003989

**Report Control No** : CER0000292656

**Sample Described by Customer as** : TET

| | |
|---|---|
| **Client Name** | : MANALI PETROCHEMICALS LIMITED |
| **Client Address** | : Ponneri High Road |
| **Postal Code** | : 600068 |
| **State** | : Tamil Nadu |
| **Country** | : INDIA |
| **Sample Type** | : TET |
| **Received** | : 11/09/2019 |
| **Sample Qty. Recd.** | : 1L |
| **Sampling Date** | : 11.09.19 |
| **Sampling Time** | : 08.00AM |
| **NABL Group** | Pollution & Enviornment |
| **NABL Sub Group** | Waste Water (Effluents/Sewage) |
| **Test Start/End Date** | : 11/09/2019 - 13/09/2019 |

| Analysis | Method | Unit | Result | | |
|---|---|---|---|---|---|
| | | | Trail-1 | Trail-2 | Trail-3 |
| COD as O2 | MPL method | mg/L | 149 | 160 | 156 |

**Per pro SGS India Private Ltd**

**M_ELLAPPAN**

**Senior Executive**

**Authorized Signatory**

****End of Report****



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**SGS India Pvt. Ltd.** Multi Laboratory, 28 B/1 (SP), 28 B/2 (SP), IInd Main Road, Opposite to State Bank of India, Ambattur Industrial Estate, Chennai - 600 058. Tel: 91-44-66081600

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# Test Report

SAMPLE NOT DRAWN BY SGS INDIA PVT. LTD.

**Report No** : CE19-003989.002 **Print Date** : 13/09/2019

**JOE No** : CE19-003989

**Report Control No** : CER0000292656

**Sample Described by Customer as** : 150 ppm COD STD IN 4.5% CaCl2

| | |
|---|---|
| **Client Name** | : MANALI PETROCHEMICALS LIMITED |
| **Client Address** | : Ponneri High Road |
| **Postal Code** | : 600068 |
| **State** | : Tamil Nadu |
| **Country** | : INDIA |
| **Sample Type** | : 150 ppm COD STD IN 4.5% CaCl2 |
| **Received** | : 11/09/2019 |
| **Sample Qty. Recd.** | : 1L |
| **Sampling Date** | : 11.09.19 |
| **Sampling Time** | : 08.00AM |
| **NABL Group** | Pollution & Enviornment |
| **NABL Sub Group** | Waste Water (Effluents/Sewage) |
| **Test Start/End Date** | : 11/09/2019 - 13/09/2019 |

| Analysis | Method | Unit | Result | | |
|---|---|---|---|---|---|
| | | | Trail-1 | Trail-2 | Trail-3 |
| COD as O2 | MPL method | mg/L | 164 | 164 | 160 |

**Per pro SGS India Private Ltd**

**M_ELLAPPAN**

**Senior Executive**

**Authorized Signatory**

****End of Report****



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# Interstellar Testing Centre Pvt. Ltd.

ITC Labs

## TEST REPORT

139

ORIGINAL

Report No. ICE-1909130130



**Issued To:**

**M/s. Manali Petrochemicals Limited.,**
Manali, Chennai - 600068

**SUBMITTED SAMPLE**

| | | | | | |
|---|---|---|---|---|---|
| Sample Registration No | : | E02-1909100126 | Received On | : | 10.09.2019 |
| Sample Description | : | TET Sample | Commenced On | : | 10.09.2019 |
| Sample Appearance | : | Colourless Liquid | Completed On | : | 13.09.2019 |
| **Sample details (If any):-** | | | Date of Report | : | 13.09.2019 |
| Sample Quantity | : | 250ml X 1 No | | | |
| Customer Reference | : | Customer Letter Dated: 10.09.2019 | | | |
| Discipline | : | **Chemical Testing** | | | |
| Group | : | **Pollution & Environment** | | | |
| Sample Condition | : | Good | | | |

| S.NO | *Parameter | Test Method | Unit | Result |
|---|---|---|---|---|
| I. | Chemical Oxygen Demand | MPL Method | mg/L | Trial – 1 = 148<br>Trial – 2 = 152<br>Trial – 3 = 152 |

* Parameters for the above sample are not covered under NABL Scope.

***** END OF REPORT *****

J. P.

Verified by

Authorised by
M. VIJAYAN
Section In-Charge
Environment Sectio

**Interstellar Testing Centre Pvt. Ltd.**
Plot No. 2,S.No.12/2A, Industrial Estate,
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Website : www.itclabs.com

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1140

# Interstellar Testing Centre Pvt. Ltd.

ITC Labs

## TEST REPORT

ORIGINAL

Report No. ICE-1909130131



Issued To:

**M/s. Manali Petrochemicals Limited.,**
Manali, Chennai - 600068

**SUBMITTED SAMPLE**

| | | | | | |
|---|---|---|---|---|---|
| Sample Registration No | : | E02-1909100127 | Received On | : | 10.09.2019 |
| Sample Description | : | 150 ppm COD STD in 4.5 % $CaCl_2$) | Commenced On | : | 10.09.2019 |
| Sample Appearance | : | Colourless Liquid | Completed On | : | 13.09.2019 |
| **Sample details (if any):-** | | | Date of Report | : | 13.09.2019 |
| Sample Quantity | : | 250ml X 1 No | | | |
| Customer Reference | : | Customer Letter Dated: 10.09.2019 | | | |
| Discipline | : | **Chemical Testing** | | | |
| Group | : | **Pollution & Environment** | | | |
| Sample Condition | : | **Good** | | | |

| S.NO | *Parameter | Test Method | Unit | Result |
|---|---|---|---|---|
| I. | Chemical Oxygen Demand | MPL Method | mg/L | Trial – 1 = 164<br>Trial – 2 = 160<br>Trial – 3 = 156 |

* Parameters for the above sample are not covered under NABL Scope.

***** END OF REPORT *****

J. P.
Verified by

Authorised by
M. VIJAYANAND
Section In-Charge
Environment Sectio

Interstellar Testing Centre Pvt. Ltd.
Plot No. 2,S.No.12/2A, Industrial Estate,
Perungudi, Sholinganallur Taluk, Chennai - 600 096.
Ph : 044 - 24962512
Email : itclabs.chennai@itclabs.com
Website : www.itclabs.com

Disclaimer :

- The test result related only to the items tested
- The test report shall not be reproduced in full or part without the written approval of ITC Labs, Chennai
- The test items shall not be retained more than 15 days from the date of issue of test report except in the case as required by the regulatory bodies and Customers

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EKDANT ENVIRO SERVICES (P) LIMITED

NABL Accredited & MoEF Recognised Laboratory
An ISO 9001 : 2008 and OHSAS 18001 : 2007 Certified Company
No R-7/1, AVK Tower, North Main Road, Anna Nagar West Extn., Chennai - 600 101, India
Phone : 044 - 2615 3349 / 4856 2349 Mobile : 9444411178
E-mail : ekdantlab@gmail.com / info@ekdantlab.co.in
Web : www.ekdantlab.co.in

Reference No. EES/W/074/09 
Report No 139/09 Report Date: 14.09.2019

Customer Name : M/s. Manali Petrochemicals Limited,

Customer Address : Ponneri High Road, Manali, Chennai-600 068.

| | | | |
|---|---|---|---|
| Sample Name | : Water | Sample Quantity | : 250 ml |
| Sample Description | : Water(TET Sample) | Sample Received on | : 10.09.2019 |
| Reference | : Test Request Form Dated 10.09.19 | Test Started on | : 10.09.2019 |
| Sample Identification | : NA | Test Completed on | : 14.09.2019 |
| Sample Drawn By | : Customer | | |

## TEST RESULTS

| S.NO | Parameter | Test Method | Unit | Results | | |
|---|---|---|---|---|---|---|
| Chemical | | | | Trail-1 | Trail-2 | Trail-3 |
| 1 | Chemical Oxygen Demand | MPL Method | mg/l | 162 | 158 | 154 |
| 2 | Chloride | IS 3025 (Part-32) | mg/l | 31,357 | | |

-- End of the Report --

EKDANT ENVIRO SERVICES (P) LTD. CHENNAI 600 101.

Authorized Signatory
R. NIRMALA DEVI

NOTE: 1. Test results shown in this test report relate only to the items tested.
2. This test report shall not be reproduce anywhere except in full and in same format without the Approval of the laboratory.
3. Unless informed by the customer the test items will not be retained for more than 10 days from The date of issue of test report (exceptional for Microbiology and wastewater for which retaining time 7 days.)

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# EKDANT ENVIRO SERVICES (P) LIMITED

NABL Accredited & MoEF Recognised Laboratory
An ISO 9001 : 2008 and OHSAS 18001 : 2007 Certified Company
No.R-7/1, AVK Tower, North Main Road, Anna Nagar West Extn., Chennai - 600 101. India
Phone : 044 - 2615 3349 / 4856 2349 Mobile : 9444411178
E-mail : ekdantlab@gmail.com / info@ekdantlab.co.in
Web : www.ekdantlab.co.in


Reference No: EES/W/075/09
Report No. 140/09


Report Date: 14.09.2019

**Customer Name** : **M/s. Manali Petrochemicals Limited,**

Customer Address : Ponneri High Road, Manali, Chennai-600 068.

| | | | |
|---|---|---|---|
| Sample Name | Water | Sample Quantity | : 250 ml |
| Sample Description | : Water(Synthetic STD 150ppm-4.5% Cl) | Sample Received on | : 10.09.2019 |
| Reference | Test Request Form Dated 10.09.19 | Test Started on | : 10.09.2019 |
| Sample Identification | NA | Test Completed on | : 14.09.2019 |
| Sample Drawn By | Customer | | |

## TEST RESULTS

| S.NO | Parameter | Test Method | Unit | Results | | |
|---|---|---|---|---|---|---|
| Chemical | | | | Trail-1 | Trail-2 | Trail-3 |
| 1 | Chemical Oxygen Demand | MPL Method | mg/l | 166 | 162 | 166 |
| 2 | Chloride | IS 3025 (Part-32) | mg/l | 23,530 | | |

---End of the Report---

EKDANT ENVIRO SERVICES (P) LTD. CHENNAI 600 101.

Authorized Signatory
R. NIRMALA DEVI

NOTE: 1 Test results shown in this test report relate only to the items tested.
2 This test report shall not be reproduce anywhere except in full and in same format without the Approval of the laboratory
3. Unless informed by the customer the test items will not be retained for more than 10 days from The date of issue of test report (exceptional for Microbiology and wastewater for which retaining time 7 days.)

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# Lens Innovation Labs Pvt Ltd.

## Test Report

-Report No : EN19090003-01 Report Date : 18 Aug 2019

SAMPLE NOT DRAWN BY LABORATORY

Customer Name : M/S. Manali Petro Chemicals

Customer Address : Ponneri High Road ,Manali, Chennai-600068

Sample Description : Water

Sample No : EN19090003-01

Sample Identification : TET

Sample Condition : Fit for Analysis

Sample Quantity : 250ml

Sample Received on : 10 Aug 2019

Test Started on : 10 Aug 2019

Test Completed on : 14 Aug 2019

### Test Results

| Sl.No | Test Name | Test Method | Sample Identification | Results | Units |
|---|---|---|---|---|---|
| 1 | Chemical Oxygen Demand | By MPL Method | Trial 1 | 156 | mg/L |
| | | | Trial 2 | 156 | |
| | | | Trial 3 | 160 | |

.....End of Report.....

Authorized Signature:
E. PRITHIVI RAJAN
LAB MANAGER



#6/1,Sri Joythi Complext, 1st Floor , Murugesan Nagar ,Balavinayagar Street Arumbakkam, Chennai -106.

WARNING: Attention is drawn to the limitations of the liability, indemnification and jurisdictional issues established in our terms of this document is limited to the information contained herein reflects the company's findings at the time of its intervention only and within the limits of client's instructions, if any. The company's responsibility is to its client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

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# Lens Innovation Labs Pvt Ltd.

## Test Report

Report No : EN19090003-02 Report Date : 18 Aug 2019

**SAMPLE NOT DRAWN BY LABORATORY**

Customer Name : M/S. Manali Petro Chemicals

Customer Address : Ponneri High Road ,Manali, Chennai-600068

Sample Description : Water

Sample No : EN19090003-02

Sample Identification : 150 PPM COD STD in 4.5% Cad2

Sample Condition : Fit for Analysis

Sample Quantity : 250ml

Sample Received on : 10 Aug 2019

Test Started on : 10 Aug 2019

Test Completed on : 14 Aug 2019

### Test Results

| Sl.No | Test Name | Test Method | Sample Identification | Results | Units |
|---|---|---|---|---|---|
| 1 | Chemical Oxygen Demand | By MPL Method | Trial 1 | 160 | mg/L |
| | | | Trial 2 | 166 | |
| | | | Trial 3 | 164 | |

.....End of Report.....

Authorized Signature:
E. PRITHIVI RAJAN
LAB MANAGER



**#6/1,Sri Joythi Complext, 1st Floor , Murugesan Nagar ,Balavinayagar Street Arumbakkam, Chennai -106.**

WARNING: Attention is drawn to the limitations of liability, indemnification and jurisdictional issues established there in. Any holder of this document is advised that information contained hereon reflects the company's findings at the time of its intervention only and within the limits of client's instructions if any. The company's sole responsibility is to its client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

ANNEXURE -6A 145



FOREWORD INTRODUCTION

# *1,2-DIHYDROXYPROPANE*
# *CAS:57-55-6*

3, 5, 6,

23- US-EPA
24

# SIDS INITIAL ASSESSMENT PROFILE

| | |
|---|---|
| **CAS No.** | 57-55-6 |
| **Chemical Name** | Propylene glycol (1,2-dihydroxypropane) |
| **Structural Formula** | $CH_3$-CHOH-$CH_2OH$ |

**RECOMMENDATIONS**

The chemical is currently of low priority for further work.

**SUMMARY CONCLUSIONS OF THE SIAR**

**Human Health**

Propylene glycol (PG) is not acutely toxic. The lowest oral LD50 values range between 18 and 23.9 grams (5 different species) and the reported dermal LD50 is 20.8 grams. PG is essentially non-irritating to the skin and mildly irritating to the eyes. Numerous studies support that PG is not a skin sensitizer. Repeated exposures of rats to propylene glycol in drinking water or feed did not result in adverse effects at levels up to 10% in water (estimated at about 10 g/kg bw/day) or 5% in feed (dosage reported as 2.5 g/kg bw/day) for periods up to 2 years. In cats, two studies of at least 90 days duration show that a species-specific effect of increased Heinz bodies was observed (NOAEL = 80 mg/kg bw/day; LOAEL = 443 mg/kg bw/day), with other haematological effects (decrease in number of erythrocytes and erythrocyte survival) reported at higher doses (6-12% in diet, or3.7-10.1 g/cat/day). Propylene glycol did not cause fetal or developmental toxicity in rats, mice, rabbits, or hamsters (NOAELs range from 1.2 to 1.6 g/kg bw/day in four species). No reproductive effects were found when propylene glycol was administered at up to 5% in the drinking water (reported as 10.1 g/kg bw/day) of mice. Propylene glycol was not a genetic toxicant as demonstrated by a battery of *in vivo* (micronucleus, dominant lethal, chromosome aberration) and *in vitro* (bacterial and mammalian cells and cultures) studies. No increase in tumors was found in all tissues examined when propylene glycol was administered in the diet of rats (2.5 g/kg bw/day for 2 years), or applied to the skin of female rats (100% PG; total dose not reported; 14 months) or mice (mouse dose estimated at about 2 g/kg bw/week; lifetime). These data support a lack of carcinogenicity for PG.

**Environment**

Propylene glycol is not volatile, but is miscible with water. Air monitoring data are not available, but concentrations of propylene glycol in the atmosphere are expected to be extremely low because of its low vapor pressure and high water solubility. It is readily biodegraded in water or soil. Four studies reported >60% biodegradation in water in 10 days. PG is not expected to bioaccumulate, with a calculated BCF <1. Measured freshwater aquatic toxicity data for fish, daphnia and algae report LC/$EC_{50}$ values of >18,000 mg/l. Therefore, PG is not acutely toxic to aquatic organisms except at very high concentrations. Using an assessment factor of 100 and the *Ceriodaphnia* data (48-hour $EC_{50}$ = 18,340 mg/l), the PNEC is 183 mg/l.

**Exposure**

PG production capacity in the US was 1312 million pounds (596 kilotonnes) in 1998. Domestic demand was 1050 million pounds (477 kilotonnes). PG is used as an ingredient in cosmetics at concentrations of <0.1% to >50%. Approximately 4000 cosmetic products contained PG in 1994. Uses

# FULL SIDS SUMMARY

| CAS NO: 57-55-6 | | SPECIES | PROTOCOL | RESULTS |
|---|---|---|---|---|
| **PHYSICAL-CHEMICAL** | | | | |
| 2.1 | Melting Point | -- | NG | <-60°C |
| | | | NG | <-57°C |
| 2.2 | Boiling Point | -- | NG | 187.4-189°C |
| 2.3 | Density | -- | NG | 1.032-1.036 g/cm3 |
| 2.4 | Vapour Pressure | -- | NG | 0.11 hPa at 20°C |
| | | | NG | 0.08 mm Hg |
| 2.5 | Partition Coefficient (Log $K_{ow}$) | -- | NG | ca. -1.41 to -0.3 |
| 2.6 A. | Water Solubility | -- | NG | Soluble at 25°C |
| B. | PH | -- | -- | |
| | Pka | -- | -- | |
| 2.12 | Oxidation:Reduction Potential | -- | -- | |
| **ENVIRONMENTAL FATE AND PATHWAY** | | | | |
| 3.1.1 | Photodegradation | -- | Est. (AopWin v 1.90) | Half Life = 10.012 hr |
| 3.1.2 | Stability in Water | -- | -- | -- |
| 3.2 | Monitoring Data | -- | -- | -- |
| 3.3 | Transport and Distribution | -- | Fugacity model (Level III) | 2.98% in air; 48.8% in water; 48.1% in soil; 0.07% in sediments. |
| 3.5 | Biodegradation | -- | Other, APHA 1971 | Readily biodegradable (79% after 20 days; aerobic, unacclimated sludge) |
| | | -- | NG | Degraded (100% after 12 days; aerobic, soil microorganisms |
| | | -- | NG | Readily biodegradable (aerobic, 84-99% after 24 hr; acclim. and unacclim. Sludge |
| | | -- | NG | Degraded to methane by anaerobic soil organisms in sandy loam, but not in surface sand |
| 3.7 | Bioaccumulation | -- | Calc. from Kow | BCF of 1.4 |
| **ECOTOXICOLOGY** | | | | |
| 4.1 | Acute/Prolonged Toxicity to Fish | Oncorhynchus mykiss | 96-hr lethality; OECD TG 203 | LC50 = 51600 mg/L (static) |
| | | Pimephales promelas | 96-hr lethality; OECD TG 203 | LC50 = 46500 mg/L (static) |
| | | Pimephales promelas | 96-hr lethality; OECD TG 203 | LC50 = 51400 mg/L (static) |
| 4.2 | Acute Toxicity to Aquatic Invertebrates *(Daphnia)* | Daphnia magna | 48-hr toxicity; OECD TG 202 | LC50 = 43500 mg/L (static) |

| CAS NO: 57-55-6 | | SPECIES | PROTOCOL | RESULTS |
|---|---|---|---|---|
| | | Mysidopsis bahia | 96-hr lethality; Other, EPA 797.1930 | LC50 = 18800 mg/L (static) |
| | | Ceriodaphnia sp. | 48-hr lethality; Other | LC50 = 18340 mg/L (static)<br>NOAEC = 13020 mg/L (static) |
| 4.3 | Toxicity to Aquatic Plants e.g. Algae | Selenastrum capricornutum | 14-day growth rate; OECD TG 201 | NOEC = 15000 mg/L<br>EC50 = 19000 mg/L (96-hr)<br>EC50 = 18100 mg/L (14-day) |
| | | Skeletonema costatum | 14-day growth rate; OECD TG 201 | EC50 = 19100 mg/L (96-hr)<br>EC50 = <5300 mg/L (14-day)<br>NOEC = <5300 mg/L (14-day) |
| 4.5.1 | Chronic Toxicity to Fish | -- | -- | No data |
| 4.5.2 | Chronic Toxicity to Aquatic Invertebrates (*Daphnia*) | Ceriodaphnia sp. | Reproduction; Other, EPA | NOEC = 13020 mg/L<br>IC25 = 13470 mg/L |
| 4.6.1 | Toxicity to Soil Dwelling Organisms | -- | -- | No data |
| 4.6.2 | Toxicity to Terrestrial Plants | -- | -- | No data |
| 4.6.3 | Toxicity to Other Non- Mammalian Terrestrial Species (Including Birds) | -- | -- | No data |
| **TOXICOLOGY** | | | | |
| 5.1.1 | Acute Oral Toxicity | Rat | Acute lethality; NG | LD50 = 22000 mg/kg |
| | | Mouse | Acute lethality; NG | LD50 = 24900 mg/kg |
| | | Guinea pig | Acute lethality; NG | LD50 = 19700 mg/kg |
| 5.1.2 | Acute Inhalation Toxicity | -- | -- | No data |
| 5.1.3 | Acute Dermal Toxicity | Rabbit | Acute lethality; NG | LD50 = 20800 mg/kg |
| 5.2.1 | Skin Irritation | Rabbit | OECD TG 404 | Not Irritating (undiluted, 4 hr, occluded) |
| | | Rabbit | Draize test; NG | Not irritating (undiluted) |
| 5.2.2 | Eye Irritation | Rabbit | OECD TG 405 | Not irritating (undiluted, 0.1 mL) |
| | | Rabbit | OECD TG 405 | Not irritating (undiluted, 0.1 mL) |
| 5.3 | Skin Sensitization | Human | Other; NG | Not sensitizing (Induction: 0.2 mL of 50% solution , semi-occlusive; Challenge: 0.2 mL of 50% solution semi-occlusive) |
| | | Human | Other, NG | Not sensitizing (Induction: 0.2 mL of 50% solution , occlusive). |
| | | Human | Other, Draize | Not sensitizing ((Induction: 0.5 g of 12% dilution in petrolatum) |
| 5.4 | Repeated Dose Toxicity | Rat | 15 wk, oral; NG | NOAEL = 50000 ppm in diet |

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United States
Environmental Protection
Agency

Prevention, Pesticides
and Toxic Substances
(7510P)

EPA-739-R-06-002
September 2006

# Reregistration Eligibility Decision For Propylene Glycol and Dipropylene Glycol

US EPA ARCHIVE DOCUMENT

## 1. Environmental Fate and Transport

Propylene glycol and dipropylene glycol are aliphatic trihydroxy chemicals that do not contain any hydrolyzable hydrogen. For this reason, the Agency granted a waiver from the aquatic hydrolysis study. However, the Agency has relied on data and fate properties of propylene glycol and dipropylene glycol obtained from published literature to assess environmental health risks.

These data suggest that propylene glycol and dipropylene glycol are miscible in water, mobile in soils, low absorptivity to soil, and stable to abiotic hydrolytic degradation as well as soil and aquatic photolysis. In aerobic soils, propylene glycol degrades to $CO_2$ in 4 days, whereas biodegradation of dipropylene glycol may be a slower process according to biological screening tests. However, this process may still be an important mechanism for removal of dipropylene glycol from aerobic soil. The low KOW indicates that propylene glycol and dipropylene glycol are not likely to bioaccumulate in aquatic organisms. With a vapor pressure of 0.129 mm Hg at 25 °C, propylene glycol and dipropylene glycol exist almost entirely in the vapor phase in the atmosphere and degrade rapidly (half-life approximately 13-32 hours) by reaction with photochemically produced hydroxyl radicals. Therefore, the presence of propylene glycol and dipropylene glycol in the environment, including the atmosphere, do not pose a concern.

## 2. Ecological Risk

### a. Toxicity (Hazard) Assessment

As a result of the Phase IV review of propylene glycol and dipropylene glycol for reregistration under FIFRA, ecological effects data requirements were waived due to its high volatility, known low toxicity, and available data. Data obtained from published studies provide additional confirmation of the low toxicity of the compound to fish and aquatic invertebrates (Table 4). As mentioned earlier in this document, no toxicological endpoints were selected for risk assessment based on the available mammalian database.

**Table 4. Ecotoxicity of Propylene Glycol and Dipropylene Glycol**

| Species | Percent Active Ingredient | Test Type | Toxicity | Reference |
|---|---|---|---|---|
| Mysid (*Mysidopsis bahia)* | 99.9 | 96-hour static acute | LC50 = 11,000 ppm | MRID #40228401 (Mayer, 1986) |
| Sheepshead minnow (*Cyprinodon variegatus*) | 99.9 | 96-hour static acute | LC50 = 48,000 ppm | MRID #40228401 (Mayer, 1986) |
| Bluegill sunfish (*Lepomis macrochirus*) | unknown | 96 hour static acute | LC50 > 10,000 ppm | Verschuren, 1983 |

| Species | Percent Active Ingredient | Test Type | Toxicity | Reference |
|---|---|---|---|---|
| *Menidia beryllina* | unknown | 96 hour static | LC50 > 10,000 ppm | Verschuren, 1983 |
| Fathead minnow (*Pimephales promelas*) | unknown | 96 hour flow-through | LC 50 59,900 - 77,400 ppm | Geiger et al., 1988 |

Adverse effects to nontarget organisms are not anticipated from the indoor use of propylene glycol and dipropylene glycol due to the low likelihood of exposure. The very low toxicity of the compound to aquatic organisms, as indicated by the high $LC_{50}$ values in the table above, further supports the unlikelihood of adverse effects to fish and aquatic invertebrates.

**b. Risk to Listed Species**

Section 7 of the Endangered Species Act, 16 U.S.C. Section 1536(a)(2), requires all federal agencies to consult with the National Marine Fisheries Service (NMFS) for marine and anadromous listed species, or the United States Fish and Wildlife Services (FWS) for listed wildlife and freshwater organisms, if they are proposing an "action" that may affect listed species or their designated habitat. Each federal agency is required under the Act to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. To jeopardize the continued existence of a listed species means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species." 50 C.F.R. § 402.02.

To facilitate compliance with the requirements of the Endangered Species Act subsection (a)(2) the Environmental Protection Agency, Office of Pesticide Programs has established procedures to evaluate whether a proposed registration action may directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of any listed species (U.S. EPA 2004). After the Agency's screening-level risk assessment is performed, if any of the Agency's Listed Species LOC Criteria are exceeded for either direct or indirect effects, a determination is made to identify if any listed or candidate species may co-occur in the area of the proposed pesticide use. If determined that listed or candidate species may be present in the proposed use areas, further biological assessment is undertaken. The extent to which listed species may be at risk then determines the need for the development of a more comprehensive consultation package as required by the Endangered Species Act.

For certain use categories, the Agency assumes there will be minimal environmental exposure, and only a minimal toxicity data set is required (Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs U.S. Environmental Protection Agency - Endangered



US EPA ARCHIVE DOCUMENT

ANNEXURE- 6B

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Established in 1981
megaloid laboratories limited
2221 Ninth Line | Oakville, ON L6H 7G7
Phone: 905-337-7411 | Fax: 905-337-1686
megaloid.ca

# *Safety Data Sheet*

## 1. PRODUCT IDENTIFICATION

| | |
|---|---|
| **Name** | **Propylene Glycol** |
| **Synonyms** | **1,2-dihydroxypropane; propane-1,2-diol; 1,2-propylene glycol** |
| **CAS#** | **57-55-6** |
| **EC#** | **200-338-0** |
| **Product Uses** | **non-toxic antifreeze, manufacture of polyester resins & other products** |

## 2. HAZARDS

***Canada – WHMIS*** **not controlled under WHMIS**

***Key:*** ***B 2*** *– Flash Point <38°C,* ***B 3*** *– Flash Point >38°C & <93°C*
***D 1*** *– Immediately Toxic,* ***D 2*** *– Chronic Toxicity*
***C*** *– Oxidising Substance,* ***E*** *– Corrosive,* ***F*** *– Reactive Substance*

**GHS Symbols –** ***none required***

**GHS Class & Category** ***not hazardous under GHS***

**Signal Words** ***none required***

**Hazard Statements** ***none required***

## 3. COMPOSITION

| | % | TWAEV / TLV mg/m³ | $LD_{50}$ (mg/kg) ORAL | $LD_{50}$ (mg/kg) SKIN | $LC_{50}$ ppm INHALATION |
|---|---|---|---|---|---|
| 1,2-Dihydroxypropane | 100% | not listed | >14,800 | 20,800 | not known |

## 4. FIRST AID

SKIN: Wash with plenty of water. Remove contaminated clothing and do not reuse until thoroughly laundered.

EYES: Wash eyes with plenty of water, holding eyelids open. Seek medical assistance promptly if there is irritation.

INHALATION: Remove from contaminated area promptly. ***CAUTION: Rescuer must not endanger himself!*** If breathing stops, administer artificial respiration and seek medical aid promptly.

INGESTION: Give plenty of water to dilute product. Do not induce vomiting (NOTE below). Keep victim quiet. If vomiting occurs, lower victim's head below hips to prevent inhalation of vomited material. Seek medical help promptly.

*Inadvertent inhalation of vomited material may seriously damage the lungs. The danger of this is greater than the risk of poisoning through absorption of this relatively low-toxicity substance. The stomach should only be emptied under medical supervision, and after the installation of an airway to protect the lungs.*

## 5. FIRE FIGHTING & FLAMMABILITY

| | |
|---|---|
| Flash Point | 99°C / 210°F (closed cup); also 104°C / 219°F (Pensky-Martens closed cup) |
| Autoignition Temperature | 371°C / 700°F |
| Flammable Limits | 2.6% – 12.5% |
| Combustion Products | carbon monoxide, nitrogen oxides, smoke, part oxidised hydrocarbon fragments |
| Firefighting Precautions | alcohol-resistant foam, dry chemical, water fog, water spray; firefighters must wear SCBA |
| Static Charge Accumulation | cannot accumulate a static charge on agitation or pumping |

***Please ensure that this MSDS is given to, and explained to people using this product.***

## 6. ACCIDENTAL RELEASE MEASURES

| | |
|---|---|
| Leak Precaution | dyke to control spillage and prevent environmental contamination |
| Handling Spill | recover free liquid with suitable pumps; absorb residue on an inert sorbent, sweep, shovel & store in closed containers for recycling or disposal |

## 7. HANDLING & STORAGE

Hygroscopic liquid; store in a dry environment to preserve quality, away from open flame and oxidising agents. Always ensure that containers, whether empty or full, are tightly sealed unless in use.

If product is heated above 100°C / 212°F, ensure adequate ventilation and avoid generating vapour. If mist forms in use, install adequate exhaust ventilation. Never cut, drill, weld or grind on or near this container. Wash work clothes frequently. An eye bath and safety shower should be available near the workplace.

## 8. EXPOSURE CONTROL & PERSONAL PROTECTION

**Ontario TWAEV** 50ppm / 155mg/m$^3$ (*total vapour & aerosol*); 10mg/m$^3$ (*aerosol only*) **Ontario STEV** not listed

| | |
|---|---|
| ACGIH TLV | not listed |
| OSHA PEL | not listed |
| Ventilation | exhaust ventilation is required if product mist forms in use or if processing occurs above 100°C |
| Hands | no special protective gloves required |
| Eyes | safety glasses with side shields – *always protect the eyes* |
| Clothing | no special protective clothing required |

## 9. PHYSICAL PROPERTIES

| | |
|---|---|
| Odour & Appearance | clear, colourless, odourless, viscous, hygroscopic liquid |
| Odour Threshold | not known - odourless |
| Vapour Pressure | 0.08mmHg / 0.011kPa (20°C / 68°F) |
| Evaporation Rate (*Butyl Acetate = 1*) | 0.01 |
| Vapour Density (air = 1) | 2.5 |
| Boiling Range | 188°C / 370°F |
| Freezing Point | -60°C / -76°F – *supercools readily* |
| Specific Gravity | 1.037 (20/20°C) |
| Water Solubility | complete |
| Also soluble in | all polar organic solvents & benzene, limited solubility in aliphatic hydrocarbons |
| Partition Coefficient (Octanol/$H_2O$) | -0.92 |
| Viscosity | 56centipoise (20°C / 68°F) |
| pH | none – (*does not dissociate into hydrogen ions when dissolved*) |
| Molecular Weight | 76 grams per mole |

## 10. REACTIVITY

| | |
|---|---|
| Dangerously Reactive With | strong oxidising agents |
| Also Reactive With | attacks polyvinyl chloride; elastomers like Dacron & epoxy are attacked above 95°C |
| Stability | stable; will not polymerize |
| Decomposes in Presence of | not known |
| Decomposition Products | none apart from Hazardous Combustion Products |
| Sensitive to Mechanical Impact | no |

***Please ensure that this MSDS is given to, and explained to people using this product.***

## 11. TOXICITY

***Effects, Acute Exposure***

| | |
|---|---|
| Skin Contact | little to no effect |
| Skin Absorption | slight; no toxic effects likely by this route |
| Eye Contact | little to no effect; *may sting very briefly, but subsides almost immediately* |
| Inhalation | vapour or mist had little if any effect |
| Ingestion | little to no effect; also little effect in experimental long-term inhalation studies |

***Effects, Chronic Exposure***

| | |
|---|---|
| General | prolonged skin exposure has caused irritation in *16% of dermatitis patients*; any irritation seen in normal people appears to be caused by skin dehydration due to local osmotic effects, disappearing rapidly after removal of propylene glycol |
| Sensitising | not a sensitiser in humans or animals |
| Carcinogen/Tumorigen | not considered a tumorigen or a carcinogen in humans or animals |
| Reproductive Effect | no known effect in humans or animals |
| Mutagen | no known effect on humans or animals |
| Synergistic With | not known |
| $LD_{50}$ (oral) | 20,000-30,000mg/kg (rat) – *several tests*, 22,000-23,900mg/kg (mouse), 22,000mg/kg (dog) 14,800 & 18,500mg/kg (rabbit), 18,900mg/kg (guinea pig) |
| $LD_{50}$ (skin) | 20,800mg/kg (rabbit) |
| $LC_{50}$ (inhalation) | not known |

## 12. ECOLOGICAL INFORMATION

| | |
|---|---|
| Bioaccumulation | propylene glycol is not a bioaccumulator |
| Biodegradation | biodegrades readily & rapidly in the presence of oxygen; 55-75% in 5 days, 78-84% in 20 days; also 99% in 1-2 days (*2 tests*) – ***rapid biodegradation means no Chronic Aquatic Toxicity testing required*** |
| Abiotic Degradation | reacts with atmospheric hydroxyl radicals; estimated ½-life in air is 32hours |
| Mobility in soil, water | water soluble; moves readily in soil and water |
| **Aquatic Toxicity** | |
| $LC_{50}$ (Fish, 96hr) | 23,800mg/litre (Cyprinodon variegatus), 51,600mg/litre (Oncorynchus mykiss), 51,400 & 54,650mg/litre (Pimephelas promelas) |
| $EC_{50}$ (Crustacea, 48hr) | 34,400 & 43,500mg/litre (Daphnia magna), 10,000mg/litre (Artemia salina, 24hr) |
| $EC_{50}$ (Algae) | 19,000mg/litre (Selenastrum capricornutum), 19,100mg/litre (Skeletonema costatum) |
| NOAEC (Bacteria) | 20,000mg/litre – *NOAEC = No Observed Adverse Effect Concentration* |

## 13. DISPOSAL

| | |
|---|---|
| Waste Disposal | **do not flush to sewer**, recycle if possible; mix with flammable waste & incinerate in approved facility |
| Containers | **Drums** should be reused. Recondition and pressure test by a licensed reconditioner prior to re-use.<br>**Pails** must be vented and thoroughly dried prior to crushing and recycling.<br>**IBCs** (intermediate bulk containers): polyethylene bottle must be pressure tested & recertified at 30 months. Replace at 60 months (5yrs). Steel containers must be inspected, pressure tested & recertified every 5 years.<br>***Never cut, drill, weld or grind on or near this container, even if empty*** |

## 14. TRANSPORT CLASSIFICATION

| | | |
|---|---|---|
| ***Canada TDG*** | **PIN** | **UN-not regulated for transport** |
| *AND* | **Shipping Name** | **not regulated for transport** |
| ***U.S.A. 49 CFR*** | **Class** | **not regulated for transport** |
| | **Packing Group** | **not regulated for transport** |
| **Marine Pollutant** | | **not a marine pollutant** |
| ***ERAP*** | | ***not required*** |

***Please ensure that this MSDS is given to, and explained to people using this product.***

## *14. TRANSPORT CLASSIFICATION, cont'd*

***EMERGENCY INFORMATION***

| | | |
|---|---|---|
| ***Canada*** | **Call CANUTEC (collect)** | **(613) 996-6666** |
| ***U.S.A.*** | **Call CHEMTREC** | **(800) 424-9300** |

## 15. REGULATIONS

| | |
|---|---|
| **Canada DSL** | **on inventory** |
| **U.S.A. TSCA** | **on inventory** |
| **Europe EINECS** | **on inventory** |

***This common substance is present on most national chemical inventories.***

**Europe Classification** ***not classified as hazardous in Europe***

***U.S.A. Regulations:***

**Acceptable Daily Intakes:** JECFA. ADI: 0 to 25 mg/kg bw

**Allowable Tolerances:** Residues of propylene glycol are exempted from the requirement of a tolerance when used in accordance with good agricultural practice as inert (or occasionally active) ingredients in pesticide formulations applied to growing crops or to raw agricultural commodities after harvest. Use: solvent, cosolvent. Residues of propylene glycol are exempted from the requirement of a tolerance when used in accordance with good agricultural practice as inert (or occasionally active) ingredients in pesticide formulations applied to animals. Use: solvent, cosolvent.

**Atmospheric Standards:** This action promulgates standards of performance for equipment leaks of Volatile Organic Compounds (VOC) in the Synthetic Organic Chemical Manufacturing Industry (SOCMI). The intended effect of these standards is to require all newly constructed, modified, and reconstructed SOCMI process units to use the best demonstrated system of continuous emission reduction for equipment leaks of VOC, considering costs, non air quality health and environmental impact and energy requirements. Propylene glycol is produced, as an intermediate or a final product, by process units covered under this subpart.

**State Drinking Water Standards:** (NY) NEW YORK 1,000 ug/L

**State Drinking Water Guidelines:** New Hampshire 140,000 ug/ L

**FIFRA Requirements:** Residues of propylene glycol are exempted from the requirement of a tolerance when used in accordance with good agricultural practice as inert (or occasionally active) ingredients in pesticide formulations applied to growing crops or to raw agricultural commodities after harvest. Use: solvent, cosolvent. Residues of propylene glycol are exempted from the requirement of a tolerance when used in accordance with good agricultural practice as inert (or occasionally active) ingredients in pesticide formulations applied to animals. Use: solvent, cosolvent. The Agency has completed its assessment of the dietary, drinking water, residential, ecological and occupational risks associated with the use of pesticide products containing the active ingredients propylene glycol and dipropylene glycol. Based on a review of these data, the Agency has sufficient information on the human health and ecological effects of propylene glycol and dipropylene glycol to make a decision as part of the tolerance reassessment process under FFDCA and reregistration under FIFRA, as amended by FQPA. The Agency has determined that propylene glycol and dipropylene glycol containing products are eligible for reregistration. EPA has determined that the established exemption from a requirement for a tolerance for propylene glycol and dipropylene glycol, meet the safety standards under the FQPA amendments to section 408(b)(2)(C) of the FFDCA, that there is a reasonable certainty of no harm for infants and children.... In determining whether or not infants and children are particularly susceptible to toxic effects from propylene glycol and dipropylene glycol residues, the Agency considered the completeness of the database for developmental and reproductive effects, the nature of the effects observed, and other information. The FQPA Safety Factor has been removed (i.e., reduced to 1X) for propylene glycol and dipropylene glycol because there is no pre- or post-natal evidence for increased susceptibility following exposure. [REF-229] As the federal pesticide law FIFRA directs, EPA is conducting a comprehensive review of older pesticides to consider their health and environmental effects and make decisions about their future use. Under this pesticide reregistration program, EPA examines newer health and safety data for pesticide active ingredients initially registered before November 1, 1984, and determines whether the use of the pesticide does not pose unreasonable risk in accordance to newer saftey standards, such as those described in the Food Quality Protection Act of 1996. Pesticides for which EPA had not issued Registration Standards prior to the effective date of FIFRA '88 were divided into three lists based upon their potential for human exposure and other factors, with List B containing pesticides of greater concern than those on List C, and with List C containing pesticides of greater concern than those on List D. Propylene glycol is found on List C. Case No: 3126; Pesticide type: insecticide, fungicide, antimicrobial; Case Status: OPP is reviewing data from the pesticide's producers regarding its human health and/or environmental effects, or OPP is determining the pesticide's eligibility for reregistration and developing the Reregistration Eligibility Decision (RED) document.; Active ingredient (AI): Propylene glycol; Data Call-in (DCI) Date(s): 08/02/93; AI Status:

**FDA Requirements:** *Substance added directly to human food affirmed as generally recognized as safe.* Propylene glycol used as an emulsifying agent in animal drugs, feeds, and related products is generally recognized as safe when used in accordance with good manufacturing or feeding practice. Propylene glycol used as a general purpose food additive in animal drugs, feeds, and related products is generally recognized as safe when used in accordance with good manufacturing or feeding practice. Drug products containing certain active ingredients offered over-the-counter (OTC) for certain uses. A number of active ingredients have been present in OTC drug products for various uses, as described below. However, based on evidence currently available, there are inadequate data to establish general recognition of the safety and effectiveness of these ingredients for the specified uses; propylene glycol is included in pediculicide drug products. Ophthalmic demulcents. The active ingredients of the product consist of any of the following, within the established concentrations for each ingredient: Propylene glyol, 0.2 to 1 percent. The Food and Drug Administration has determined that propylene glycol in or on cat food is not generally recognized as safe and is a food additive subject to section 409 of the Federal Food, Drug, and Cosmetic Act (the act). The Food and Drug Administration also has determined that this use of propylene glycol is not prior sanctioned. The Food and Drug Administration has determined that propylene glycol in or on cat food has not been shown by adequate scientific data to be safe for use. Use of propylene glycol in or on cat food causes the feed to be adulterated and in violation of the Federal Food, Drug, and Cosmetic Act (the act), in the absence of a regulation providing for its safe use as a food additive under section 409 of the act, unless it is subject to an effective notice of claimed investigational exemption for a food additive under part 570.17 of this chapter, or unless the substance is intended for use as a new animal drug and is subject to an approved application under section 512 of the act or an effective notice of claimed investigational exemption for a new animal drug under part 511 of this chapter.

## 16. OTHER INFORMATION

*Prepared for Megaloid Laboratories by Peter Bursztyn, (705) 734-1577*
*Data from* ***RTECS, HSDB*** *(Haz. Substance Data Base),* ***Cheminfo*** *(CCOHS),* ***IUCLID*** *Datasheets (ESIS – European Chem. Substance Info. System), & others.*
*Preparation Date:* ***April 2010*** *Revision Date:* ***April 2013***

***Please ensure that this MSDS is given to, and explained to people using this product.***

ANNEXURE -7 156

BEFORE THE NATIONAL GREEN TRIBUNAL,

SOUTHERN ZONE, CHENNAI

Application No. 19 of 2013(SZ)

(W.P.No.6922 of 2011, Madras High Court)

Meenavargal Membattu Sangam,
Represented by its President
Mr.K.R.Selvaraj Kumar
Having office at Old No.97/2, New No.199
S.N. Chetty Street,
Royapuram, Chennai-600 013. ... Applicant/Petitioner in W.P.No.6922 of 2011

-Vs-

1. The Chief Secretary,
Government of Tamil Nadu,
Secretariat,
Chennai-600 009.

2. The State of Tamil Nadu
Represented by its Secretary to Government,
Industries Department,
Fort St. George,
Chennai-600 009.

3. The District Collector,
Thiruvallur District,
Thiruvallur.

4. The Chairman,
Tamil Nadu Pollution Control Board,
No.76, Mount Salai, Guindy,
Chennai-600 032.

5. M/s. Manali Petrochemical Ltd.,
Having its Principal Office at
Ponneri High Road,
Chennai-600 068. ... Respondent(s)/Respondent(s) In W.P.No.6922 of 2011.

**REPLY AFFIDAVIT FILED ON BEHALF OF THE 4th RESPONDENT - TAMIL NADU POLLUTION CONTROL BOARD.**

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I, Jayakumar T.C.Ethiraju, Son of Thiru.C. Ethiraju, Hindu, aged about 54 years having office at 76, Mount Salai, Guindy, Chennai - 600 032 do hereby solemnly affirm and sincerely state as follows:-

I am Joint Chief Environmental Engineer, Tamil Nadu Pollution Control Board, Chennai and I am filing this Reply Affidavit on behalf of the 4th Respondent Board and as such I am well acquainted with the facts of the case as per records.

2. It is respectfully submitted that M/s.Meenavargal Membattu Sangam, Old No.97/2, New No.199, S.N.Chetty street, Royapuram, Chennai-13 has filed a Writ Petition, before the Hon'ble High Court of Judicature at Madras (W.P.No.6822 of 2011), which was transferred before the NGT, South Zone, Chennai. The same has been taken as Application No.19 of 2013.

3. This respondent deny all the averments made in this affidavit, except which are specifically admitted herein.

4. It is respectfully submitted that in the application filed, it has been requested to take necessary action against the unit of M/s. Manali Petrochemicals Ltd, Ponneri High Road, Chennai-68 which discharges their treated effluent into the sea through pipeline stating that the effluent affects the life of the aquatic organisms in the sea.

5. It is respectfully submitted that M/s.Manali Petrochemical Limited (MPL) was promoted by Southern Petrochemical Industries Corporation (SPIC). It operates two production plants at Manali Industrial area for the manufacture of Propylene Oxide (PO), Propylene Glycol (PG) and various grades of Polyol and formulations.

6. It is respectfully submitted that the construction of MPL Plant-I was commenced in 1988 and commercial production started in the year 1990. Plant–I was set up with the technology of Atochem for Propylene Oxide and Propylene Glycol and the basic engineering was done by Technip of France and the detailed engineering executed by Engineers India Ltd. The Polyol technology was provided BY ARCO, USA through Technip. MPL Plant-I is capable of manufacturing 18000 MT of Propylene Oxide, 10,000 MT of Propylene Glycol and 25000 MT of Polyol.

7. It is respectfully submitted that the Plant-II was promoted By UB Group and TIDCO and this was incorporated in 1986. The commercial production started in the year 1990 and it was taken over by M/s. SPIC in the year 1995 and named as M/s.Spic Organics Limited and then merged with MPL in the year 2000. Again the name has been changed as M/s. Manali Petrochemicals Limited Plant – II. The plant is capable of manufacturing 18000 MT of Propylene oxide, 10,000 MT of Propylene Glycol and 25000 MT of Polyol.

8. It is respectfully submitted that the Propylene Oxide is an intermediate product produced and is utilized for conversion into Propylene glycol and Polyol. Propylene Glycol is widely used for Pharmaceutical formulations, in Food Flavour and Fragrance industries and in the manufacture of unsaturated polyester Resins.

9. It is respectfully submitted that the Polyol is the raw material for manufacture of Polyurethanes. Polyol of different grades are reacted with Isocyanates of different grades to produce several of

Polyurethane with distinctively different, desired properties. Major supplier of the raw material is Chennai Petroleum Corporation Ltd(CPCL). There are no other manufacturers of Propylene Oxide,Propylene glycol, and Polyol in India.

10. It is respectfully submitted that the Latest consent was issued from the Board to the unit of M/s.Manali Petroleum Corporation Ltd., Plant-I on 28.3.2002 for the production of the following products namely 1.Propylene oxide 1- 1000 T/Month. 2. Propylene Glycol- 520 T/Month. 3. Poyol - 500 T/Month and 4.Propylene Glycol Mono Methyl Ether – 225 T/Month. Consent was issued for the generation of sewage effluent of 15 KLD and the trade effluent of 3400 KLD. Theunit has been consented that the treated trade effluent shall be disposed into Sea.

11. It is respectfully submitted that the unit has provided the ETP to treat the trade effluent of 3400 KLD which consists of Clariflocculator, Thickener, Cooling Tower, Bio reactor-6 Nos, Nutrient Tank, Mass culture tank and Rotary vacuum Filter and Treated effluent storage Tank. The consolidated ROA of the treated effluent reveals that the parameters such as pH, BOD and COD are in excess of the standards prescribed for the marine coastal areas prescribed by the Board.

12. It is respectfully submitted that the Consent was subsequently renewed to this unit under Water Act vide Board's proce. No.T5/ PET/TNPCB/62402/RL/W/11 Dated 11.10.2011 and under Air Act vide

Board's proce.No. T5/PET/TNPCB/62402/RL/A/11 Dated 11.10.2011 with certain conditions with validity up to 31.03.2012.

13. It is also submitted that the respondents has also issued directions Proce.No. T5 //TNPCB /PET/ F.No.62402/TLR/W&A/11 Dated 11.10.2011 under Water and Air Acts to carry out the following:-

1. The unit shall restrict the production quantity as per the consent order issued
2. The unit shall improve the Effluent Treatment Plant to achieve the standards within three months
3. The unit shall conduct study to ensure any contamination soil and ground water due to landfill facility.
4. The unit shall furnish details of low lying areas to dispose the sludge and to conduct survey to have baseline data.
5. The unit shall furnish log book extract on the disposal of sludge to brick manufacturers
6. The unit shall provide online Ambient Air Quality/emission with the connectivity to Care Air Centre
7. The unit shall implement the action points for critically polluted area.
8. The unit shall connect the gas detector/sensor to ascertain the fugitive emission with the connectivity to Care Air Centre.
9. The unit shall have a leak detection and repair system.
10. The unit shall implement online monitoring of Effluent Treatment Plant / Sewage Treatment Plant with a connectivity to Care Air Centre.
11. The unit shall make provisions to collect samples at the discharge point.
12. The unit shall conduct impact study periodically.

14. It is respectfully submitted that the Consent was issued by the Board to the unit of M/s. Manali Petroleum Corporation Ltd.. Plant-II

for the production of the following products namely 1.Propylene oxide 1-1000 T/Month. 2. Propylene Glycol- 650 T/Month. 3. Poyol - 1000 T/Month 4. Propylene Di Chloro Propane- 175 T/Month 5. Di Propylene Glycol- 80 T/Month and 6. Tri Propylene Glycol- 10 T/Month. Consent was issued for the generation of sewage effluent of 15 KLD and the trade effluent of 4500 KLD. It has been consented that the treated trade effluent shall be disposed into Sea.

15. It is respectfully submitted that the unit has provided the ETP to treat the trade effluent of 5400 KLD which consists of High rate thickener, Flocculation Tank, Rotary drum vacuum filter, Effluent collection Tank, Primary Clarifier, Cooling Tower, Aeration Tank, secondary clarifier and Treated effluent sump. The consolidated ROA of the treated effluent reveals that the parameters such as pH, BOD and COD are in excess of the standards prescribed for the marine coastal areas prescribed by the Board.

16. It is respectfully submitted that consent orders were subsequently renewed to this unit under Water Act vide Board's proce. No.T5/ PET/TNPCB/19637/ TVLR/RL/W/11 Dated 11.10.2011 and under Air Act vide Board's proce.No. T5/PET/TNPCB/19637/TVLR/RL/A/11 Dated 11.10.2011 with certain conditions and validity up to 31.03.2012.

17. It is also respectfully submitted that the respondent Board has issued directions to this unit vide Proce.No. T5 //TNPCB /PET/

F.No.42913/TLR/W&A/11 Dated 11.10.2011 under Water and Air Acts to carry out the following works.

1. The unit shall restrict the production quantity as per the consent order issued
2. The unit shall improve the Effluent Treatment Plant to achieve the standards within three months
3. The unit shall conduct study to ensure any contamination soil and ground water due to landfill facility.
4. The unit shall furnish details of low lying areas to dispose the sludge and to conduct survey to have baseline data.
5. The unit shall furnish log book extract on the disposal of sludge to brick manufacturers
6. The unit shall provide online Ambient Air Quality/emission with the connectivity to Care Air Centre
7. The unit shall implement the action points for critically polluted area.
8. The unit shall connect the gas detector/sensor to ascertain the fugitive emission with the connectivity to Care Air Centre
9. The unit shall have a leak detection and repair system.
10. The unit shall implement online monitoring of Effluent Treatment Plant / Sewage Treatment Plant with a connectivity to Care Air Centre.
11. The unit shall make provisions to collect samples at the discharge point.
12. The unit shall conduct impact study periodically.

18. It is respectfully submitted that the unit of MPL has laid separate pipeline of 0.25 m dia of 6 Km length from their units into coastal area of Ennore and disposed into sea at Ramakrishna Nagar East side, Ennore coastal area. It is respectfully submitted that when

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the Writ Petition filed during 2011 the unit was laying new pipeline instead of the old one for discharging the treated effluent into Sea.

19. This respondent respectfully state that the averment of the petitioner, that the unit used to drain the waste water effluent into sea water without adopting proper method of treatment, thereby toxic items mixed in the sea water is false and hence denied. It is respectfully submitted that the industry of M/s. Manali Petrochemical Limited, has provided effluent treatment plants for treating the effluent before discharging the same in to sea. It is further submitted that there is no leakage of effluent from the marine outfall pipelines as alleged by the applicant.

20. The averment of the applicant that the high concentration of metallic effluents flow in the roadside, thereby affects biological metabolism, causes diseases is false and hence denied. It is respectfully submitted that the samples of the treated effluents discharged revealed that the level of metallic pollutants are generally within the standards prescribed for marine discharge.

21. The averment of the applicant that this respondent to enforce their constitutional duties and responsibilities in order to check the activities of the Fifth Respondent, who is indulging in disposing the hazardous substances and endanger the life of the common people is hereby denied. This respondent is continuously monitoring the industry and the discharges made by it. It is respectfully submitted that directions have been issued to the respondent units for certain non-

compliance and further action would be examined in accordance with merits.

22. The averment that this respondent had not maintained any transparency either through the media or through his web site regarding the prescribed procedure of treating or discharging the wastages and water effluent into the sea is false and hence denied. The standards for the discharge of treated effluents into the complaints of Environment. Viz. Inland surface waters, sewer, on land for irrigation and marine coastal areas are very well available in the website of the respondent as well as available in the websites of Central Pollution Control Board.

23. The averment of the applicant that this respondent failed to conduct periodical inspection in the fifth respondent's factory, from where the hazardous substances draining to the sea is false and hence denied. The industry is periodically monitored for compliance and the samples of treated effluents discharged are collected and analysed.

24. It is respectfully submitted that the pipeline carrying effluents into sea has been relaid in 2011, and since then there is no leakage of effluents due to broken pipeline.

Under the above circumstances, it is humbly prayed that this Hon'ble National Green Tribunal (Southern Zone) may be pleased to pass appropriate orders or any other order as it may deem fit and proper in this case and thus render justice.

JOINT CHIEF ENVIRONMENTAL ENGINEER
TAMIL NADU POLLUTION CONTROL BOARD
CHENNAI - 600 032.

BEFORE ME

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## VERIFICATION

I, Jayakumar T.C.Ethiraju working as Joint Chief Environmental Engineer, Tamil Nadu Pollution Control Board, Chennai-32 do hereby verify that the contents of above report are true to the best of my knowledge through records.

Verified at Chennai on this 20th day of September, 2013.

JOINT CHIEF ENVIRONMENTAL ENGINEER
TAMIL NADU POLLUTION CONTROL BOARD
CHENNAI - 600 032.

ANNEXURE - 8A

Report

# Inspection Report on

M/s. Meenavargal Membattu Sangam

Vs.

The Government of Tamil Nadu and others

**(Application No. 19 of 2013 (SZ)(THC)**

**(W.P. No. 6922 of 2011; HighCourt of Madras)**

***Submitted to***

**THE NATIONAL GREEN TRIBUNAL**

**SOUTHERN ZONE, CHENNAI**

**September 2014**

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1. Introduction

Complaints have been received from the local fishing communities about the marine pollution by the industries located at Manali area discharging their treated effluent into sea through pipe line. The Hon'ble National Green Tribunal (NGT), South Zone, Chennai for adjudication of the application in the matter of Meeenavargal Membattu Sangam (MMS), Royapuram, Chennai Vs. The state of Govt. of Tamilnadu and others has constituted an expert Committee consisting of two members namely

1. Dr.K.Palanivelu,
   Professor of Environmental Chemistry,
   Centre for Environmental Studies, Anna University,
   Chennai-600 025

and

2. Dr.N.Vedaraman,
   Senior Technical Officer,
   Chemical Engineering Division,
   CLRI, Chennai-600 020,

with a direction to conduct a study vide its letter No. NGT/SZ/application No. 19 of 2013(SZ)(THC)/1204 dated 30-7-2014.

**2. Terms of Reference of the study**

i. To inspect and submit a report regarding methods of treating the effluent in the 5th respondent company, namely M/s. Manali Petro-Chemical Ltd. (MPL), prior to the disposal of the same into the sea in order to ascertain the compliance of the rules and norms by the 5th respondent company.

ii. To assess the present status of the pipelines through which the effluent is disposed of into the sea.

iii. To assess the pollution level in the sea water in the area where the 5th respondent plants effluent is mixing.

iv. To make recommendations for the environmental safety measures keeping in mind the fishermen community in the light of the study findings.

v. To recommend further studies relevant to the issue, if any.

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3. Study Approach

The evaluation was based on actual study conducted at the field. The study was conducted on 12-9-2014 and 14-9-2014 to the Manali area with prior intimation to all the concerned. The studies were carried out in the presence of representatives from MPL, MMS and Tamil Nadu pollution Control Board (TNPCB).

The list of particlpants during the inspection is furnished below.

1. Mr. G. Balasubramanian-MPL
2. Mr. Balaguru, MPL
3. Mr M. R.Thiagarajan, MMS
4. Mr S. Daniel, MMS
5. Mr. S. Rajan, DE, TNPCB
6. Mr. G. Venkatasamy, AE, TNPCB

During the visit on 12-9-2014, M/s.MPL presented their production details and effluent treatment. After discussion, the two plants, MPL -I and MPL-II effluent treatment plants were inspected and inlet and outlet of ETPs samples (Four Numbers) were collected for analysis. Then, the treated effluent carrying pipeline was inspected to see any leak before disposed into the sea.

On 14-9-2014, sea water samples from top and bottom near the mixing point and effluent sample from pipe line before entering sea were collected for analysis (3 samples).

4. **M/s. MPL products-Capacity of Plants**

The two plants namely MPL-1 and MPL-2 products and by-products manufactured annually are given in Table 1 and Table 2 respectively. The main raw materials used are propylene, Chlorine and lime

WATER ACT NO : 2808 Renewal dated 11-10-2011
AIR ACT NO : 1156 11-10-2011

EFFLUENT CONSENT QUANTITY UNDER WATER ACT

| | | |
|---|---|---|
| SEWAGE | : | 15 CU.M PER DAY |
| TRADE EFFLUENT | : | 4500 CU.M PER DAY |
| TOTAL | : | 4515 CU.M PER DAY |

The units MPL-I & II have applied for renewal of consent to TNPCB.

5. **Water use Details**

a. **MPL Plant- I**

Source of water :- Metro water , MFL RO rejects water, CMWSSB secondary treated sewage water

For Process water: 883.342 $M^3$/Day
For Cooling water: 291.008 $M^3$/Day
For Domestic Water: 63.898 $M^3$/Day

The above quantity excludes 1273.569. $m^3$ / day of R.O. rejects water from MFL & Kodungaiyur secondary treated sewage water used in PO Plant.

b. **MPL Plant- II**

Source of water: - Metro water , CPCL RO rejects water, CMWSSB secondary treated sewage water

For Process water: 1401.509 $M^3$/Day
For Cooling water: 290.465 $M^3$/Day
CPP use (Power Plant) : 135.780 $M^3$/Day
For Domestic Water: 64.013 $M^3$/Day

The above quantity excludes 889.095$M^3$ / day of R.O. rejects water from MFL & Kodungaiyur secondary treated sewage water used in PO Plant.

Table 1 : Annual products manufactured quantity details

| Sl.No. | Product | MPL-Plant -1 | MPL-Plant -2 |
|---|---|---|---|
| 1. | Propylene Oxide(PO) | 18,000 MT | 18,000 MT |
| 2. | Propylene Glycol(PG) | 10,000 MT | 10,000 MT |
| 3. | Polyols | 25,000 MT | 25,000 MT |

**Table 2 :By products manufactured quantity details**

| Sl.No. | By-Product | MPL Plant- I | MPL Plant- II |
|---|---|---|---|
| 1 | DICHLOROPROPANE - DCP | 3600 MT /Annum | 3600 MT/Annum |
| 2 | DIPROPYLENE GLYCOL - DPG | 1000 MT /Annum | 1320 MT/Annum |
| 3 | DI PROPYLENE GLYCOL MONOMETHYLE ETHER-DPGMME | 460 MT/Annum | - |
| 4 | TRIPROPYLENE GLYCOL -TPG | 120 MT /Annum | 168 MT/Annum |

The two plants have obtained consent for existing operation from TNPCB as stated below .

CONSENT VALIDITY FOR WATER ACT AND AIR ACT : **MPL plant-I**
RENEWAL UNDER PROGRESS

WATER ACT NO : 1386 Renewal dated 11-10-2011
AIR ACT NO : 892 Renewal dated 11-10-2011

EFFLUENT CONSENT QUANTITY UNDER WATER ACT

SEWAGE : 15 CU.M PER DAY
TRADE EFFLUENT : 3400 CU.M PER DAY
TOTAL : 3415 CU.M PER DAY

6. MPL Treatment plant

Both the units (MPL –I and MPL-II) have established effluent treatment plant(ETP) . The ETPs are having facility to treat Process + sewage wastewater. Process effluent generated from propylene oxide and sewage are pumped to high rate thickener (HRT), where the effluent is concentrated at the bottom of the thickener to the level of 8% solids. The HRT (combination of clarifloculator and thickener) erected and commissioned requires flocculent. Approx 3.7 to 4.5 kg flocculent **(Electro Floc 6050)** used / day. It is dissolved in the flocculent dosing tank and dosed continuously to HRT.

The thickener underflow is taken to the Rotary vacuum filter. The solids are dried on the cloth using vacuum. The dry solids are scrapped by scrapper and discharge into trucks, which is used for brick manufacturing and cement plant industries.

The overflow from the thickener flows to cooling tower and cooled to $40^{0}$ C and then pumped to bioreactors. The organics ( COD and BOD) are expected to reduce below permissible standards of TNPCB using the bacteria and aeration process in the bioreactor. Surface aerators are in operation to maintain the dissolved oxygen level. From bio reactor, treated effluent flows to treated effluent tank. Treated effluent collected in the tank is pumped to the sea through pipe line.

THE FOLLOWING EQUIPMENT IS IN THE ETP PLANT AT MPL-I PLANT

| | | |
|---|---|---|
| 1. Clarifloculator | – | 1 No. |
| 2. Thickener | – | 1 No. |
| 3. Rotary vacuum drum filter | – | 2 Nos. |
| 4. Cooling tower | – | 2 Nos. |
| 5. Bio reactors | – | 6 Nos. |
| 6. Mass culture tank | – | 1 No |
| 7. Nutrient tank | – | 2 Nos |
| 8. Treated effluent tank | – | 2 Nos |
| 9. Aerator, surface | – | 6 Nos. |
| 10. High rate thickener | – | 1 No. |

The layout of ETP is shown in Fig.1.

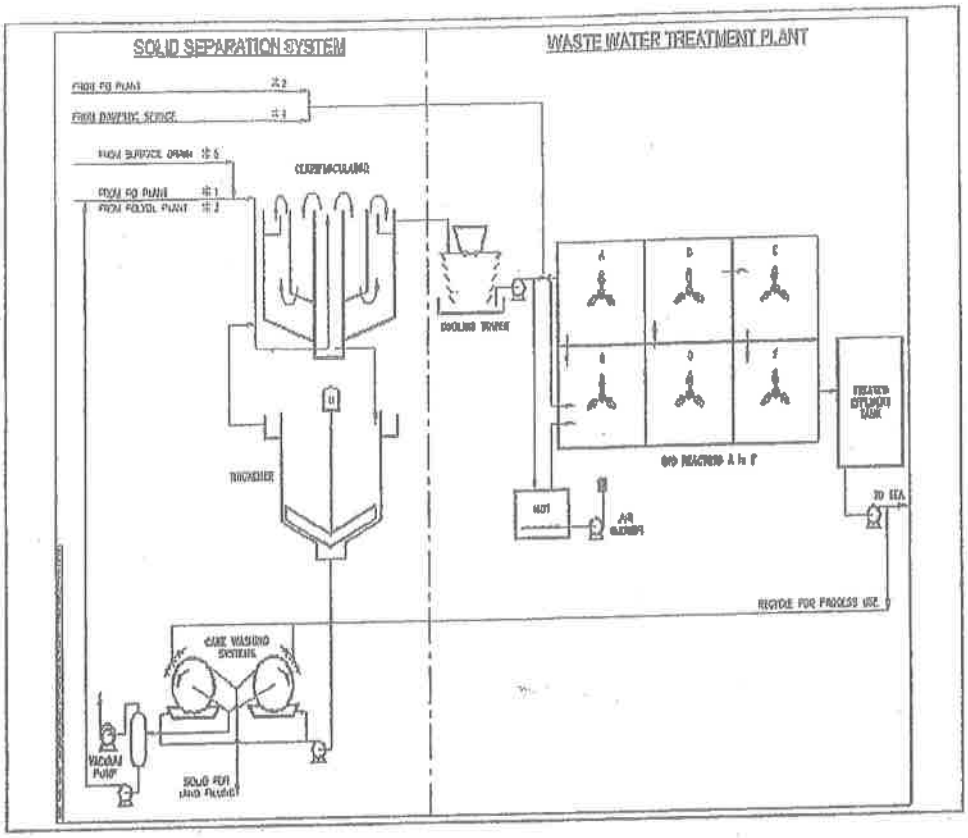
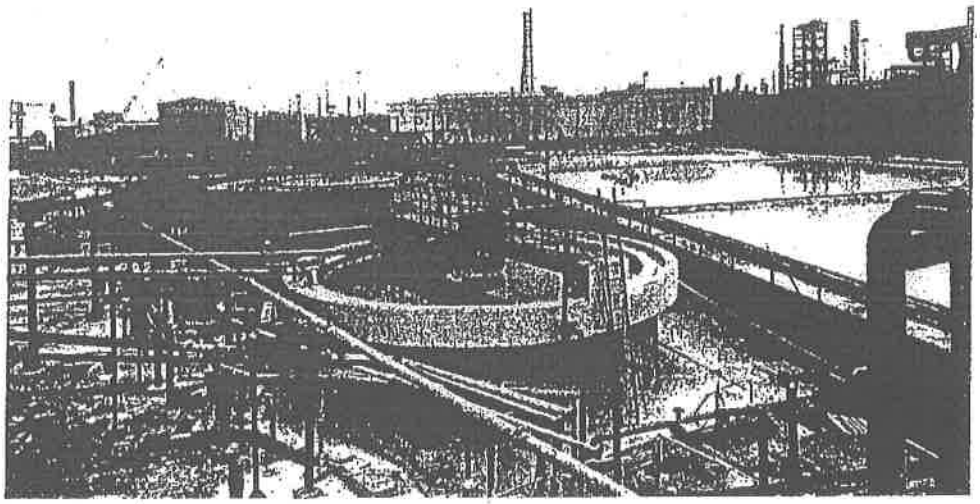
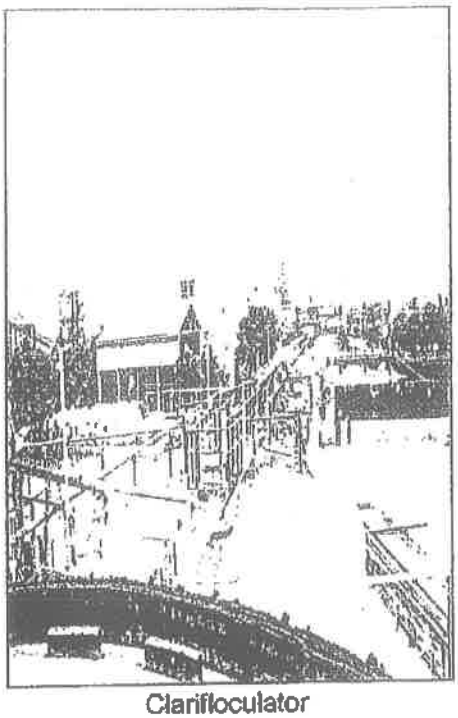



**Fig.1 :ETP lay out**

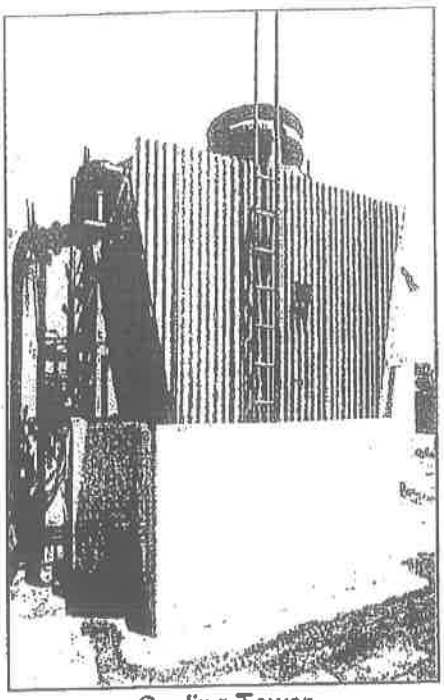
Some of the photographs taken at the MPL-I ETP facility are shown below



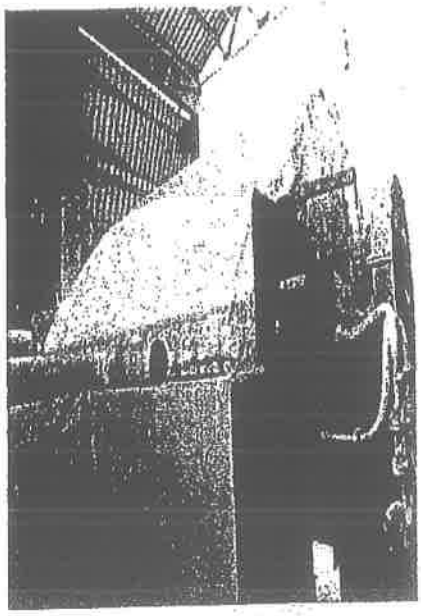
**ETP view**

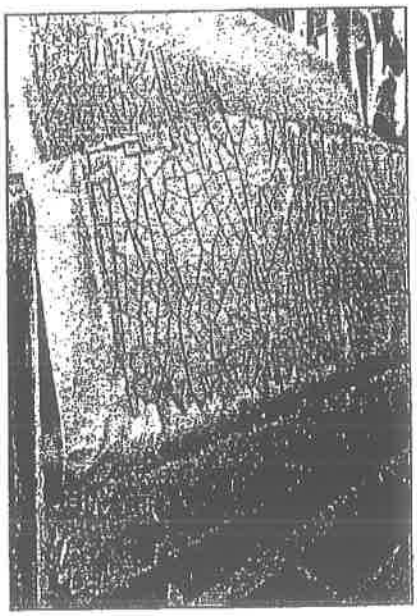


Clariflocculator

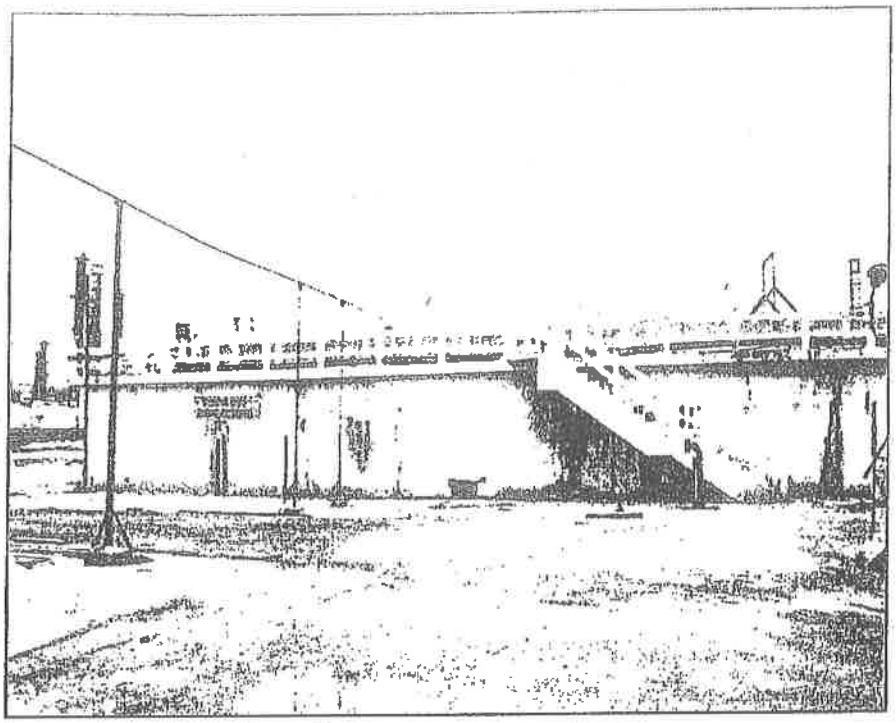


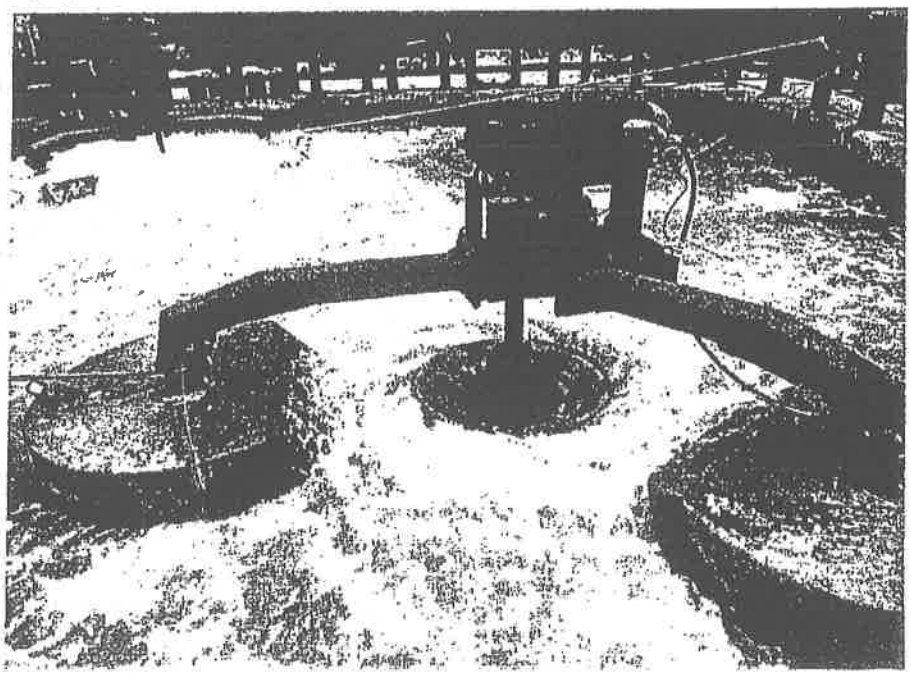
Cooling Tower



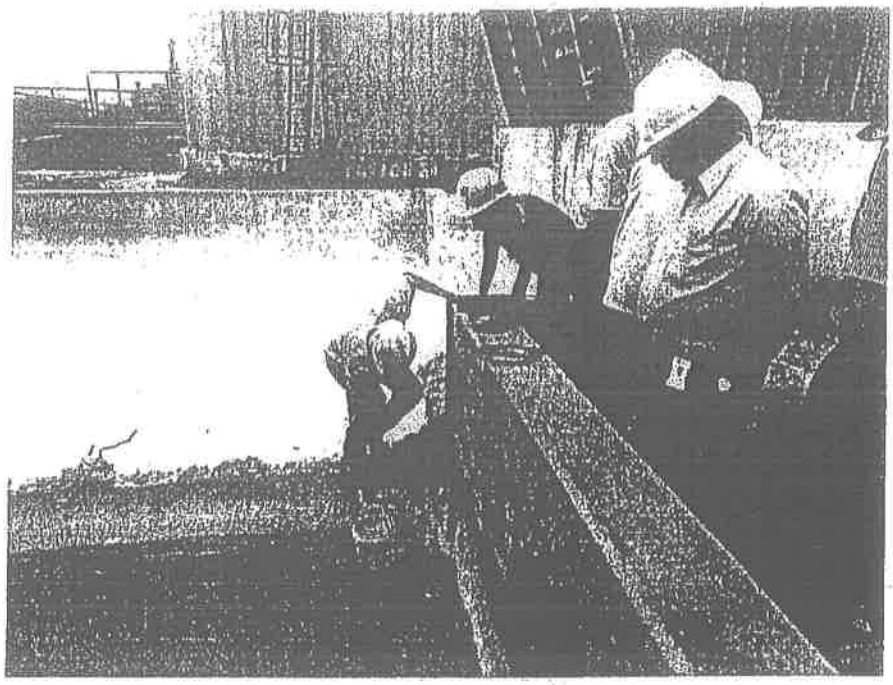


Rotary drum filter





**Bio-Reactor**



**Sample Collection (Raw)**

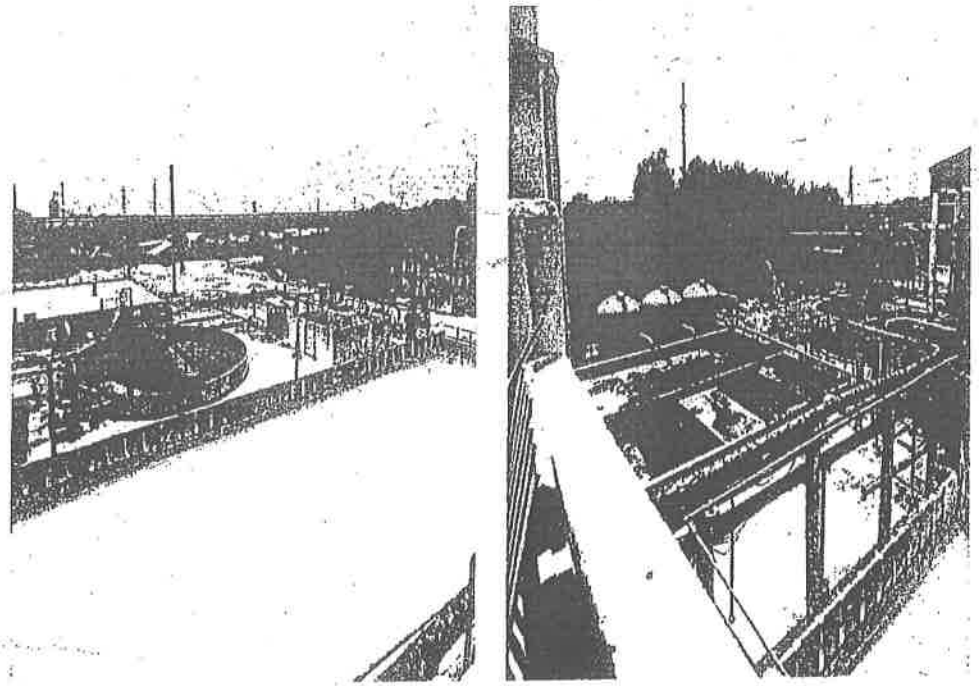
The inlet and the outlet samples of ETP collected during the inspection (12-9-2014) were analyzed by the TNPCB and the results are given in Annexure-I (a&b-NGT1&2). An examination of the results clearly indicates that the present ETP is not able to treat the effluent to the permissible standard with respect to COD below 250 mg/L at MPL-I. Hence, the present ETP facility is not capable of reducing the COD below the TNPCB norms. This should be rectified to meet the compliance immediately.

MPL –II also have similar ETP facility to treat the effluent

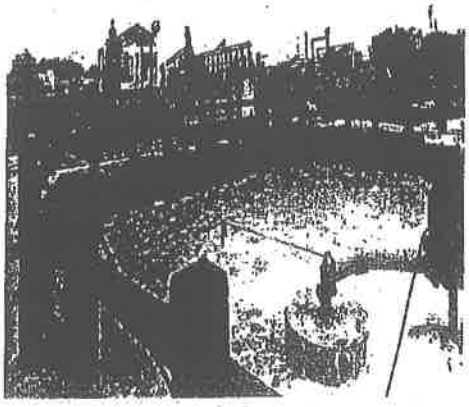
THE FOLLOWING EQUIPMENT IS IN THE ETP PLANT AT MPL PLANT – II

1. High rate thickener – 2 Nos.
2. Rotary vacuum drum filter – 2 Nos.
3. Equalization tank – 3 Nos.
4. Primary, clarifier – 1 No.
5. Aeration tank – 1 No.
6. Treated effluent sump – 1 No.
7. Floating mixer, surface – 3 Nos.
8. Cooling tower. – 2 No.

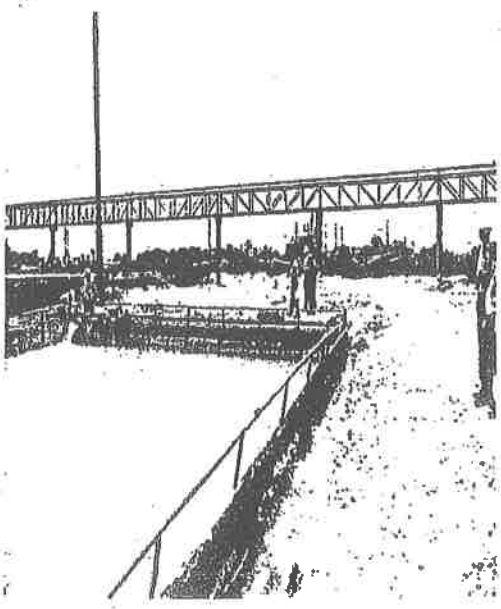
View of ETP at MPL-II is shown below



**ETP view**



Aerator



Sample Collection (Treated)

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Similarly, the inlet and the outlet samples collected during the inspection were analyzed by the TNPCB and the results are given in Annexure-I (c&d- NGT 3&4) An examination of the results clearly indicates that the present ETP at MPL-II is not able to treat the effluent to the permissible limits with respect to COD below 250 mg/L and BOD below 100. Compared to MPL-I, the performance of ETP in MPL-II is very poor with respect to BOD and COD removal. This should be rectified to meet the compliance immediately.

## 7 Pipe Line to sea status

The pipeline to sea was laid initially during 1990 to carry the treated effluent. Now due to aging, the MPL replaced the pipe line during 2011. Approximate length of the line is 6.0 kilometers with HDPE material (PE100 GRADE PN6). The drawings (Existing new effluent disposal line, Alignment of pipeline over the sea bed and outfall diffuser port) are given in Annexure-II (a,b,c).

The length details and outfall pipe line are furnished in Table 3 and 4 respectively.

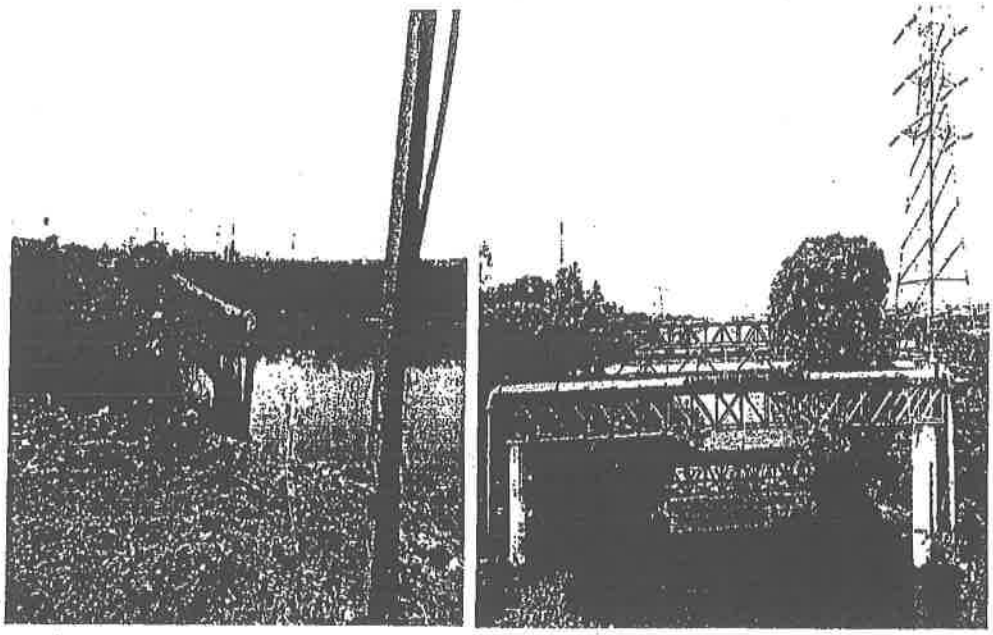
**Table.3 : Line Size & Length Detail**

| Line Size & Length Detail | | | | |
|---|---|---|---|---|
| Sl.No | From | To | Line size mm od | Length in meters |
| 1 | MPL- I | TPL | 280 | 800 |
| 2 | TPL | SATHYAMOORTHY NAGAR | 315 | 1400 |
| 3 | SATHYAMOORTHY NAGAR | SEASHORE | 400 | 3700 |
| 4 | SEASHORE | DIFFUSER | 400 | 700 |
| 5 | MPL-II | SATHYAMOORTHY NAGAR | 280 | 4000 |

Table.4 :Details of the Outfall Pipe Line

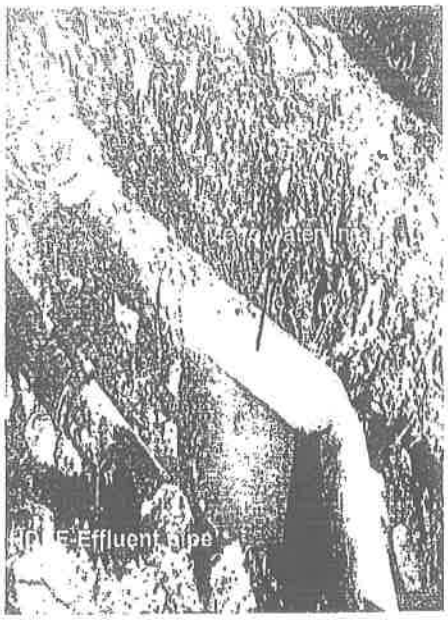
| Description | HDPE 10 PE 100 | Length (m) |
|---|---|---|
| Outfall pipeline off shore | 400 mm OD | 700 |
| Flow rate | 385 $m^3/h$ | --- |
| Water depth level at outfall distance | 9.4 m | --- |

The present condition of the pipe line is shown in the photos below. The line is buried under ground in about 1-3 m depth except where canal water is flowing.



**Open pipe line**

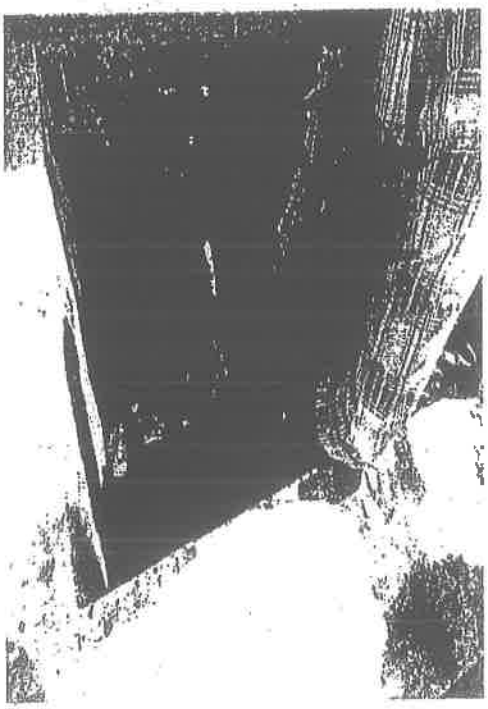
Recently, during laying pipeline for drinking water at one place, it was punctured and the problem is rectified (photo). The condition of the pipe line is now in order.




Punctured line rectified

Buried pipe line near canal

Air vent for pipe line before disposal point



Sample collection from air vent point

The combined treated effluent collected from the air vent point (A1 (e-NGT 5) before disposal, COD value was also above the permissible value of 250 mg/L. This clearly indicates that the units connected to the disposal line are not treating their effluent properly for mandatory COD removal.

The diffuser meant for releasing the treated effluent into the sea details are given below

**Diffuser Details**

| | | |
|---|---|---|
| Diffuser type | – | Unidirectional |
| Diffuser endpoint | – | 680 m -700 m |
| Number of openings | – | 4 |
| Port /Nozzle diameter | – | 0.12 m |
| Total area of openings | – | 0.0301$m^2$ |
| Discharge velocity | – | 2.05 m/s |
| Total discharge flow rate | – | 0.1 $m^3/s$ |
| Nozzle arrangement | – | Unidirectional without fan |
| Diffuser alignment angle | – | 90 $^o$ |
| Discharge density | – | 1005 $kg/m^3$ |

**8. Sea water Sampling**

Two samples were collected, one from sea surface and another one from 9 m depth with a help of bottom sampler ~ 700 m from shore on 14-9-2014. The sea water samplings are shown in the photos below.

The results are furnished in Annexure –I(e-NGT 6&7). The results show that the bottom sample TDS, COD, chloride and calcium are more than the surface sea water sampled. However, it is difficult to strongly conclude that the observed high value is due to industrial effluent alone or not. Hence, continues monitoring of the sea water in and around the release point may provide more insight about the issue and finding a permanent solution for this problem.

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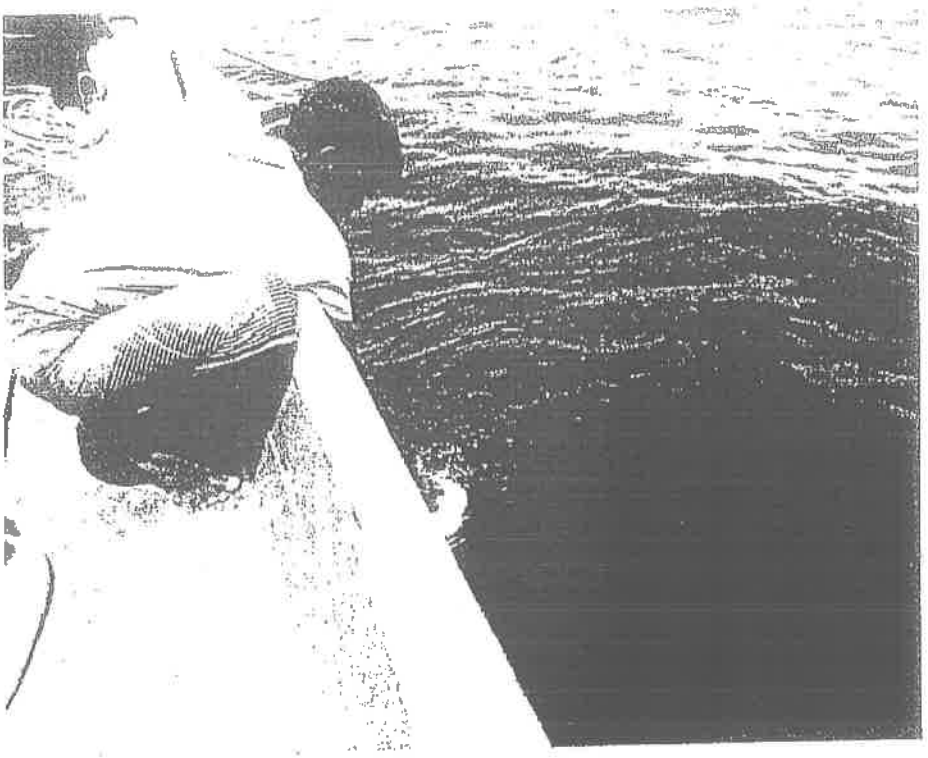
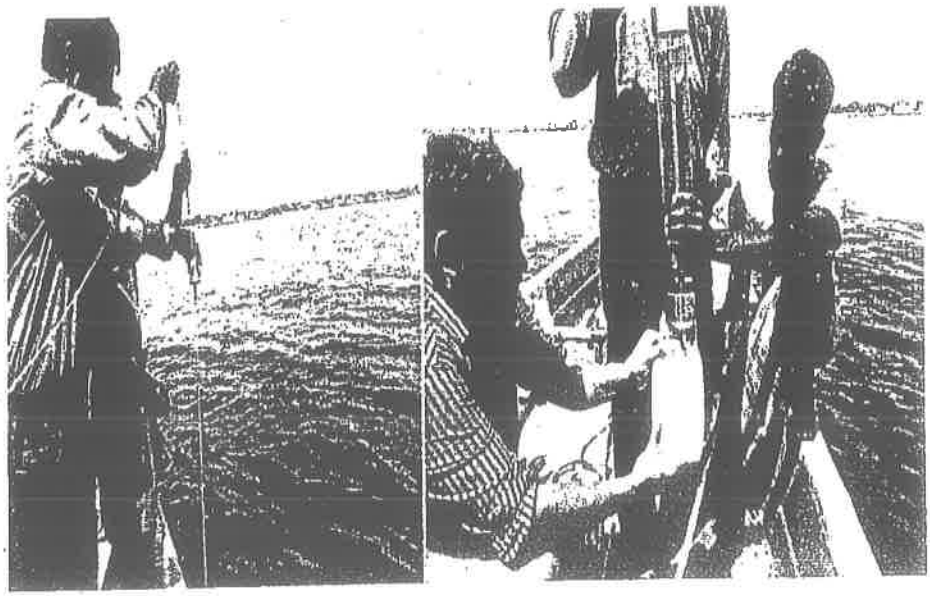


Sea water sampling (surface)



Sea water sampling (bottom) with bottom sampler

9. Recommendations for the environmental safety

Specific

- The units shall have leak detection system and necessary arrangements for immediate repair of the pipe line to avoid soil and ground water contamination.
- Sea water samples to be collected (around mixing point, away from point of mixing and at different depth) once in six months by TNPCB/Ministry of Environment and Forest & Climate Change or by reputed third party organizations in presence of TNPCB officials and analyzed for constituents. Appropriate marine studies to be made including disappearance of marine species, if any, in that zone. This continuous monitoring will provide pollution status of this zone.
- Toxicity studies should be conducted for the combined effluent before the discharge into sea once in six months.
- The MPL units in their process are not using any toxic metals. However, TNPCB may ensure this by analyzing for presence of heavy metals in the treated effluent of units.

General

- As the metro water pipe line and treated effluent pipe line runs close by in some locations, accidental mix up both may led to contamination of drinking water. This may lead to public health problem. Hence, it is recommended to isolate both the pipelines to avoid the problem foresee wherever necessary.
- Pipeline routes may be marked or identified by suitable means for easy identification and follow up.
- Necessary arrangements may be made well in advance to replace the pipe according to its life time to ensure environmental safety
- Open area pipeline (Canals) may be covered with suitable materials to prevent damage

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## 10. Recommendations

### Specific

**Short Term** (within three months)

1. The present ETP established at MPL –I and MPL –II seems to be ineffective in reducing the organics (COD and BOD) to the permissible levels. Efforts should be made at the earliest to improve the proper working of the ETPs or go for better efficient effluent treatment process to achieve the marine discharge standards.
2. The industries should make necessary provisions for the collection of samples from the pipeline after the interconnection point of the treated effluent (down stream point after mixing zone) and near the discharge point. These 3 points (MPL-I & II,TPL (ECH) and Kothari petro chemicals Ltd) and another one before entering sea (near Ramkrihna Nagar) may be covered and locked. One set of key may with the industry for maintenance and another set with TNPCB for sample collection from these four locations. Monthly samples (surprise) may be collected and tested by TNPCB.

**Long term**

In the context of sustainable development, the following may be paid attention

1. M/s.MPL (I&II) should make effort to do away with the present Chlorohydrin route and switch to catalytic process of manufacturing PO. As this process is a sustainable one and eliminates the use of hazardous chlorine gas and lime which ultimately end up as waste.
2. M/s MPL (I&II) and other industries should look into possibilities of Zero liquid discharge with suitable technologies like RO to get water and reject for suitable byproduct recovery. This will eliminate the sea disposal of treated effluent.

**General**

**Short Term** (within six months)

Appropriate flow meter for liquid effluent discharge that has been installed should be connected to TNPCB care-Air centre and online monitoring meters for parameters like, pH, Temperature, Electrical Conductivity (TDS), COD, BOD, etc., may be installed and this may also be connected to TNPCB at the earliest by all the units.

29/9/14

Member-Expert committee

Dr. N. Vedaraman, M Sc., Ph.D.,
Senior Technical Officer
Chemical Engineering Division
CSIR - Central Leather Research Institute
Adyar, Chennai - 600 020. T...

Chairman- Expert committee

Dr. K. PALANIVELU, Ph.D.,
Professor
Centre for Environmental Studies
Anna University
Chennai-600 025, India

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BY REGD. POST ACK. DUE

BEFORE THE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI
[See Rule 15)

Application No.18 of 2013 (SZ)
(W.P. No. 6922 of 2011, Madras High Court)

In the matter of:

1) Meenavargal Membattu Sangam
Represented by its President
Mr. K.R. Selvaraj Kumar
Having office at Old NO. 97/2, New No. 199
S.N. Chetty Street --
Royapuram, Chennai – 600 013.

Applicant / Petitioner in
W.P. No. 6922 of 2011

Versus

1) The Chief Secretary
Government of Tamil Nadu
Secretariat
Chennai – 600 009.

2) The State of Tamil Nadu
Represented by its Secretary to Government
Industries Department
Fort St George
Chennai – 600 009.

3) The District Collector
Thiruvallur District
Thiruvallur.

4) The Chairman
Tamil Nadu Pollution Control Board
No. 76, Mount Salai
Guindy, Chennai – 600 032.

5) M/s. Manali Petrochemical Ltd
Having its Principal office at
Ponneri High Road
Chennai – 600 068.

Respondent(s)/Respondent(s)
In W.P. No. 6922 of 2011

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## NOTICE BEFORE ADMISSION

Whereas a Writ Petition No. 6922 of 2011filed by the above named Applicant before the High Court of Judicature of Madras praying to issue a writ, order or direction in the nature of the writ of Mandamus directing the respondents No. 1 to 4 to initiate appropriate action against the 5th respondent for disposing the untreated water effluent into the sea thereby polluting the water resources, has been transferred to the National Green Tribunal and whereas the Tribunal has taken the Writ Petition in the Registry as Application No. 19 of 2013 (SZ) for further proceedings, and whereas you have been mentioned as Applicant/Respondents in the Writ Petition:

Notice is hereby given to you to appear before this Tribunal in person or through legal practitioner in this matter on **21.03.2013 at 11 a.m.** in the premises No. 950/1, 2nd and 3rd Floor, Poonamallee High Road, TNPCB Building, Arumbakkam, Chennai – 600 106 and further you are hereby directed to file reply along with supporting documents, if any, on the said date.

Take notice that, in default, the said application will be heard and determined in your absence.

Given under my hand and the seal of the Tribunal, on this, the 27th day of February 2013.

By the order of the Tribunal

(S. Kumar)
Deputy Registrar

ANNEXURE - 85

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## Two Member Expert Committee Points Compliance Report ( 12 -14th Sep 2014)

| | Expert Committee Points | MPL Action Taken Details | STATUS |
|---|---|---|---|
| | **Specific Recommendations for environment safety** | | |
| * — | The units shall have leak detection system and necessary arrangements for immediate repair of pipeline to avoid soil and ground water contamination. | MPL inspection team is daily checking entire length physically, daily inspection is carried out for entire length. We have a dedicated team of Engineers always available to attend and any emergency / leak at any time. So far no such exigency has arised. | COMPLIED |
| * — | Sea water samples to be collected around mixing point, away from point of mixing and at different depth once in six months by TNPCB / MoEF /reputed third party in the presence of TNPCB officials and analysed for constituents. Appropriate marine studies to be made including disappearance of marine species, if any in that zone. This continuous monitoring will provide pollution status of this zone. | TNPCB /CPCB has been collecting samples taken from the Plants and Effluent line, Sea entry point and samples are taken from sea. MPL is extending necessary co-operation to the authorities in this matter for taking samples all the facilities provided. **NIOT carried out the study as per requirement during 2015 and 2020 .Report submitted.** | COMPLIED |
| * — | Toxicity studies to be conducted for the combined effluent before discharge into sea once in six months | MPL does not use any toxic metals which have been recorded by the committee itself in the report. However a study was done by SGS and the report is submitted, from which it could be seen that no toxic metals in their process. | COMPLIED |
| * — | The MPL Units in their process are not using any toxic metals. However TNPCB may ensure this by analysing for presence of heavy metals. In the treated effluent of units. | TNPCB is regularly analysing the heavy metals in the treated effluent and the values are within the limit. | COMPLIED |
| | **Observation in the ECR – General** | | |
| * — | As the Metro water pipeline and treated effluent pipe line runs closely in some locations, accidental mix up both may led to | There are no possibilities of mixing up of metro water and treated effluent since the respective lines have been laid at | |

| | | | |
|---|---|---|---|
| | contamination of drinking water. This may lead to public health problem. Hence it is recommended to isolate both the pipe lines to avoid problem foresee wherever necessary | different levels. Further MPL has used heavy thick HDPE pipes which are generally unbreakable under the normal conditions. MPL pipe line pressure is less if compared with Metro water line pressure.<br>As stated earlier MPL's Team is carrying out regular inspection of the entire stretch of the pipeline. Also, it co-ordinates with agencies such as High Ways, TWAD, CMWSSB etc. whenever they undertake any digging or other work near the effluent line to ensure that the line is not affected/ tampered with. | COMPLIED |
| * — | Pipeline routes may be marked/identified by suitable means for easy identification and follow-up | Pipeline route marker provided in the entire length in 75 places. Photos submitted. | COMPLIED |
| * — | Necessary arrangements may be made well in advance to replace the pipe according to its lifetime to ensure environmental safety. | The effluent line was originally laid and commissioned in the year 1990 with an estimated life of over 25 years. Though there were no leaks or any other issue relating to the line, in spite of a huge capital outlay MPL on its own took steps for replacement of the line and completed the same in 2011, well within the validity of the original line. Similar action will be taken in future also at an appropriate time. With the inspection taking place on daily basis, MPL will take actions on this based on exigencies.<br><br>Line renewal Photocopies submitted, CRZ clearance letter submitted. Line renewal completed informed to TNPCB. | COMPLIED |
| * — | Open area lines (Canals) may be closed with suitable materials to | The exposed pipeline is already covered with suitable cross over | |

| | | | |
|---|---|---|---|
| | prevent damage. | bridge with strong structural materials to prevent any damage. These will be ensured in the inspection and action taken to maintain the same in good order. Photo Submitted. | COMPLIED |

| | | | |
|---|---|---|---|
| | **Recommendations :- Short Term** (within three months) | | |
| * – | The present ETP established at MPL - I and MPL – II seems to be ineffective in reducing the organics (COD and BOD) to the permissible levels. Efforts should be made at the earliest to improve the proper working of the ETPs or go for better efficient treatment process to achieve marine discharge standards. | MPL Plant-I & Plant-II ETP up gradation done with advanced Bio-Treatment process. Necessary new equipment's erected and commissioned new aeration system, online monitoring system installed and efficiently and consistently ETP is working. Treated effluent meeting the prescribed limits. | COMPLIED |
| * – | The industry should make necessary provisions for the collection of samples from the pipeline after the interconnection point of the treated effluent (downstream point after mixing zone) and near the discharge point. These three points (MPL –I & II, TPL ECH and Kothari petro chemicals Ltd) and another one before entering sea (near Ramakrishna Nagar) may be covered and locked. One set of key may with the industry for maintenance and another set with TNPCB for sample collection from these four locations. Monthly samples (surprise) may be collected and tested by TNPCB. | Sample points provided in the above required places with grill gate protection with Lock and Key. One set of key handed over to TNPCB. Photos submitted. | COMPLIED |

| | | | |
|---|---|---|---|
| | **Long Term** | | |
| * – | M/s MPL I & II should make effort to do away with the present chlorohydrin route and switch to catalytic process of manufacturing PO.As this process is a sustainable one and eliminates the use of hazardous chlorine gas and lime which ultimately end up as waste. | MPL is the leading manufacturer of PO in India from 1990 and is using the chlorohydrin process. In fact this project was started as an import substitution project with the then available (only) technology. The recommendations has been evaluated in detail and based on the evaluation the new technology is not viable for this type of small capacity Propylene oxide plant.<br><br>MPL produces 36 KT per annum of P.O and India requirement of PO is around 60 KT only. New technology minimum economic size is 200KT and now viable size is 300 KT per annum. For small capacities new technology is not available in catalytic process. The project cost is more than 4000 crores and still with Indian demand being much lower, MPL can move to new technology only when Indian demand can rise to the economic size of the plant. In the catalytic process comparatively pollutant load per MT /PO is higher than this chlorohydrin route and also has metallic catalyst waste. | COMPLIED |
| * – | M/s MPL I& II and other industries should look into possibilities of zero liquid discharge with suitable technologies like RO to get water and reject for suitable by product recovery. This will eliminate the sea disposal of treated effluent. | MPL done various water conservation measures for recycle, reuse, and recovery. MPL surrendered maximum quantity of metro water to CMWSSB for city use and using tertiary treated water and TTRO water for plant use. | COMPLIED |

| | | | |
|---|---|---|---|
| | **Short Term** (within six months) | | |
| * – | Appropriate flow meter for liquid effluent discharge that has been installed should be connected to TNPCB car-Air centre and online monitoring meters for parameters like pH, Temperature, TDS, COD, BOD etc, may be installed and this may also be connected to TNPCB at the earliest by all the units. | Appropriate flow meter for liquid effluent discharge line has already been installed. Flow measurement online monitoring instruments are installed, and online connectivity connected to TNPCB Care–Air centre in April 2015 itself. Online monitoring meters for pH, Temperature, TDS, COD, BOD installed and connected to TNPCB Care–Air centre. | COMPLIED |

**Annexure A**

# MPL Marine outfall survey report

**Description of the study area**

The study area consisted of 1 km wide x 2 km long stretch along the Ennore coast to include the near field and far field area of the MPL outfall. The adjoining Ennore creek has also been sampled due to its proximity to the discharge site and possible flushing of its input to the North Chennai coastal waters. M/S.Manali Petrochemicals Ltd. treated effluent discharge outfall is located in Ennore coast, East coast of India. The sampling stations were located at 500m and 1000m distances along three transects to the north, east and south of outfall.

**Sampling protocol**

Water samples were collected from 10 sampling locations nearby effluent outfall area & 4 stations along the creek with respect to the tidal cycle (Fig.1). The Niskin water sampler was used to collect water samples and transferred to pre-cleaned 2liter polypropylene bottles. Sediment samples were collected using a Van Veen Grab, transferred to clean polythene bags and transported to the laboratory.

The BOD samples were fixed immediately after collection using Winkler's A & B. The collected samples were stored at 4°C in the icebox for nutrients and other parameters analysis. Samples were stored as per the standard requirement of various water quality parameters and preserved with standard preservatives. Most of the samples require to be preserved in sub-zero conditions on-board immediately after collection.Acid rinsed bottles used to collect the samples for metal analysis and amber bottles used for organic analysis.The collected water samples were analyzed for dissolved oxygen (DO), salinity, nutrients, PHC & heavy metals. Air & Water temperature was measured under field condition using a water quality YSI Probe. The collected water& sediment samples were immediately handed over to CPCB officials located at Manali Petrochemicals LTD, Chennai. After that, samples were transferred to Glens Innovation Labs PVT LTD for laboratory analysis.

**Fig.1 Depicting Sampling locations along with the offshore discharge sites**

**Table1.The sampling locations near the outfall area of MPL at Ennore coast, East coast of India.**

| S No | Sampling locations | Longitude and Latitude | Remarks |
|---|---|---|---|
| 1 | EMPL1 | 13°11'23.61"N80°19'33.79"E | North of outfall |
| 2 | EMPL2 | 13°11'06.27"N 80°19'29.36"E | Northof outfall |
| 3 | EMPL3 | 13°10'33.68" N80°19'23.03"E | South of outfall |
| 4 | EMPL4 | 13°10'17.42"N 80°19'19.52"E | South of outfall |
| 5 | EMPL5 | 13°11'20.55"N 80°19'51.07"E | Northeast of outfall |
| 6 | EMPL6 | 13°11'02.02"N 80°19'47.35"E | Northeastof outfall |
| 7 | EMPL7 | 13°10'47.74"N 80°19'42.69"E | 500m away from outfall area (Eastern side) |
| 8 | EMPL8 | 13°10'31.24"N 80°19'39.03"E | Southeast of outfall |
| 9 | EMPL9 | 13°10'15.38"N 80°19'36.42"E | Southeast of outfall |
| 10 | EMPL10 | 13°10'46.71"N 80°19'56.05"E | 1km away from the outfall (Eastern side) |
| 11 | ENC 1 | 13°13'52"N 80°19'48"E | Ennore creek mouth |
| 12 | ENC 2 | 13°13'25"N 80°19'08"E | Near railway bridge |
| 13 | ENC 3 | 13°12'13"N 80°18'32"E | Near to ETPS intake point |
| 14 | ENC 4 | 13°11'02"N 80o17'42"E | Downstream of Ammulvoyal junction |

Samples were adequately handled, and all necessary quality assurance and quality control (QA/QC) measures such as preservation, storage, and labelling followed. All sample containers were pre-treated by washing in dilute hydrochloric acid and rinsed with distilled water.

The following sections discuss the present data obtained from laboratory analysis of samples collected during March 2020 and comparison with previous data available with NIOT during the various surveys carried out in the same area during 2015intending to establish any possible trend.

*Temperature*

Temperatures affect the kinetics of chemical and physical processes such as dissolved oxygen, photosynthesis, metabolic processes and thus controls the water quality characteristics. Seawater temperature measured during the different tidal cycles recorded negligible variation in space and time.

It varied between 28.3 and 29.1℃ during the study period. In general, surface temperatures showed minor variations with time of the day. Water temperature is influenced by several factors, such as the intensity of solar radiation, evaporation, and sewage influx.

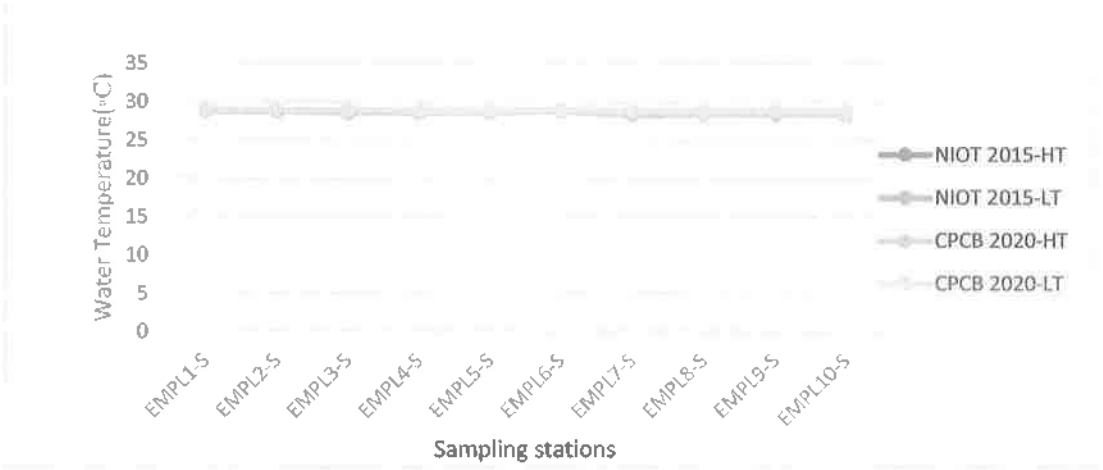



**Fig.2 Water temperature variation in the surface waters around MPL offshore discharge**

*Salinity*

Salinity value ranges between 34.9 and 39.4 PSU at coastal waters. The maximum values of 37.9 PSU recorded at surface waters of EMPL8 during low tide with a bottom value of 35.3

PSUmay be a spike of analytical abnormality (outlier value). Further, it needs multiple samples of&in-depth studies to confirm the same.

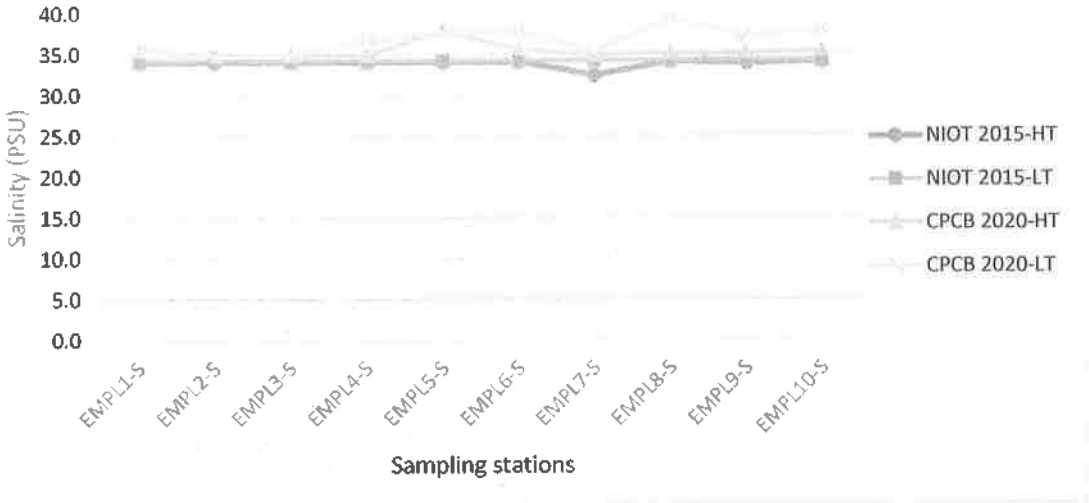



**Fig.3 Salinity variationin the surface waters around MPL offshore discharge**

*pH*

The variation of observed pH in the samples ranged between 7.50 and 7.90in the surface waters of the study area. The Observed pH values are within the range of normal coastal waters.

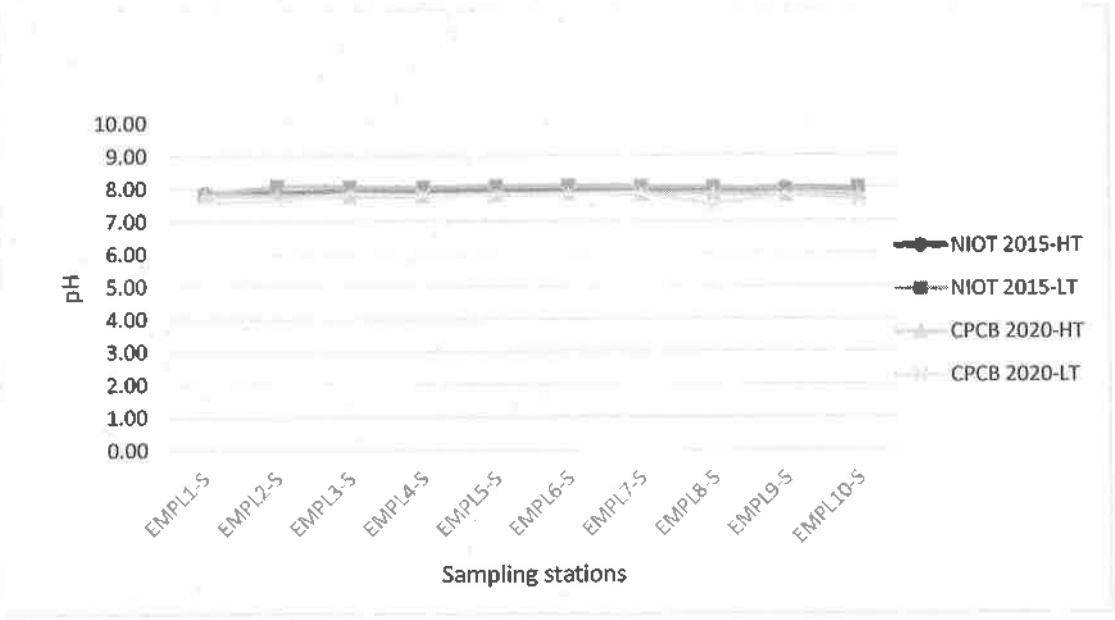



**Fig.4 pH variation in the surface waters around MPL offshore discharge**

*Total Suspended Solids (TSS)*

The variation of observed suspended solids is 3.1 to 6.4 mg/l during the study period. Maximum was recorded at EMPL5 during high tide at surface waters, and the bottom water recorded 4.5 mg/l. Reduction in TSS values is observed with compared to 2015 study.

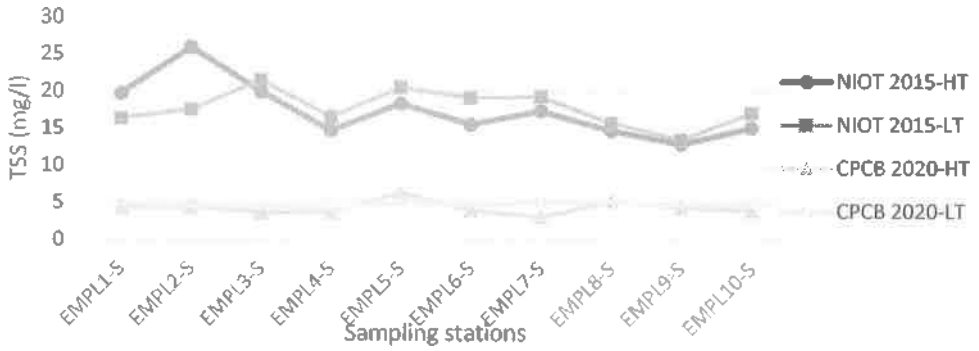



**Fig.5 Total suspended solid variationin the surface waters around MPL offshore discharge**

*Dissolved Oxygen (DO)*

Dissolved oxygen in water depends on several factors, some of which are the salinity, temperature, wind velocity, reaeration, organic matter, productivity and the presence of pollutants.

The observed dissolved oxygen ranged between 5.4 to 6.4 mg/l at surface waters. The minimum value was recorded during low tide of EMPL4 station and the bottom water recorded 6.4mg/l. The DO values conform to SeaWater Quality Standards SW I to SW IV prescribed by CPCB.

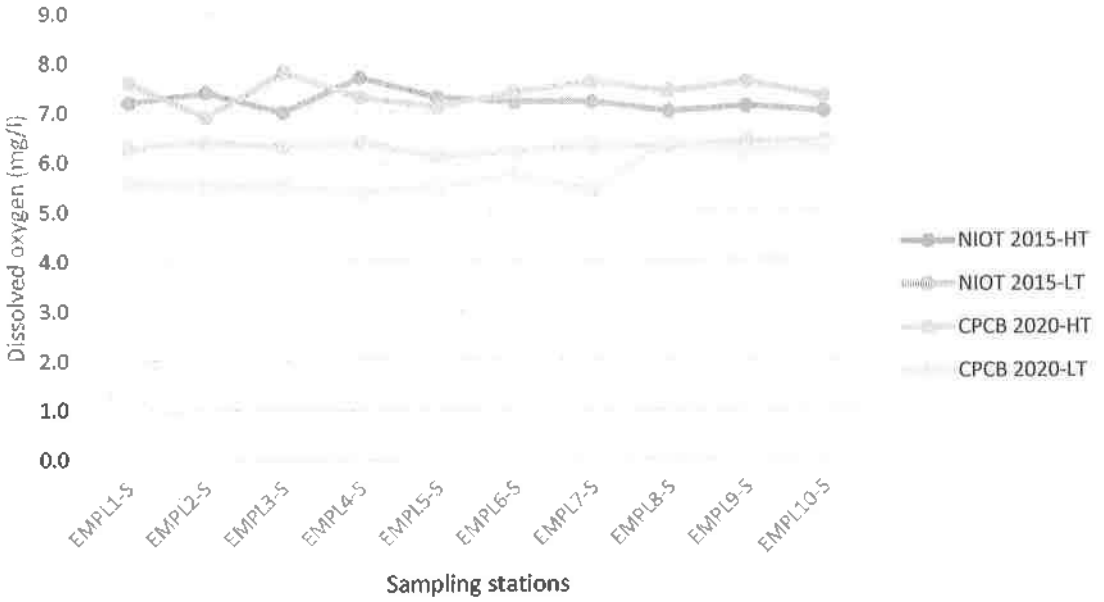



**Fig.6 Dissolved oxygen variation in the surface waters around MPL offshore discharge**

*Biological Oxygen Demand*

In general, BOD values in surface water varied between 2.8 to 3.2 mg/l. The bottom water values are lesser than the surface waters. There is a slight increase in BOD levels compared to 2015 levels. However, it is within the limits of SWIV& SWII criteria.

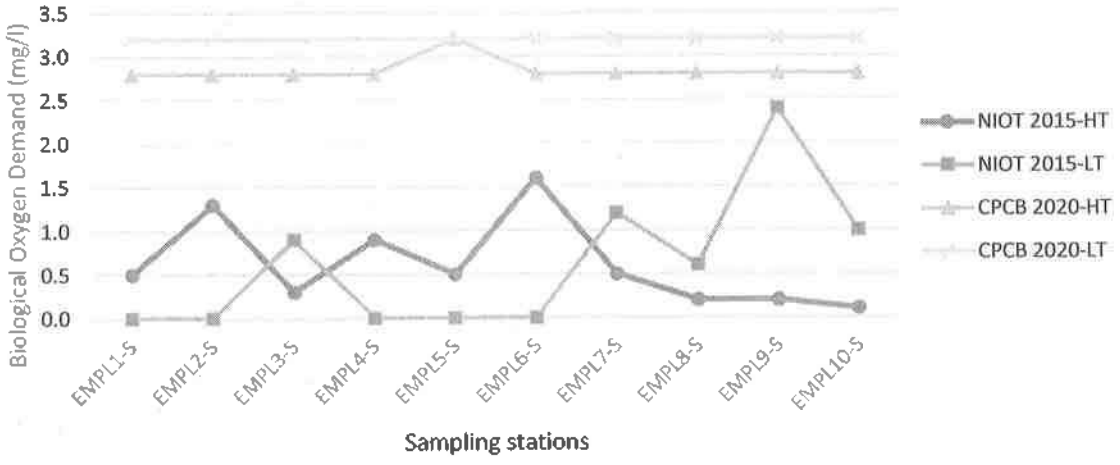



**Fig.7 BOD variation in the surface waters around MPL offshore discharge**

*Nutrients*

The water chemistry of the sea is a result of the hydrodynamics and biological activity, which cause variations in nutrient concentrations. Enhanced concentrations generally imply

anthropogenic inputs. Very high concentrations can result in eutrophication, resulting in DO problems.

In general, nutrient concentrations in the seawater are very low;minor increases or decreases can alter primary productivity. The concentration ranges of nutrients are as follows.

a. Ammonia Nitrogen

The ammonia values recorded 2.91 µmol./lat EMPL1 and all the other stations are below the detectable limits. However, the bottom water samples during low tide, all the stations recorded 2.91 µmol./ldespite the values of below detectable quantity in surface waters during this period. The unusual increase in ammoniacal nitrogen values requires detailed studies.

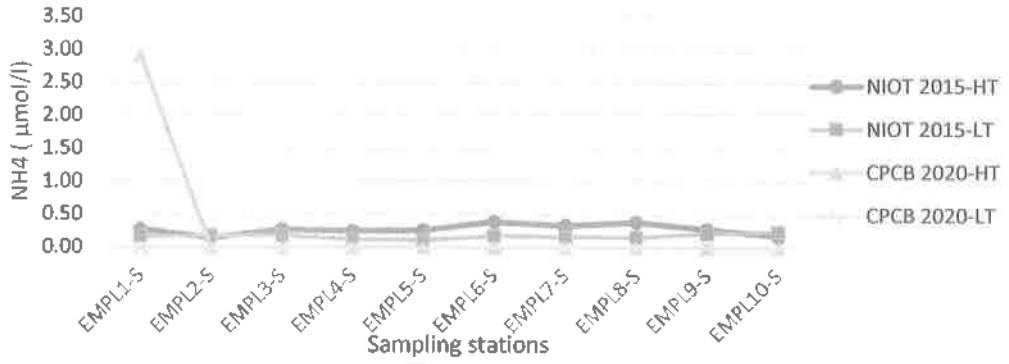



**Fig.8Ammoniacal nitrogen variation in the surface waters around MPL offshore discharge**

b. Nitrate Nitrogen

Among the three inorganic forms of Nitrogen, Nitrate Nitrogen is likely to be abundant at all stations, as it is thermodynamically the most stable oxidation level of nitrogen in the presence of oxygen in seawater and would accumulate in the sediments if left unutilized by plankton or bacterial decomposition.

In general, Nitrate values varied from10.0to 20.4 µmol./lrecorded during the study period. The maximum value found to be reported at all the stations except EMPL9 at low tide during the study period. However, the bottom water samples recorded 4.9 to 9.9 µmol./l in both the tides. The nitrate values recorded a significant increase when compared to 2015 studies.

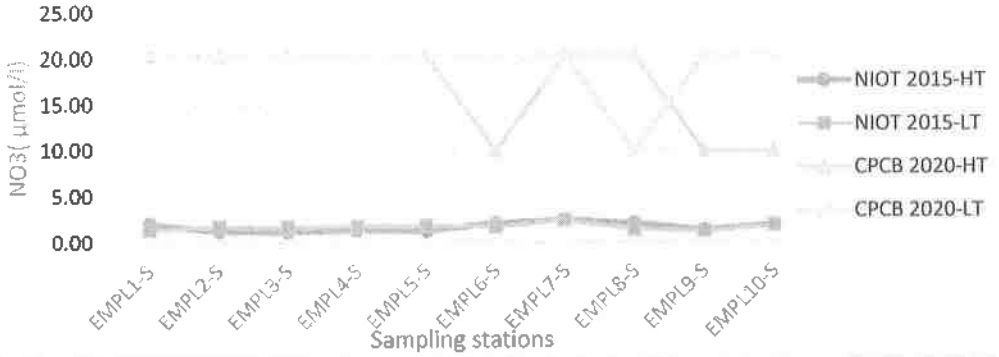



**Fig.9 Nitrate nitrogen variation in the surface waters around MPL offshore discharge**

c. Nitrite Nitrogen

The transitional Nitrogen product Nitrite varied between 0.04 to 0.67 µmol./l in surface waters during the study period. The maximum value was recorded at EMPL4 and the minimum values in all the stations during low tide. The measured values were comparedwith the previous observations during 2015 by NIOT. Nitrite concentrations recorded a decrease within five years. The same trend of surface water also been documented in bottom waters.

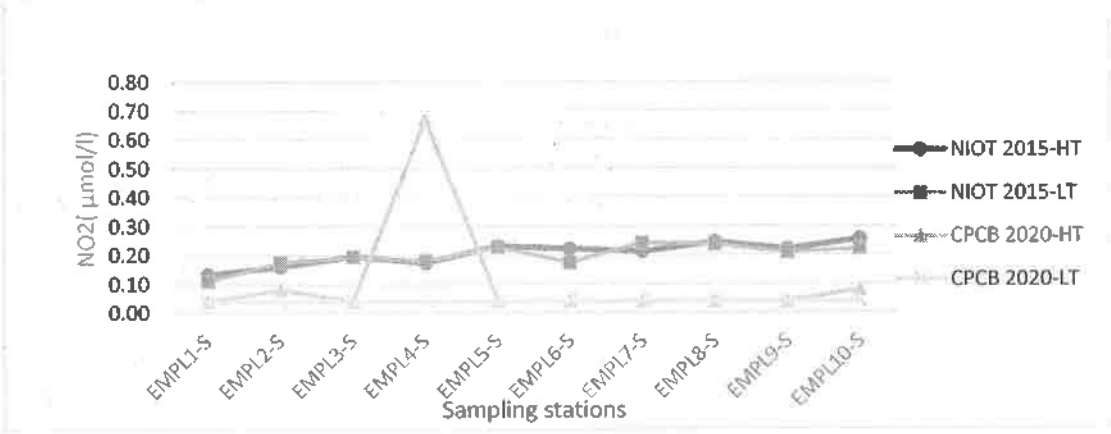



**Fig.10 Nitrite nitrogen variation in the surface waters around MPL offshore discharge**

d. Phosphate Phosphorous

In general, the Phosphate phosphorous concentrations recorded a constant concentration of 0.21 µmol./l at all the station despite the tidal and depth variation. A manifold decrease in phosphate concentration is observed when compared to 2015 condition.

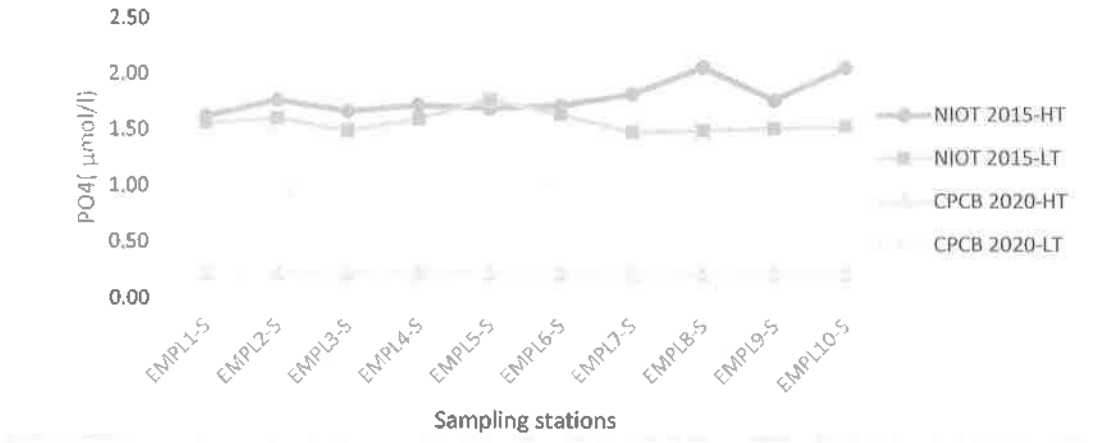



**Fig.11Phosphate variation in the surface waters around MPL offshore discharge**

**Petroleum hydrocarbon** (PHC)

Petroleum hydrocarbons are the primary constituents in oil, gasoline, diesel, and a variety of solvents and penetrating oils. Petroleum hydrocarbon residue in the surface water column found to be nil during the survey period. Compared to previous studies, and the present observation recorded many folds decrease in concentration.

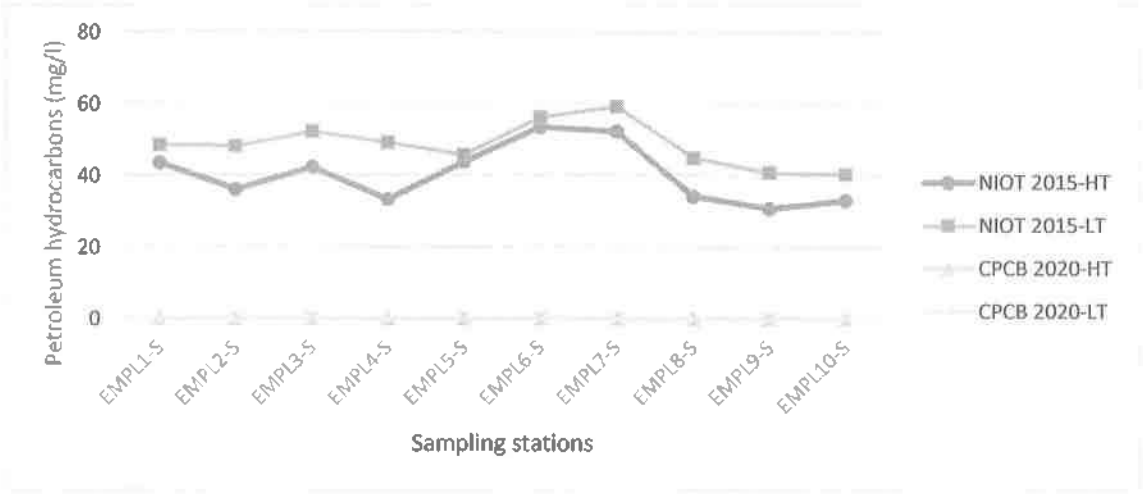



**Fig.12 PHC variation in the surface waters around MPL offshore discharge**

**Heavy Metals**

The heavy metals like Arsenic, Nickel, Copper, Chromium, Cadmium, Zinc, Lead, Selenium, Cobalt, Manganese, and Mercury were analyzed in water and sediment. The range ofmetal concentrations is below the detectable limit in most of the stations when compared to previous studies of 2015. However, Manganese recorded some quantifiable measures of Mn

(0.004 to 0.286 µg/l) in the bottom water samples. The results are not showing any trend among the location as well as tides.

***SEDIMENTS***

Sediments are seafloor materials which eroded from land to ocean through rivers or wind. The constituent ofthe sediments depends upon the local geological condition and other anthropogenic activities. Sediments are major nutrient sources for the aquatic faunas. The present study monitors the quality of marine sediments in the MPL offshore discharge sites along Ennore coast. The selected metals concentrations of sediments are shown in Table(Annexure 1: Table No.5).

The range of Ni (BDL to 3.81µg/g), Co (BDL to 3.09 µg/g), Cu (BDL to 3.18 µg/g), Cd (BDL), Pb(1.47 to 3.70 µg/g), Cr (4.48 to 9.69 µg/g), Hg (BDL to 3.18 µg/g),Fe (2332.74to 5221.67 mg/kg),Mn (11.58 to 50.93 mg/kg) and Zn (3.16 to 12.50 mg/kg) are observed in the sediment. The lower concentrations of most of the metals are found in the location EMPL 9. Thehigher concentration of Ni, Co, Cu, Cd, Cr,Fe atEMPL 5 and Mn at EMPL 9 and Hg atEMPL10are recorded respectively.

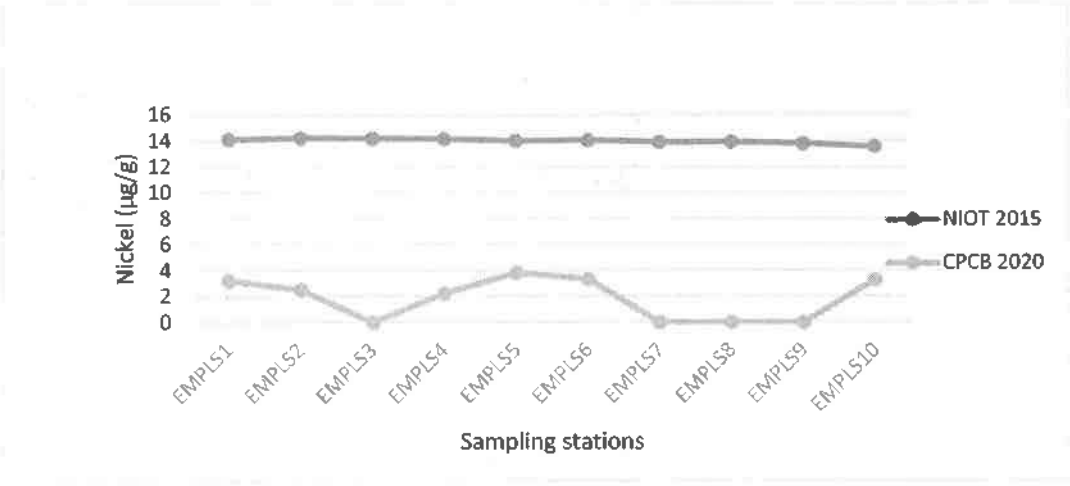



**Fig. 13Nickel variation in the seafloor sediments around MPL offshore discharge**

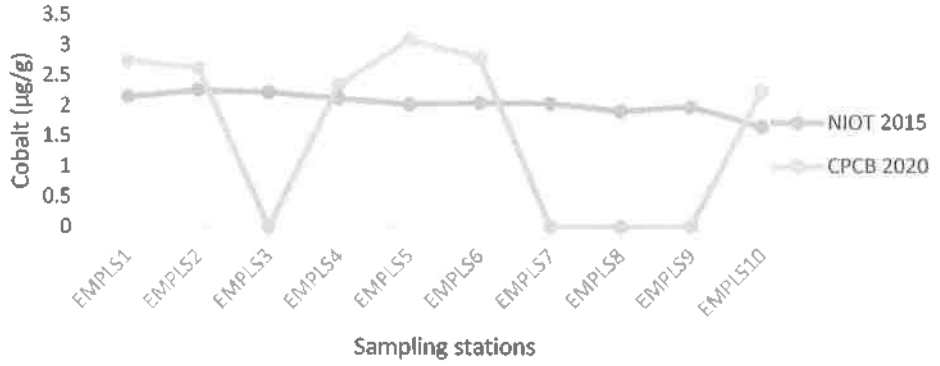



**Fig. 14Cobalt variation in the seafloor sediments around MPL offshore**

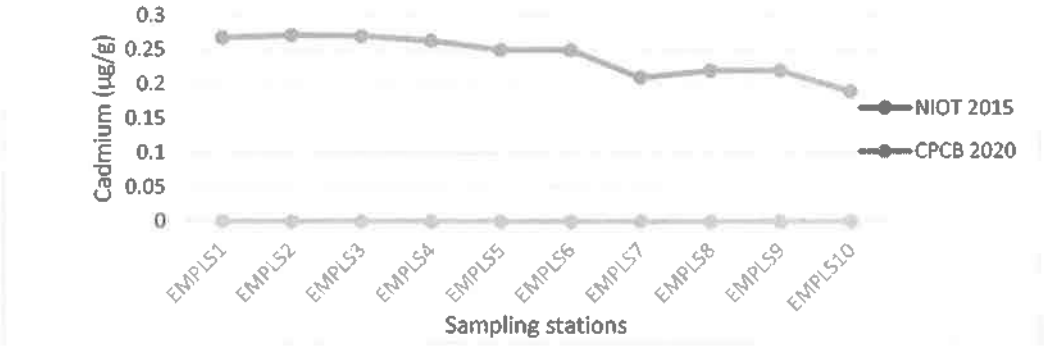



**Fig.15Cadmium variationin the seafloor sediments around MPL offshore**

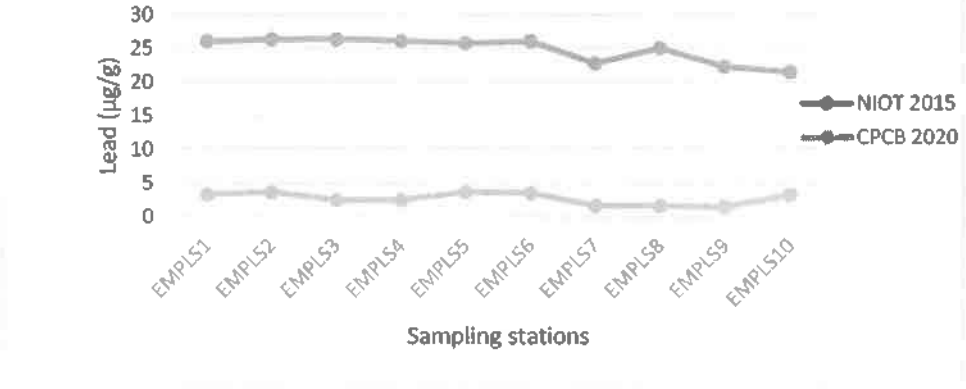



**Fig. 16Leadvariation in the seafloor sediments around MPL offshore discharge**

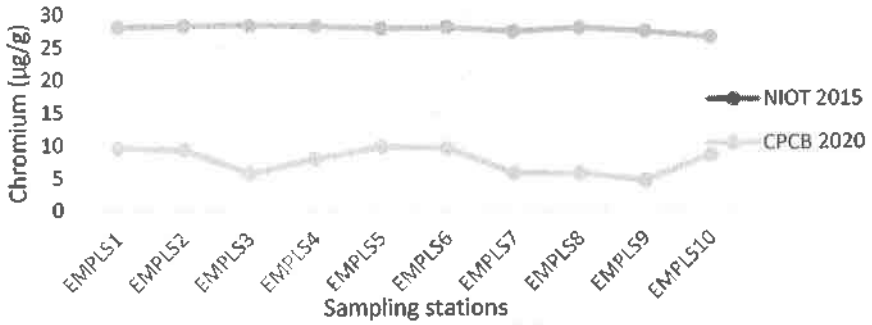



**Fig. 17Chromiumvariation in the seafloor sediments around MPL offshore discharge**

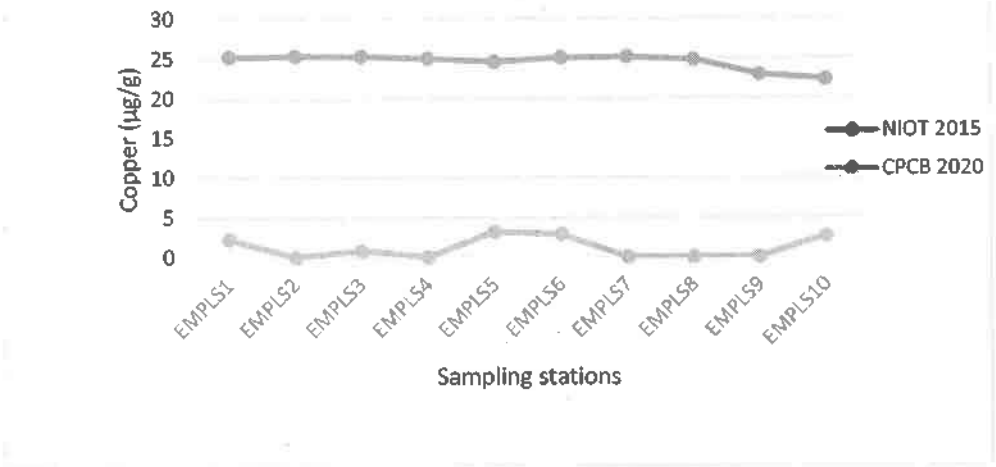



**Fig. 18Coppervariation in the seafloor sediments around MPL offshore discharge**

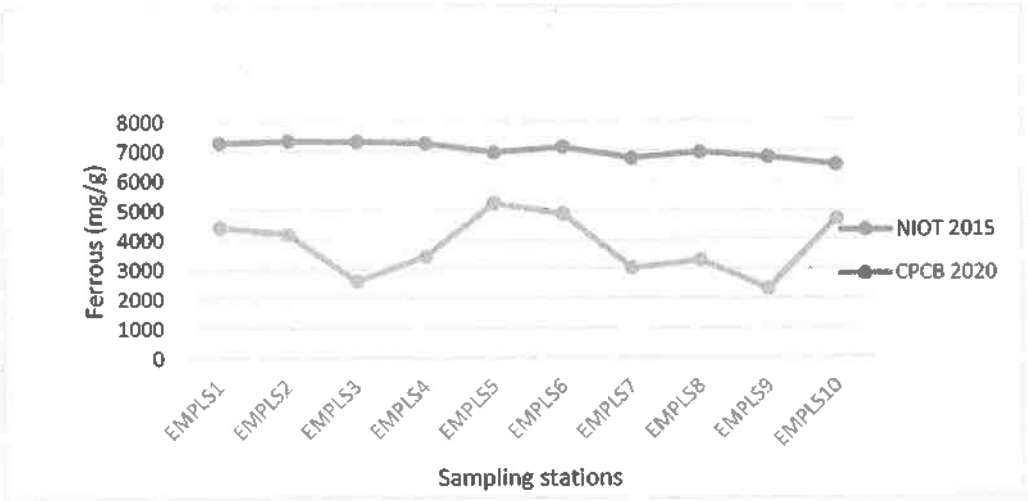



**Fig. 19Ferrous variationin the seafloor sediments around MPL offshore discharge**

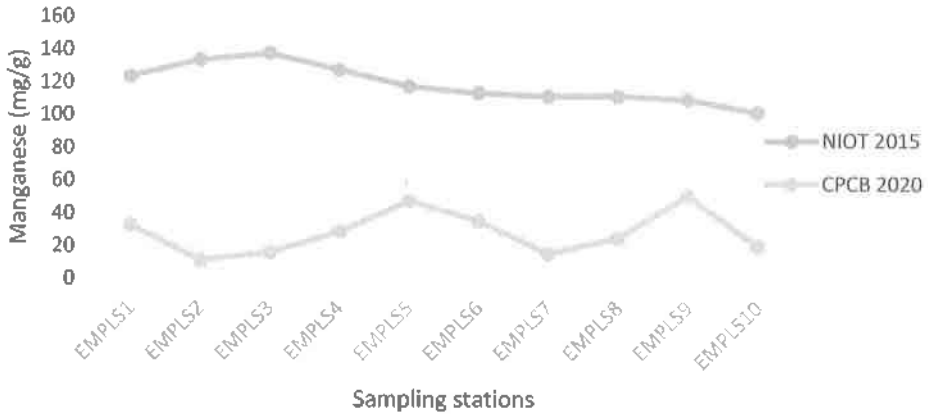



**Fig.20 Manganesevariation in the seafloor sediments around MPL offshore**

Petroleum hydrocarbon concentration of sediment at all the stations is below detectable levels.

## BIOLOGICAL OCEANOGRAPHIC STATUS

Biological analysis in the study area describes the population dynamics of marine lives and their interaction with the surrounding environment in space and time. The current study reveals the status of various planktonic and benthic lives in and around the outfall Appendix- A provides detailed primary data.

### *BIOLOGICAL DATA COLLECTION*

The impact of MPL discharge on biological oceanographic characteristic was studied at 10 locations in the vicinity of the outfall. The surveys were synoptic, carried out over tidal cycles covered within a day. Hydrographic measurements, water and sediment quality were also assessed at the same 10 locations. Impact of the outfall needs to be assessed by comparing the present biological data with the previous NIOT studies during 2015.

### *BIOTIC ENVIRONMENT*

In most aquatic habitats, the three biotic communities are the pelagic community of the open waters, the benthic community living in the bottom deposits and the fringing community where water is shallow. The pelagic community consists of the neutrally buoyant plankton community, and the larger active swimming animals called the nekton.

The benthic community is mostly dependent on the settling organic matter from the water column in the form of live phytoplankton, dead plankton, detritus, faecal pellets etc. The percentage of organic matter reaching the benthos is diminished with increasing depth as the community of planktonic consumers progressively removes sinking material. Thus, the shallower waters have a relatively larger benthic community, as the food supply is high. In too shallow areas, where light penetrates, there is a sharp increase in biomass.

The fringing community in the marine environment depends on the type of substrate and climate. In areas of high wave and current action, the rocky areas may be dominated by algae known as seaweeds that attach to the bottom without roots. Uptake of nutrients takes place over the entire surface. Shores with lesser water movement where sedimentation occurs, tend to have rooted plants, intertidal marshes and seagrass beds. The most critical role of the marine plants is to provide a substrate for vascular, microscopic and macroscopic algae

(periphyton). Besides, they trap sediments and food, providing a habitat for young fish where large predators cannot follow.

The distribution of the various communities is typically classified by the trophic levels in a food chain (or energy chain). Typically, the first level consists of primary producers (phytoplankton). The second level consists of the primary consumers, namely, zooplankton, while the secondary consumers consist of larger animals or nekton. The top of the food chain would be humans. The biotic sampling consisted of evaluating the phytoplankton and zooplankton communities. Sediment samples were analyzed for macrobenthos.

***BIOLOGICAL SAMPLING***

Chlorophyll, phytoplankton, zooplankton and macrobenthos were measured for assessing the biological characteristics. Niskin water sampler, Plankton nets, and grab samples were utilized for sample collection. Collected samples were preserved in sub-zero condition, formaldehyde and rose bengal dye solution. Standard procedures were used for analysis and quality control. Diversity analysis was carried out to establish the population dynamics along with different stations concerning various time scales based on the location of the effluent discharge point.

***PHYTOPLANKTON***

Analysis of phytoplankton samples indicate the presence of 20 species phytoplankton and the cell counts ranging from 1826 Nos./L to 5880 Nos./L along the sampling locations EMPL1 to EMPL10. The diatom species *Biddulphia regia* was found to be a major contributor to the total population of phytoplankton. This species belongs to blooming type along the Indian coast. Detailed data table at Annexure-II: Tables 1 to 2.

Among the Phytoplankton *Biddulphia regia, Rhizosolenia imbricate, R. styliformis, Thalassionemanitzschioides, Nitzschia sp., Chaetoceroslaevis, skeletonemacostatum, Chaetocerosdecipiens*, were found to be dominant along the study area. The phytoplankton population density is higher compared to past studies during 2015. The diversity index scores indicated the moderately healthy nature of the environment and recorded a rise in diversity also. It may be attributed to the significant increase in nitrate-nitrogen values(Fig.2.1).

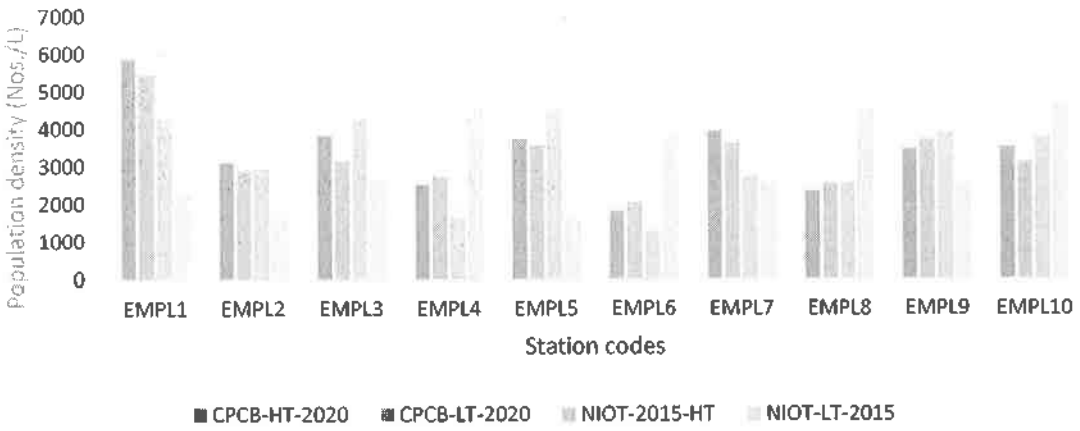



**Fig. 21 Phytoplankton population density variation in the surface waters around MPL offshore discharge location during the study period**

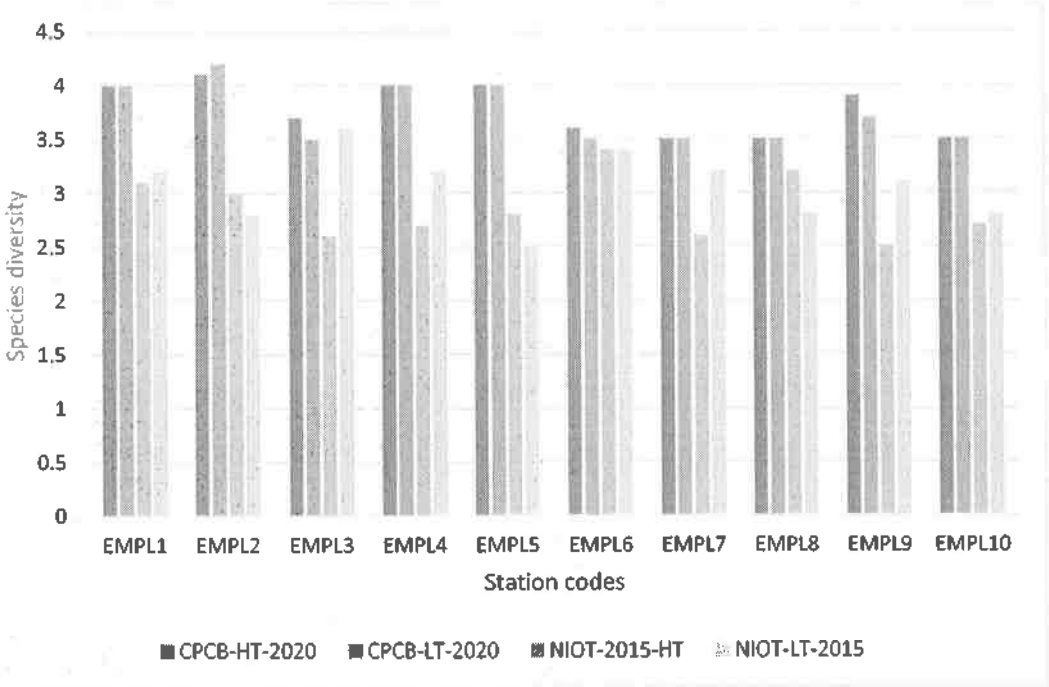



**Fig. 22 Phytoplankton species diversity variation in the surface waters around MPL offshore discharge location during the study period**

***ZOOPLANKTON***

Zooplankton is composed of floating organisms, including the larval stages of many economically important species of prawn and fishes. The density of the population varied from 1180 to 3093 Nos./ $m^3$ during the sampling period between EMPL 1 to EMPL 10. A total number of 13 species were recorded in the coastal waters. *Calanoid, Cladocerans, Appendicularians, Naupli larvae* and fish eggs are the dominant forms of zooplankton

recorded during the survey. A significant increase in zooplankton population at EMPL4 where the Nitrite content recorded a hike in concentration followed by a decrease in phytoplankton population density. It may be attributed to the zooplankton grazing potential. The zooplankton trend does not reflect any abnormalities.

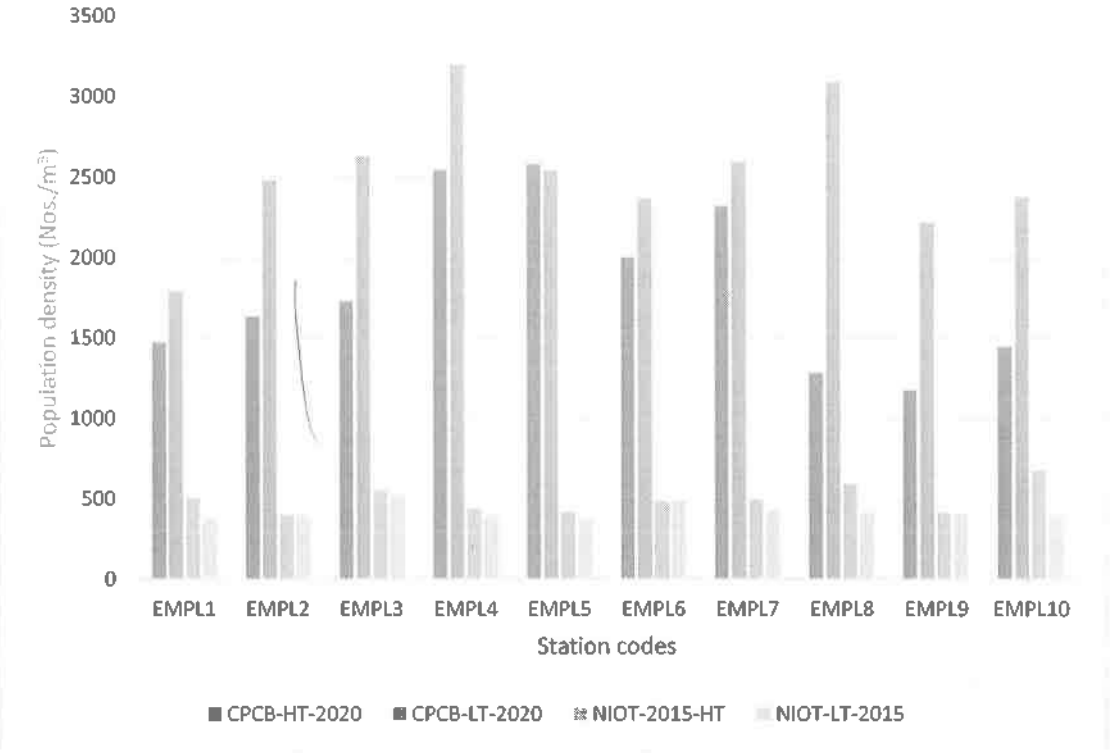



**Fig. 23 Zooplankton population density variation in the surface waters around MPL offshore discharge location during the study period**

***BENTHOS***

The subtidal benthic organisms recorded moderate fluctuation of standing stock and diversity. In terms of population, macrobenthos varied between 91 and 329 Nos./$m^2$. The faunal composition consisted of *Gastropods, Bivalves, Polychaetes, and Nematodes* as the dominant group. The minimum density recorded at EMPL2 and its proximity to the discharge site may be attributed to this drop. The site (EMPL2) located 500m away in the northeastern side of the discharge site. However, 2015 observations also recorded a decline in benthic biota at EMPL7 located 500m away from the discharge site in the southwestern direction. It may be traceable by whole effluent toxicity bioassay studies of USEPA. However, various effluent discharges along the Ennore coastal waters alongwith the MPL discharge needs to be

considered and subdue the effluent specific impact on biosystems along this coast. Hence, further studies are warranted to establish the effect of the discharge site.

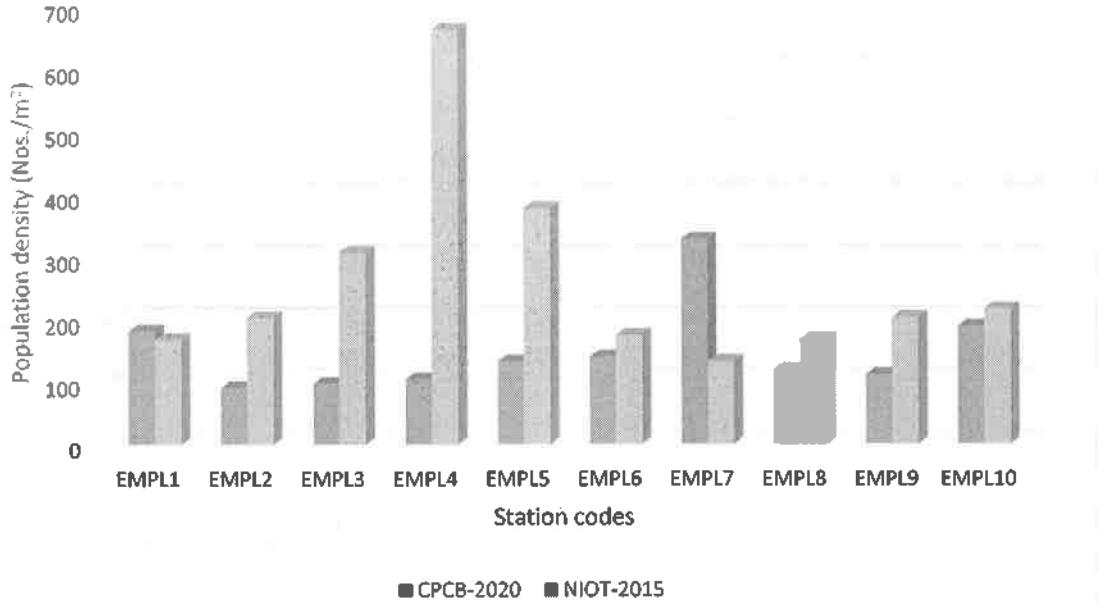



**Fig. 24 Benthos population density variation in the sea bottom sediments around MPL offshore discharge location during the study period**

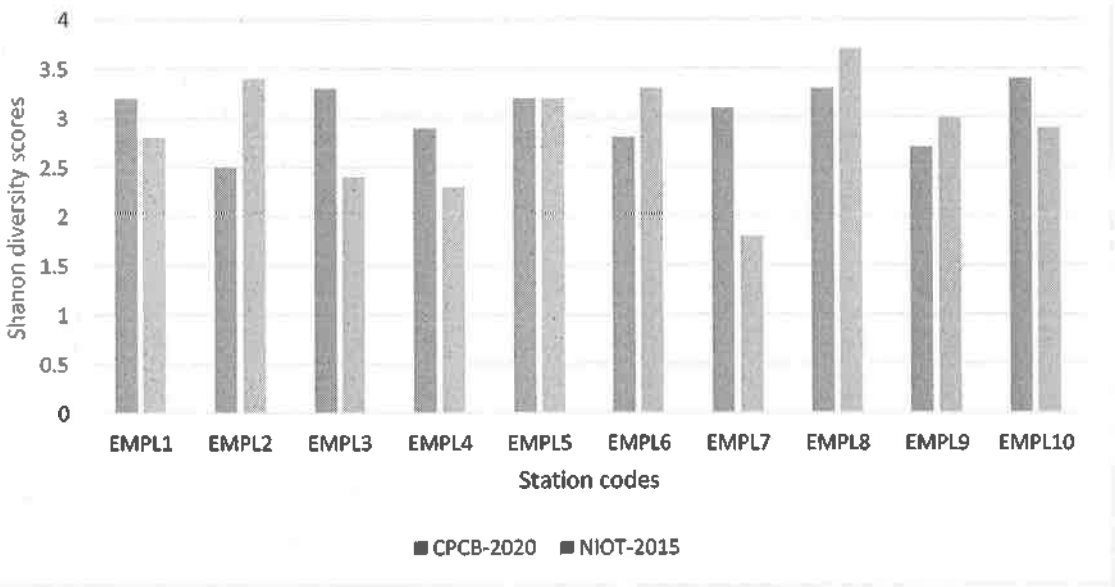



**Fig. 25 Benthos population diversity variation in the sea bottom sediments around MPL offshore discharge location during the study period**

## SUMMARY

The results of selected parameters and comparison with previous study records reveal that there arespatial and temporal variations within the study area.Increase in nutrient parameters like nitrate recorded maximum value of 20.4 □mol./lis comparable to values recorded in samples collected during low tide at the Ennore creek during the study (AnnexureI: Table 2). The BOD values werealso relative to quantities recorded inEnnore creeksamples(Annexure I: Table 1). The sediment heavy metal content also recorded higher values than the offshore discharge site indicates the possibility of pollutants input from nearby sources which cannot be ruled out. It is well known that this Ennore creek is traversed by Manali industrial belt and Buckingham canal loaded with industrial, domestic sewage load. Considering the proximity of Ennore creek and its pollutant loading to the coastal waters, there is likely to bethe synergistic effect on nutrient loading in the coastal waters off North Chennai due to possible flushing from Ennore Creek. It leads to increase in background concentrations of the study area in addition to sources like Royapuram fisheries harbour, Chennai Port, Royapuramsewage outfall and several other industries discharging in this area, which account for the values recorded during the sampling surveys carried out in March 2020.

The values recorded in the receiving waters off North Chennai coastal waters need to be compared with the values of various parameters analyzed in the discharge waters of MPL to reach any conclusion.

The studies on biological characteristics reveal the following:

- The increase in nutrient load reflected in improvement plankton population is corroborated.
- A slight drop in benthic population in the near field of offshore discharge may be attributed to the synergistic effects of various discharges from partner industries sharing the common effluent discharge along Ennore coast. Theeffect of toxicant on the benthic population in the certain station needs to be studied by whole effluent toxicity bioassay. It warrants detailed long term monitoring studies in the receiving waters (off Chennai coast) as well asat the discharge locations of the various industries.
- All these observations have been validated with the effluent quality of industrial discharge collected by CPCB and are within the discharge limits. Given that the benthos in receiving waters (marine waters are observed to vary, it is suggested to conduct whole

effluent toxicity studies. These tests are expected to reveal the influence of other possible chemicals not in the regulatory control, influence the sustainability of marine biota (Fishes, molluscs, etc.).

- The levels of toxic chemicals are found to be within the acceptable levels, and therefore the concentrations of the other chemicals shall have to be reviewed. It is possible that chlorides used in the processes may be released into the receiving water body. Studies show that chloride concentrations produce corrosion in wastewater pipelines and are likely to inhibit marine biota growth. However, these aspects have to be confirmed only through seasonal, comprehensive field studies over a long period.

# Annexure I

**Table 1 Physico-chemical parameters variation along the MPL offshore discharge site & adjoining Ennore creek**

| Sample ID as per Glens Innovation Lab record | Report ID | Depth (m) | Tide | Air Temperature (°C) | Water Temperature (°C) | pH | DO (mg/L) | BOD (mg/L) | Salinity (PSU) | TSS (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| EN-S-HT-01 | EMPL1-S | 0 | HT | 28.9 | 28.8 | 7.78 | 6.3 | 2.8 | 35.5 | 4.4 |
| EN-S-HT-02 | EMPL2-S | 0 | HT | 28.9 | 28.8 | 7.79 | 6.4 | 2.8 | 34.9 | 4.4 |
| EN-S-HT-03 | EMPL3-S | 0 | HT | 29.0 | 28.6 | 7.77 | 6.3 | 2.8 | 34.9 | 3.7 |
| EN-S-HT-04 | EMPL4-S | 0 | HT | 29.0 | 28.6 | 7.77 | 6.4 | 2.8 | 34.9 | 3.7 |
| EN-S-HT-05 | EMPL5-S | 0 | HT | 29.1 | 28.6 | 7.81 | 6.1 | 3.2 | 37.9 | 6.4 |
| EN-S-HT-06 | EMPL6-S | 0 | HT | 29.2 | 28.8 | 7.83 | 6.2 | 2.8 | 35.6 | 4.0 |
| EN-S-HT-07 | EMPL7-S | 0 | HT | 28.9 | 28.3 | 7.82 | 6.3 | 2.8 | 34.9 | 3.1 |
| EN-S-HT-08 | EMPL8-S | 0 | HT | 29.0 | 28.4 | 7.83 | 6.3 | 2.8 | 35.1 | 5.2 |
| EN-S-HT-09 | EMPL9-S | 0 | HT | 29.0 | 28.4 | 7.78 | 6.4 | 2.8 | 35.1 | 4.4 |
| EN-S-HT-10 | EMPL10-S | 0 | HT | 29.0 | 28.4 | 7.82 | 6.4 | 2.8 | 35.4 | 4.0 |
| | | | | | | | | | | |
| EN-B-HT-01 | EMPL1-B | 9.5 | HT | 28.9 | 27.9 | 7.79 | 6.4 | 2.8 | 37.2 | 3.2 |
| EN-B-HT-02 | EMPL2-B | 10.2 | HT | 28.9 | 28.0 | 7.92 | 5.1 | 3.2 | 34.6 | 5.0 |
| EN-B-HT-03 | EMPL3-B | 9.5 | HT | 29.0 | 28.6 | 7.69 | 6.8 | 2.8 | 36.3 | 18.9 |
| EN-B-HT-04 | EMPL4-B | 9.6 | HT | 29.0 | 27.8 | 7.83 | 6.8 | 2.8 | 36.7 | 3.2 |
| EN-B-HT-05 | EMPL5-B | 11.6 | HT | 29.1 | 28.6 | 7.76 | 6.7 | 2.8 | 34.9 | 4.5 |
| EN-B-HT-06 | EMPL6-B | 11.6 | HT | 29.2 | 28.5 | 7.69 | 6.8 | 2.8 | 36.7 | 4.5 |
| EN-B-HT-07 | EMPL7-B | 11.6 | HT | 28.9 | 28.4 | 7.82 | 6.8 | 2.8 | 35.4 | 4.5 |
| EN-B-HT-08 | EMPL8-B | 12.3 | HT | 29.0 | 28.1 | 7.82 | 6.9 | 3.2 | 35.4 | 4.0 |
| EN-B-HT-09 | EMPL9-B | 11.5 | HT | 29.0 | 28.1 | 7.93 | 6.8 | 2.8 | 36.8 | 4.0 |
| EN-B-HT-10 | EMPL10-B | 12.6 | HT | 29.0 | 27.9 | 7.87 | 6.8 | 2.8 | 35.4 | 4.5 |
| | | | | | | | | | | |
| EN-S-LT-01 | EMPL1-S | 0 | LT | 31.1 | 29.1 | 7.61 | 5.6 | 3.2 | 35.3 | 4.7 |

| Sample ID as per Glens Innovation Lab record | Report ID | Depth (m) | Tide | Air Temperature (°C) | Water Temperature (°C) | pH | DO (mg/L) | BOD (mg/L) | Salinity (PSU) | TSS (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| EN-S-LT-02 | EMPL2-S | 0 | LT | 30.9 | 29.0 | 7.63 | 5.5 | 3.2 | 34.9 | 4.5 |
| EN-S-LT-03 | EMPL3-S | 0 | LT | 31.0 | 29.0 | 7.85 | 5.5 | 3.2 | 34.9 | 4.3 |
| EN-S-LT-04 | EMPL4-S | 0 | LT | 30.9 | 29.0 | 7.8 | 5.4 | 3.2 | 36.8 | 4.3 |
| EN-S-LT-05 | EMPL5-S | 0 | LT | 31.0 | 29.0 | 7.83 | 5.5 | 3.2 | 37.7 | 5.1 |
| EN-S-LT-06 | EMPL6-S | 0 | LT | 31.1 | 29.1 | 7.83 | 5.7 | 3.2 | 37.9 | 4.7 |
| EN-S-LT-07 | EMPL7-S | 0 | LT | 30.9 | 28.9 | 7.85 | 5.4 | 3.2 | 35.3 | 5.1 |
| EN-S-LT-08 | EMPL8-S | 0 | LT | 30.8 | 28.8 | 7.49 | 6.4 | 3.2 | 39.4 | 5.1 |
| EN-S-LT-09 | EMPL9-S | 0 | LT | 30.9 | 28.9 | 7.81 | 6.2 | 3.2 | 37.2 | 4.7 |
| EN-S-LT-10 | EMPL10-S | 0 | LT | 30.9 | 28.8 | 7.65 | 6.3 | 3.2 | 37.9 | 4.7 |
| | | | | | | | | | | |
| EN-B-LT-01 | EMPL1-B | 9.5 | LT | 31.1 | 28.7 | 7.84 | 6.4 | 2.8 | 37.9 | 4.6 |
| EN-B-LT-02 | EMPL2-B | 10.2 | LT | 30.9 | 28.6 | 7.78 | 6.4 | 2.8 | 34.8 | 4.0 |
| EN-B-LT-03 | EMPL3-B | 9.5 | LT | 31.0 | 28.4 | 7.77 | 6.4 | 2.8 | 35.3 | 3.8 |
| EN-B-LT-04 | EMPL4-B | 9.6 | LT | 30.9 | 28.9 | 7.76 | 6.4 | 3.2 | 34.9 | 3.6 |
| EN-B-LT-05 | EMPL5-B | 11.6 | LT | 31.0 | 30.8 | 7.83 | 6.1 | 2.8 | 34.8 | 3.2 |
| EN-B-LT-06 | EMPL6-B | 11.6 | LT | 31.1 | 29.0 | 7.75 | 6.1 | 2.8 | 35.4 | 2.4 |
| EN-B-LT-07 | EMPL7-B | 11.6 | LT | 30.9 | 29.0 | 7.76 | 5.3 | 3.2 | 35.4 | 2.6 |
| EN-B-LT-08 | EMPL8-B | 12.3 | LT | 30.8 | 28.8 | 7.84 | 6.3 | 2.8 | 35.3 | 5.3 |
| EN-B-LT-09 | EMPL9-B | 11.5 | LT | 30.9 | 28.6 | 7.91 | 6.3 | 2.8 | 35.4 | 2.0 |
| EN-B-LT-10 | EMPL10-B | 12.6 | LT | 30.9 | 28.7 | 7.86 | 6.4 | 2.8 | 37.2 | 3.2 |
| | | | | | | | | | | |
| ENC-S-HT-01 | ENC1-S | 0 | HT | 29.5 | 29.1 | 7.84 | 6.9 | 2.8 | 37.9 | 4.9 |
| ENC-S-HT-02 | ENC2-S | 0 | HT | 30.1 | 29.8 | 7.58 | 4.5 | 3.2 | 34.6 | 2.9 |
| ENC-S-HT-03 | ENC3-S | 0 | HT | 29.8 | 29.9 | 7.63 | 6.7 | 2.8 | 25.2 | 17.9 |
| ENC-S-HT-04 | ENC4-S | 0 | HT | 30.2 | 30.1 | 7.86 | 5.6 | 3.2 | 17.1 | 2.8 |
| | | | | | | | | | | |
| ENC-S-LT-01 | ENC1-S | 0 | LT | 30.5 | 30.3 | 7.93 | 6.8 | 2.8 | 35.4 | 3.6 |

| Sample ID as per Glens Innovation Lab record | Report ID | Depth (m) | Tide | Air Temperature (°C) | Water Temperature (°C) | pH | DO (mg/L) | BOD (mg/L) | Salinity (PSU) | TSS (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| ENC-S-LT-02 | ENC2-S | 0 | LT | 31.2 | 31.1 | 7.62 | 5.5 | 3.2 | 26.8 | 15.8 |
| ENC-S-LT-03 | ENC3-S | 0 | LT | 31.1 | 31.7 | 7.76 | 6.9 | 2.8 | 20.2 | 17.1 |
| ENC-S-LT-04 | ENC4-S | 0 | LT | 31.5 | 31.4 | 7.42 | 6.7 | 3.2 | 15.4 | 3.2 |

**Table 2 Nutrient variation along the MPL offshore discharge site & adjoining Ennore creek**

| Sample ID as per Glens Innovation Lab record | Report ID | Depth (m) | Tide | Ammonia (µmol/L) | Nitrate (µmol/L) | PO4 (µmol/L) | NO2 (µmol/L) |
|---|---|---|---|---|---|---|---|
| EN-S-HT-01 | EMPL1-S | 0 | HT | 2.91 | 20.4 | 0.21 | 0.04 |
| EN-S-HT-02 | EMPL2-S | 0 | HT | BLQ | 20.4 | 0.21 | 0.08 |
| EN-S-HT-03 | EMPL3-S | 0 | HT | BLQ | 20.4 | 0.21 | 0.04 |
| EN-S-HT-04 | EMPL4-S | 0 | HT | BLQ | 20.4 | 0.21 | 0.67 |
| EN-S-HT-05 | EMPL5-S | 0 | HT | BLQ | 20.4 | 0.21 | 0.04 |
| EN-S-HT-06 | EMPL6-S | 0 | HT | BLQ | 9.99 | 0.21 | 0.04 |
| EN-S-HT-07 | EMPL7-S | 0 | HT | BLQ | 20.4 | 0.21 | 0.04 |
| EN-S-HT-08 | EMPL8-S | 0 | HT | BLQ | 20.4 | 0.21 | 0.04 |
| EN-S-HT-09 | EMPL9-S | 0 | HT | BLQ | 9.99 | 0.21 | 0.04 |
| EN-S-HT-10 | EMPL10-S | 0 | HT | BLQ | 9.99 | 0.21 | 0.08 |
| | | | | | | | |
| EN-B-HT-01 | EMPL1-B | 9.5 | HT | BLQ | 9.99 | 0.21 | 0.04 |
| EN-B-HT-02 | EMPL2-B | 10.2 | HT | BLQ | 9.99 | 0.21 | 0.04 |
| EN-B-HT-03 | EMPL3-B | 9.5 | HT | BLQ | 243 | 0.21 | 0.04 |
| EN-B-HT-04 | EMPL4-B | 9.6 | HT | BLQ | 9.99 | 0.21 | 0.04 |
| EN-B-HT-05 | EMPL5-B | 11.6 | HT | BLQ | 4.2 | 0.21 | 0.04 |

| Sample ID as per Glens Innovation Lab record | Report ID | Depth (m) | Tide | Ammonia (µmol/L) | Nitrate (µmol/L) | PO4 (µmol/L) | NO2 (µmol/L) |
|---|---|---|---|---|---|---|---|
| EN-B-HT-06 | EMPL6-B | 11.6 | HT | BLQ | 9.99 | 0.21 | 0.08 |
| EN-B-HT-07 | EMPL7-B | 11.6 | HT | BLQ | 9.99 | 0.21 | 0.04 |
| EN-B-HT-08 | EMPL8-B | 12.3 | HT | BLQ | 9.99 | 0.21 | 0.08 |
| EN-B-HT-09 | EMPL9-B | 11.5 | HT | BLQ | 9.99 | 0.21 | 0.08 |
| EN-B-HT-10 | EMPL10-B | 12.6 | HT | BLQ | 9.99 | 0.21 | 0.12 |
| | | | | | | | |
| EN-S-LT-01 | EMPL1-S | 0 | LT | BLQ | 20.4 | 0.21 | 0.04 |
| EN-S-LT-02 | EMPL2-S | 0 | LT | BLQ | 20.4 | 0.21 | 0.04 |
| EN-S-LT-03 | EMPL3-S | 0 | LT | BLQ | 20.4 | 0.21 | 0.04 |
| EN-S-LT-04 | EMPL4-S | 0 | LT | BLQ | 20.4 | 0.21 | 0.04 |
| EN-S-LT-05 | EMPL5-S | 0 | LT | BLQ | 20.4 | 0.21 | 0.04 |
| EN-S-LT-06 | EMPL6-S | 0 | LT | BLQ | 20.4 | 0.21 | 0.04 |
| EN-S-LT-07 | EMPL7-S | 0 | LT | BLQ | 20.4 | 0.21 | 0.04 |
| EN-S-LT-08 | EMPL8-S | 0 | LT | BLQ | 9.99 | 0.21 | 0.04 |
| EN-S-LT-09 | EMPL9-S | 0 | LT | BLQ | 20.4 | 0.21 | 0.04 |
| EN-S-LT-10 | EMPL10-S | 0 | LT | BLQ | 20.4 | 0.21 | 0.04 |
| | | | | | | | |
| EN-B-LT-01 | EMPL1-B | 9.5 | LT | 2.91 | 9.99 | 0.21 | 0.04 |
| EN-B-LT-02 | EMPL2-B | 10.2 | LT | 2.91 | 9.99 | 0.21 | 0.04 |
| EN-B-LT-03 | EMPL3-B | 9.5 | LT | 2.91 | 4.2 | 0.21 | 0.04 |
| EN-B-LT-04 | EMPL4-B | 9.6 | LT | 2.91 | 4.2 | 0.21 | 0.04 |
| EN-B-LT-05 | EMPL5-B | 11.6 | LT | 2.91 | 9.99 | 0.21 | 0.04 |
| EN-B-LT-06 | EMPL6-B | 11.6 | LT | 2.91 | 4.2 | 0.21 | 0.04 |
| EN-B-LT-07 | EMPL7-B | 11.6 | LT | 2.91 | 4.2 | 0.21 | 0.04 |
| EN-B-LT-08 | EMPL8-B | 12.3 | LT | 2.91 | 9.99 | 0.21 | 0.04 |
| EN-B-LT-09 | EMPL9-B | 11.5 | LT | 2.91 | 4.2 | 0.21 | 0.04 |
| EN-B-LT-10 | EMPL10-B | 12.6 | LT | 2.91 | 4.2 | 0.21 | 0.04 |

| Sample ID as per Glens Innovation Lab record | Report ID | Depth (m) | Tide | Ammonia (µmol/L) | Nitrate (µmol/L) | PO4 (µmol/L) | NO2 (µmol/L) |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| ENC-S-HT-01 | ENC1-S | 0 | HT | 5.41 | 4.2 | 0.21 | 0.54 |
| ENC-S-HT-02 | ENC2-S | 0 | HT | 2.91 | 4.2 | 0.67 | 1.25 |
| ENC-S-HT-03 | ENC3-S | 0 | HT | 50 | 20.4 | 1.33 | 1.29 |
| ENC-S-HT-04 | ENC4-S | 0 | HT | 142 | 20.4 | 1.75 | 14.5 |
| | | | | | | | |
| ENC-S-LT-01 | ENC1-S | 0 | LT | BLQ | 20.4 | 0.21 | 0.04 |
| ENC-S-LT-02 | ENC2-S | 0 | LT | 55 | 9.99 | 1.91 | 10.7 |
| ENC-S-LT-03 | ENC3-S | 0 | LT | 111 | 20.4 | 2.1 | 0.75 |
| ENC-S-LT-04 | ENC4-S | 0 | LT | BLQ | 20.4 | 0.96 | 2.54 |

**Table 3 Heavy Metals variation along the MPL offshore discharge site & adjoining Ennore creek**

| Sample ID as per Glens Innovation Lab record | Report ID | Depth (m) | Tide | Arsenic (µg/L) | Nickel (µg/L) | Copper (µg/L) | Chromium (µg/L) | Cadmium (µg/L) | Zinc (µg/L) | Lead (µg/L) | Selenium (µg/L) | Cobalt (µg/L) | Manganese (µg/L) | Mercury (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EN-S-HT-01 | EMPL1-S | 0 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | 0.034 | BLQ | BLQ | BLQ | 0.007 | BLQ |
| EN-S-HT-02 | EMPL2-S | 0 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | 0.009 | BLQ | BLQ | BLQ | 0.014 | BLQ |
| EN-S-HT-03 | EMPL3-S | 0 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | 0.047 | BLQ | BLQ | BLQ | 0.014 | BLQ |
| EN-S-HT-04 | EMPL4-S | 0 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | 0.004 | BLQ | BLQ | BLQ | 0.010 | BLQ |
| EN-S-HT-05 | EMPL5-S | 0 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | 0.005 | BLQ | BLQ | BLQ | 0.004 | BLQ |
| EN-S-HT-06 | EMPL6-S | 0 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | 0.030 | BLQ | BLQ | BLQ | 0.006 | BLQ |
| EN-S-HT-07 | EMPL7-S | 0 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | 0.004 | BLQ | BLQ | BLQ | 0.038 | BLQ |
| EN-S-HT-08 | EMPL8-S | 0 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | 0.006 | BLQ | BLQ | BLQ | 0.013 | BLQ |
| EN-S-HT-09 | EMPL9-S | 0 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | 0.007 | BLQ | BLQ | BLQ | 0.005 | BLQ |
| EN-S-HT-10 | EMPL10-S | 0 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | 0.007 | BLQ | BLQ | BLQ | BLQ | BLQ |
| | | | | | | | | | | | | | | |
| EN-B-HT-01 | EMPL1-B | 9.5 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.190 | BLQ |
| EN-B-HT-02 | EMPL2-B | 10.2 | HT | BLQ | 0.004 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.008 | BLQ |
| EN-B-HT-03 | EMPL3-B | 9.5 | HT | BLQ | 0.017 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.253 | BLQ |
| EN-B-HT-04 | EMPL4-B | 9.6 | HT | BLQ | 0.018 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.011 | BLQ |
| EN-B-HT-05 | EMPL5-B | 11.6 | HT | BLQ | 0.010 | BLQ | 2.94 | BLQ | 0.019 | BLQ | BLQ | BLQ | 0.286 | BLQ |
| EN-B-HT-06 | EMPL6-B | 11.6 | HT | BLQ | 0.017 | BLQ | BLQ | BLQ | 0.004 | BLQ | BLQ | BLQ | 0.115 | BLQ |
| EN-B-HT-07 | EMPL7-B | 11.6 | HT | BLQ | 0.014 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.010 | BLQ |
| EN-B-HT-08 | EMPL8-B | 12.3 | HT | BLQ | 0.005 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.073 | BLQ |
| EN-B-HT-09 | EMPL9-B | 11.5 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.024 | BLQ |
| EN-B-HT-10 | EMPL10-B | 12.6 | HT | BLQ | 0.008 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.005 | BLQ |

| Sample ID as per Glens Innovation Lab record | Report ID | Depth (m) | Tide | Arsenic (µg/L) | Nickel (µg/L) | Copper (µg/L) | Chromium (µg/L) | Cadmium (µg/L) | Zinc (µg/L) | Lead (µg/L) | Selenium (µg/L) | Cobalt (µg/L) | Manganese (µg/L) | Mercury (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |
| EN-S-LT-01 | EMPL1-S | 0 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-S-LT-02 | EMPL2-S | 0 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.004 | BLQ |
| EN-S-LT-03 | EMPL3-S | 0 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-S-LT-04 | EMPL4-S | 0 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-S-LT-05 | EMPL5-S | 0 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-S-LT-06 | EMPL6-S | 0 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-S-LT-07 | EMPL7-S | 0 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-S-LT-08 | EMPL8-S | 0 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.010 | BLQ |
| EN-S-LT-09 | EMPL9-S | 0 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.006 | BLQ |
| EN-S-LT-10 | EMPL10-S | 0 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| | | | | | | | | | | | | | | |
| EN-B-LT-01 | EMPL1-B | 9.5 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.007 | BLQ |
| EN-B-LT-02 | EMPL2-B | 10.2 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-B-LT-03 | EMPL3-B | 9.5 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-B-LT-04 | EMPL4-B | 9.6 | LT | BLQ | 0.006 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-B-LT-05 | EMPL5-B | 11.6 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-B-LT-06 | EMPL6-B | 11.6 | LT | BLQ | 0.005 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-B-LT-07 | EMPL7-B | 11.6 | LT | BLQ | 0.005 | BLQ | BLQ | BLQ | 0.007 | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-B-LT-08 | EMPL8-B | 12.3 | LT | BLQ | 0.006 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.023 | BLQ |
| EN-B-LT-09 | EMPL9-B | 11.5 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| EN-B-LT-10 | EMPL10-B | 12.6 | LT | BLQ | 0.004 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| | | | | | | | | | | | | | | |
| ENC-S-HT-01 | ENC1-S | 0 | HT | BLQ | 0.005 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.007 | BLQ |

| Sample ID as per Glens Innovation Lab record | Report ID | Depth (m) | Tide | Arsenic (µg/L) | Nickel (µg/L) | Copper (µg/L) | Chromium (µg/L) | Cadmium (µg/L) | Zinc (µg/L) | Lead (µg/L) | Selenium (µg/L) | Cobalt (µg/L) | Manganese (µg/L) | Mercury (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ENC-S-HT-02 | ENC2-S | 0 | HT | BLQ | 0.005 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| ENC-S-HT-03 | ENC3-S | 0 | HT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.079 | BLQ |
| ENC-S-HT-04 | ENC4-S | 0 | HT | BLQ | 0.007 | BLQ | BLQ | BLQ | 0.004 | BLQ | BLQ | BLQ | 0.111 | BLQ |
| | | | | | | | | | | | | | | |
| ENC-S-LT-01 | ENC1-S | 0 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ |
| ENC-S-LT-02 | ENC2-S | 0 | LT | BLQ | BLQ | BLQ | BLQ | BLQ | 0.005 | BLQ | BLQ | BLQ | 0.030 | BLQ |
| ENC-S-LT-03 | ENC3-S | 0 | LT | BLQ | 0.011 | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | BLQ | 0.088 | BLQ |
| ENC-S-LT-04 | ENC4-S | 0 | LT | BLQ | 0.009 | 0.005 | BLQ | BLQ | 0.015 | BLQ | BLQ | BLQ | 0.210 | BLQ |

**Table 4 PHC and Faecal Coliform variation along the MPL offshore discharge site & adjoining Ennore creek**

| Sample ID as per Glens Innovation Lab record | Report ID | Depth (m) | Tide | Petroleum hydrocarbons (mg/L) | Oil & Grease (mg/L) | Total Coliform (MPN/100ml) | Faecal Coliform (MPN/100ml) |
|---|---|---|---|---|---|---|---|
| EN-S-HT-01 | EMPL1-S | 0 | HT | BLQ | BLQ | 23 | 13 |
| EN-S-HT-02 | EMPL2-S | 0 | HT | BLQ | BLQ | 23 | 8 |
| EN-S-HT-03 | EMPL3-S | 0 | HT | BLQ | BLQ | 34 | 14 |
| EN-S-HT-04 | EMPL4-S | 0 | HT | BLQ | BLQ | 60 | 21 |
| EN-S-HT-05 | EMPL5-S | 0 | HT | BLQ | BLQ | 90 | 22 |
| EN-S-HT-06 | EMPL6-S | 0 | HT | BLQ | BLQ | 50 | 26 |
| EN-S-HT-07 | EMPL7-S | 0 | HT | BLQ | BLQ | 27 | 11 |
| EN-S-HT-08 | EMPL8-S | 0 | HT | BLQ | BLQ | 30 | 17 |
| EN-S-HT-09 | EMPL9-S | 0 | HT | BLQ | BLQ | 50 | 11 |
| EN-S-HT-10 | EMPL10-S | 0 | HT | BLQ | BLQ | 50 | 14 |
| | | | | | | | |
| EN-B-HT-01 | EMPL1-B | 9.5 | HT | BLQ | BLQ | 40 | 13 |
| EN-B-HT-02 | EMPL2-B | 10.2 | HT | BLQ | BLQ | 50 | 27 |
| EN-B-HT-03 | EMPL3-B | 9.5 | HT | BLQ | BLQ | 60 | 21 |
| EN-B-HT-04 | EMPL4-B | 9.6 | HT | BLQ | BLQ | 60 | 21 |
| EN-B-HT-05 | EMPL5-B | 11.6 | HT | BLQ | BLQ | 50 | 21 |
| EN-B-HT-06 | EMPL6-B | 11.6 | HT | BLQ | BLQ | 60 | 21 |
| EN-B-HT-07 | EMPL7-B | 11.6 | HT | BLQ | BLQ | 30 | 17 |
| EN-B-HT-08 | EMPL8-B | 12.3 | HT | BLQ | BLQ | 33 | 14 |
| EN-B-HT-09 | EMPL9-B | 11.5 | HT | BLQ | BLQ | 34 | 13 |
| EN-B-HT-10 | EMPL10-B | 12.6 | HT | BLQ | BLQ | 50 | 14 |
| | | | | | | | |
| EN-S-LT-01 | EMPL1-S | 0 | LT | BLQ | BLQ | 40 | 8 |
| EN-S-LT-02 | EMPL2-S | 0 | LT | BLQ | BLQ | 50 | 14 |
| EN-S-LT-03 | EMPL3-S | 0 | LT | BLQ | BLQ | 50 | 14 |

| Sample ID as per Glens Innovation Lab record | Report ID | Depth (m) | Tide | Petroleum hydrocarbons (mg/L) | Oil & Grease (mg/L) | Total Coliform (MPN/100ml) | Faecal Coliform (MPN/100ml) |
|---|---|---|---|---|---|---|---|
| EN-S-LT-04 | EMPL4-S | 0 | LT | BLQ | BLQ | 70 | 26 |
| EN-S-LT-05 | EMPL5-S | 0 | LT | BLQ | BLQ | 22 | 8 |
| EN-S-LT-06 | EMPL6-S | 0 | LT | BLQ | BLQ | 33 | 11 |
| EN-S-LT-07 | EMPL7-S | 0 | LT | BLQ | BLQ | 70 | 26 |
| EN-S-LT-08 | EMPL8-S | 0 | LT | BLQ | BLQ | 26 | 9 |
| EN-S-LT-09 | EMPL9-S | 0 | LT | BLQ | BLQ | 34 | 8 |
| EN-S-LT-10 | EMPL10-S | 0 | LT | BLQ | BLQ | 22 | 8 |
| | | | | | | | |
| EN-B-LT-01 | EMPL1-B | 9.5 | LT | BLQ | BLQ | 34 | 13 |
| EN-B-LT-02 | EMPL2-B | 10.2 | LT | BLQ | BLQ | 30 | 17 |
| EN-B-LT-03 | EMPL3-B | 9.5 | LT | BLQ | BLQ | 60 | 14 |
| EN-B-LT-04 | EMPL4-B | 9.6 | LT | BLQ | BLQ | 34 | 13 |
| EN-B-LT-05 | EMPL5-B | 11.6 | LT | BLQ | BLQ | 50 | 13 |
| EN-B-LT-06 | EMPL6-B | 11.6 | LT | BLQ | BLQ | 34 | 17 |
| EN-B-LT-07 | EMPL7-B | 11.6 | LT | BLQ | BLQ | 70 | 14 |
| EN-B-LT-08 | EMPL8-B | 12.3 | LT | BLQ | BLQ | 60 | 26 |
| EN-B-LT-09 | EMPL9-B | 11.5 | LT | BLQ | BLQ | 40 | 17 |
| EN-B-LT-10 | EMPL10-B | 12.6 | LT | BLQ | BLQ | 23 | 8 |
| | | | | | | | |
| ENC-S-HT-01 | ENC1-S | 0 | HT | BLQ | BLQ | 34 | 11 |
| ENC-S-HT-02 | ENC2-S | 0 | HT | BLQ | BLQ | 33 | 14 |
| ENC-S-HT-03 | ENC3-S | 0 | HT | BLQ | BLQ | 110 | 30 |
| ENC-S-HT-04 | ENC4-S | 0 | HT | BLQ | BLQ | 140 | 33 |
| | | | | | | | |
| ENC-S-LT-01 | ENC1-S | 0 | LT | BLQ | BLQ | 34 | 13 |
| ENC-S-LT-02 | ENC2-S | 0 | LT | BLQ | BLQ | 70 | 14 |
| ENC-S-LT-03 | ENC3-S | 0 | LT | BLQ | BLQ | 80 | 27 |

| Sample ID as per Glens Innovation Lab record | Report ID | Depth (m) | Tide | Petroleum hydrocarbons (mg/L) | Oil & Grease (mg/L) | Total Coliform (MPN/100ml) | Faecal Coliform (MPN/100ml) |
|---|---|---|---|---|---|---|---|
| ENC-S-LT-04 | ENC4-S | 0 | LT | BLQ | BLQ | 90 | 50 |

**Table 5 Heavy metals, PHC & TOC variation along the MPL offshore discharge site & adjoining Ennore creek**

| Sample code as per Glens Innovation Lab record | Report ID | Manganese (mg/kg) | Zinc (mg/kg) | Cadmium (mg/kg) | Lead (mg/kg) | Mercury (mg/kg) | Cobalt (mg/kg) | Nickel (mg/kg) | Chromium (mg/kg) | Copper (mg/kg) | Iron (mg/kg) | Petroleum hydrocarbons (mg/kg) | TOC (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EN20030007-01 | EMPLS1 | 33.12 | 10.95 | BDL | 3.30 | BDL | 2.74 | 3.21 | 9.60 | 2.22 | 4416.29 | BDL | BDL |
| EN20030007-02 | EMPLS2 | 11.58 | 8.23 | BDL | 3.62 | BDL | 2.62 | 2.54 | 9.37 | BDL | 4180.36 | BDL | BDL |
| EN20030007-03 | EMPLS3 | 16.25 | 5.09 | BDL | 2.45 | BDL | BDL | BDL | 5.75 | 0.78 | 2593.85 | BDL | BDL |
| EN20030007-04 | EMPLS4 | 29.17 | 8.03 | BDL | 2.45 | BDL | 2.34 | 2.23 | 7.88 | BDL | 3428.34 | BDL | BDL |
| EN20030007-05 | EMPLS5 | 48.04 | 12.50 | BDL | 3.70 | BDL | 3.09 | 3.81 | 9.69 | 3.18 | 5221.67 | BDL | BDL |
| EN20030007-06 | EMPLS6 | 35.78 | 10.28 | BDL | 3.53 | BDL | 2.79 | 3.32 | 9.49 | 2.86 | 4864.51 | BDL | BDL |
| EN20030007-07 | EMPLS7 | 15.81 | 4.54 | BDL | 1.62 | BDL | BDL | BDL | 5.62 | BDL | 3033.43 | BDL | BDL |
| EN20030007-08 | EMPLS8 | 25.50 | 4.96 | BDL | 1.62 | BDL | BDL | BDL | 5.54 | BDL | 3290.54 | BDL | BDL |

| Sample code as per Glens Innovation Lab record | Report ID | Manganese (mg/kg) | Zinc (mg/kg) | Cadmium (mg/kg) | Lead (mg/kg) | Mercury (mg/kg) | Cobalt (mg/kg) | Nickel (mg/kg) | Chromium (mg/kg) | Copper (mg/kg) | Iron (mg/kg) | Petroleum hydrocarbons (mg/kg) | TOC (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EN20030007-09 | EMPLS9 | 50.93 | 3.16 | BDL | 1.47 | BDL | BDL | BDL | 4.48 | BDL | 2332.74 | BDL | BDL |
| EN20030007-10 | EMPLS10 | 20.56 | 7.84 | BDL | 3.24 | 3.18 | 2.24 | 3.26 | 8.32 | 2.64 | 4683.99 | BDL | BDL |
| | | | | | | | | | | | | | |
| EN20030007-11 | ENCS1 | 22.92 | 1607.02 | 14.23 | 27.04 | BDL | 7.14 | 23.39 | 75.55 | 117.76 | 23947.16 | BDL | 1.09 |
| EN20030007-12 | ENCS2 | 19.20 | 1084.73 | 10.71 | 19.65 | BDL | 5.40 | 17.22 | 59.18 | 89.76 | 19624.39 | BDL | 0.86 |
| EN20030007-13 | ENCS3 | 14.27 | 263.74 | 2.52 | 7.76 | BDL | 3.01 | 6.60 | 21.68 | 29.36 | 7139.08 | BDL | 0.45 |
| EN20030007-14 | ENCS4 | BDL | 2.70 | BDL | 0.66 | BDL | BDL | BDL | 3.55 | BDL | 1026.54 | BDL | BDL |

# ANNEXURE II

**Table 1: Phytoplankton population variation along MPL offshore discharge sites and adjoining Ennore creek system during HT**

| Station code | Population (No/l) | Faunal Groups | *Percentage of species contribution* |
|---|---|---|---|
| EMPL 1 | 5880 | 19 | *Biddulphia regia (7.14), Biddulphia sinensis (4.29), Biddulphia mobiliensis (2.86), Rhizosolenia imbricata (11.43), Rhizosolenia stolterfothii (1.43), Rhizosolenia alata (2.86), Coscinodiscus radiatus (1.43), Ceratium tripos (4.29), Ceratium fusus (7.14), Thalassionema frauenfeldii (4.29), Guinardia flaccida (10.00), Guinardia striata (4.29), Skeletonema costatum (7.14), Leptocylindrus sp (4.29), Asterionella japonica (7.14), Streptotheca thamensis (2.86), Chaetoceros decipiens (5.71), Chaetoceros coarctatus (10.00), & Grammatophora marina (1.43).* |
| EMPL 2 | 3108 | 20 | *Biddulphia regia (4.05), Biddulphia sinensis (2.70), Rhizosolenia imbricata (4.05), Rhizosolenia stolterfothii (8.11), Rhizosolenia robusta (5.41), Rhizosolenia bergonii (2.70), Coscinodiscus radiatus (6.76), Ceratium tripos (4.05), Ceratium fusus (9.46), Thalassionema frauenfeldii (5.41), Guinardia flaccida (8.11), Guinardia striata (2.70), Skeletonema costatum (12.16), Asterionella japonica (5.41), Streptotheca thamensis (2.70), Bellerochea malleus (1.35), Chaetoceros decipiens (1.35), Chaetoceros coarctatus (6.76), Grammatophora marina (4.05) & Trichodesmium sp. (2.70).* |
| EMPL 3 | 3831 | 15 | *Biddulphia regia (13.89), Rhizosolenia imbricata (3.97), Rhizosolenia stolterfothii (7.94), Rhizosolenia calcar-avis (9.92), Coscinodiscus radiatus (11.90), Coscinodiscus granii (1.98), Ceratium fusus (7.94), Ceratium furca (3.97), Dinophysis caudata (5.30), Thalassionema frauenfeldii (5.95), Guinardia flaccida (3.97), Asterionella japonica (0.48), Streptotheca thamensis (3.97), Skeletonema costatum (3.97), Nitzschia sp (1.78) & Chaetoceros decipiens (9.92).* |
| EMPL 4 | 2196 | 19 | *Biddulphia regia (1.64), Biddulphia mobiliensis (8.74), Rhizosolenia imbricata (4.37), Rhizosolenia stolterfothii (3.28), Rhizosolenia alata (7.65), Rhizosolenia robusta (5.46), Rhizosolenia calcar-avis (8.74), Rhizosolenia bergonii (3.28), Coscinodiscus radiates (9.84), Coscinodiscus granii (2.19), Coscinodiscus centralis (4.37), Ceratium tripos (3.28), Ceratium furca (6.56), Ceratium fusus (5.46), Thalassionema frauenfeldii (6.56), Guinardia flaccida (12.02), Skeletonema costatum (2.19), Streptotheca thamensis (1.09), & Chaetoceros decipiens (3.28).* |

| Station code | Population (No/l) | Faunal Groups | *Percentage of species contribution* |
|---|---|---|---|
| EMPL 5 | 3740 | 20 | *Biddulphia regia (14.12), Rhizosolenia imbricata (5.88), Rhizosolenia alata (4.71), Rhizosolenia robusta (8.24), Coscinodiscus centralis (4.71), Coscinodiscus radiatus (7.06), Ceratium fusus (3.53), Thalassionema frauenfeldii (7.06), Guinardia flaccida (4.71), Skeletonema costatum (3.53), Leptocylindrus sp (1.18), Asterionella japonica (2.35), Anabaena sp (1.18), Streptotheca thamensis (2.35), Bellerochea malleus (4.71), Pleurosigma sp (3.53), Nitzschia sp (1.18), Chaetoceros decipiens (7.06), Chaetoceros coarctatus (9.41) & Chaetoceros gracilis (3.53).* |
| EMPL 6 | 1826 | 13 | *Biddulphia regia (8.43), Biddulphia sinensis (4.82), Rhizosolenia imbricata (9.64), Coscinodiscus radiatus (12.05), Ceratium tripos (4.82), Ceratium furca (9.64), Thalassionema frauenfeldii (4.82), Guinardia flaccid (9.64), Skeletonema costatum (7.23), Streptotheca thamensis (9.64), Bellerochea malleus (2.41), Chaetoceros decipiens (12.05) & Chaetoceros coarctatus (4.82).* |
| EMPL 7 | 3963 | 13 | *Biddulphia mobiliensis (13.12), Rhizosolenia imbricata (9.84), Coscinodiscus granii (6.56), Ceratium tripos (9.84), Ceratium fusus (16.40), Ceratium longiceps (3.23), Thalassionema frauenfeldii (4.92), Guinardia flaccid (3.28), Skeletonema costatum (11.48), Streptotheca thamensis (1.64), Chaetoceros decipiens (4.92), Chaetoceros coarctatus (9.84) & Trichodesmium sp. (4.92).* |
| EMPL 8 | 2340 | 13 | *Biddulphia regia (15.56), Biddulphia sinensis (4.44), Rhizosolenia imbricata (8.89), Coscinodiscus radiatus (1.11) Ceratium tripos (4.44), Ceratium furca (8.89), Thalassionema frauenfeldii (4.44), Guinardia flaccida (8.89), Skeletonema costatum (6.67), Streptotheca thamensis (8.89), Nitzschia sp (2.22), Chaetoceros decipiens (11.11), & Chaetoceros coarctatus (4.44).* |
| EMPL 9 | 3472 | 16 | *Biddulphia regia (14.52), Biddulphia sinensis (3.23), Rhizosolenia imbricata (6.45), Rhizosolenia calcar-avis (8.06), Coscinodiscus centralis (6.45), Ceratium arcticum (3.23), Ceratium fusus (6.45), Dinophysis caudata (4.84), Dictyocha spp. (3.23), Guinardia flaccida (4.84), Guinardia striata (8.06), Leptocylindrus sp (6.45), Bellerochea malleus (4.84), Pleurosigma sp. (6.45), Nitzschia sp. (4.84) & Chaetoceros decipiens (8.06).* |
| EMPL 10 | 3510 | 13 | *Biddulphia regia (1.53), Biddulphia sinensis (9.26), Rhizosolenia imbricata (14.81), Rhizosolenia stolterfothii (5.56), Rhizosolenia alata (3.70), Rhizosolenia calcar-avis (5.56), Dinophysis caudate (3.70), Thalassionema frauenfeldii (3.70), Guinardia flaccida (12.96), Streptotheca thamensis (12.96), Pleurosigma sp (5.56), Chaetoceros decipiens (14.81) & Chaetoceros coarctatus (5.56).* |

| Station code | Population (No/l) | Faunal Groups | *Percentage of species contribution* |
|---|---|---|---|
| ENC 1 | 2736 | 20 | *Biddulphia regia (7.02), Rhizosolenia imbricata (5.26), Rhizosolenia stolterfothii (3.51), Rhizosolenia bergonii (1.75), Coscinodiscus radiatus (5.26), Ceratium fusus (5.26), Dinophysis caudata (3.51), Dictyocha spp. (7.02), Guinardia striata (3.51), Skeletonema costatum (8.77), Leptocylindrus sp (7.02), Asterionella japonica (5.26), Anabaena sp (3.51), Streptotheca thamensis (7.02), Bellerochea malleus (3.51), Pleurosigma sp (5.26), Nitzschia sp (7.02), Chaetoceros decipiens (5.26), Chaetoceros gracilis (1.75) & Grammatophora marina (3.51).* |
| ENC 2 | 1110 | 4 | *Anabaena sp (24.32), Spirulina sp. (35.14), Scenedesmus dimorphis (21.62) & Pediastrum duplex (18.92).* |

**Table 2: Phytoplankton population variation along MPL offshore discharge sites and adjoining Ennore creek system during LT**

| Station code | Population (No/l) | Faunal Groups | *Percentage of species contribution* |
|---|---|---|---|
| MPL 1 | 5382 | 18 | *Biddulphia regia (8.70), Biddulphia sinensis (2.90), Rhizosolenia imbricata (14.49), Rhizosolenia stolterfothii (4.35), Rhizosolenia alata (7.25), Coscinodiscus radiatus (4.35), Ceratium tripos (5.80), Ceratium fusus (4.35), Thalassionema frauenfeldii (1.45), Guinardia flaccida (5.80), Guinardia striata (2.90), Skeletonema costatum (5.80), Leptocylindrus sp (7.25), Asterionella japonica (4.35), Streptotheca thamensis (5.80), Chaetoceros decipiens (4.35), Chaetoceros coarctatus (5.80), & Grammatophora marina (4.35).* |
| EMPL 1 | 3002 | 18 | *Biddulphia mobiliensis (5.06), Rhizosolenia imbricata (2.53), Rhizosolenia stolterfothii (6.33), Rhizosolenia robusta (5.06), Rhizosolenia bergonii (7.59), Coscinodiscus radiatus (6.33), Ceratium tripos (3.80), Ceratium fusus (5.06), Thalassionema frauenfeldii (6.33), Guinardia flaccida (7.59), Guinardia striata (5.06), Skeletonema costatum (1.27), Asterionella japonica (8.86), Streptotheca thamensis (7.59), Chaetoceros decipiens (3.80), Chaetoceros coarctatus (2.53), Grammatophora marina (5.06) & Trichodesmium sp. (6.33).* |

| Station code | Population (No/l) | Faunal Groups | *Percentage of species contribution* |
|---|---|---|---|
| EMPL 2 | 3920 | 18 | *Biddulphia regia (8.93), Biddulphia mobiliensis (5.36), Rhizosolenia imbricata (7.14), Rhizosolenia alata (3.57), Rhizosolenia calcar-avis (7.14), Rhizosolenia bergonii (1.79), Coscinodiscus radiatus (8.93), Coscinodiscus granii (5.36), Ceratium tripos (5.36), Ceratium furca (7.14), Ceratium fusus (3.57), Thalassionema frauenfeldii (3.57), Guinardia flaccida (1.79), Guinardia striata (3.57), Streptotheca thamensis (8.93), Skeletonema costatum (7.14), Chaetoceros coarctatus (3.57), Chaetoceros decipiens (5.36) & Grammatophora marina (1.79).* |
| EMPL 3 | 2704 | 17 | *Biddulphia regia (12.50), Biddulphia mobiliensis (8.65), Rhizosolenia imbricata (4.81), Rhizosolenia stolterfothii (1.92), Rhizosolenia robusta (2.88), Rhizosolenia calcar-avis (5.77), Coscinodiscus radiatus (9.62), Coscinodiscus granii (2.88), Coscinodiscus centralis (4.81), Ceratium tripos (4.81), Ceratium furca (6.73), Ceratium fusus (5.77), Thalassionema frauenfeldii (3.85), Guinardia flaccida (13.46), Skeletonema costatum (4.81), Streptotheca thamensis (2.88), & Chaetoceros decipiens (3.85).* |
| EMPL 4 | 3570 | 18 | *Biddulphia regia (12.94), Rhizosolenia imbricata (7.06), Rhizosolenia alata (3.53), Rhizosolenia robusta (5.88), Coscinodiscus radiatus (10.59), Ceratium fusus (4.71), Thalassionema frauenfeldii (9.41), Guinardia flaccida (2.53), Skeletonema costatum (3.53), Leptocylindrus sp (2.53), Asterionella japonica (4.71), Streptotheca thamensis (3.53), Bellerochea malleus (2.35), Pleurosigma sp (8.24), Nitzschia sp (3.53), Chaetoceros decipiens (4.71), Chaetoceros coarctatus (7.06) & Chaetoceros gracilis (3.53).* |
| EMPL 5 | 2116 | 13 | *Biddulphia regia (13.04), Biddulphia sinensis (8.70), Rhizosolenia imbricata (6.52), Coscinodiscus radiatus (8.70), Coscinodiscus centralis (2.17), Ceratium tripos (6.52), Ceratium furca (8.70), Thalassionema frauenfeldii (2.17), Guinardia flaccid (6.52), Skeletonema costatum (4.35), Bellerochea malleus (10.87), Chaetoceros decipiens (13.04) & Chaetoceros coarctatus (8.70).* |
| EMPL 6 | 3886 | 12 | *Biddulphia mobiliensis (14.93), Rhizosolenia imbricata (11.94), Coscinodiscus radiatus (5.97), Ceratium tripos (10.45), Ceratium fusus (8.96), Thalassionema frauenfeldii (5.97), Guinardia flaccid (1.49), Skeletonema costatum (7.46), Streptotheca thamensis (5.97), Chaetoceros decipiens (7.46), Chaetoceros coarctatus (11.94) & Trichodesmium sp. (7.46).* |
| EMPL 7 | 2464 | 12 | *Biddulphia regia (18.18), Biddulphia sinensis (2.27), Rhizosolenia imbricata (6.82), Coscinodiscus radiatus (7.95) Ceratium furca (13.64), Thalassionema frauenfeldii (6.82), Guinardia flaccida (5.68), Skeletonema costatum (5.68), Streptotheca thamensis (11.36), Nitzschia sp (4.55), Chaetoceros decipiens (10.23), & Chaetoceros coarctatus (6.82).* |

| Station code | Population (No/l) | Faunal Groups | *Percentage of species contribution* |
|---|---|---|---|
| EMPL 8 | 3456 | 15 | *Biddulphia regia (10.94), Biddulphia sinensis (6.25), Rhizosolenia imbricata (7.81), Coscinodiscus centralis (14.06), Ceratium arcticum (6.25), Ceratium fusus (4.69), Thalassionema frauenfeldii (7.81), Guinardia flaccida (1.56), Guinardia striata (3.13), Skeletonema costatum (6.25), Asterionella japonica (4.69), Pleurosigma sp. (7.81), Nitzschia sp. (3.13), Chaetoceros decipiens (6.25) & Chaetoceros coarctatus (9.38).* |
| EMPL 9 | 3480 | 13 | *Biddulphia regia (5.00), Rhizosolenia imbricata (16.67), Rhizosolenia stolterfothii (6.67), Rhizosolenia calcar-avis (8.33), Ceratium longiceps (5.00), Dinophysis caudate (6.67), Thalassionema frauenfeldii (1.67), Guinardia flaccida (15.00), Streptotheca thamensis (10.00), Pleurosigma sp (3.33), Chaetoceros decipiens (15.00), Chaetoceros coarctatus (3.33) & Trichodesmium sp. (3.33).* |
| EMPL 10 | 2756 | 15 | *Biddulphia regia (5.66), Rhizosolenia imbricata (9.43), Rhizosolenia stolterfothii (5.66), Coscinodiscus radiatus (9.43), Ceratium fusus (9.43), Thalassionema frauenfeldii (1.89), Guinardia flaccida (5.66), Skeletonema costatum (1.89), Asterionella japonica (11.32), Anabaena sp (5.66), Streptotheca thamensis (9.43), Bellerochea malleus (5.66), Pleurosigma sp (1.89), Chaetoceros decipiens (7.55) & Trichodesmium sp. (9.43).* |
| ENC 2 | 1064 | 4 | *Anabaena sp (21.05), Spirulina sp. (39.47), Scenedesmus dimorphis (15.79) & Pediastrum duplex (23.68).* |

**Table 3: Zooplankton population variation along MPL offshore discharge sites and adjoining Ennore creek system during HT**

| Station code | Population (No/$m^3$) | Faunal Groups | Major groups (%) |
|---|---|---|---|
| EMPL 1 | 1476 | 12 | *Calanoid copepods (10.16), Cyclopoid copepods (5.42), Sagitta (3.93), Medusa (1.02), Siphonophores (5.08), Cladocerans (35.57), Mysids (6.78), Brachyuran larvae (2.03), Fish eggs and larvae (3.25), Lucifer (22.02), Polychaete larvae (3.93) & Nauplius ( 0.81)* |
| EMPL 2 | 1638 | 11 | *Calanoid copepods (13.80), Cyclopoid copepods (0.61), Sagitta (2.81), Siphonophores (1.28), Cladocerans (48.35), Appendicularians (1.95), Mysids (8.79), Fish eggs and larvae (0.92), Lucifer (19.54), Polychaete larvae (0.98) & Nauplius ( 0.98)* |

| | | | |
|---|---|---|---|
| EMPL 3 | 1731 | 13 | *Calanoid copepods (10.40), Cyclopoid copepods (5.20), Sagitta (7.22), Medusa (1.10), Siphonophores (7.22), Cladocerans (32.93), Appendicularians (6.93), Mysids (1.04), Brachyuran larvae (1.44), Fish eggs and larvae (2.60), Lucifer (21.66), Polychaete larvae (1.44) & Nauplius ( 0.81)* |
| EMPL 4 | 2546 | 12 | *Calanoid copepods (11.00), Cyclopoid copepods (2.08), Sagitta (1.10), Medusa (2.36), Siphonophores (2.55), Cladocerans (40.85), Appendicularians (1.18), Mysids (3.53), Fish eggs and larvae (5.89), Lucifer (21.41), Polychaete larvae (3.34) & Nauplius ( 4.71)* |
| EMPL 5 | 2586 | 11 | *Calanoid copepods (5.08), Cyclopoid copepods (6.03), Sagitta (4.06), Cladocerans (46.40), Appendicularians (1.93), Mysids (3.87), Brachyuran larvae (2.90), Fish eggs and larvae (2.90), Lucifer (17.40), Polychaete larvae (2.90) & Nauplius ( 5.80)* |
| EMPL 6 | 2003 | 12 | *Calanoid copepods (6.14), Cyclopoid copepods (2.15), Sagitta (8.89), Medusa (3.15), Siphonophores (1.05), Cladocerans (37.59), Appendicularians (0.60), Mysids (5.24), Fish eggs and larvae (2.10), Lucifer (26.21), Polychaete larvae (6.14) & Nauplius ( 0.75)* |
| EMPL 7 | 2325 | 12 | *Calanoid copepods (3.53), Cyclopoid copepods (4.65), Sagitta (1.94), Medusa (1.20), Siphonophores (2.49), Cladocerans (52.90), Mysids (9.98), Brachyuran larvae (1.08), Fish eggs and larvae (1.08), Lucifer (15.14), Polychaete larvae (2.49) & Nauplius ( 3.53)* |
| EMPL 8 | 1287 | 13 | *Calanoid copepods (14.69), Cyclopoid copepods (2.18), Sagitta (1.09), Medusa (1.09), Siphonophores (5.59), Cladocerans (40.02), Appendicularians (1.09), Mysids (8.24), Brachyuran larvae (2.10), Fish eggs and larvae (1.09), Lucifer (20.05), Polychaete larvae (1.09) & Nauplius ( 1.71)* |
| EMPL 9 | 1180 | 12 | *Calanoid copepods (7.20), Cyclopoid copepods (6.10), Sagitta (1.53), Medusa (0.76), Siphonophores (3.47), Cladocerans (47.12), Appendicularians (6.10), Mysids (6.44), Fish eggs and larvae (1.69), Lucifer (16.78), Polychaete larvae (1.27) & Nauplius ( 1.53)* |
| EMPL 10 | 1450 | 11 | *Calanoid copepods (10.90), Cyclopoid copepods (2.93), Sagitta (7.59), Medusa (4.69), Siphonophores (9.10), Cladocerans (39.24), Mysids (3.03), Fish eggs and larvae (1.52), Lucifer (10.48), Polychaete larvae (7.59) & Nauplius ( 3.03)* |
| ENC 1 | 630 | 11 | *Calanoid copepods (20.32), Cyclopoid copepods (4.44), Sagitta (1.90), Medusa (0.48), Cladocerans (36.83), Appendicularians (2.22), Mysids (2.38), Fish eggs and larvae (6.83), Lucifer (3.97), Polychaete larvae (12.06) & Nauplius (8.57)* |
| ENC 2 | 497 | 10 | *Calanoid copepods (19.72), Cyclopoid copepods (10.46), Medusa (0.40), Cladocerans (41.05), Appendicularians (1.61), Mysids (2.41), Fish eggs and larvae (5.63), Lucifer (3.62), Polychaete larvae (8.05) & Nauplius (7.04)* |

**Table 4: Zooplankton population variation along MPL offshore discharge sites and adjoining Ennore creek system during LT**

| Station code | Population (No/m$^3$) | Faunal Groups | Major groups (%) |
|---|---|---|---|
| EMPL 1 | 1794 | 11 | *Calanoid copepods (8.03), Cyclopoid copepods (0.89), Medusa (0.89), Siphonophores (3.01), Cladocerans (38.35), Appendicularians (1.78), Mysids (12.19), Fish eggs and larvae (1.74), Lucifer (27.87), Polychaete larvae (1.74) & Nauplius ( 3.48)* |
| EMPL 2 | 2480 | 12 | *Calanoid copepods (8.63), Cyclopoid copepods (0.20), Sagitta (1.39), Medusa (2.78), Siphonophores (1.39), Cladocerans (37.38), Appendicularians (0.48), Mysids (9.73), Fish eggs and larvae (4.17), Lucifer (31.98), Polychaete larvae (1.39) & Nauplius ( 0.48)* |
| EMPL 3 | 2631 | 10 | *Calanoid copepods (3.76), Cyclopoid copepods (2.62), Sagitta (2.20), Cladocerans (47.78), Appendicularians (2.27), Mysids (11.35), Fish eggs and larvae (2.27), Lucifer (24.90), Polychaete larvae (2.27) & Nauplius ( 0.57)* |
| EMPL 4 | 3199 | 11 | *Calanoid copepods (6.31), Cyclopoid copepods (2.56), Sagitta (1.59), Siphonophores (4.78), Cladocerans (61.39), Appendicularians (1.47), Mysids (5.10), Fish eggs and larvae (1.28), Lucifer (13.91), Polychaete larvae (1.03) & Nauplius ( 0.56)* |
| EMPL 5 | 2543 | 12 | *Calanoid copepods (11.84), Cyclopoid copepods (0.98), Harapacticoid (2.91), Medusa (3.97), Siphonophores (5.70), Cladocerans (50.29), Appendicularians (1.30), Mysids (5.27), Fish eggs and larvae (0.71), Lucifer (15.81), Polychaete larvae (0.47) & Nauplius ( 0.75)* |
| EMPL 6 | 2367 | 12 | *Calanoid copepods (6.34), Cyclopoid copepods (3.13), Sagitta (1.35), Medusa (1.31), Siphonophores (3.72), Cladocerans (56.61), Appendicularians (1.86), Mysids (4.06), Fish eggs and larvae (1.31), Lucifer (17.11), Polychaete larvae (2.70) & Nauplius ( 0.51)* |
| EMPL 7 | 2599 | 11 | *Calanoid copepods (20.62), Cyclopoid copepods (0.69), Sagitta (2.46), Siphonophores (3.23), Cladocerans (47.98), Mysids (7.08), Brachyuran larvae (1.61), Fish eggs and larvae (1.73), Lucifer (12.50), Polychaete larvae (1.23) & Nauplius ( 0.85)* |
| EMPL 8 | 3093 | 12 | *Calanoid copepods (15.06), Cyclopoid copepods (2.29), Sagitta (1.33), Medusa (2.29), Siphonophores (2.29), Cladocerans (47.69), Appendicularians (2.29), Mysids (7.25), Fish eggs and larvae (2.29), Lucifer (15.06), Polychaete larvae (1.78) & Nauplius ( 0.39)* |
| EMPL 9 | 2219 | 12 | *Calanoid copepods (13.50), Cyclopoid copepods (1.58), Harapacticoid (0.99) Sagitta (1.44), Medusa (2.43), Siphonophores (0.72), Cladocerans (43.88), Mysids (16.88), Fish eggs and larvae (5.06), Lucifer (8.44), Polychaete larvae (1.69) & Nauplius ( 3.38)* |

| | | | |
|---|---|---|---|
| EMPL 10 | 2378 | 8 | *Calanoid copepods (7.69), Cyclopoid copepods (2.56), Medusa (5.13), Siphonophores (2.56), Cladocerans (48.72), Mysids (10.26), Lucifer (20.51) & Nauplius ( 2.56)* |
| ENC 1 | 802 | 12 | *Calanoid copepods (19.45), Cyclopoid copepods (1.50), Harapacticoid (0.50) Sagitta (2.0), Medusa (1.25), Cladocerans (39.40), Appendicularians (1.75), Mysids (2.49), Fish eggs and larvae (7.23), Lucifer (5.49), Polychaete larvae (10.72) & Nauplius ( 8.23)* |
| ENC 2 | 615 | 11 | *Calanoid copepods (17.56), Cyclopoid copepods (0.65), Sagitta (0.81), Medusa (0.81), Cladocerans (46.83), Appendicularians (1.30), Mysids (4.07), Fish eggs and larvae (5.69), Lucifer (7.32), Polychaete larvae (8.46) & Nauplius ( 6.50)* |

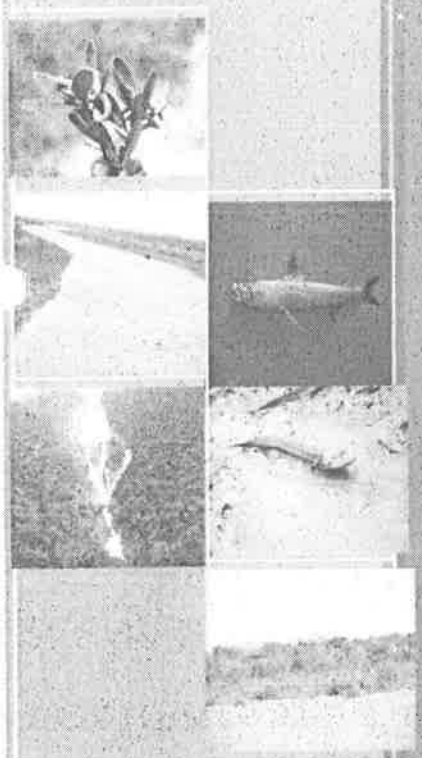
**Table 5: Benthos population variation along MPL offshore discharge sites and adjoining Ennore creek system during HT**

| *Station code* | *Total (Nos./m²)* | *Percentage of species contribution* |
|---|---|---|
| EMPL 1 | 182 | *Tube worm (3.855), Arca sp.(15.38), Anadara granosa (11.54), Meretrix casta (7.69), Donax sp. (23.08), Astarte elliptica (3.85), Meretrix meretrix (15.38), Cerethedia sp. (3.85) & Clithon oualaniense (15.38).* |
| EMPL 2 | 91 | *Tube worm (7.69), Terebellides sp.(7.69), Angulus tenuis (7.69), Arca sp.(7.69), Anadara granosa (7.69), Meretrix casta (7.69), Donax sp. (15.38), Cerethedia sp. (23.08), Parvanachis obesa (7.69) & Cellena radiata (7.69).* |
| EMPL 3 | 98 | *Goniada sp.(4.5),Terebellides sp.(2.3), Arca sp.(9.1), Pecten sp.(40.9), Donax sp.(6.8), Meretrix meretrix(2.3), Umbonium vestiarium(27.3), Balanus sp.(2.3),Oliva sp.(4.5).* |
| EMPL 4 | 105 | *Tube worm (20.00), Terebellides sp. (6.67), Arca sp.(6.67), Anadara granosa (13.33), Donax sp.(13.33), Meretrix meretrix (13.33), Cerethedia sp. (20.00) & Umbonium vestiarium (6.67).* |
| EMPL 5 | 133 | *Cirratulus cirratus (15.79), Ancistrosyllis sp.(10.53), Tube worm (5.26), Arca sp.(10.53), Anadara granosa(5.26), Donax sp. (10.53), Meretrix meretrix (15.79), Cerethedia sp. (10.53), Umbonium vestiarium (10.53) & Sand Dollar (5.26).* |
| EMPL 6 | 140 | *Prionospio sp.(5.00), Tube worm (15.00), Angulus tenuis (5.00), Arca sp. (5.00), Anadara granosa (10.00), Donax sp.(15.00), Meretrix meretrix (20.00), Cerethedia sp. (5.00), Umbonium vestiarium(10.00) & Turtella sp. (10.00).* |
| EMPL 7 | 329 | *Tube worm (6.38), Terebellides sp (4.26), Arca sp. (10.64), Anadara granosa (14.89), Meretrix casta (8.51), Pecten sp. (2.13), Astarte elliptica (4.26), Donax sp. (23.40), Meretrix meretrix (19.15), Cerethedia sp. (2.13) & Umbonium vestiarium (4.26).* |
| EMPL 8 | 119 | *Tube worm (11.76), Terebellides sp. (5.86), Angulus tenuis (5.88), Arca sp. (5.88), Meretrix casta (11.76), Pecten sp. (5.88), Donax sp.(17.65), Meretrix meretrix (11.76), Cerethedia sp.(11.76), Umbonium vestiarium(5.88) & Oliva sp.(5.88).* |

| *Station code* | *Total (Nos./m²)* | *Percentage of species contribution* |
|---|---|---|
| EMPL 9 | 112 | *Terebellides sp. (6.25), Arca sp.(12.50), Anadara granosa (12.50), Meretrix casta (18.75), Donax sp.(31.25), Meretrix meretrix(6.25), Cerethedia sp. (6.25) & Umbonium vestiarium (6.25).* |
| EMPL 10 | 189 | *Prionospio sp.(3.70), Cirratulus cirratus (3.70), Para heteromastus tenuis (3.70), Tube worm(18.52), Terebellides sp.(7.41), Angulus tenuis (7.41), Arca sp.(7.41), Anadara granosa (11.11), Meretrix casta (14.81), Donax sp.(7.41), Meretrix meretrix(11.11) & Cerethedia sp.(3.70).* |
| ENC 1 | 98 | *Prionospio sp.(14.29), Angulus tenuis (14.29), Donax sp.( 14.29), Meretrix meretrix(14.29), Cerethedia sp.( 14.29) & Clithon oualaniense (28.57).* |

ANNEXURE - 9B 2236

# Marine Environmental Status and Impact Assessment of Manali Petrochemicals Limited (MPL), Manali, Chennai



**FINAL REPORT**

**Submitted to**

**MANALI PETROCHEMICALS LIMITED,**
**Ponneri High Road, Manali, Chennai-68,**
**Tamil Nadu**

**Submitted by**

**BLUE BAY COASTAL RESEARCH FOUNDATION (BBCRF)**
**KANCHIPURAM**

**December 2020**

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# Declaration by the EIA Consultant

This study dealing with the coastal environmental status and impact entitled, "Marine Environmental Status and Impact Assessment of Manali Petrochemical Limited, (MPL), Manali, Chennai' has been prepared by Blue Bay Coastal Research Foundation, Kanchipuram following all norms of impact assessment study in an unbiased and truthful manner.

The skill, care and diligence required to prepare this report has been exercised by the team within the terms of the contract with the client, incorporating our General Terms and Conditions of Business and taking into account of the resources devoted to it by agreement with the client.

This report is confidential to the client and the use of this report by unauthorized third parties without written authorization from MPL shall be at their own risk.

**For and on behalf of Blue Bay Coastal Research Foundation**

**Sign:**

**Date: 19/12/2020**

**Designation: Executive Director**

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## Study Team

| Name & Signature | Qualification | Experience and Expertise | Role in the Project |
|---|---|---|---|
| G A Thivakaran | MSc., M.Phil., PhD in Marine Biology and Oceanography | 31 years of post-doctoral research experience, NABET accredited Functional Area expert for (Marine) Ecology and Biodiversity | Principal Investigator and Project Lead |

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## Abbreviations

| | |
|---|---|
| 'H' | Shannon Diversity Index |
| µg/l and µg/g | Microgram per litre; microgram per gram |
| µmol/L | Micro mole per litre |
| AAS | Atomic Absorption Spectrophotometer |
| AAS | Automic Absorption Spectrophotometer |
| APHA | American Public Health Association |
| Avg | Average |
| BDL | Below Detectable Limit |
| BOD | Biological Oxygen Demand |
| Cd | Cadmium |
| cm | Centimetre |
| COD | Chemical Oxygen Demand |
| CPCB | Central Pollution Control Board |
| CPUE | Catch Per Unit Effort |
| Cr | Chromium |
| CRZ | Coastal Regulation Zone |
| Cu | Copper |
| DO | Dissolved Oxygen |
| ECD | electron capture detector |
| EIA | Environmental Impact Assessment |
| ETP | Effluent Treatment Plant |
| Fe | Iron |
| g/l | Grams per litre |
| GIS | Geographical Information System |
| GPS | Global Positioning System |
| ha. | Hectares |
| HCl | Hydrochloric acid |
| $HClO_4$ | Perchloric Acid |
| Hg | Mercury |
| $HNO_3$ | Nitric Acid |
| $K_2Cr_2O_7$ | Potassium Dichromate |
| kg | kilogram |
| km | Kilometres |
| $KMnO_4$ | Potassium Permanganate |
| kmph | Kilometer per hour |
| KOH | Potassium Hydroxide |
| l | Litre |
| m | Meter |
| m/s | Minutes per second |
| $m^2$ | Square meter |
| max | maximum |
| mg/l | Milligram per litre |
| $mg/m^3$ | Milligram per cubic meter |

| | |
|---|---|
| $MgCO_3$ | Magnesium Carbonate |
| MHWS | Mean High Water Spring |
| min | Minimum |
| ml | millilitre |
| mm | millimeter |
| Mn | Manganese |
| MoEF & CC | Ministry of Environment, Forests & Climate Change |
| MPN | Most Probable Number |
| MRL | Manali Petrochemicals Limited |
| MSL | Mean Sea Level |
| MW | Mega Watt |
| NCCR | National Centre of Coastal Research |
| $NH_3$ | Ammonia |
| Ni | Nickel |
| NIO | National Institute of Oceanography |
| nm | nanometer |
| $NO_2$ | Nitrite |
| $NO_3$ | Nitrate |
| NTU | Nephelometer Turbidity Unit |
| $O_2$ | Oxygen |
| °C | Celsius |
| Pb | Lead |
| pH | Hydrogen Ion Concentration |
| PHc | Petroleum Hydrocarbon |
| ppm | Parts per million |
| ppt | Parts per thousands |
| PSU | Practical Salinity Unit |
| SPME | Solid-Phase Micro Extraction |
| TDS | Total Dissolved Solids |
| TDS | Total Dissolved solids |
| TNPCB | Tamil Nadu Pollution Control Board |
| TOC | Total Organic Carbon |
| TP | Total Phosphorus |
| TSS | Total Suspended Solids |
| TSS | Total Suspended Solids |
| UK | United Kingdom |
| USCS | Unified Soil Classification System |
| USEPA | United States Environment Protection Agency |
| WQI | Water Quality Index |
| Zn | Zinc |

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# 1 Introduction

Increasing demand for Petro-products triggers aggressive development of petrochemical industries and the concomitant environmental concern associated with it. Manali Petrochemicals Limited (MPL) located at Manali at the outskirts of Chennai was established in the year 1986 in view of the growing demand for petrochemical based products. Presence of many petrochemical based industries in Manali and availability of refinery feedstock in the vicinity were the major reasons for its establishment. The two units of the MPL are engaged in the manufacture of products such as Polyols, Propylene Glycol and Propylene Oxide whose versatility is better than steel and rubber has found wide applications in numerous industries such as automobiles, bedding, furniture, aeronautical, footwear, paints, pharmaceuticals and many others. Application of these products in numerous other industries is ever-growing due to their unique physical features. MPL receives raw materials such as Propylene either through pipelines or road tankers. Since products of MPL is a good import substitute and save foreign currency, it is imperative to retain and promote such industries with rigorous environmental sustainability ensured in their operation.

Since these petrochemical products have very wide application in an assortment of industries, the demand for these products are growing steadily which prompted the MPL management to enhance production in a phased manner ever since its inception during 1986. In spite of its economic significance, presence of MPL in the Manali coastline of Chennai, which already bristles with an assortment of industrial, economic and social activities, calls for a serious attention to the environmental implications of MPL operations. Effluents of MPL mostly contain calcium chloride and traces of Propylene Glycol which are environmentally benign. In addition, MPL has a well-defined environmental goal and maintaining safety and environmental integrity in its operations is stated to be the guiding principle in its mission statement.

MPL intends to carry out a study on the present status of the marine environment in and around its effluent discharge point at Ennore, Chennai along with the marine ecological impact of its discharges, especially with respect to water quality and biotic

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components of the marine environment. Blue Bay Coastal Research Foundation (BBCRF), Kanchipuram is assigned this task by MPL.

As per the Terms of Reference (ToR) assigned by MPL, this study attempts to assess the marine environmental status in and around the effluent discharge outfall of MPL at Ennore coast along with the likely impact in the long run. This study also suggests appropriate measures to ward-off negative impact and come out with a management plan in order to maintain the long-term integrity of the marine environment in and around the effluent discharge point of MPL. The whole process revolves around identifying potential impact of a development on vital components of the environment and suggesting concrete and practical work plan to offset the negative consequences. Environmental status and impact studies are most crucial component for any developmental project at its operational stage in order to achieve sustainable development and to safeguard and protect economic, social and ecological integrity of their operation. This project is part of the commitment of MPL, to ensure the environmental health of its surroundings and that their operation cause acceptable level of impact on the social and environmental realm.

### 1.1 Scope of the Study

This study intends to investigate the present marine environmental status and thereby the impact of the MPL effluents in and around its effluent outfall point in the coastal belt of Ennore, near Chennai.

For this purpose, 19 parameters in coastal waters, 6 parameters in bottom sediment and 5 biological parameters were analyzed with an aim to characterize the marine environment holistically and to visualize the impact of the ongoing operations of MPL.

Samplings in the marine environment were collected in a radius of 5 km at a distance of every 1.5 km in three directions from the outfall point. Accepted guidelines and protocols were followed for collection and analysis of samples.

A sound marine environmental management plan is formulated based on the marine environmental status and the predicted impact. The study, in concrete terms brings out the following:

1. Present status of marine environment and its health in terms of water and sediment quality and biological and ecological parameters as per the accepted norms and standards fixed by national statutory bodies.
2. Predicted impact of the ongoing MPL activity on the marine ecology of the Ennore coast on a long-term basis.
3. Required mitigation measures that are to be carried out by MPL if some impacts are perceived to be serious.
4. Salient points for better marine environmental management.

## 1.2 Study Area

This study was carried out at the proposed Effluent outfall point of Manali Petrochemicals Limited located at a distance of approx. 7.5 km from the MPL plant (Fig. 1.1) at Ennore coast of Chennai, Tamil Nadu. General environmental characteristics of the Ennore coastal belt is presented in table 1.1.

The diffuser outfall of MPL which discharges the MPL's effluents is located at the Ennore Coast in the outskirts of Chennai (Bay of Bengal) approximately at around 700 m from the shoreline. The Diffuser outfall is south of Ennore port at an aerial distance of around 8 km, North of Chennai port at 10 km aerial distance, north to the Kasimedu Fishing harbour at an aerial distance of 6 km and south of Ennore creek at an aerial distance of 6 km. Ennore coast is sandy in nature and is protected with sea walls, groynes and other erosion control structures as this coast experiences severe coastal erosion induced by constant dredging activities of many harbours, ports and jetties in this coastal stretch.

The tide at the Ennore coast is semi diurnal in nature with an average interval of six (6) hours between high and low tides. The mean tidal height at Chennai is in the order of 0.914 m to 1.219 m at spring and between 0.805 m to 0.610 m at neap tides, corresponding slack water period being 1.30 to 2.00 hours and 2 to 2.30 hours at spring and neap tides, respectively. Some more details of tides at Ennore is as follows:

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| | |
|---|---|
| Mean High Water level springs | + 1.15 m |
| Mean High Water Neaps | + 0.84 m |
| Mean Low water level springs | + 0.14 m |
| Mean Low Water Neaps | + 0.40 m |

The Sea level pressure varies from 1003.9 to 1014.9 mill bars with an average of 1008.6. Chennai experiences a tropical wet and dry climate, and the weather is hot and humid in most part of the year. Average annual maximum (33°C) and minimum (25°C) temperature was recorded during the months of May and January at Chennai. The maximum humidity was observed during the month of October to December with 76%. The maximum wind speed in the study site was 28.3 kmph, with an average of 22.9 kmph. There are no major perennial or seasonal rivers in Chennai, and rainfall is the only source of water for all requirements. The region experiences maximum rainfall during Southwest monsoon (June to September) with the annual mean rainfall of 1197 mm.

Wave height in this Coast Ranges from 0.4 to 2.0 m and the predominant being between 0.4 m to 1.2 m. The wave direction during the Southwest monsoon is predominantly 145° North with a swell of 0.61 to 0.91 m and 65°; South during the Northeast monsoon with a swell of 0.91 to 1.22 m. In the study location in and around the MPL's diffuser point, current direction is mostly Northward from January to May at a speed of 1 to 2 knots, whereas during June to December the current direction is southwards with a speed of 2 to 3 knots. Environmental setting of the study location is indicated in the table 1.1 given below.

**Table 1.1. Environmental Setting of the MPL Effluent Outfall Point**

| S. No. | Particulars | Details |
|---|---|---|
| 1 | Co-ordinates of MPL's Diffuser Outlet Point | 13°10'51.00"N; 80°12'21.00"E |
| 3 | Elevation above Mean Sea level | 6 m |
| 4 | Climatic Conditions | Annual Mean Max Temp: 37° C<br>Annual Mean Min Temp: 23° C<br>Rainfall: 1197 mm (2019)<br>Humidity: 66 to 69% |
| 5 | Land Use Pattern of MPL's nearby area | Industrial hub with assortment of industries such as Petrochemical, Petroleum, thermal, rubber and many others |
| 6 | Nearest Highway | National Highway 16(~16 km, West) |
| 7 | Nearest Railway Station | Chennai Central RS (~15 km, South) |
| 8 | Nearest Airport | Meenambakkam (~37 km, SW) |
| 9 | Nearest Port | Ennore Port (~13 km, North) |
| 10 | Nearest habitation | Thiruvottiyur (~2.5 km, South) |
| 11 | Reserved Forest | Nanmangalam Reserved Forest (~40 km, South) |
| 12 | Historically Important Places | Victoria Public Hall (~14 km, South) |
| 13 | Rivers/streams/creeks around the project environs | Kosasthalaiyar, Coovum rivers and Ennore creek in the north |
| 14 | Major Dams and barrages | Nil |
| 15 | Survey of India Topo sheet covering the MPL site and its surroundings | 66C08 |
| 16 | Seismic zone | Zone -III |

Ennore creek north of Manali is rich in biodiversity and fishery resources supporting fishing community of nearby six villages. Manali in North Chennai where MPL is located was once a rich marshland. It is now a highly industrialized area with an assortment of industries in spite of its CRZ-I status (Table 1.2). Assortment of industries such as thermal power plants, ports, container terminals, fishery jetties, ship building/repairing yards, coal terminals, petrochemical industries, oil refineries, fertilizer factories and automobile steel works are located along this coastal stretch. Presence of two major ports for raw material export and import, copious availability of land, ease of effluent discharge in the open sea and easy and cheap availability of labour force has resulted in aggressive industrial development and urbanization in this coastal stretch of Ennore (Table 1.2)

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Table 1.2 Nature of Industries in the Ennore Coastal Belt

| S. No | Industries | Products |
|---|---|---|
| 1 | North Chennai Thermal Power Station (NCTPS) | Around 2000 MW power |
| 2 | Kamaraj Port Limited (KPL) | Handles around 34 MMT during 2018-19 |
| 3 | L&T Ship Building Yard | Mega ship yard catering defence needs |
| 4 | Chettinad International Coal Terminal | Handled 31.5 MMT of cargo during 2019-20 |
| 5 | TECL's Vallur Thermal Power Plant | 3×500 MW |
| 6 | CPCL – Chennai Petroleum Corporation Limited | Oil refinery and supplier of many petroleum feedstock |
| 7 | Ennore Thermal Power Plant | 120 MW 3 x 110 MW |
| 8 | Manali Industrial Estate | Houses many medium and minor industries |
| 9 | Coromandel Fertilizer | Largest phosphate based fertilizers and organic fertilizers and many other agricultural chemicals |
| 10 | Madras Fertilizer Limited | Produces a range of agricultural supplements including fertilizers |
| 11 | Hinduja Foundries | Automobile casting and other steel manufacturing |
| 12 | Ennore SEZ Thermal Power Plant | 1.3 GW coal fired power station |
| 13 | North Chennai Power Company at Katupalli | Coal fired power station, produces 1200 MW |
| 14 | Chennai Power Generation Ltd, Katupalli and Kalanji village | 1320 MW coal fired power stations |

## 1.3 Study Period

Present study was carried out during the post-monsoon month of October 2020. The reconnaissance survey and sample site fixing were carried out during the third week of September 2020 followed by the collection of samples for baseline data through field sampling during first week of October after the culmination of the monsoon. Major parameters of water, sediment, benthic and pelagic communities were gathered as indicated below.

## 1.4 Parameters Studied

Primary data gathering and sampling was carried out for three broad environmental attributes namely water, sediment and biota each containing many parameters as given in the table 1.3 below. The required secondary information was gathered from the office of the MPL, websites of India Meteorology Office, local office of the state fisheries and from different literature sources.

Table 1.3 Parameters studied in and around the MPL Effluent Outfall Point

| Environmental Attribute | Environmental Parameters |
|---|---|
| Water | Temperature, pH, Electrical Conductivity, Total Suspended Solids, Total Dissolved Solids, Salinity, Turbidity, Dissolved Oxygen, Biological Oxygen Demand, Chemical Oxygen Demand, Ammoniacal Nitrogen, Nitrate, Nitrite, Inorganic Phosphate, Oil and Grease, Petroleum Hydrocarbon, Heavy Metals (Cr, Cu, Fe, Mn, Ni, Pb, Zn, Hg), Pesticide residues, Total Coliform, Faecal Coliform |
| Sediment | pH, Sediment Texture, Total Organic Carbon, Oil and Grease, Petroleum hydrocarbon, Heavy Metals (Cr, Cu, Fe, Mn, Ni, Pb, Zn, Hg) |
| Biota | Phytoplankton density, community structure and diversity, Zooplankton density, taxa, biomass, Productivity (Chlorophyll 'a' and 'b'), Benthic fauna-Species/generic composition and Density |

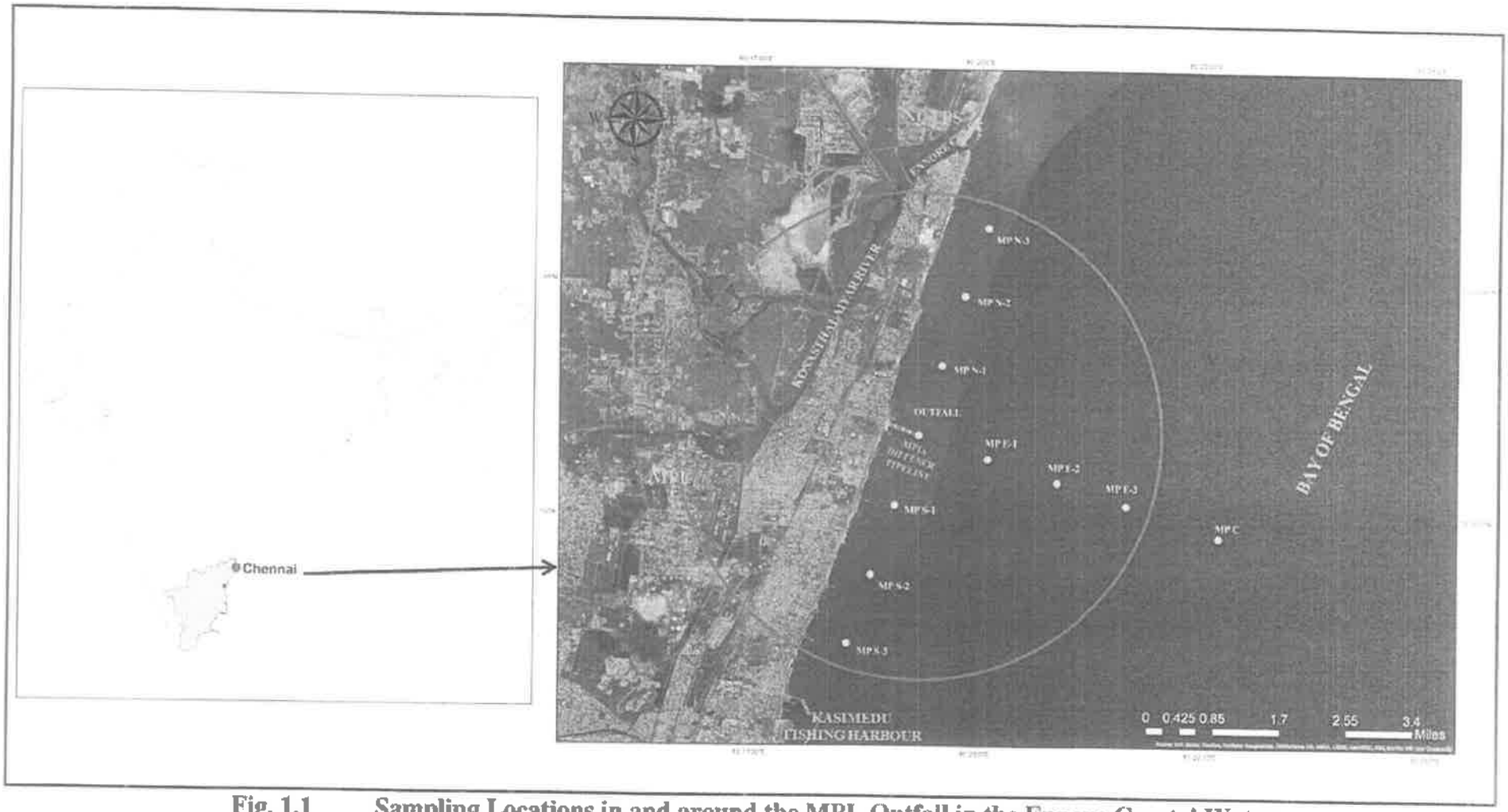


**Fig. 1.1 Sampling Locations in and around the MPL Outfall in the Ennore Coastal Waters**

# 2 Project Approach and Methodology

## 2.1 Macro-level Assessment and Sampling site Delineation

In order to understand the project site and its marine ecosystems in and around MPL outfall point, a reconnaissance survey was carried out in a fishing trawler. Referring appropriate toposheets and GIS imageries, sampling sites were delineated and types of sampling techniques to be employed was decided. Based on this reconnaissance survey, eleven (11) sampling locations in North, East and South of the diffuser point were fixed each with a distance of 1.5 km from each other. Thus, in each direction three sampling locations and a sampling location at the diffuser point and a 'Control' site 2 km east of the last eastern site (MPE-3) were fixed totalling eleven sites in a radius of approximately 6 km from the diffuser point (Table 2.1). In these GPS fixed locations, the parameters listed above in the preceding section were investigated for water, sediment and biological entities.

**Table 2.1 GPS Location of the Sampling locations**

| S. No. | Sampling Sites | GPS References |
|---|---|---|
| 1 | MPC (Control) | 13° 10' 51" 80° 19' 21" |
| 2 | MPO (Diffuser Point) | 13° 11' 35" 80° 19' 42" |
| 3 | MPN1 | 13° 11' 35" 80° 19' 42" |
| 4 | MPN2 | 13° 12' 19" 80° 20' 04" |
| 5 | MPN3 | 13° 13' 04" 80° 20' 27" |
| 6 | MPS 1 | 13° 10' 06" 80° 19' 00" |
| 7 | MPS 2 | 13° 09' 21" 80° 18' 40" |
| 8 | MPS 3 | 13° 08' 35" 80° 18' 19" |
| 9 | MPE 1 | 13° 10' 24" 80° 20' 03" |
| 10 | MPE 2 | 13° 09' 58" 80° 20' 45" |
| 11 | MPE 3 | 13° 09' 31" 80° 21' 27" |

## 2.2 Secondary Information Gathering

Sources such as technical reports, fisheries data from the fisheries department, Government gazette and other research publications were extensively referred to gather information on different aspects of the project domain and the coastal belts of Ennore, Chennai. Detailed discussions were held with the officials of MPL in order to glean all relevant information on the MPL's manufacturing process, ETP and other environment related information. All layout maps and other structural details procured

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from MPI, were thoroughly consulted to understand the project operation from environmental point of view.

### 2.3 Sampling and Analysis of Marine Environmental Variables

#### 2.3.1 Subtidal Habitat

Triplicate samples at 11 subtidal locations in three directions from the diffuser points were gathered using Peterson grab with a covering area of 0.625m$^2$.In total eleven (11) subtidal samples were collected in the GPS locations shown in Table 2.1 and Fig. 1.1. The triplicate benthic samples were pooled together to get a composite collection which was subjected to further analysis and the subtidal faunal density was calculated for 1 m$^2$. The wet sediment was sieved with the sieve of 0.5 mm mesh size for segregating the benthos. The organisms retained in the sieve were fixed in 5-7% formalin and stained further with Rose Bengal solution for easy spotting at the time of sorting. The number of organisms in each grab sample was expressed as number per meter square. All the species were sorted, enumerated and identified to the advanced taxonomic level possible with the consultation of standard literature. The works of Fauvel (1953), Day (1967) were referred for polychaetes; Barnes (1980) and Lyla *et al.* (1999) for crustaceans; Subba Rao *et al.* (1991) and Ramakrishna (2003) for molluses.

#### 2.3.2 Plankton

Phyto and zooplankton samples were collected in the eleven (11)prefixed sampling sites where data on *in situ* water and sediment quality parameters were also collected using standard plankton net with a mesh size of 51 and 125 µm for phyto and zooplankton, respectively (Fig. 2.2). Plankton nets are with a square mouth covering an area of 0.900 cm$^2$ (30cm square mouth) fitted with a flowmeter (Hydrobios). Nets were towed from a moving fishing trawler for 10 minutes and the plankton adhering to the net was concentrated in the net bucket. Plankton soup from the net bucket was transferred to a pre-cleaned and rinsed container and preserved with 5% neutralized formaldehyde. The containers were appropriately labelled. The initial and final flow meter reading was noted down for calculating the amount of water filtered in order to estimate plankton density. One litre of seawater was separately collected for density

estimation in order to counter check density values obtained by the flow meter reading.

Quantitative analysis of plankton (cell count) was carried out using sedgewick-Rafter counting chamber for phytoplankton and a plankton counting chamber for zooplankton. For phytoplankton, one ml of soup added to a Sedgwick counting chamber was observed under an inverted compound microscope. Number of cells present in individual cells of the counting chambers (1/1000) were noted and identified up to generic level and the recorded data were used to calculate density(No/l) using the formula,

$N = n \times v/V$ (where N is the total no/l; n is average number of cells in 1 ml; v is volume of concentrate; V is total volume of water filtered).

For zooplankton quantitative analysis, the sample was again sub sampled by Folssom splitter and a 5 ml soup was analysed for groups and species. Quantitative estimation was made following the same formula mentioned above.

**Chlorophyll 'a' and 'b'**

Water samples for productivity studies (Chlorophyll '*a*') were collected at immediate subsurface level using a clean polyurethane bucket and transferred to amber bottle (500ml) and transported to laboratory in Ice box at 5°C. Samples were filtered using 0.45 µm pore size Millipore filter paper laced with a few drops of $MgCO_3$. The filter paper with the filtrate was crushed with 90% acetone and stored in dark condition for 24 hrs. This sample was crushed again, centrifuged at 3000 RPM and the absorbance of the supernatant was measured at 645 and 750 nm in a spectrophotometer.

### 2.3.3 Faecal Coliform

Faecal Coliform was studied by MPN test for quantification. Serially diluted samples were inoculated into the fermentation tubes then incubated at 37°C. The tubes were observed at the end of 24 and 48 hours for the production of gas. The possible presence of coliform group bacteria is confirmed by tubes showing gas production and recorded as positive in the presumptive tubes. The presumptive tubes are then transferred to EC broth fermentation tubes to confirm the presence of fecal coliform

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bacteria. The final count was made with the help of standard chart for MPN test and the unit is expressed as MPN/100 ml.

### 2.3.4 Water Quality

Triplicate water samples were collected from each pre-designated sites shown in table 2.1in a pre-cleaned polyethylene bottles and the collected samples were stored in an ice box and transferred to laboratory and refrigerated at 4°C till further analysis. The analysis of the water quality parameters was carried out following the method of APHA (2017). All extracting reagents were prepared using metal-free, Analar grade chemicals using double distilled water. Room temperature was 29°C while extractions were carried out.

**Temperature:** Temperature was recorded using a mercury thermometer with an accuracy of ±0.1°C.

**pH:** pH was measured using a microprocessor-controlled pH analyser. The instrument was calibrated with standard buffers before use.

**Total Suspended Solids (TSS):** Hundred (100) ml of surface water was filtered through a pre-weighed0.45-micron membrane filter paper (Millipore), dried and weighed again. The difference between these two weight gave the total suspended solids extrapolated to one litre.

**Turbidity:** Turbidity was measured in a calibrated Nephelometer (Hanna make) and the results were expressed in Nephelometer Turbidity Unit (NTU).

**Salinity:** A suitable volume of the sample was titrated against silver nitrate (25g/l) with potassium chromate as an indicator. Standardization of silver nitrate was done using standard seawater (IAPSO, OSIL, UK).

**DO and BOD:** DO was determined by Winkler's method. For the determination of BOD, direct unseeded method was employed. The sample was taken in a BOD bottle in the field and incubated in the laboratory for 3 days at 27°C after which DO was again determined. The difference between the two readings is considered as the BOD of the given sample.

**Chemical Oxygen Demand (COD)**

The COD of the samples were determined by open reflux method for 2 hrs as described by Saxena (1994). This was performed by digesting the sample in COD digester with $K_2Cr_2O_7$ and sulphuric acid followed by titration against Ferrous ammonium sulphate with Ferroin as an indicator. The end point was indicated by change of colour from bluish green to reddish brown. Simultaneously, distilled water blank was performed in order to ascertain the veracity of the results.

**Phosphate:** Acidified molybdate reagent was added to the sample to yield a phosphomolybdate complex that was then reduced with ascorbic acid to a highly coloured blue compound. This compound was measured at the wavelength of 690 nm in spectrophotometer (Shimadzu UV 5040).

**Nitrite:** Nitrite in water sample was allowed to react with sulphanilamide acid solution. The resulting diazo compound was reacted with N – 1-Naphthylethylenediaminedihydrochloride to form a highly coloured azo-dye. The light absorbance was measured at the wavelength of 543 nm in spectrophotometer (Shimatzu UV 5040).

**Nitrate:** Nitrate was determined as nitrite (as mentioned above) after its reduction bypassing the sample through a column packed with amalgamated cadmium.

**Ammonia:** Ammonium compounds ($NH_3$, $NH_4^+$) in water were reacted with phenol in presence of hypochlorite to give a blue colour of indophenol. The absorbance was measured at the wavelength of 630 nm in a spectrophotometer (Shimatzu UV 50400).

**Total nitrogen:** Nitrogen compounds in the sample were oxidized to nitrate by autoclaving with alkaline per sulphate. The solution was neutralized and nitrate was estimated and described as total nitrate.

**Petroleum Hydrocarbons (PHc):** Water sample (2.5 l) was extracted with hexane and the organic layer was separated, dried over anhydrous sodium sulphate and reduced to 10 ml at 30°C under low pressure. Fluorescence of the extract was measured at 360 nm (excitation at 310 nm) with Saudi Arabian crude residue as a standard. The residue was obtained by evaporating lighter fractions of the crude oil at 100°C.

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**Oil and grease (mg/l)**

The oil and grease content in the samples were estimated by gravimetric method. About 500 ml of the sample was taken and extracted with petroleum ether or hexane and gravimetric determination of oil and grease content of the water samples were performed by taking initial and final weight of the container after drying it in the oven at specified temperature.

**Phenols:** Phenols in water (500 ml) were converted to an orange coloured antipyrine complex by adding 4-aminoantipyrine solution. The complex was extracted in chloroform (25 ml) and the absorbance was measured at 460 nm using phenol as a standard.

**Heavy metals**

About 100 ml of the sample was digested with triple acid mixture comprising nitric acid, sulphuric acid and perchloric acid in a ratio of 9:3:1 and kept in a hot plate overnight. Then the residues formed in the samples were analyzed for heavy metals with their respective standards and the concentrations were determined in an Atomic Absorption Spectrophotometer (Perkin-Elmer-AAS 200).

**Pesticide Residues**

Pesticides from a unit of seawater were extracted using Solid-Phase Micro Extraction (SPME) method. Standards and reagents such as chlorinated pesticide mixture and monocrotophos standards, methanol and acetonitril (HPLC grade) were purchased and analytical grade reagents such as perchloric acid, sodium hydroxide, tert-butanol and iso-propanol were used for the analysis. Pesticides were analysed us in a gas chromatograph (6890 N series, Agilent Technologies, Palo, CA, USA) equipped with ECD (63Ni) and split/splitless injector.

### 2.3.5 Sediment Quality

Sediment analyses were carried out using standard methodologies. Sediment samples were collected in the eleven (11) prefixed stations. In each station, sediments were collected from three different locations using a Van Veen grab. Collected samples were pooled together to make a composite sample which represent that particular site. Collected samples were stored in a sterile, black polythene bag at 4°C in an icebox to

avoid possible bio leaching of metals by microbes. The collected samples were air dried and used for further analysis.

**Sediment Texture**

For sediment texture analysis, specified unit of sediment was sieved using sieves of different mesh size as per USCS. Cumulative weight retained in each sieve was calculated starting from the largest sieve size and adding subsequent sediment weights from the smaller size sieves. The percent retained was calculated from the weight retained and the total weight of the sample. The cumulative percent was calculated by sequentially subtracting percent retained from 100%.

**Total Organic carbon**

Percentage of organic carbon in the dry sediment was determined by oxidizing organic matter in the sample by chromic acid and estimating excess chromic acid by titrating against ferrous ammonium sulphate with ferroin as an indicator.

**Petroleum Hydrocarbon-PHc**

For estimating Petroleum hydrocarbon (PHc) in the sediment, the sample was reflexed with KOH-Methanol mixture and extracted with hexane. After removal of excess hexane, the residue was subjected to silica gel chromatography. PHC and the florescence was estimated at 360 nm.

**Heavy Metals**

Sediment was brought into solution by treatment with conc. HF-$HClO_4$-$HNO_3$-HCl and the metals were estimated on a Perkin Elmer AAS 200. Mercury was estimated by flameless AAS technique after digesting the sediment with aquaregia followed by oxidation with $KMnO_4$, Sodium borohydride was used as reductant.

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# 3 Coastal Environmental Status

## 3.1 Introduction

Coastal area is the most dynamic and productive ecosystems attracting human settlements, industries and tourism. Thus, the environmental wellbeing of the coastal waters plays a vital role in the overall social, economic and environmental wellbeing of coastal communities and the country. Natural processes and human activities play a major role in determining the quality of the coastal waters. Increasing maritime activities and usage of coastal zone as an area of habitation and development due to the copious availability of water and ease of waste disposal has rendered coastal waters highly vulnerable to pollution. Marine water quality has become a matter of serious concern because of its effects on human health and aquatic ecosystem including marine life (Gupta et al., 2009). This chapter presents the results of the study carried out on the water and sediment quality and biota such as subtidal fauna, plankton and productivity in and around the marine outfall location of the MPL at Ennore coastal waters of Chennai. The major focus of this study is to assess the present coastal water health and the impact caused due to MPL activity in order to formulate appropriate remedial management practices.

Sampling location, regimen and method of analysis of this study is presented in the previous chapters.

## 3.2 Results

In the present investigation, nineteen (19) parameters in the surface waters, six (6) parameters in sediment and five crucial biological parameters were analyzed. In water and sediment quality, occurrence, range and source and ecological and environmental significance of analyzed parameters are indicated in the table 3.1 and in the following section.

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### 3.2.1 Water Quality

Coastal water quality characterized in terms of nineteen physical and chemical parameters of the surface water collected at the MPL outfall location is presented below:

**Water Temperature**

Water temperature is a fundamental factor for water quality as it mediates numerous chemical and biological processes of the environ. In the eleven study stations, water temperature varied from 28.4°C to 30.2°C with a mean of 28.92°C (Table 3.2).

**Hydrogen Ion Concentration (pH)**

The pH of a healthy marine water is usually quite stable and alkaline and ranges between 7.5 to 8.5. Water pH in the eleven sampling locations varied from 7.9 to 8.1 with a mean of 8.03 (Table 3.2). Recorded values are well within the limits and did not show any abnormality. Values at 'Control' was marginally higher than the other sampling locations and the 'Outfall' station.

**Total Suspended Solids (TSS)**

Suspended solids in seawater originate either from human activities in the near coastal environment or from natural processes such as erosion, planktonic suspension and others. Physical factors such as wave and tidal action, depth and sediment budget of the coast also influences TSS.

The TSS in the eleven sampling sites varied from 17.2 to 39 mg/l with a mean value of 26.8 mg/l indicating that background suspended load is low and TSS levels do not interfere with the primary productivity of the water column. (Table 3.2).

**Total dissolved Solids (TDS)**

The total dissolved solids (TDS) in water consist of inorganic salts and dissolved materials. In natural coastal waters, salts are chemical compounds comprised of anions and cations which contribute to the TDS of the seawater. Normal seawater has a TDS content of approximately 35,000 mg/l. Values of TDS recorded in the eleven stations

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fluctuated rather moderately. Likewise, recorded TDS values were lower than the normal seawater levels possibly due to impact of the just concluded monsoon.

A minimum TDS value of 20.3 g/l and a maximum of 28.13 g/l with the mean of 24.84 g/l was recorded in the eleven sampling stations (Table 3.2). The station MPE-1 recorded much lower value (20.3 g/l) than other stations. Value recorded at 'Outfall' was comparatively lower (24.89 g/l) than many stations including 'Control'.

**Salinity**

Water salinity profoundly influences the abundance and distribution of the biota in coastal, marine and estuarine environments. In the present study, values of salinity showed minimum of 21.6 ppt and a maximum of 27.7 ppt in the eleven sampling stations with a mean value of 24.81 ppt (Table 3.2). Salinity values recorded at the three sampling stations in the south (MPS-1-3) were much lower than that of other stations. Recorded values were lower than the normal background seawater salinity of 35 ppt probably due to the just concluded monsoon season.

**Turbidity**

Turbidity was below detectable limit (BDL) at stations such as MPN-2, MPN-3, MPS-2 and MPS-3 In the rest of the stations, the measured turbidity varied from 0.6 to 1.8 NTU with an average value of 1.06 NTU (Table 3.2). Recorded turbidity values were lower and did not vary significantly among stations, indicating that the water mass is very clear, thoroughly mixed and homogenous in nature. Highest levels of turbidity were recorded at MPS-1 and turbidity levels at 'Outfall' was below detectable limits.

**Dissolved Oxygen**

Due to tide and wind induced turbulence, the coastal waters are normally rich in DO unless altered by some anthropogenic or natural processes. Variation in the DO in the eleven sampling locations was from 4.15 to 5.62 mg/l with a mean of 4.52 mg/l (Table 3.2).

Shallowness of the water column, rainfall in the immediate past and freshwater input, wind velocity and direction are some major factors that enhance dissolved oxygen levels significantly.

**Biological Oxygen Demand (BOD)**

Biological Oxygen Demand indicates the extent of oxygen utilization during a specified incubation period for the biochemical degradation of organic matter. It is also a good health indicator of coastal waters as values above 3 ml/l indicates the extent of pollution.

BOD levels were below detectable limits at all the eleven sampling stations indicating good health of this coastal water and very less organic enrichment in the study locations (Table 3.2).

**Chemical Oxygen Demand (COD)**

Chemical Oxygen Demand stands for the amount of oxygen required to oxidize dissolved and particulate matter and is a practical measure of organic contamination. In other words, COD is a measure of oxygen requirement of a sample that is susceptible to oxidation by strong chemical oxidant.

Similar to the values of BOD, the values of COD were very much lesser than the standard value of 250 mg/l and ranged from 7 mg/l to a maximum of 17 mg/l with a mean of 12.8 mg/l (Table 3.2). Recorded COD values were well within the prescribed limits of different statutory bodies and indicates the good healthiness of the studied water body.

**Ammoniacal Nitrogen**

Levels of Ammoniacal Nitrogen in all the eleven stations were below detectable limits without exception (Table 3.2).

**Nitrate- $NO_3$**

As a vital nutrient, levels of nitrate ($NO_3$) determine the productivity of the water and indirectly influences many biotic processes. Nitrate as a limiting nutrient in the coastal waters ranged from 1.86 to 2.88 mg/l with an average value of 2.4 mg/l. Levels at the

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'Outfall' was much lower than the 'Control' stations (Table 3.2). Recorded values are normal for any coastal waters and do not indicate any state of eutrophication.

**Nitrite-$NO_2$**

Occurrence of nitrite ($NO_2$) at a minimum level of 0.01 mg/l was recorded only in two sampling stations (MPN-1, MPC) out of the eleven sampling locations. In other stations it was below detectable limits (Table 3.2).

**Inorganic Phosphate**

Inorganic Phosphate was recorded in seven (7) sampling stations only. In the stations where it was recorded the levels ranged from 0.02 to 0.37 mg/l. Level at the 'Outfall' station was 0.28 mg/l and at the 'Control' it was 0.02 mg/l (Table 3.2).

**Petroleum Hydrocarbon, Oil and Grease**

Similar to sediment, PHC, oil and grease were below detectable limit in the coastal waters of Ennore in all the sampling stations (Table 3.2). High turn-over time and carrying capacity could be the reason for this absence of PHC.

**Heavy Metals**

In the present study, eight (8) crucial heavy metals that are environmentally important were analyzed. All the eight heavy metals were below detectable limits in the eleven sampling stations, indicating that the study area is not polluted by heavy metals (Table 3.2).

**Pesticide Residues**

For pesticide residues, thirty (30) fractions of pesticides were analyzed and all were below detectable limits (Table 3.2).

**Total Coliform**

Total coliform in the sampling locations ranged from 34 to 80 MPN/100 ml with an average value of 47 MPN/100 ml (Table 3.2). The recorded values were much below the prescribed limits by statutory agencies and do not pose any health issues.

**Faecal Coliform**

Faecal Coliform ranged in levels from 11 to 35 MPN/100 ml at 'Control' and 'Outfall' stations, respectively. This recorded values of faecal coliform is far lower the CPCB prescribed limits of 100 MPN/100 ml (Table 3.2) for bathing and commercial fishing purposes for Seawater Quality standard II.

**Table 3.1 Range, Source and Ecological Significance and conformation to environmental standards of the Water Quality Parameters in Eleven Sampling locations at the MPL Outfall Point**

| Parameters | Range and Average | Source | Ecological Significance | Standard Values |
|---|---|---|---|---|
| Temperature-°C | 28.4- 30.2°C (28.92°C) | Natural sources such as sunlight and human sources such as coastal thermal power plants and other industries releasing hot water from their coolant system. | Exerts great influence on aquatic system-influences biological, chemical and physical activities and dissolved oxygen; Influenced by depth, season, tidal mixing, wind, storms, amount of freshwater and water column stratification. Influence the physico-chemical characteristics and distribution and abundance of flora and fauna in the aquatic environment. | |
| pH | 7.9-8.1 (8.03) | Uptake of $CO_2$ by photosynthesizing organisms and release of chemicals from the coastal industries. | Decrease or increase alter marine environment drastically; best indicators to find out zones of pollution. | 6.5-8.5* |
| TSS-mg/l | 17.2-39 (26.8) | Autochthonous (biological) or allochthonous (terrestrial matter) sources; coastal developmental activities, terrestrial run-off, etc. | Influences photosynthesis and thereby the productivity of the water column and fisheries; wind direction and force and terrestrial input determines suspended solids in the coastal waters other than the ongoing anthropogenic activities. | 25 mg/l maximum |
| TDS-g/l | 20.3-28.13 | Natural occurrence in seawater and some anthropogenic sources such as salt works, industrial and urban effluents | Exerts very high influence on physiology, metabolism and ecological functions of marine organisms; reproduction, feeding and species distribution are greatly influenced | -- |
| Salinity-ppt | 21.6-27.7 (24.8) | Natural occurrence in seawater and some anthropogenic sources such as salt works | Exert very great influence on the abundance and distribution of biota; alters physiology, reproduction, spatial distribution and other metabolic activities | -- |
| Turbidity-NTU | 0.6-1.8 (1.06) | Anthropogenic (coastal industries) and natural sources (river run-off, erosion, plankton and other suspended materials) | Controls photosynthesis and productivity and biomass as it attenuates penetrating light. | 30 NTU* |
| DO-mg/l | 4.15-5.62 (4.25) | Photosynthesis and respiration of aquatic flora and fauna | Most important life supporting dissolved gas for the survival of aquatic biota-basis for respiration and body metabolism. | 3* mg/l or 40 percent saturation value. |
| BOD-mg/l | BDL | Predominantly human; coastal organic industries, urban sewage | Index of pollution- indicates extent of biodegradable organic matter content; has the capacity to alter species diversity if it increases beyond a limit. | -- |
| COD-mg/l | 7-17 (12.8) | Coastal industries | Indicates levels of organic contamination and measure of oxygen required to oxidize contaminants | 250 mg/l or less |
| Amm.Nitro- | BDL | River run-off, storm water, | Indicates health of aquatic environment | 50 mg/l |

| Parameters | Range and Average | Source | Ecological Significance | Standard Values |
|---|---|---|---|---|
| µmol/L | | agricultural run-off | | |
| Nitrate-µmol/L | 1.86-2.88 (2.4) | Terrestrial run-off; sewage enrichment, organic effluents from coastal industries | Final oxidation product of nitrogen compounds; very important micronutrient; controls primary production; governed by microbial oxidation of $NH_3$ and uptake by primary producers | (maximum) 10 mg/l |
| Nitrite-µmol/L | 0.01 | Terrestrial run-off; sewage enrichment, organic effluents from coastal industries | Important nutrient in determining productivity and thereby fishery resources of the coastal region. | -- |
| Inorg.Phos-µmol/L | 0.02-0.37 | land run off and domestic sewage. | Important nutrient next to nitrate; major role in the primary production of the sea. | -- |
| Oil and Grease-mg/l | BDL | Mostly anthropogenic, discharge of lubricating oil, motor oils, municipal, industrial, automobile discharges. | Physiological impairment, smothering, impairment of embryonic development, reduced dissolved oxygen levels, feeding disturbances | No oil and grease film on the surface |
| Petroleum Hydrocarbon-PHC | BDL | Land run-off, oil refineries and other petrochemical industries, automobiles, industrial processes. | Non-essential element for biota; major pollutant in the marine environment due to shipping; impacts general wellbeing of the aquatic biota; interferes with the reproduction and feeding of aquatic organism. | 0.1 mg/l |
| Chromium-µg/L | BDL | Atmospheric fallout and precipitation, electroplating, leather, textile, metallurgic and chemical industries | Highly hazardous to all aquatic life; impairs nervous system, reproduction and other vital metabolic activities | 0.1[@] |
| Cadmium-µg/L | BDL | Weathering and erosion and transport by rivers; volcanic activity and natural fallout, electroplating, plastic, glass, smelting industries. | Non-essential trace metal; toxic to wide range of aquatic organisms; impairs growth and reproduction and other metabolic activities | 33[@] |
| Copper-µg/L | BDL | Weathering, agriculture run-off, atmospheric fallout, industrial effluents | Essential trace metal for metabolism and normal growth, but detrimental at high concentration. | 3 mg/l |
| Iron-µg/L | BDL | Abundant in natural soils and sediments | Essential trace metal and micronutrient for all aquatic organisms for normal physiological functions; influences biogeochemical cycle of many heavy metals; a limiting agent for primary production. | 0.5 mg/l or less* |
| Manganese-µg/L | BDL | Earth crust, forest fire, volcanic activities, vegetation and some industrial activities | Essential trace element; plays key role in forming oxygen during photosynthesis of plankton; crucial for growth, metabolism and survival of aquatic organism | 0.5 mg/l or less* |



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| Parameters | Range and Average | Source | Ecological Significance | Standard Values |
|---|---|---|---|---|
| Nickel-µg/L | BDL | Natural and anthropogenic in source; smelting, coastal mining, fertilizer industries, Urban sewage | Non-essential and toxic heavy metal to aquatic fauna, interfere with embryonic development, impairs nervous system and respiration | -- |
| Lead-µg/L | BDL | Natural processes such as weathering, erosion, Industrial activity inland and coastal belt, automobile emissions. | Non-essential heavy metal; pose major threat to aquatic organism; no biological function; interferes in embryonic development, breeding, spawning, growth and other reproductive activities, acutely toxic to bottom living organisms. | 5.6µg/L[@] |
| Zinc-mg/L | BDL | Atmospheric fallout, effluents of mining, fertilizer industry, paints, agricultural run-off | Essential for metabolism and many body functions; toxic beyond a limit | 0.01 mg/l |
| Mercury-mg/l | BDL | Coal combustion, electricity generation, industrial effluents, Natural weathering, volcanic activity | Non-essential heavy metals and most toxic even at low concentration; impairs breeding, spawning, reproduction, feeding behaviours; disrupts neurological functions | 0.01 mg/l |
| Pesticide | BDL | Agricultural and other terrestrial run-off, pesticide industries | Highly toxic to marine organisms; impairs reproduction, embryonic development, causes direct mortality in many invertebrates in excess levels | -- |
| Total Coliform | 34-80 MPN/100 ml | Sewages and other non-point sources | Pathogenic and leads to health issues to human and some aquatic organisms | -- |
| Faecal coliform | 11-35 MPN/100 | Sewages, municipal discharges and other non-point sources | Pathogenic and leads to health issues to human and some aquatic organisms | 100 MPN/100 ml |

**Standard fixed by TNPCB for SW-III (Industrial Cooling, Recreation and Aesthetics);*

*@ USEPA standards*

***Range and average given is for the present study.***

**Table 3.2 Water Quality in the eleven sampling locations in and around MPL Outfall**

| Parameters | MPN-1 | MPN-2 | MPN-3 | MPS-1 | MPS-2 | MPS-3 | MPE-1 | MPE-2 | MPE-3 | MPC | MPO | Standard |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature-°C | 28.5 | 28.5 | 28.6 | 28.4 | 28.5 | 28.5 | 29.1 | 29.2 | 30.1 | 30.2 | 28.5 | -- |
| Conductivity-ms/cm | 43.06 | 42.64 | 42.92 | 36.85 | 35.99 | 35.13 | 34.41 | 40.81 | 38.70 | 41.52 | 36.70 | -- |
| pH | 8.1 | 8 | 8 | 7.9 | 8 | 8 | 8 | 8.1 | 8.1 | 8.1 | 8 | 6.5-8.5 |
| TDS-g/l | 28.13 | 23.94 | 28.02 | 24.01 | 23.52 | 22.73 | 20.3 | 26.63 | 23.93 | 27.09 | 24.89 | -- |
| TSS-mg/l | 33 | 34.4 | 26 | 19 | 32.8 | 17.2 | 19.4 | 39 | 20 | 19.2 | 34.8 | |
| Salinity-PSU | 27.7 | 27.4 | 27.6 | 23.3 | 22.7 | 22.1 | 21.6 | 26.1 | 24.6 | 26.6 | 23.2 | -- |
| Turbidity-NTU | 0.7 | BDL | BDL | 1.8 | BDL | 1.2 | 1.1 | 1 | BDL | 0.6 | BDL | 30 NTU or less |
| DO-mg/l | 5.62 | 4.72 | 4.49 | 4.15 | 4.37 | 4.05 | 4.27 | 4.49 | 4.49 | 4.94 | 4.15 | 4 mg/l or more |
| BOD-mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 30 mg/l or less |
| COD- mg/l | 17 | 14 | 9 | 17 | 9 | 13 | 16 | 15 | 7 | 10 | 14 | 250 mg/l or less |
| Amm.Nitro- mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | -- |
| Nitrate- mg/l | 2.8 | 2.88 | 2.46 | 2.75 | 1.86 | 2.55 | 2.15 | 1.9 | 2.32 | 2.71 | 2.05 | 10 mg/l or less |
| Nitrite- mg/l | 0.01 | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.01 | BDL | 10 mg/l or less |
| Inorg. Phos- mg/l | 0.37 | 0.06 | BDL | BDL | BDL | 0.17 | BDL | 0.08 | 0.02 | 0.02 | 0.28 | 0.1 mg/l or less |
| Oil and Grease- mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | -- |
| PHe- mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | -- |
| Chromium- mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.1 mg/l |
| Copper- mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.02 mg/l |
| Iron- mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.1 mg/l |
| Manganese- mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.1 mg/l |
| Nickel- mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.1 mg/l |
| Lead- mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.1 mg/l |
| Zinc- mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.1 mg/l |
| Mercury- mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | 0.1 mg/l |
| Pesticide- mg/l | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | -- |
| Total Coliform-MPN/100 ml | 34 | 38 | 51 | 56 | 53 | 44 | 49 | 37 | 40 | 36 | 80 | |
| Faecal Coliform-MPN/100 ml | 12 | 17 | 16 | 20 | 16 | 19 | 17 | 17 | 12 | 11 | 35 | |

***Ammoniacal Nitrogen BDL- 0.05 mg/l; Nitrite BDL-0.001 mg/l; Inorganic Phosphate BDL- 0.01 mg/l; BOD BDL- 2 mg/l; Turbidity BDL-0.5 NTU***

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### 3.2.2 Sediment Quality

Sediments at the bottom of the water column in the coastal waters are more susceptible to pollutant enrichment which are often highly variable in their concentration. Water borne pollutants settle down in the sediment and get incorporated into the organic matters and finally settle at the sediment.

The contaminant levels of different pollutants in the sediment are much reliable pollution indicators. In view of this, physical and chemical quality of sediments in the eleven (11) sampling locations were analyzed in order to delineate the impact of the MPL effluents. The proceeding section presents the results of the investigation of six (6) parameters in the bottom sediments collected from the eleven sampling locations in and around MPL outfall point.

**Hydrogen Ion Concentration (pH)**

As a major parameter, pH influences mobility and impact of pollutants such as heavy metals and numerous other biological and chemical processes in the coastal waters.

The bottom sediment in the study stations were alkaline in nature and hydrogen Ion Concentration (pH) varied from 8.9 to 9.6 in all eleven sampling stations with an average value of 9.1 (Table 3.3). The lowest level of 8.9 was recorded at the `Outfall` point and the highest level of 9.6 was at `Control`. Recorded values of pH are normal and did not indicate and pollution.

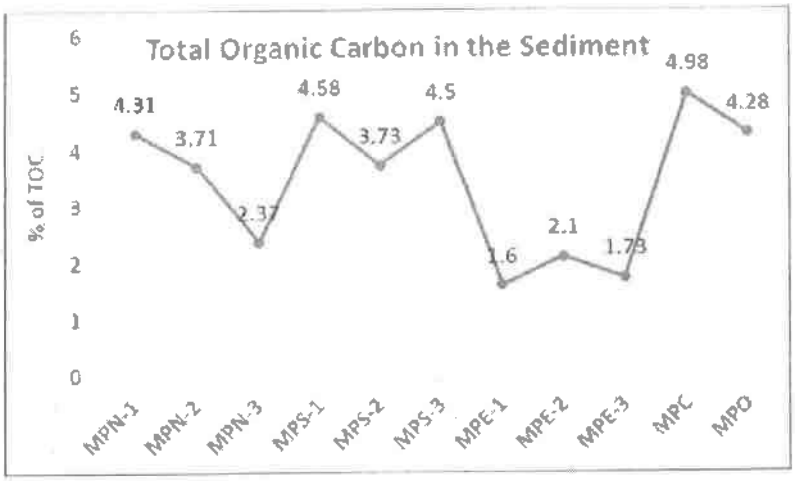
**Total Organic carbon (TOC)**

Total Organic Carbon (TOC) refers to the amount of organic matter preserved within the sediment. Organic load in the sediment is determined by the amount of organic matter reaching the sediment and its degradation rate by the microbial organisms.

In the eleven sampled locations in the vicinity of MPL outfall, TOC concentration ranged from 1.6 to 4.98% with a mean value of 3.44% (Table 3.3; Fig. 3.1). Recorded levels of

TOC do not indicate any environmental degradation as these levels are common in estuarine mouths and other coastal regions influenced by river run-off.

**Fig. 3.1. Total Organic Carbon in the Sediment**




**Petroleum Hydrocarbons (PHC), Oil and Grease**

Levels of Petroleum hydrocarbon, oil and grease in all the eleven sediment samples were Below Detectable Limits (BDL) in spite of heavy vessel movements and presence of four major ports in Ennore-Manali coastal stretch (Table 3.3). This could be due to the quick turnover time of the water mass in the Ennore-Manali coastal belt.

**Heavy Metals**

Physical factors such as nature, texture, adsorption and retention capacity of the sediment determines the metal concentration in sediment other than the degree of input. Sediment metal enrichment is related to the removal of metal from the overlying water by terrestrial organic matter, which eventually becomes incorporated into the bottom sediment. Levels of different metals analysed during the present study is as follows.

**Chromium (Cr)**

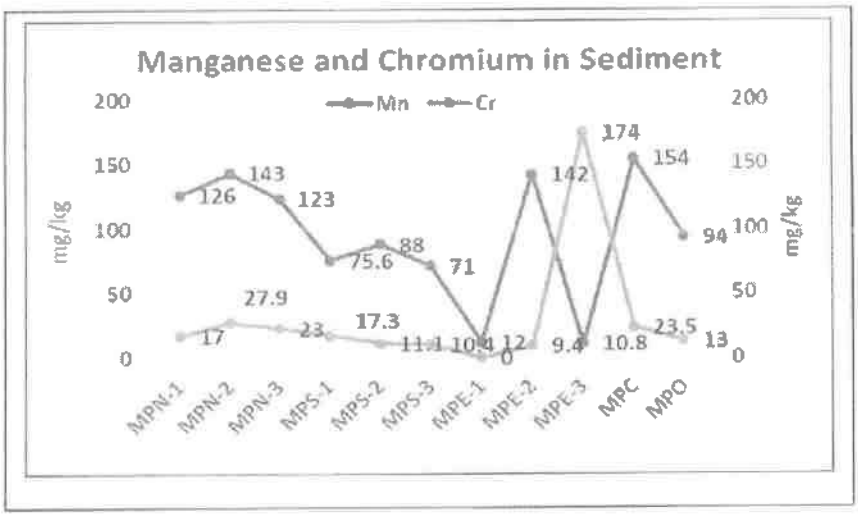
Chromium is a non-essential metal and toxic to aquatic life. Levels of Chromium in the eleven sediment samples ranged from 9.4 to 174 mg/kg at MPE-2 and MPE-3 (Table 3.3; Fig. 3.2) with an average value of 32.66 mg/kg. Recorded levels of Chromium seems to

represent background levels as similar values have been reported in many coastal belts of India and other in other foreign waters.

**Manganese (Mn)**

Manganese levels in the eleven sediment samples ranged widely between 10.8 and 154 mg/kg with an average value of 94.5 mg/kg (Fig. 3.2). Control station recorded the highest value of 154 mg/kg whereas at the 'Outfall' it was 94 mg/kg. Values at 'Outfall' did not differ much from other impacted stations and much lower than the 'Control' station.

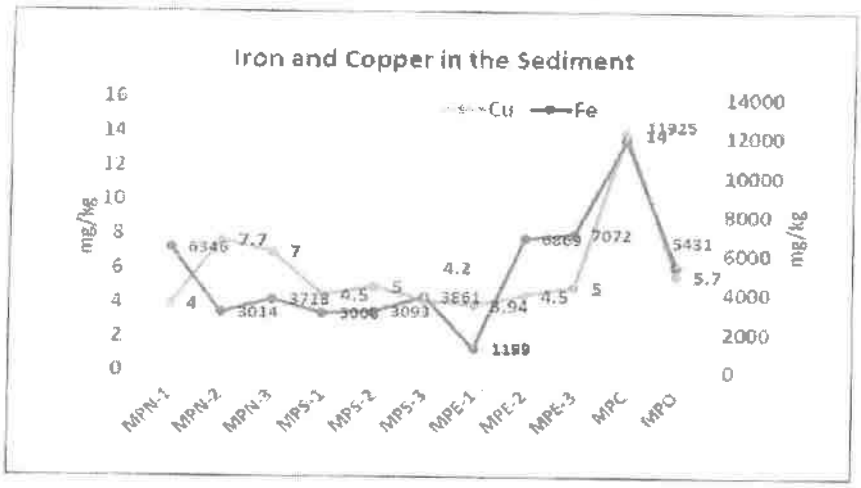
**Fig. 3.2 Concentration of Manganese and Chromium in the sediment**




**Copper (Cu)**

Copper is an essential metal for respiration and other vital metabolic activities. Levels of Copper in the eleven sediment samples ranged from 3.94 to 14 mg/kg in all the stations with an average value of 5.95 (Table 3.3; Fig. 3.3). 'Control' station recorded the highest copper value of 14 mg/kg whereas the lowest value of 3.94 mg/kg was at MPE-1. Values at the 'Outfall' station (5.7 mg/kg) was much lower than the 'Control' station.

Fig. 3.3 Concentration of Iron and Copper in the Sediment




**Iron (Fe)**

Iron is an essential element for many metabolic activities. Levels of Iron in the sediment samples ranged very widely from 1199 to 11925 mg/kg in all the stations with an average value of 5048.7 mg/kg (Table 3.3; Fig. 3.3). 'Control' station recorded the highest value (11925 mg/kg) whereas the lowest value was recorded at MPE-1. Value at 'Outfall' was 5431 mg/kg which was much lower than the 'Control'.

**Nickel (Ni)**

Nickel in the sediment did not vary much among stations and ranged from 3.1 to 10 mg/kg in all the eleven stations (Table 3.3; Fig. 3.4) with an average value of 5.54 mg/kg. Nickel level at the 'Control' was the highest (10 mg/kg) than the impacted stations. The 'Outfall' station recorded a value of 4.4 mg/kg which was much lower than the 'Control' and average value.

**Lead (pb)**

Levels of Lead in the sediment samples ranged from 3.5 to 21.8 mg/kg in all the eleven stations with an overall average value of 7.39 mg/kg (Table 3.3; Fig. 3.4). Station MPS-2 had highest level of 21.8 mg/kg. The 'Control' station had a value of 7.8 mg/kg which is comparatively higher than the value (4.6 mg/kg) recorded at the 'Outfall' station.

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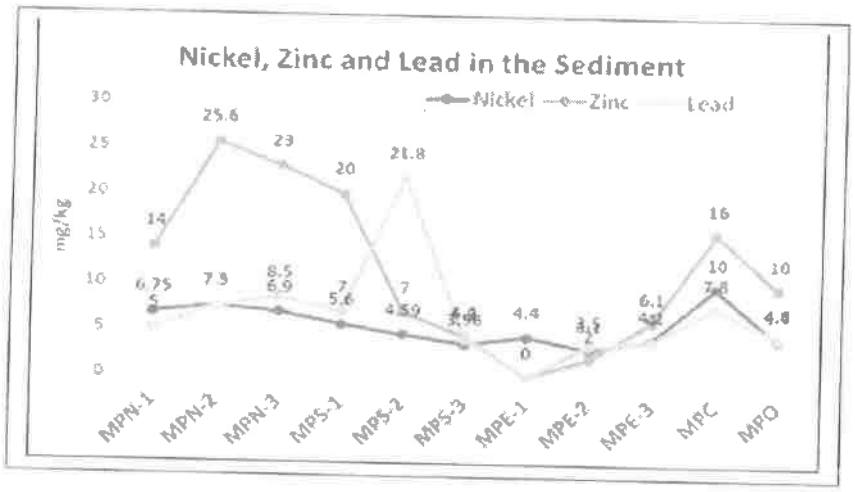
**Zinc (Zn)**

Zinc levels in the sampled stations ranged from 2 to 25.6 mg/kg with an average value of 12.81 mg/kg (Table 3.3; Fig. 3.4). Sampling stations in the east (MPE-1-3) recorded far lower values than the other stations. The 'Control' station had a value of 16 mg/kg which is higher than the value of 10 mg/kg recorded at 'Outfall' station.

**Fig. 3.4 Nickel, Zinc and Lead Concentration in the Sediment**




**Mercury (Hg)**

Levels of Mercury in the sediments of eleven stations were not detectable with all the stations recording Below Detectable Levels (Table 3.3). No gross contamination of mercury could be observed in the study stations.

**Pesticide Resides**

Analysis of samples collected from the eleven sample locations did not reveal presence of any pesticide fractions in any of the stations apparently due to the absence of agricultural activities in the terrestrial region (Table3.3).

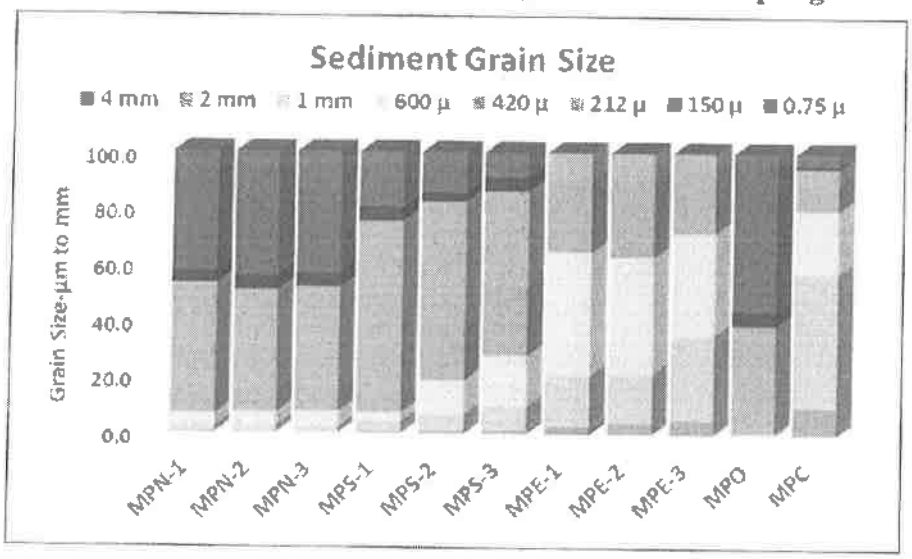
**Sediment Texture**

Grain size analysis is important in classifying the sediment environment. Grain size is a powerful tool for describing a site's geomorphic setting, interpreting the geomorphic

significance of fluid dynamics in the natural environment, and distinguishing local versus regional sediment transport mechanisms. It is a dominant controlling factor in sediment geochemistry.

Percentages of eight (8) sediment fractions ranging from 0.75 µm to 4 mm are shown in Table 3.4 and Figure 3.5. Bottom sediment in the vicinity of MPL outfall point are mostly composed of fine fractions. Composition of sediment in the eleven sampling locations showed two distinct compositions. Near coastal stations in the north and south of 'Outfall' station showed a qualitative shift in substrate nature and composition from those of the stations towards open waters in the east. In the near coastal stations (MPN and MPS) fractions of 212 and 0.75 µm grain size predominated whereas in the stations towards east in the open coast, sediment is composed mostly of coarser grain sizes of 1 and 4 mm except at the 'Outfall' where sediment was mostly composed of 0.212 and 0.75 µm fractions. This could be due to natural processes like prevailing littoral currents and other physical factors locally prevailing in the 'Outfall' station. Intense dredging activities by different ports and harbors in the vicinity could also contribute to drastic change the bottom sediment composition.

**Fig. 3.5 Grain Size Analysis of Sediments in the Sampling locations**



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Recorded levels of heavy metals in the sediments of MPL outfall location in Ennore waters indicate no gross contamination and represent natural background levels. Values of heavy metals recorded at 'Outfall' station were much lower than the 'Control' station implying that the benthic (sediment) habitat in and around the MPL Outfall is not contaminated very much. In the sediment, metals such as mercury, Oil, grease and Petroleum hydrocarbon in the sediment very below detectible limits in all the stations.

Table 3.3 Sediment Quality in the eleven stations in and around MPL Outfall

| Parameter | MPN -1 | MPN 2 | MPN -3 | MPS -1 | MPS -2 | MPS -3 | MPE -1 | MPE -2 | MPE -3 | MPC | MPO | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 8.9 | 8.9 | 9.0 | 8.9 | 9.1 | 9.3 | 9.1 | 9.3 | 9.5 | 9.6 | 8.9 | 9.1 |
| Manganese (Mn)-mg/kg | 126 | 143 | 123 | 75.6 | 88 | 71 | 12 | 142 | 10.8 | 154 | 94 | 94.49 |
| Chromium (Cr) -mg/kg | 17 | 27.9 | 23 | 17.3 | 11.1 | 10.4 | BDL | 9.4 | 174 | 23.5 | 13 | 32.66 |
| Copper (Cu) -mg/kg | 4 | 7.7 | 7 | 4.5 | 5 | 4.2 | 3.94 | 4.5 | 5 | 14 | 5.7 | 5.95 |
| Iron (Fe) -mg/kg | 6346 | 3014 | 3718 | 3008 | 3093 | 3861 | 1199 | 6869 | 7072 | 11925 | 5431 | 5048 |
| Nickel (Ni) -mg/kg | 6.75 | 7.5 | 6.9 | 5.6 | 4.59 | 3.56 | 4.4 | 3.1 | 4.2 | 10 | 4.4 | 5.54 |
| Zinc (Zn) -mg/kg | 14 | 25.6 | 23 | 20 | 7 | 4.4 | BDL | 2 | 6.1 | 16 | 10 | 12.81 |
| Lead (Pb) -mg/kg | 5 | 7.5 | 8.5 | 7 | 21.8 | 4.2 | BDL | 3.5 | 4 | 7.8 | 4.6 | 7.39 |
| Mercury (Hg) -mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | -- |
| Total Organic Carbon-% | 4.31 | 3.71 | 2.37 | 4.58 | 3.73 | 4.5 | 1.6 | 2.1 | 1.73 | 4.98 | 4.28 | 3.44 |
| Oil and Grease-mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | -- |
| PHC-mg/kg | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | -- |

**ISO 10500 Standards; **WHO Standards*

Table 3.4 Sediment Grain Size in the Sampling Locations

| Grain Size | MPN-1 | MPN-2 | MPN-3 | MPS-1 | MPS-2 | MPS-3 | MPE-1 | MPE-2 | MPE-3 | MPO | MPC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 mm | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 mm | 0.5 | 0.4 | 0.4 | 1.0 | 1.2 | 1.3 | 2.1 | 4.1 | 5.3 | 0.2 | 10.2 |
| 1 mm | 1.8 | 1.9 | 1.8 | 2.9 | 5.4 | 8.3 | 17.9 | 17.2 | 29.8 | 0.2 | 47.1 |
| 600 µ | 4.6 | 5.0 | 5.6 | 3.4 | 12.1 | 18.0 | 43.8 | 41.5 | 36.6 | 0.4 | 22.4 |
| 420 µ | 7.5 | 8.1 | 8.0 | 5.6 | 19.5 | 24.9 | 25.6 | 27.3 | 22.5 | 0.9 | 9.5 |
| 212 µ | 38.9 | 35.3 | 36.2 | 62.3 | 44.1 | 33.6 | 9.7 | 9.7 | 5.9 | 37.1 | 5.5 |
| 150 µ | 4.3 | 5.0 | 5.0 | 4.8 | 3.2 | 4.8 | 0.0 | 0.1 | 0.0 | 5.1 | 0.8 |
| 0.75 µ | 42.5 | 44.3 | 43.1 | 19.7 | 14.4 | 9.0 | 0.0 | 0.0 | 0.0 | 56.1 | 4.4 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

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### 3.2.3 Phytoplankton

**Phytoplankton Pigments**

The phytoplankton pigments determine the productivity of aquatic ecosystems as it regulates synthesis of organic matter and eventually the fishery potential of marine environments.

**Chlorophyll 'a'**

Levels of chlorophyll '*a*' at the eleven (11) sampling stations in and around MPL outfall point ranged from 0.43 to 6.96 mg/m$^3$ with an average value of 1.77 mg/m$^3$ (Table 3.5). Outfall station (MPO) where the effluent is discharged recorded the lowest value (0.43 mg/m$^3$) whereas the highest value of 6.96 mg/m$^3$ was at MPE-1. Generally, value of chlorophyll content is influenced by shallowness and less mixing of water in addition to current generated turbidity.

**Chlorophyll 'b'**

Levels of chlorophyll '*b*' ranged from 0.01 to 8.11 mg/m$^3$ with an average value of 1.34 mg/m$^3$ (Table 3.5). Shallowness and less mixing of the water column and turbidity play major roles in determining Chlorophyll 'b' levels. Levels at 'Outfall' was much lower than the 'Control'.

**Carotenoids**

Levels of Carotenoids varied from 0.41 to 7.91 mg/m$^3$ with an average value of 1.89 mg/m$^3$. Lowest level of 0.41 mg/m$^3$ was at the Outfall station (MPO) and the highest level of 7.91 mg/m$^3$ was at MPE-1.

**Table 3.5 Chlorophyll and Carotenoid levels in the Study locations**

| Stations | Chl 'a' | Chl 'b' | Carotenoids |
|---|---|---|---|
| MPN-1 | 1.12 | 0.53 | 1.49 |
| MPN-2 | 0.77 | 0.23 | 0.97 |
| MPN-3 | 1.42 | 0.90 | 1.73 |
| MPS-1 | 2.55 | 2.41 | 2.39 |
| MPS-2 | 0.47 | 0.22 | 0.48 |
| MPS-3 | 1.63 | 0.25 | 1.36 |
| MPE-1 | 6.96 | 8.11 | 7.91 |
| MPE-2 | 1.56 | 0.92 | 1.47 |
| MPE-3 | 0.91 | 0.35 | 0.83 |
| MPC | 1.69 | 0.79 | 1.77 |
| MPO | 0.43 | 0.01 | 0.41 |
| **Average** | **1.77** | **1.34** | **1.89** |

**Phytoplankton Composition and Distribution**

Phytoplankton composition and distribution was similar in all the sampling locations with minor variation except at the outfall station (MPO) where the discharge pipeline of MPL is located. The phytoplankton community is constituted by two major groups namely diatoms (Pennate and Centric) and dinoflagellates with the dominance of diatoms. Centric diatoms dominated the phytoplanktonic composition with 15 species followed by dinoflagellates (7 species) and pennates (5 species). A total of 27 species were recorded with the lowest (11) richness at the Outfall station (MPO) and highest at MPE-1 (24) (Table 3.6). Group wise composition showed diatoms (both centric and pennate) were more dominant at all the stations. Overall distribution in all the eleven stations showed that species such as *Rhizosolenia calcar-avis, R. imbricata, Coscinodiscus* sp., *Ceratium tripos* and *Protoperidinium depressum* had wider frequency of occurrence in all the stations whereas fewer occurrence was recorded for species such as *Chaetoceros* sp., *Licmophora abbreviate and Navicula* sp. The species *Rhizosolenia calcar-avis* recorded the highest density and occurrence among all the species possibly due to its high adaptation to the prevailing ambience.

**Phytoplankton Density**

Phytoplankton density values across sampling stations ranged between 3063 to 9463 units/l with an average value of 5970 Units/l (Table 3.6; Fig. 3.6). Control Station (MPC) in the offshore waters in the east recorded highest density of 9463 units/l whereas outfall station (MPO) recorded the lowest density of 3063 Units/l. Species-specific relative abundance could be observed with few species such as *Rhizosolenia calcar-avis* numerically more dominant than the others. Species such as *Guinardia* sp., *Ceratium fusus*, *Asterionella japonica* and *Rhizosolenia robusta* were recorded in low density. This observed dominance of few species might be due to their ability to take advantage of the prevailing conditions and available nutrients as nutrient requirement of the individual species vary depending on species specific nutrient uptake kinetics. Except the Outfall station (MPO), where density was comparatively lower, density among stations did not show significant variation.

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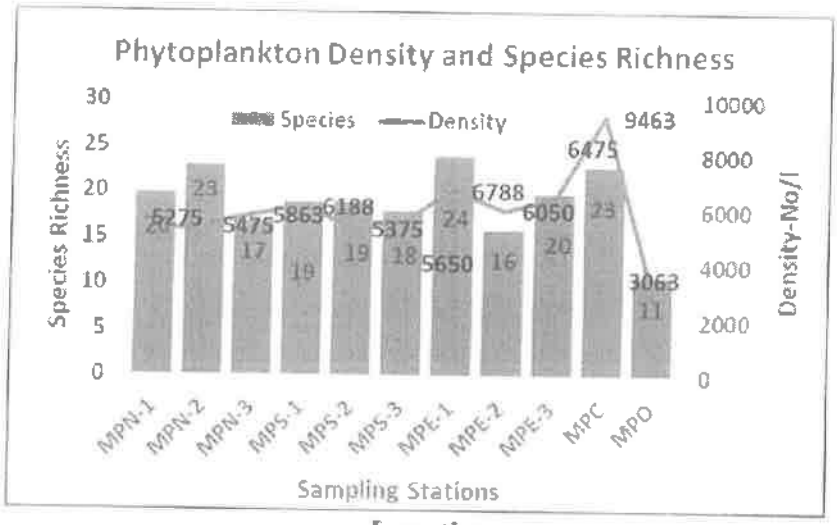
Fig. 3.6 Phytoplankton Density and Species Richness in the Sampling




**Locations**

**Phytoplankton Diversity**

Information on species diversity, richness and evenness of biological components of the ecosystem is essential to understand detrimental changes in environs or deterioration of water quality. Species diversity is a basic measure of community structure and organization and the most important parameter to understand the health status of the ecosystem. The index gives a measure of how the individuals in a community are distributed.

Shannon diversity indices (H') values for phytoplankton in the 11 sampling locations ranged from 0.55 to 1.22 (Table 3.7) with the lowest value recorded at MPE-3 and highest value at MPN-1 with an average value of 0.86. The 'Control' recorded 0.83 whereas the Outfall station (MPO) recorded higher value of 1.19.

Simpson' species evenness index measures evenness of the community from 0 to 1. It is a measure of degree of concentration of individuals in different types (species/taxa or groups) and indicates whether the community is dominated by few species or many species. Simpson's diversity index ranged from 0.17 to 0.48, 0.17 was recorded at stations MPE-3 and 0.48 at Outfall station (MPO), showing that the species composition in the community is not uniform and dominated by few species.

Pielou's evenness values ranged between 0.09 to 0.30 (Table 3.7) at station MPE-1 and MPO, respectively. Recorded evenness values showed that species distribution was not uniform and the species are very unevenly distributed in all the studied stations.

Margalef's Species Richness Index provides a measure of richness of species/taxa that is normalized for sample size. Two factors, namely number of taxa/species and number of individuals in each taxa is taken into consideration to calculate species richness. Mergalef's values in the 11 stations ranged from 1.25 to 2.61 (Table 3.7) at stations MPO and MPE-1 which is normal for any coastal waters.

*Table 3.6 Station-wise Phytoplankton Species and their Density (No/l) at MPL Outfall Site*

| S.No | Species | MPN-1 | MPN-2 | MPN-3 | MPS-1 | MPS-2 | MPS-3 | MPE-1 | MPE-2 | MPE-3 | MPC | MPO | % | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Rhizosolenia calcar-avis | 4000 | 4525 | 5063 | 4938 | 4438 | 5025 | 5938 | 5250 | 5900 | 8063 | 2188 | 100.0 | 5030 |
| 2 | R. imbricata | 188 | 150 | 100 | 125 | 225 | 100 | 125 | 100 | 38 | 313 | 125 | 100.0 | 144 |
| 3 | R. alata | | 75 | | | 38 | | 50 | | 38 | 125 | | 45.5 | 65 |
| 4 | *R. robusta* | 25 | 13 | | | | | 13 | | 13 | 50 | | 45.5 | 23 |
| 5 | *Biddulphia sinensis* | 38 | 13 | 38 | 75 | 13 | 38 | 25 | 100 | 13 | 25 | | 90.9 | 38 |
| 6 | *Coscinodiscus centralis* | 75 | 38 | 13 | 25 | | 13 | 50 | 63 | | | | 63.6 | 39 |
| 7 | *C. radiatus* | 63 | 13 | 13 | 100 | 50 | | 13 | | 38 | 50 | 50 | 81.8 | 43 |
| 8 | *C. granii* | | 13 | | 38 | | 13 | 25 | 100 | 13 | 38 | 125 | 72.7 | 45 |
| 9 | *Coscinodiscus sp* | 63 | 113 | 63 | 375 | 63 | 63 | 88 | 125 | 50 | 100 | 188 | 100.0 | 117 |
| 10 | *Ceratium tripos* | 63 | 13 | 38 | 75 | 38 | 13 | 25 | 25 | 25 | 38 | 138 | 100.0 | 44 |
| 11 | *C. furca* | 38 | 50 | 38 | 38 | 13 | 25 | 13 | 50 | 13 | 13 | | 90.9 | 29 |
| 12 | *C. fusus* | | | 25 | 13 | | 25 | 25 | 13 | 13 | 25 | | 63.6 | 20 |
| 13 | *C. macroceros* | 163 | 38 | | 25 | 38 | | 63 | 13 | 50 | 50 | | 72.7 | 53 |
| 14 | *Guinardia flaccida* | 75 | 38 | | 75 | 25 | | 13 | | | 63 | 25 | 63.6 | 45 |
| 15 | *G.uinardia sp* | 13 | 13 | 13 | | 13 | 13 | | | 13 | 25 | | 63.6 | 14 |
| 16 | *Hemidiscus sp* | 38 | 13 | 13 | 63 | 25 | 50 | 38 | 25 | | 13 | 13 | 90.9 | 29 |
| 17 | *Licmophora abbreviata* | | | | | | | 13 | 88 | | | 13 | 27.3 | 38 |
| 18 | *Navicula sp* | | | | | | 38 | | | 13 | 25 | | 27.3 | 25 |
| 19 | *Pleurosigma sp* | 50 | 25 | 25 | 38 | 50 | 13 | 25 | 38 | 13 | 25 | | 90.9 | 30 |
| 20 | *Chaetoceros coarctatus* | | 13 | 13 | | 38 | | 13 | | | 50 | | 45.5 | 25 |
| 21 | *Chaetoceros sp* | | | | 38 | | | | | | | | 9.1 | 38 |
| 22 | *Grammatophora marina* | 38 | 38 | | | | | 38 | | 50 | 75 | | 45.5 | 48 |
| 23 | *Thalassiosira sp* | 113 | 63 | 225 | 63 | 100 | 125 | 88 | 13 | 88 | 125 | | 90.9 | 100 |
| 24 | *Protoperidinium depressum* | 113 | 100 | 88 | 38 | 75 | 13 | 50 | 25 | 38 | 50 | 100 | 100.0 | 63 |
| 25 | *Dinophysis caudata* | 50 | 50 | 75 | 25 | 100 | 38 | 38 | | 25 | 25 | 100 | 90.9 | 53 |
| 26 | *Pyrophacus sp* | 38 | 63 | 25 | | 13 | 38 | 13 | 25 | 38 | 100 | | 81.8 | 39 |
| 27 | *Asterionella japonica* | 38 | 13 | | 25 | 25 | 13 | 13 | | | | | 54.5 | 21 |
| | **Species Count** | **20** | **23** | **17** | **19** | **19** | **18** | **24** | **16** | **20** | **23** | **11** | | |
| | **Density** | **5275** | **5475** | **5863** | **6188** | **5375** | **5650** | **6788** | **6050** | **6475** | **9463** | **3063** | | **5969** |

*MPN-North Stations; MPS-South Stations; MPE-East Stations; MPC-Control; MPO-Outfall Station*

*Table 3.7 Diversity Indices for Phytoplankton in the study stations in and around MPL outfall*

| Indices | MPN-1 | MPN-2 | MPN-3 | MPS-1 | MPS-2 | MPS-3 | MPE-1 | MPE-2 | MPE-3 | MPC | MPO |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa_S | 20 | 23 | 17 | 19 | 19 | 18 | 24 | 16 | 20 | 23 | 11 |
| Individuals | 5275 | 5475 | 5863 | 6188 | 5375 | 5650 | 6788 | 6050 | 6475 | 9463 | 3063 |
| Dominance_D | 0.58 | 0.68 | 0.75 | 0.64 | 0.68 | 0.79 | 0.76 | 0.75 | 0.83 | 0.73 | 0.52 |
| Shannon_H | 1.22 | 0.95 | 0.72 | 1.01 | 0.91 | 0.63 | 0.74 | 0.72 | 0.55 | 0.83 | 1.19 |
| Simpson_1-D | 0.42 | 0.32 | 0.25 | 0.36 | 0.32 | 0.21 | 0.24 | 0.25 | 0.17 | 0.27 | 0.48 |
| Evenness_e^H/S | 0.17 | 0.11 | 0.12 | 0.14 | 0.13 | 0.10 | 0.09 | 0.13 | 0.09 | 0.10 | 0.30 |
| Menhinick | 0.28 | 0.31 | 0.22 | 0.24 | 0.26 | 0.24 | 0.29 | 0.21 | 0.25 | 0.24 | 0.20 |
| Margalef | 2.22 | 2.56 | 1.84 | 2.06 | 2.10 | 1.97 | 2.61 | 1.72 | 2.17 | 2.40 | 1.25 |
| Equitability_J | 0.41 | 0.30 | 0.26 | 0.34 | 0.31 | 0.22 | 0.23 | 0.26 | 0.18 | 0.26 | 0.50 |
| Fisher_alpha | 2.63 | 3.07 | 2.15 | 2.42 | 2.47 | 2.31 | 3.12 | 2.00 | 2.55 | 2.84 | 1.44 |
| Berger-Parker | 0.76 | 0.83 | 0.86 | 0.80 | 0.82 | 0.89 | 0.87 | 0.87 | 0.91 | 0.85 | 0.71 |

*MPN-North Stations; MPS-South Stations; MPE-East Stations; MPC-Control, MPO-Outfall Station*



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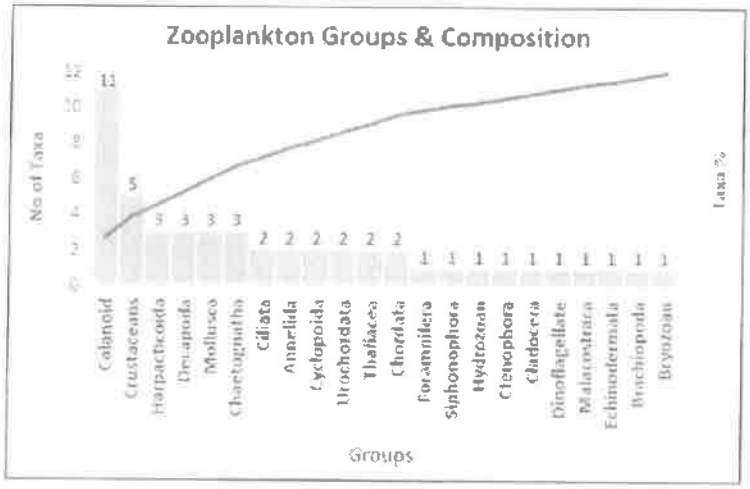
### 3.2.4 Zooplankton

**Zooplankton Composition and Distribution**

Composition of zooplankton in the eleven study stations was diverse and mainly contributed by copepods, crustaceans, molluscs, harpacticoids, cladocerans and fish larvae in different proportions. A total of 22 groups containing 50 taxa were recorded in these eleven stations (Table 3.8). Control station (MPC) had highest species richness and density showing the pristine nature of offshore waters. As is the case with all tropical waters, copepods constituted the major group followed by crustaceans in all the stations (Table 3.8; Fig. 3.7). Among copepods, calanoids constituted the major group whereas other groups were poorly represented with one or more taxa. Copepods such as *Acrocalanus longicornis, Acartia erythraea,* and *Oithona spinirostris* showed wider spatial distribution since they are euryhaline in nature and tolerate wide salinity fluctuations. The species, *Noctiluca scintilanus* contributed at a highest level in the zooplankton composition of all the station and had a bloom like occurrence. As most of the crustaceans are prolific breeders, their larval forms were reported in all the stations. Similarly, meroplanktonic forms such as decapods, fish eggs and larvae, chaetognaths, and *Salpa* sp. were well represented in many stations.

**Fig. 3.7 Zooplankton Group Composition in the MPL Study Stations**




**Zooplankton Density**

Density of zooplankton in the eleven sampling stations ranged from 2375 to 7188/m$^3$ with an average value of 4095/m$^3$. Station-wise density was maximum at the 'Control' station (MPC) located in the offshore waters and minimum at the 'Outfall' station

(MPO) (Table 3.8). Calanoid copepods, crustaceans, molluscs, fish larvae and harpacticoids contributed predominantly to the zooplankton density due to their numerical abundance and higher group composition whereas density of other forms such as Cyclopoids, Ctenophores, Annelids and Salps was least. The species, *Noctiluca scintillans* had exceptionally higher density in all the stations constituting the major part of zooplankton density in each station. Higher and lower values of density recorded at 'Control' and 'Outfall' stations clearly showed the impact of MPL effluents on the zooplankton biota in the Ennore coastal waters.

**Zooplankton Diversity Indices**

Shannon diversity index ('H') values for zooplankton did not fluctuate much among stations and ranged between 2.26 and 2.98 with an average value of 2.64 (Table 3.9). Station-wise, MPN-1 recorded highest value and MPE-2 recorded lowest diversity value. Recorded diversity values were lower for a healthy ecosystem as values higher than 3 is considered to indicate healthy coastal waters.

Pielou's Evenness values ranged between 0.344 and 0.6302 showing uneven distribution of zooplankton among the study locations (Table 3.9). Simpson's diversity index ranged from 0.7415 to 0.9107 at stations MPN-3 and station MPE-1, respectively showing that the generic composition in the community is fairly uniform. Margalef's richness values ranged from 3.102 to 4.751. Margalef's values varied moderately showing that the study stations differ moderately with respect to zooplankton composition and diversity.

*Table 3.8 Station-wise Zooplankton taxa and their Density (No/m³) in and around MPL Outfall*

| S. No | Species | MPN-1 | MPN-2 | MPN-3 | MPS-1 | MPS-2 | MPS-3 | MPE-1 | MPE-2 | MPE-3 | MPC | MPO | % | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *Globigerina sp.* | 175 | 75 | 100 | | 113 | 163 | 100 | | | 300 | 63 | 72.7 | 1088 |
| 2 | *Favella sp.* | 25 | | 25 | | 38 | 25 | | 13 | 38 | 63 | 13 | 72.7 | 238 |
| 3 | *Tintinnopsis tubulosa* | | | | 50 | | 13 | 63 | | 25 | 50 | | 45.5 | 200 |
| 4 | *Diphyes sp.* | | 38 | 50 | 25 | | 13 | | | 13 | 38 | | 54.5 | 175 |
| 5 | *Obelia sp.* | 38 | | 25 | 13 | | 50 | 38 | | 13 | 25 | 13 | 72.7 | 213 |
| 6 | *Beroe sp.* | | | 38 | 25 | | 38 | | | | | | 27.3 | 100 |
| 7 | Bristle larvae | 25 | | 38 | | | | | | | 63 | 25 | 36.4 | 150 |
| 8 | *Trochopore larvae* | 50 | | 25 | | | | 50 | | 25 | 13 | 13 | 54.5 | 175 |
| 9 | *Pareucalanus attenuates* | 63 | | | 113 | 150 | 163 | 100 | | | 288 | 50 | 63.6 | 925 |
| 10 | *Pseudodiaptomas serricaudatus* | 88 | 138 | 100 | 50 | | 100 | 138 | 125 | 175 | 188 | | 81.8 | 1100 |
| 11 | *Acrocalanus gracillis* | | 63 | | | 63 | | 200 | 225 | 263 | 113 | 38 | 63.6 | 963 |
| 12 | *A. longicornis* | 75 | 100 | 113 | 150 | 100 | 125 | 150 | 113 | 188 | 300 | 25 | 100.0 | 1438 |
| 13 | *A. gibber* | | 75 | 50 | 63 | 88 | 113 | 113 | 138 | 163 | 150 | 63 | 90.9 | 1013 |
| 14 | *Euchaeta marina* | 113 | 63 | | 75 | | 50 | | | 25 | 38 | | 54.5 | 363 |
| 15 | *Centropages calaminus* | | | 38 | 25 | 63 | | 63 | | | | 13 | 45.5 | 200 |
| 16 | *Acartia erythraea* | 88 | 113 | 25 | 63 | 38 | 75 | 225 | 250 | 288 | 400 | 25 | 100.0 | 1588 |
| 17 | *A. danae* | 50 | 63 | 38 | 138 | 163 | 225 | 113 | 150 | 188 | 225 | 38 | 100.0 | 1388 |
| 18 | *Calanopia minor* | 25 | | 88 | 50 | | 88 | | 88 | | 113 | | 54.5 | 450 |
| 19 | *Subcalanus subcrassus* | | 138 | 75 | | 75 | | 63 | | | | 25 | 45.5 | 375 |
| 20 | *Oithona spinirostris* | 100 | 163 | | 125 | 175 | 200 | | 113 | 188 | 350 | | 72.7 | 1413 |
| 21 | *O. brevicornis* | | 88 | | 88 | | 163 | 138 | | 225 | 163 | | 54.5 | 863 |
| 22 | *Macrosetella gracilis* | 50 | 63 | | | 88 | 113 | | | 175 | 225 | 50 | 63.6 | 763 |
| 23 | *M. rosea* | | 100 | | 100 | 138 | | 163 | | 113 | | | 45.5 | 613 |
| 24 | *Euterpina acutifrons* | 38 | 125 | 75 | 63 | | 75 | 88 | 150 | | 175 | | 72.7 | 788 |
| 25 | *Penilia avirostris* | 25 | | | 63 | | 38 | 25 | | 63 | 100 | | 54.5 | 513 |
| 26 | *Noctiluca scintilans* | 813 | 1375 | 1563 | 1225 | 1813 | 1988 | 850 | 2113 | 2363 | 2625 | 950 | 100.0 | 17675 |
| 27 | *Mesopodopsis orientalis* | | 38 | | 63 | | 50 | 75 | | 100 | 150 | | 54.5 | 475 |
| 28 | *Mysis larvae of shrimp* | 38 | 38 | | 63 | 75 | 100 | 63 | 25 | 63 | 50 | 50 | 90.9 | 563 |
| 29 | *Lucifer hanseni* | 75 | 50 | 63 | 100 | 125 | 150 | 38 | 50 | 75 | 38 | 75 | 100.0 | 838 |
| 30 | *Brachyuran zoea* | | 25 | | 38 | | | | 63 | | 50 | | 36.4 | 175 |
| 31 | *Veliger larvae* | 63 | | 38 | 25 | 50 | | | | | | | 36.4 | 175 |
| 32 | *Bivalve larvae* | | | | 50 | | 63 | | 75 | | 100 | | 36.4 | 288 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | *Gastropod larvae* | 25 | | | 13 | 38 | | | 25 | | 38 | | 45.5 | 138 |
| 34 | *Barnacle nauplii* | 38 | 25 | | 25 | 63 | 88 | 25 | | 13 | 25 | 25 | 81.8 | 325 |
| 35 | *Cyprid larvae* | | 38 | | 38 | | 38 | | | | | | 27.3 | 113 |
| 36 | *Copepod nauplii* | 63 | 88 | | 113 | 88 | 150 | 88 | 113 | 150 | 100 | | 81.8 | 950 |
| 37 | *Crab Zoea* | | 63 | | 100 | 150 | 125 | 63 | 50 | 75 | 113 | 63 | 81.8 | 800 |
| 38 | *Barnacle molt* | 25 | 50 | 25 | 50 | 25 | 38 | | 38 | | 50 | 13 | 81.8 | 313 |
| 39 | *Ophiopluteus larva* | 38 | | | 25 | | 13 | | 63 | | | | 36.4 | 138 |
| 40 | *Sagitta bipunctata* | 138 | 50 | 50 | 125 | 100 | 75 | 100 | 63 | 75 | 113 | 275 | 100.0 | 1163 |
| 41 | *S. bedoti* | | 100 | | | | 63 | 38 | 88 | | 63 | 100 | 54.5 | 450 |
| 42 | *Sagitta sp.* | 63 | | | 38 | 50 | | 13 | | 25 | 13 | 138 | 63.6 | 338 |
| 43 | *Brachiopod larvae* | 25 | | 88 | | 25 | | | 38 | | | | 36.4 | 175 |
| 44 | *Bryozoan larvae* | 63 | 25 | 38 | | | | | | 38 | 50 | | 45.5 | 213 |
| 45 | *Okioplewra parva* | 63 | 88 | 113 | 88 | 75 | 50 | 50 | 38 | 63 | 88 | 125 | 100.0 | 838 |
| 46 | *O. dioica* | 50 | 25 | 75 | 38 | 0 | 38 | | | 13 | 25 | 75 | 81.8 | 338 |
| 47 | *Salpa fusiformis* | 38 | 25 | 38 | 63 | 75 | 50 | 38 | 25 | 63 | 50 | 25 | 100.0 | 488 |
| 48 | *Doliolum sp.* | 25 | | 13 | 25 | | 38 | | | 13 | 25 | 13 | 63.6 | 150 |
| 49 | *Fish eggs* | 75 | 63 | 100 | 63 | 88 | 113 | 75 | 100 | 63 | 38 | | 90.9 | 775 |
| 50 | *Fish larvae* | 25 | 38 | 38 | 25 | 13 | 38 | 25 | 38 | 25 | 13 | | 90.9 | 275 |
| | ***Total Species*** | **35** | **33** | **29** | **40** | **30** | **38** | **31** | **27** | **33** | **42** | **27** | | |
| | ***Density*** | **2763** | **3600** | **3138** | **3663** | **4138** | **5088** | **3363** | **4363** | **5375** | **7188** | **2375** | | |

***Table 3.9 Station-wise Diversity Indices for Zooplankton at MPL Vicinity***

| | MPN-1 | MPN-2 | MPN-3 | MPS-1 | MPS-2 | MPS-3 | MPE-1 | MPE-2 | MPE-3 | MPC | MPO |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa | 35 | 33 | 29 | 40 | 29 | 38 | 31 | 27 | 33 | 42 | 27 |
| Individuals | 2771 | 3609 | 3145 | 3672 | 4145 | 5098 | 3371 | 4370 | 5385 | 7197 | 2381 |
| Dominance | 0.106 | 0.160 | 0.258 | 0.126 | 0.205 | 0.166 | 0.089 | 0.248 | 0.209 | 0.15 | 0.187 |
| Shannon H | 2.98 | 2.72 | 2.3 | 2.96 | 2.48 | 2.74 | 2.97 | 2.26 | 2.43 | 2.79 | 2.4 |
| Simpson 1-D | 0.89 | 0.83 | 0.74 | 0.87 | 0.79 | 0.83 | 0.91 | 0.75 | 0.79 | 0.84 | 0.81 |
| Evenness e^H/S | 0.56 | 0.46 | 0.34 | 0.48 | 0.41 | 0.41 | 0.63 | 0.35 | 0.34 | 0.38 | 0.41 |
| Menhinick | 0.66 | 0.54 | 0.51 | 0.66 | 0.45 | 0.53 | 0.53 | 0.40 | 0.44 | 0.49 | 0.55 |
| Margalef | 4.28 | 3.9 | 3.4 | 4.75 | 3.36 | 4.33 | 3.69 | 3.10 | 3.72 | 4.61 | 3.34 |

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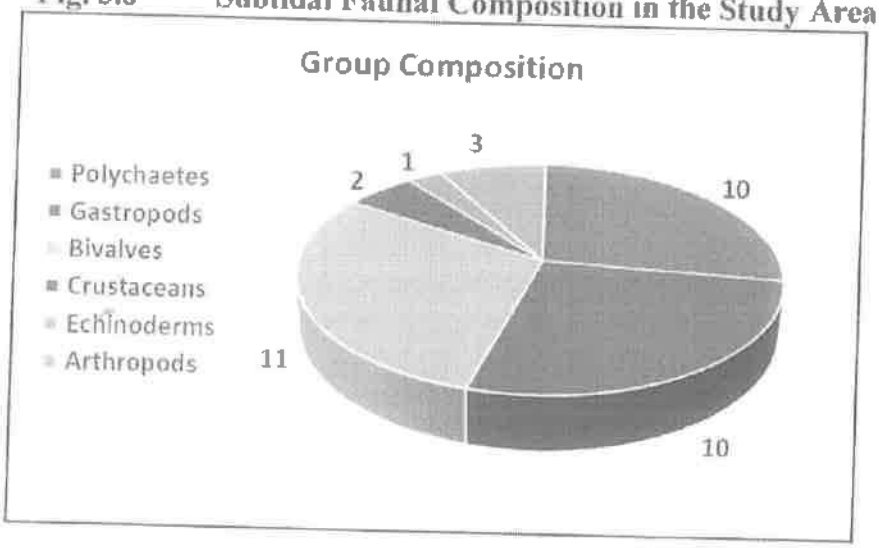
### 3.2.5 Subtidal Benthos

Marine organisms that habitually live in or on the seabed at any time during their life history constitute the benthos. Benthic monitoring is a relatively sensitive, effective and reliable technique. It can detect subtle changes that serve as an early indicator before more drastic environmental changes occur. Benthos reflects the effect of pollution like organic enrichment by responding through detectable changes in population dynamics. Data collected from the eleven subtidal environments of the MPL outfall location were consolidated on the subtidal macrofaunal composition, distribution and abundance in order to find out the impact of the MPL effluents.

***Faunal Composition and Distribution***

Spatial distribution of benthic fauna in the study sites is shown in Table 3.10. Overall, 37 taxa of benthic organisms in six major groups were recorded in the eleven (11) stations. This includes 10 taxa of polychaetes and gastropods each, 11 bivalves 2 crustaceans, 1 echinoderm and 3 other crustaceans (Arthropods) (Table 3.10; Fig. 3.8). Bivalves, gastropods and polychaetes were dominant groups in the benthic fauna followed by crustaceans and echinoderm which were represented by less numbers. (Fig. 3.8). This order of dominance was followed in all the eleven (11) stations with the predominance of bivalves, gastropods and polychaetes.

**Fig. 3.8 Subtidal Faunal Composition in the Study Area**



Among the subtidal forms, *Cerithidea cingulata*, *Donax scortum* and hermit crab had 100% frequency of occurrence as they were recorded in all the study stations followed by forms such as *Amphitrite* sp., and *Turritella duplicata* which were distributed in 10 out of 11 stations (Table 3.10) Minimum frequency of occurrence was recorded for forms such as *Oliva sericea*, *Tegillarca granosa*, *Dentalium aprinum* and *Clypeaste* sp. Groupwise, maximum frequency of occurrence was recorded by polychaetes, bivalves and gastropods. Forms such as echinoderms and crustaceans were very poorly represented with only one taxa.

**Faunal Density**

Represented by 10 and 11 taxa, group density and taxon richness of polychaetes, bivalves and gastropods were higher than other taxa accounting for a major portion of the subtidal density (Figs 3.9, 3.10). Among polychaetes, nereids and *Amphitrite* sp. were dominant followed by an unidentified polychaete. Among gastropods and bivalves, *Turritella duplicata*, *Donax scortum* and *Anadara granosa* were the dominant forms (Table 3.10). The outfall station (MPO) had the lowest taxon richness and density. Station MPS-1 south of Outfall point recorded highest level of abundance (3000/$m^2$). Control station (MPC) in the offshore waters towards east recorded the highest species richness of 28 where density was also fairly high. Overall, subtidal faunal density did not indicate any condition of severe deterioration in the sampled stations.

**Fig. 3.9 Mean Density and Richness of Taxa in the Study Stations**

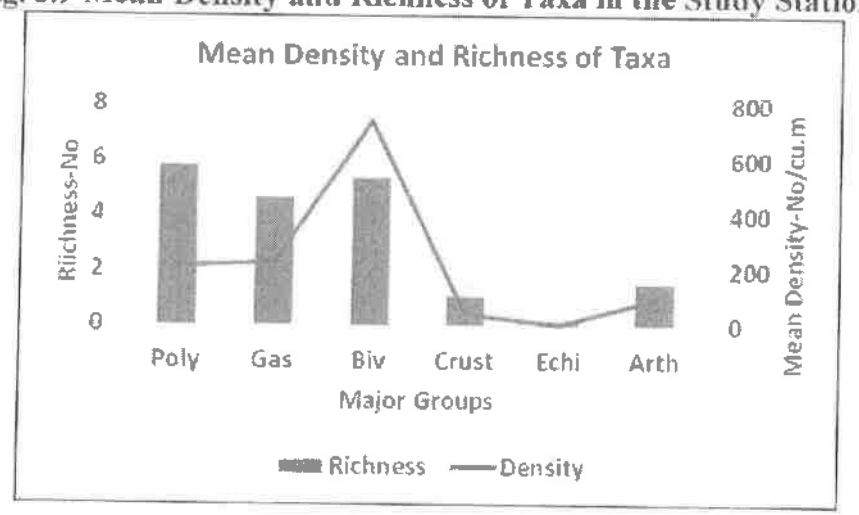


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**Fig. 3.10 Benthic Density in the Study Stations**

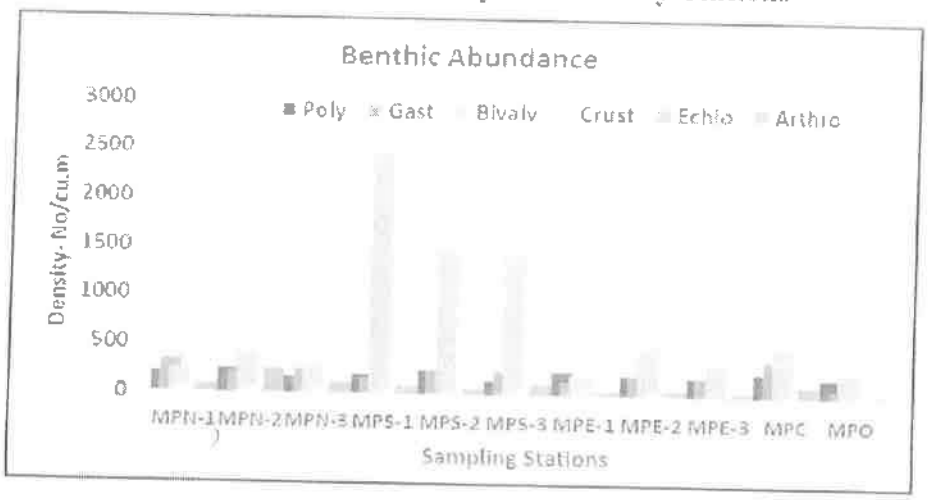
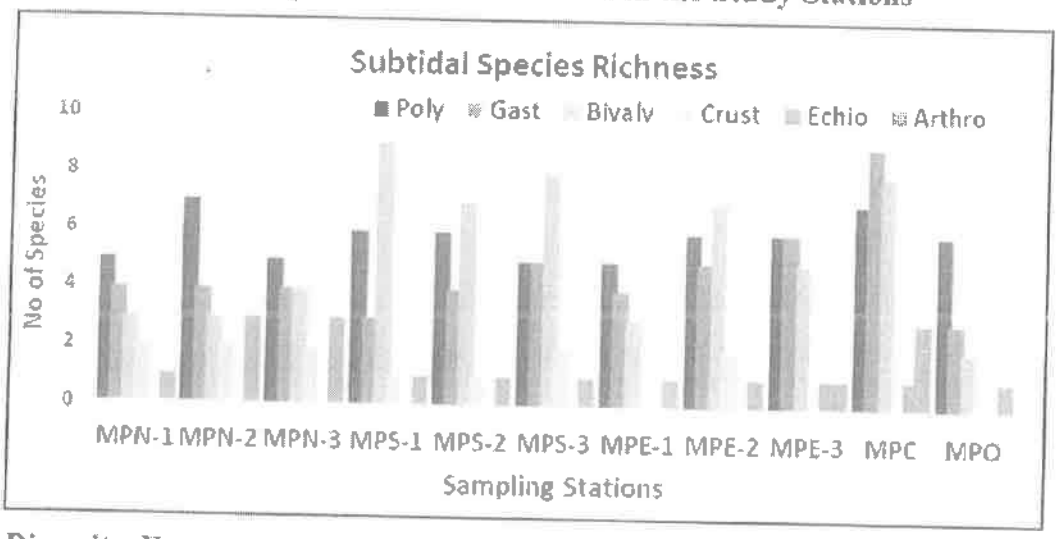



**Fig. 3.11 Richness of Taxa in the Study Stations**




***Diversity, Evenness and Richness***

Shannon diversity values of subtidal fauna varied from 2.15 to 3.21 at the Outfall (MPO) and 'Control' (MPC) stations (Fig. 3.11). Margalef index take into account both the number of taxa and number of individuals in taxa is a measure of richness of forms. It fluctuated from 1.72 to 3.77 with the 'Outfall' station (MPO) recording the lowest values (Table 3.11).

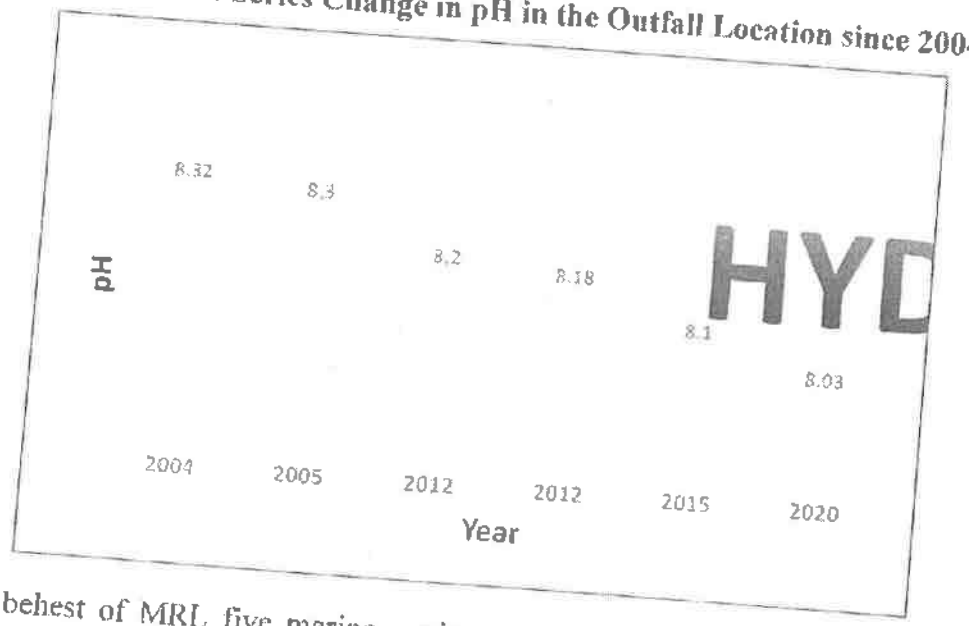
Generally, the diversity indices indicate a healthy environment when the shannon diversity is 3.0 and above in the coastal environment (Magurran 1991). In the present study, except the 'Control' station (MPC) all other stations recorded diversity values lower than 3 indicating only moderate level of environmental healthiness in these coastal waters.

Simpson's index, used to test the abundance of the commonest species, varied from 0.84 to 0.95 indicating that the common species are abundant in the studied stations. Higher values of Simpson index were mostly recorded for stations away from the Outfall station (MPO) confirming the impact of effluents on the subtidal faunal diversity. Berger-Parker index, a dominance measure expressing the proportional abundance of species, ranged from 0.08 to 0.33 at the 'Outfall' and 'Control' stations (Table 3.11).

To sum up, subtidal faunal density, diversity and evenness recorded in the eleven study stations are mostly normal similar to any other healthy coastal waters except at the 'Outfall' point which showed signs of impact due to effluent discharge. However, it is confined to the point of discharge and do not extend beyond to the other stations.

### 3.2.6 Comparison with earlier MRL Studies

**Fig. 3.12 Time Series Change in pH in the Outfall Location since 2004**




On the behest of MRL, five marine environmental impact assessment studies were carried out earlier since 2004 by reputed organizations such as NIOT, Chennai. These studies gathered exhaustive information on different facets of marine environment in and around the outfall locations of MRL in the Ennore coastal waters. An attempt is made here to analyze the results of these studies with a view to glean the impact of MPL on the Ennore coastal waters in a time series manner and its compliance with the statutorily fixed standards for different parameters. Crucial water quality parameters

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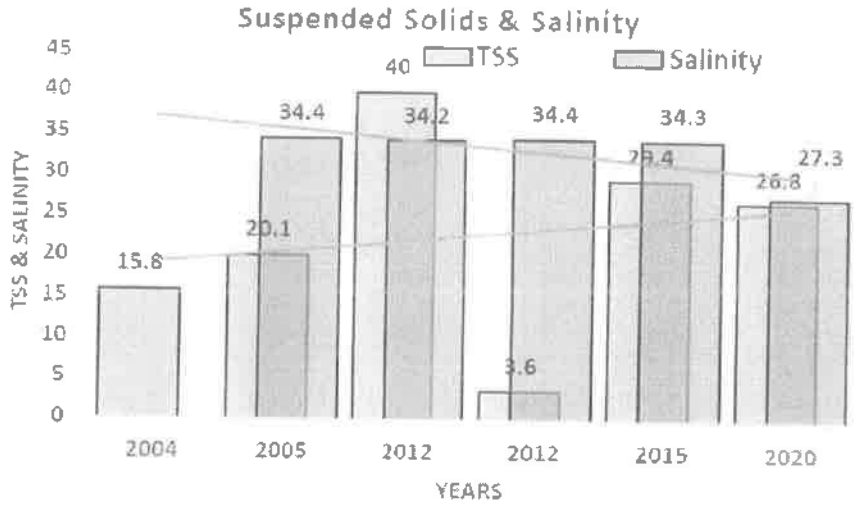
gathered in all the earlier studies are compared with the results of the present study in order to glean the long-term, time series impact of the MPL outfall effluents.

Variations of pH in MRL outfall vicinity registered a consistent decline in the six studies including the present one (Fig. 3.12) indicating continued acidification of the coastal waters, though at a very marginal levels. However, this decline is quite are moderate and were within the prescribed statutory range of 6.5 to 8.5.

Total suspended solids in and around the MPL outfall vicinity in the six studies carried out earlier did not vary much from that of the present study and showed only a marginal increase (Fig. 3.13).

**Fig. 3.13 Comparison of TSS and Salinity with the earlier Studies**




Salinity as a major influencing parameter in the outfall vicinity over the years since 2004 registered a general declining trend which could be due to seasonal factors as the data were collected during different seasons in ten different locations in and around the outfall vicinity (Fig. 3.13).

BOD during the years 2012, 2012, 2015 and in the present study showed a declining trend. Data available for different heavy metals during 2015 and in the present study showed a sharp decline. It is apparent that management interventions such as establishment/strengthening the ETP facilities were the reasons for this sharp decline in the effluent BOD levels. Heavy metals including mercury were recorded in the earlier study during 2015 whereas all the heavy metals were absent in all the sampling

locations of the present study indicating improvement of quality in the discharged effluents.

### 3.2.7 Conclusion

Analysis of coastal water health through examination of 19 water quality parameters at eleven sampling locations in and around the outfall point of MPL at Ennore coastal waters indicated most of the parameters are well within the prescribed limits. Important parameters like dissolved oxygen, nutrients (phosphate, nitrite and nitrate), BOD, COD, heavy metals are either comparable with the other healthy coastal waters or are within the prescribed limits (Table 3.1). Crucial water quality parameters such as heavy metals, BOD, COD, Petroleum Hydrocarbon (PHC) and Oil and grease were below detectible limits in all the stations. Similarly, levels of dissolved oxygen, turbidity, COD, nutrients conform prescribed standards.

National Centre for Coastal Research (NCCR), Chennai conducted a long-term study spanning over 25 years on the coastal water quality of India in 24 coastal belts including Ennore which are hotspot for industrial development (Madeswaran et al. 2018). This study classified Ennore coastal water quality as 'moderate' as per the Water Quality Index (WQI) developed by them. Five major parameters (Faecal Coliform, Productivity in terms of Chlorophyll concentration, Total Phosphate, Total Nitrogen, BOD and Dissolved Oxygen) graded in five scales (Very Good, Good, Moderate, Poor, Very Poor) determined Ennore coastal waters as 'Good' for productivity (Chlorophyll) and BOD, 'Very Poor' for fecal coliform, 'Poor' for dissolved oxygen content and 'Moderate' for nutrients (Phosphate and Nitrates). Overall assessment classified Ennore coastal waters as 'Moderate' in its quality assessment.

Table 3.10 **Subtidal faunal Groups, Taxa and their Stationwise Density in the Eleven Study Locations**

| Group/Taxa | MPN-1 | MPN-2 | MPN-3 | MPS-1 | MPS-2 | MPS-3 | MPE-1 | MPE-2 | MPE-3 | MPC | MPO | sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Polychaetes** | | | | | | | | | | | | | |
| *Cirratulus cirratus* | 25 | 25 | | 25 | 50 | 25 | | 25 | | | 25 | 200 | 63.6 |
| *Amphitrite sp.* | 50 | 25 | 50 | 25 | 75 | 50 | 75 | 50 | 25 | 25 | | 450 | 90.9 |
| *Para heteromastus tenuis* | | | | 50 | | | | | 50 | 50 | | 150 | 27.3 |
| *Ancistrosyllis sp* | | | 25 | | | | | 25 | | 25 | 25 | 100 | 36.4 |
| *Prionospio sp* | | 25 | | 25 | 25 | | 50 | | 25 | | | 150 | 45.5 |
| *Nereis sp.* | 50 | 25 | | | 50 | 25 | 25 | 25 | 25 | 50 | 25 | 300 | 81.8 |
| *Sabellids* | 25 | 50 | 50 | | 25 | | 50 | 50 | | 25 | 25 | 300 | 72.7 |
| *Sigalion sp* | | | 25 | 25 | | | | | 25 | 25 | | 100 | 36.4 |
| *Terebellids* | | 25 | | | | 25 | | 50 | | | 25 | 125 | 36.4 |
| *Unidentified Poly* | 75 | 75 | 25 | 50 | 25 | 25 | 50 | | 50 | 50 | 75 | 500 | 90.9 |
| **Richness** | **5** | **7** | **5** | **6** | **6** | **5** | **5** | **6** | **6** | **7** | **6** | **64** | |
| **Density** | **225** | **250** | **175** | **200** | **250** | **150** | **250** | **225** | **200** | **250** | **200** | **2375** | |
| **Gastropods** | | | | | | | | | | | | | |
| *Turritella duplicata* | 225 | 75 | 100 | 50 | 100 | 50 | 75 | | 25 | 75 | 25 | 800 | 90.9 |
| *Cerithidea cingulata* | 50 | 50 | 75 | 100 | 75 | 75 | 25 | 100 | 50 | 100 | 50 | 750 | 100.0 |
| *Dentalium aprinum* | | | | | | | | 25 | 50 | 25 | | 100 | 27.3 |
| *Purpura persica* | 50 | 75 | 50 | 25 | 50 | 50 | | 25 | 25 | 25 | | 375 | 81.8 |
| *Oliva sp.* | | | | | | | | | | 25 | 25 | 50 | 18.2 |
| *Oliva sericea* | | | | | | | | | | 25 | | 25 | 9.1 |
| *Umbonium vestarium* | | | 25 | | | 50 | 25 | 50 | 25 | 50 | | 225 | 54.5 |
| *Parvanachis obesa* | | | | | | 25 | | | | 25 | | 50 | 18.2 |
| *Nassarius sp.* | | 25 | | | | | 25 | 25 | | | | 75 | 27.3 |
| *Murex sp.* | 25 | | | | 25 | | | | 25 | 25 | | 100 | 36.4 |
| **Richness** | **4** | **4** | **4** | **3** | **4** | **5** | **4** | **5** | **6** | **9** | **3** | | |
| **Density** | **350** | **225** | **250** | **175** | **250** | **250** | **150** | **225** | **200** | **375** | **100** | | |
| **Bivalves** | | | | | | | | | | | | | |
| Bivalve Spat | | | 25 | 125 | 25 | 50 | | 100 | | 50 | | 375 | 54.5 |



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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cardites bicolor* | | | | 300 | 200 | 125 | 50 | 75 | 150 | 100 | | 1000 | 63.6 |
| *Mactra antiquate* | | | | 125 | 75 | 75 | | | 25 | | | 300 | 36.4 |
| *Donax scortum* | 75 | 50 | 100 | 475 | 150 | 200 | 100 | 75 | 75 | 75 | 75 | 1450 | 100.0 |
| *Solen aspertus* | | | | 50 | | | | | 50 | 75 | | 175 | 27.3 |
| *Dentalium aprinum* | | | | | | | | 25 | 50 | | | 75 | 18.2 |
| *Anadara granosa* | 150 | 300 | 125 | 375 | 275 | 450 | | 100 | | 50 | 200 | 2025 | 81.8 |
| *Astarte elliptica* | | | | 225 | | 125 | | | | 75 | | 425 | 27.3 |
| *Tegillarca granosa* | | | | | | | | | | 50 | | 50 | 9.1 |
| *Meretrix casta* | | | 25 | 425 | 475 | 225 | | 75 | | | | 1225 | 45.5 |
| *Meretrix meretrix* | 25 | 50 | | 350 | 275 | 200 | 75 | 50 | | 50 | | 1075 | 72.7 |
| **Richness** | **3** | **3** | **4** | **9** | **7** | **8** | **3** | **7** | **5** | **8** | **2** | | |
| **Density** | **250** | **400** | **275** | **2450** | **1475** | **1450** | **225** | **500** | **350** | **525** | **275** | **8175** | |
| **Crustaceans** | | | | | | | | | | | | | |
| Amphipods | 25 | 50 | 50 | 75 | 25 | 50 | | 25 | | | | 300 | 63.6 |
| Nematodes | 75 | 25 | 50 | | | 25 | | 25 | | | | 200 | 45.5 |
| **Richness** | **2** | **2** | **2** | **1** | **1** | **2** | **0** | **2** | **0** | **0** | **0** | 12 | |
| **Density** | **100** | **75** | **100** | **75** | **25** | **75** | **0** | **50** | **0** | **0** | **0** | **500** | |
| **Echinodermata** | | | | | | | | | | | | **0** | |
| *Clypeaste sp.* | | | | | | | | | 25 | 25 | | 50 | 18.2 |
| Richness | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | |
| Density | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 25 | 0 | 50 | |
| Arthropods | | | | | | | | | | | | 0 | |
| *Solenocera crassicornis* | | 50 | 25 | | | | | | | 25 | | 100 | 27.3 |
| *Alpheus paladicola* | | 25 | 25 | | | | | | | 25 | | 75 | 27.3 |
| *Hermit Crab* | 100 | 175 | 75 | 100 | 75 | 125 | 50 | 75 | 50 | 75 | 25 | 925 | 100.0 |
| **Richness** | **1** | **3** | **3** | **1** | **1** | **1** | **1** | **1** | **1** | **3** | **1** | 17 | |
| **Density** | **100** | **250** | **125** | **100** | **75** | **125** | **50** | **75** | **50** | **125** | **25** | **1100** | |
| **Total Richness** | **15** | **19** | **18** | **20** | **19** | **21** | **13** | **21** | **19** | **28** | **12** | | |
| **Total Density** | **1025** | **1200** | **925** | **3000** | **2075** | **2050** | **675** | **1075** | **825** | **1300** | **600** | | |

**Table 3.11 Diversity Indices of Subtidal Fauna in the Study locations**

| Indices | MPN-1 | MPN-2 | MPN-3 | MPS-1 | MPS-2 | MPS-3 | MPE-1 | MPE-2 | MPE-3 | MPC | MPO |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa S | 15 | 19 | 18 | 20 | 19 | 21 | 13 | 21 | 19 | 28 | 12 |
| Individuals | 1025 | 1200 | 925 | 3000 | 2075 | 2050 | 675 | 1075 | 825 | 1300 | 600 |
| Dominance D | 0.11 | 0.11 | 0.08 | 0.10 | 0.11 | 0.10 | 0.09 | 0.06 | 0.08 | 0.05 | 0.16 |
| Shannon H | 2.46 | 2.59 | 2.73 | 2.56 | 2.50 | 2.65 | 2.47 | 2.91 | 2.78 | 3.21 | 2.15 |
| Simpson 1-D | 0.89 | 0.89 | 0.92 | 0.90 | 0.89 | 0.90 | 0.91 | 0.94 | 0.92 | 0.95 | 0.84 |
| Evenness e^H/S | 0.78 | 0.70 | 0.85 | 0.65 | 0.64 | 0.67 | 0.91 | 0.87 | 0.85 | 0.88 | 0.72 |
| Menhinick | 0.47 | 0.55 | 0.59 | 0.37 | 0.42 | 0.46 | 0.50 | 0.64 | 0.66 | 0.78 | 0.49 |
| Margalef | 2.02 | 2.54 | 2.49 | 2.37 | 2.36 | 2.62 | 1.84 | 2.87 | 2.68 | 3.77 | 1.72 |
| Equitability J | 0.91 | 0.88 | 0.94 | 0.85 | 0.85 | 0.87 | 0.96 | 0.95 | 0.94 | 0.96 | 0.87 |
| Fisher alpha | 2.49 | 3.21 | 3.17 | 2.88 | 2.89 | 3.26 | 2.28 | 3.70 | 3.47 | 5.04 | 2.13 |
| Berger-Parker | 0.22 | 0.25 | 0.14 | 0.16 | 0.23 | 0.22 | 0.15 | 0.09 | 0.18 | 0.08 | 0.33 |

*MPN-North Stations; MPS-South Stations; MPE-East Stations; MPC-Control; MPO-Outfall Station*

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# 4 POTENTIAL IMPACT

## 4.1 Polyols and Aquatic Environment

Polyols and allied chemicals such as Propylene glycol and Propylene oxide contain multiple hydroxyl groups and produce many polyethers and polyesters. They do not occur in nature and are synthetically produced chemicals and serves as base compound and feedstock for numerous polyester products. They are soluble in water, miscible with many organic solvents and volatile in nature. They are generally considered as safe by the chemical industry. Their level of toxicity is very low as proved by many studies (ATSDR, 1997) and are highly biodegradable in aquatic environments. Thousands of different derivative species of these chemicals are known and their unique physical characters enable them to find wide application in a spectrum of fields and industrial processes such as pharmaceuticals, fumigants, adhesives, flame retardants, food, beverage and tobacco industries, detergents, bedding, etc. These chemicals are highly mobile and they persist in the marine environment only for a short duration. In aquatic environment they undergo aerobic biodegradation and they have very low persistence (Kent et al. 1999) rendering them environmentally not very toxic.

High biodegradability of Polyols and Propylene Glycols leads to many concomitant chemical events in the aquatic environment. Bioaccumulation and eco-toxicological studies conducted on marine organisms such as mullets and gold fish shows their low toxicity. Fishes (mullets) had an $LC_{50}$ value of 89 ppm/96 hours while gold fish had an $LC_{50}$ value of 170 mg/l/24 hours (USEPA, 1985).

In India, studies on the distribution, environmental occurrence and impact of Polyols and Poly Propylene and their numerous chemical derivatives are not known. However, studies on its environmental toxicology and degree of persistence in different biotope in other parts of world indicates that these chemical's impact on the aquatic environment

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and biota are not chronic and its occurrence even in the marine environment is not reported to produce any major impact on the marine biota including fishes.

Analysis of the life cycle of polypropylenes indicates that 91% of the environmental loads arise not from the end product of the industry (i.e. Polyols and Propylenes) but from its production process (Mannheim and Simenfalvi, 2020). In addition, release of manufacturing products in the effluent discharge will be negligible as the manufacturing process ensures very low wastage of their main products. Hence, the present impact analysis mostly considers the impacts from its effluent discharges which carry the by-products of the manufacturing process rather than the major products of the industry whose occurrence in the effluent is very low

### 4.2 Cumulative Impact in Ennore Coastal Waters

Ennore creek and coastal waters receive treated, untreated, partially treated effluents from coastal industries, urban centers and other non-point sources. Even clandestine, unauthorized release of effluents has been reported earlier (NIOT, 2004). There are about 14 mega industrial establishments in the 15 km coastal stretch between Manali and Kattupalli. A study conducted during 2004 by NIOT reported that the measured BOD load at Ennore coastal waters represented less than 40% of the total BOD release, indicating that around60% of effluent release in Ennore waters are untreated from non-point urban sources whose treatment is a big management challenge (NIOT, 2004). With additional developmental activities since 2004, it is most likely that this condition deteriorated further as of 2020. These proliferating coastal industries are the major drivers of change in the coastal ecosystem of Ennore. With more than 20 major industries clustered within 20 km coastal stretch, coastal waters of Ennore chronically faces the cumulative impact of these industries on its coastal and ground waters, air and biota. The impact is further accentuated with the diversity of industries as Ennore-Manali coastal stretch harbours ports, fertilizers, steel, petrochemical, thermal and many other industries. Treating all industrial and urban sewage effluent in conformity with the fixed standards for each parameter, especially BOD, nutrients, TSS seems to be the only way out to

address this issue of increasing coastal water deterioration at Ennore. It is to be noted that non-point urban effluents which can be treated fully is the major pollution issue in Ennore coast, since the point sources from industries adhere to pollution norms and release only treated effluents.

### 4.3 Nature of Impact from the MPL Effluents

Based on the analysis of water, sediment and biotope in the vicinity of the MPL outfall pipeline, it could be concluded that the impact arising out of MPL's effluent discharge is highly localized with very low intensity. Out of 19 water quality parameters analyzed, all the critical parameters such as heavy metals, PHC, nutrients, pesticides are either below detectible limits or are within the prescribed limits. Marginal level impact identified at the 'Outfall' point is highly confined totally reversible. An attempt is made in the proceeding section to analyze the nature, extent and magnitude of the impact in the three major components of the environment namely, water, sediment and biota of Ennore coast for which baseline data were gathered in the present study.

### 4.4 Impact on Coastal Water Quality

All the 19 water quality parameters analyzed in the present study were normal or rarely marginally lower than the fixed standards, indicating that the seawater quality in the vicinity of the outfall is not contaminated. All the eight heavy metals analyzed were below the detectable limits indicating that the Ennore coastal waters do not face the problem of heavy metal pollution at this time of the year. At the outfall site tidal currents flow towards north in NNE direction with a flow velocity of 16.07 cm/second (NIOT, 2015).

All the eight heavy metals analyzed were below detectable limits indicating that the effluent discharge does not impact the receiving water body in terms of heavy metals.

Levels of dissolved oxygen in all the 11 stations were higher than the standard ceiling of 4 mg/l except one station. At this station, organic load in the effluent discharge may contribute to these reduced DO levels. Since tidal current is fairly high at the project site,

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the zone of oxygen depletion due to this increased organic load will be highly localized around the outfall zone and normal background level is seen to be restored whenever DO levels falls below the critical level of 4 mg/l. No major shift in temperature of the water column was observed as it was lesser at 'Outfall' site compared with 'Control' and impacted sites. Similarly, no shift in pH level was observed in the impacted sites comparing 'Control'.

Impact due to nutrient enrichment originating from the effluent discharge looks absent as nutrients such as nitrate, nitrite, inorganic phosphates are at normal level in all the study locations including the outfall point. Ammonical nitrogen was below detectable limits in all the eleven sampling locations.

A level of TSS at the 'Outfall' is marginally higher than the other sites. However, this zone of marginal increase in suspended matter is highly localized and confined to an effluent discharge point only. It is evident that the suspended load level quickly reaches the background concentration within 1 km from the discharge point as TSS levels are normal in the sampling locations nearby. In addition, levels of TSS in all the sampling locations including the 'Outfall' site was comparatively lower than any other coastal stretch and do not indicate any stressed condition of this water body.

All the eight heavy metals analyzed in the surface waters were below detectable limits indicating that the vicinity of MPL outfall is not polluted with toxic heavy metals.

To sum up, analysis of nineteen (19) water quality parameters in the surface waters indicated that crucial parameters such as BOD, COD, DO, nutrients (phosphate and nitrate) and heavy metals were not critical and posed no threat to the water quality or biota.

### 4.5 Impact on Sediment Quality

All the six crucial parameters including eight heavy metals analyzed in the sediments of the sampling locations established that the bottom sediment in the vicinity of MPL is not polluted though the levels of some parameters such as organic carbon were marginally

higher at the outfall location. Similar to water, Petroleum Hydrocarbons, oil and grease in all the sediment samples were below detectable limits and the coastal sediments of Ennore-Manali is not contaminated with petroleum products. Heavy metals, though recorded in all the stations in varying concentrations, their level is comparable with the background values. Concentration of all eight heavy metals did not differ much between 'Control' and 'Outfall' stations and often values at 'Control' was higher than the 'Outfall' station. Impact due to critical heavy metals such as mercury and pesticide residues were not established as they were absent in the sediment samples in all the stations.

### 4.6 Impact on Benthic Communities

Overall average population density of macrobenthos in the eleven sampling sites was 71.9 no/$m^2$ which will be impacted in an area of 0.5 sq.kms they will be directly exposed to the impact of the effluents at the outfall site. It is most likely that the prevailing tidal current at a rate of 16.07 cm/second will disperse these pollutants to the offshore regions and only a small benthic population confined to an area of 500 sq.m at the outfall proper will be affected. In general, an overall decline in epibenthic and endobenthic communities is expected only within the small confined zone of effluent disposal at the outfall and the benthic community will be normal beyond this zone of impact.

Bottom sediments at the sites are mostly muddy which will favor only slow recovery. However, total area impacted is proportionately small given the vastness of the subtidal extent in the offshore waters of Ennore-Manali belt. Estimated loss of benthic macrofauna of 71.9/$m^2$ in an area of 500 sq.mis not significant comparing the total benthic community and vastness of the Ennore-Manali coastal Stretch.

### 4.7 Impact on Planktonic Communities

Major factors that influence planktonic community in coastal waters are nutrients, suspended load and sunlight. Recorded values of nitrate, nitrite and phosphate as the major nutrients did not show any abnormal elevation. Similarly, suspended solids and

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turbidity were not elevated by the MPL discharges exerting least influence on the planktonic community of the surroundings. Initial elevation registered by turbidity and suspended load at the outfall site will be highly localized as altered water quality will be confined only in the area of outfall. The estimated nutrient load and their uptake possibly will not change planktonic community structure, composition and primary productivity levels. Similarly, uptake of heavy metals by phytoplankton is far-fetched as heavy metal level in the water column was below detectable limits.

To sum up, the impacts caused due to the effluent discharge of MPL on the coastal waters of Ennore is highly localized as only a marginal impact was established at the 'Outfall' site while other ten (10) sampling locations did not show any signs of impact. Water Quality Index formulated by NCCR classified Ennore coast as 'Moderate' in pollution (Madheswaran, 2018).Ecological components such as BOD and productivity were 'good' whereas parameters such as faecal coliform and DO were in poor and very poor category. Results of the present study also confirm this result. Levels of important ecological parameters such as BOD, COD and DO do not pose any threat to the coastal ecosystem of Ennore/Manali region were well within the statutory limits.

# 5 MITIGATION AND MANAGEMENT PLAN

Managing the ambient environment in its original state is an important and imperative element in any developmental initiative, especially for coastal industries, to ensure sustainability of their operation. Formulating and implementing a viable environmental management plan for a coastal industry is essential to render the development sustainable. Environmental management plan aims to suggest concrete measures that would negate or mitigate the impact paving way for maintaining the integrity of the project environ. Coastal development produces impacts of varying degrees in the coastal water quality of its surroundings calling for sustainable and inclusive development which ensures healthiness of its marine environment.

To begin with, a genuine interest to maintain the integrity of its environment is the foremost requirement of a good environmental management practice. Assuming ownership of its environment and working towards the support of different government and non-government agencies are other essentials.

The developers of coastal industries need to understand the marine ecological *milieu* of their industry including its water quality, biotic components and factors governing it along with the impact their operations are likely to produce on the environment. The coastal ecosystem, in spite of facing intense stress delivers many services which are often intangible. In order to maintain these services intact, it is imperative that different biotic and abiotic components of the coastal waters is sustainably managed.

The coastal/marine ecosystem has a huge capacity for self-correction if the impact is within its limits. Hence, maintaining a close watch on different components of coastal ecosystem such as water, sediment and biota to understand the system's response is the first step in a viable management practice.

Based on the baseline data gathered and impact visualized, the present chapter attempts to suggest practical management and mitigation framework for conserving the marine

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environment of Ennore. Given the economic importance of the industrial development and the increasing national and global demand for sustainability, this chapter suggests some implementable measures for the marine environmental management of Ennore.

## 5.1 Ongoing Environment Management Measures by MPL

Many environmental management measures are in place in MPL in compliance to the statutory requirement and as mandated by the TNPCB and CPCB and on its own with the purpose of maintaining and preserving coastal environmental integrity. The following measures have been taken by the MPL authorities earlier:

**Measure 1: Two functional and well maintained ETP in place**

Two ETPs, each with a capacity of 150 $cm^3$/hour is operational in both the units of MPL which process a total effluent volume of 4988 $cm^3$/day. All crucial parameters of the ETP are monitored real time and connected online with the monitoring systems of CPCB and TNPCB. Water quality parameters of the ETP release are well within the statutorily prescribed range (pH- 6-8.0; Temperature-< 39°C, TSS - < 100 ppm, BOD -< 50 ppm, COD -< 225 ppm). Both the ETPs are maintained and operated by 15 well qualified and dedicated staff. These two ETPs ensure that the MPL's effluent meet the statutory requirements and does not pollute the coastal waters of Ennore.

**Measure 2: Periodic Studies on coastal environmental Status and Impact Assessment in and around its Outfall location at Ennore coastal waters.**

Prior to this present study, five extensive studies were conducted by MPL. Out of that the study conducted during 2015 was through NIOT. These studies periodically assessed the coastal water quality in and around the outfall location of MPL. Based on these technical reports MPL implemented up-gradation of EPT in order to ensure that the effluents from both the plants are treated as per statutory requirements.

## 5.2 Management

Analysis of different water quality data collected by these studies indicate that the water quality in and around the outfall location did not show any trend. Parameters such as pH

TSS and BOD registered a decline during the years 2004, 2005, 2012 and 2015 when compared with the present study; many parameters were neutral without any trend.

It is suggested that MPL formulate an in-house regular coastal monitoring and impact assessment study at its outfall point in addition to periodic assessment of its inlet and out effluents at its ETP. Keeping a watch on crucial coastal environmental parameters at regular time interval (once in a year) in and around the outfall point will ensure that the MPL operation does not negatively impact the coastal environment.

Establishing such a proper information base through a comprehensive regular monitoring of its marine and other environment, evaluation of the results of such monitoring and reporting the actions taken will go a long way in alleviating major environmental issues of MPL.

This monitoring program could be carried out by adequately training the in-house staff of the EHS department without hiring any external agency. Reliable time series data on crucial parameters of water, sediment and biota could be gathered and documented with simple basic laboratory set-up. This activity will positively reflect in their regular Environmental Statements (ES). Besides, this regular monitoring will meet the overall objective of compliance verification, problem identification, environmental performance and housekeeping, data base for corrective action and will render the industry totally environmentally benign and their operations sustainable.

It is suggested to have trained marine biologists/Environmentalists in the pay-role of MPL who will take care of such regular monitoring along with other marine environmental related activities.

It is also suggested that the in-house EHS staff undergo periodic training with reputed organization to update themselves on different aspects of water pollution control and analytical technique. Having a qualified and trained in-house staff will be helpful in several counts.

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The EHS team of MPL may carry out a partial in-house Life Cycle Assessment (LCA) from an environmental point of view critically reviewing their manufacturing process, packaging and distribution streamlining every step and making them more environments friendly. If required, MPL may contemplate minor process modification to infuse higher environmental efficiency in their system.

MPL authorities may carry out a predictive model study with the help of agencies such as NIOT to predict water quality trends in their outfall vicinity. The pollution assimilative study carried out by NIOT during 2004 at Ennore creek and North Chennai is now outdated due to fast industrialization of Manali-Ennore coast. Pollution assimilative capacity of coastal waters at the Outfall vicinity and beyond it may be re-evaluated in order to know the present status. This study may be jointly funded by other industries along Ennore and Manali coastal stretch.

A consortium of coastal industries of Ennore and Manali with a common funding could be contemplated with the overall objective of sustainable development in this region. Keeping the coastal waters of North Chennai to commercial and recreational standard will be one of the major objectives. The structure, function, funding and operational guidelines could be drawn for this consortium with active assistance and supervision of TNPCB and CPCB.

Controlling and managing coastal pollution in a heavy industrialized coastal stretch such as Ennore-Manali-Kattupalli is a multi-sectoral attempt requiring genuine contribution of concerned industries, government agencies, research organisations and the general public. Deteriorating coastal ecology of this coastal stretch could be arrested only by an integrative management approach involving all these stakeholders. Individual initiatives will yield only limited results. It is again stressed that all industries in this coastal belt should join together to maintain the environmental health of this coastal stretch.

# 6 Summery and Conclusion

The present study investigated the impact of the Manali Petrochemical Limited's (MPL) effluent outfall at Ennore coastal stretch near Chennai. In order to characterize and quantify the impact, if any, samples of water, sediment and biota from eleven fixed locations in and around the MPL outfall were collected during first week of October 2020. Analyses includes nineteen (19) water quality parameters, six (6) sediment quality parameters and six biological parameters which are vital ecological components of coastal environment and indicative of its health status. Collected data were used to characterize the marine environment of the Ennore coastal waters. Based on the primary information, impact of the MPL's effluent on the water, sediment and biota of Ennore coastal environment has been predicted and outlined.

In the subtidal benthic habitat, 37 taxa in six major groups were recorded in the eleven stations. This includes 10 taxa of polychaetes and gastropods each, 11 bivalves, 2 crustaceans, 1 echinoderm and 3 other crustaceans (Arthropods). Bivalves, gastropods and polychaetes were dominant groups. Shannon's diversity values ranged from 1.96 to 2.24 and evenness values ranged from 0.51 to 0.69. Benthic density and diversity was moderately less at the 'Outfall' station. This reduction in density and diversity of subtidal fauna, however, was localized and did extend beyond 1 km radius as indicated by the normal density and diversity of benthic fauna in other stations.

Analysis of nineteen (19) water quality parameters in the surface waters indicated that crucial parameters such as BOD, COD, and DO, nutrients (phosphate and nitrate) were normal and posed no threat to the water quality or biota. All the eight toxic heavy metals analysed were below detectable limits (BDL) in all the sampling locations. Similarly, values of salinity, suspended solids and turbidity were well within the normal range for coastal waters and did not indicate any abnormality. Recorded values of dissolved oxygen were well within the safer limits except in one station while in other stations it did not indicate any stressed condition of the water column. Similarly, levels of total and

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faecal coliform were within the range and did not show any signs of contamination. In all the study stations, Petroleum Hydrocarbon (PHC), Oil, grease and pesticide residues were below detectible limits (BDL) indicating the fast turn-over time and adequate carrying capacity of the water mass in this coastal stretch. Productivity of the water column in terms of Chlorophyll 'a' 'b' and carotinoid pigments was normal for a healthy water column. Nutrients like nitrate and phosphate recorded in the present study appears to originate from the terrestrial sources. In general, recorded water quality parameters were normal and did not indicate any gross contamination.

Six crucial parameters including eight heavy metals indicating the sediment health in the Outfall vicinity were analysed. Sediment pH with a range of 8.9 to 9.6 and average of 9.1 was alkaline in all stations and did not indicate any abnormality. Concentration of TOC ranged from 1.6 to 4.98% with a mean of 3.44%. Values of TOC at 'Control' and 'Outfall' stations were higher than the other sampled stations. Similar to water, Petroleum Hydrocarbons, oil and grease in all the sediment samples were below detectable limits and the coastal sediments of Ennore-Manali is not contaminated with petroleum products. Unlike surface water, presence of heavy metals was recorded in all the stations in varying concentrations. Concentration of all eight heavy metals did not differ much between 'Control' and 'Outfall' stations and often values at 'Control' was higher than the 'Outfall' station. Mercury and pesticide residues were not recorded in the sediment samples in all the stations.

Analysis of bottom sediment texture revealed that the sediment composition of near coastal environment differs from that of offshore environment. In the near coastal stations (MPN and MPS) grain sizes of 212 and 0.75 µm predominated whereas in the open water stations towards east (MPE-1-3, MPO, MPC), sediment was mostly composed of coarser grain sizes of 1 and 4 mm except at the 'Outfall' station. Recorded levels of heavy metals in the sediments of MPL outfall location in Ennore waters indicate no gross contamination and represent natural background levels. Values of heavy metals recorded

at 'Outfall' station were much lower than the 'Control' station implying that the benthic (sediment) habitat in and around the MPL Outfall is not contaminated very much.

Water productivity in terms of chlorophyll '*a*' ranged from 0.43 to 6.96 mg/m$^3$ with an average value of 1.77 mg/m$^3$. Outfall station (MPO) recorded the lowest value (0.43 mg/m$^3$) and the highest value of 6.96 mg/m$^3$ was at MPE-1. Levels of chlorophyll '*b*' ranged from 0.01 to 8.11 mg/m$^3$ with an average value of 1.34 mg/m$^3$. In general, productivity in these coastal waters in terms of Chlorophyll content was good.

Phytoplankton composition and distribution did not vary much among the sampling locations except at the outfall station (MPO). The phytoplankton community is constituted by three major groups namely, Pennates, Centric diatoms and dinoflagellates with the dominance of pennates and centrics. A total of 27 species were recorded with lowest species richness at the Outfall station (MPO). Group wise composition showed diatoms (both centric and pennate) were more dominant at all the stations. Recorded density, diversity and community composition of phytoplankton is normal for any unpolluted coastal waters.

Phytoplankton density values ranged between 3063 and 9463 units/l with an average value of 5970 Units/l. Control Station (MPC) recorded highest density of 9463 units/l whereas outfall station (MPO) recorded the lowest density of 3063 Units/l indicating the impact of the effluent in this station. Except the Outfall station (MPO), where density was comparatively lower, density among other stations did not show significant variation. Diversity indices (H') for phytoplankton in the 11 sampling locations ranged from 0.55 to 1.22 with an average value of 0.86. Recorded diversity values were rather low for healthy coastal water.

Composition of zooplankton in the eleven study stations was diverse and mainly contributed by copepods, crustaceans, molluscs, harpacticoids, cladocerans and fish larvae in different proportions. A total of 22 groups containing 50 taxa were recorded in these eleven stations. Control station (MPC) had the highest species richness and density. Copepods were the major group followed by crustaceans.

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Zooplankton density ranged from 2375 to 7188/$m^3$ with an average value of 4095/$m^3$. Station-wise density was maximum at the 'Control station (MPC) and minimum at the 'Outfall' station (MPO). Calanoid copepods, crustaceans, molluses, fish larvae and harpacticoids contributed predominantly to the zooplankton density due to their numerical abundance and higher group composition. Shannon diversity index ('H') values did not fluctuate much among stations and ranged between 2.26 and 2.98.

Ennore creek and coastal waters receive treated, untreated, partially treated effluents from coastal industries, urban centers and other non-point sources as there are about 14 mega industrial establishments in this coastal stretch. However, around 60% of the effluent discharge into Ennore waters is from the non-point urban sources which are the major drivers of change in the coastal ecosystem of Ennore. Coastal waters of Ennore, chronically faces the cumulative impact of coastal industries and the untreated urban discharge. Treating all industrial and urban sewage effluent in conformity to the fixed standards for each parameter seems to be the major environmental challenge and needs an orchestrated effort.

As a management measure, it is suggested to institute regular monitoring study once in two years in the in a radius of 10 km on indicative ecological components in water, sediment and biota. Comparison of the gathered data over the years will help the authorities to track changes and formulate suitable remedial measures.

It is also suggested that a team of well-trained in-house EHS staff be created who will carry out a partial in-house Life Cycle Assessment (LCA) from an environmental point. Similarly, pollution assimilative capacity of the coastal waters at the Outfall vicinity and beyond it may be evaluated in order to know the present status. A consortium of coastal industries of Ennore and Manali with a common funding could be contemplated with the overall objective of sustainable coastal environmental management in this region.

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ANNEXURE - 9C 311

# Studies on the impact of Effluents discharge from Manali Petrochemicals Ltd. outfall at Ennore, East coast of India

FOR

MANALI PETROCHEMICALS LIMITED, CHENNAI

Prepared by

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August 2015

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## Report Summary

| Client | Client's representative |
|---|---|
| **Manali Petrochemicals Ltd.**<br>**Ponneri High Road**<br>**Chennai-600068** | **The Head-Corporate Affairs**<br>**Manali petrochemical Limited**<br>**Ponneri High Road**<br>**Chennai-600068** |
| **Project**<br>**Studies on the impact of Effluents discharge from Manali Petrochemicals Ltd. outfall at Ennore,** | **Project No**<br>**NIOT/CEE/MPL/1176** |

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## 1. INTRODUCTION

Manali is an industrial centre located in the sub-urban area of Chennai. There are many medium and large scale industries are in this region of which Manali petrochemicals Ltd. (MPL) is one of the major petrochemical industry. MPL discharges its treated effluents through a common effluent discharge pipeline at the depth of 10 meters into the sea off Ennore coast. This study attempts to understand the ecological impact of the effluent out fall at Ennore coast.

The environmental impacts of petroleum aromatic hydrocarbons are often negative because these are toxic to all forms of life. Hydrocarbons are closely linked to all aspects of present society, especially as fuel for transportation and industrial activities. The oil industry competes with an array of health, safety and environmental concerns throughout its range of operations. As per the Environment, Health and Safety (EHS) regulations, companies need to implement effective environmental management systems to protect the natural resources.

MPL approached NIOT to conduct this study for assessing the impact of their discharge on the ecology and surrounding environment and issued the work order No. MPL/DIR(W)/NIOT/2015/01 dated 09-03-2015.

### 1.1 SCOPE OF STUDY

- Measurement of Physical, chemical and biological water quality, sediment quality and biology measurements in the near field and far field region of the outfall.
- Collection of tide and current data for 4 days at the site during the period of water quality measurement.
- Evaluation of the present scenario and comparison with baseline study (report carried out by MPL for their EIA study) to determine the impact of the marine outfall

### 1.2 OBJECTIVES

- Objective of the study is to determine the changes of water, sediments and biological quality due to the discharge of treated process water.

## 2. CHARACTERISTICS OF THE TREATED EFFLUENT

MPL has provided the following data (MPL outfall EIA report 2012) with respect to the characteristics of the treated effluent

| S.NO. | Characteristics | Unit | MPL Plant-1 | MPL Plant-2 |
|---|---|---|---|---|
| 1 | pH | | 7.8 | 7.6 |
| 2 | Oil and Grease | mg/l | 1 | 2 |
| 3 | BOD (5 days) @ 20°C | mg/l | 28 | 24 |
| 4 | COD | mg/l | 186 | 184 |
| 5 | Sulphate | mg/l | 110 | 140 |
| 6 | Chloride | mg/l | 27400 | 21396 |
| 7 | TSS | mg/l | 82 | 82 |
| 8 | TDS | mg/l | 42280 | 33862 |
| 9 | TRC | mg/l | BDL | BDL |
| 10 | Phosphate | mg/l | BDL | BDL |
| 11 | Calcium | mg/l | 15400 | 12054 |
| 12 | Total Chromium | mg/l | BDL | BDL |
| 13 | Hexavalent Chromium | mg/l | BDL | BDL |
| 14 | Phenolic compounds | mg/l | BDL | BDL |
| 15 | Fluoride | mg/l | BDL | BDL |
| 16 | Sulphide | mg/l | BDL | BDL |

## 3. STUDY AREA

Study area consisted of 1 km wide x 2 km long stretch along the Ennore coast to include the near field and far field area of the MPL outfall. Manali Peterochemicals Ltd. treated effluent discharge outfall is located in Ennore coast (13°10'51.00"N ; 80°19'21.00"E, Fig. 1), East coast of India. The sampling stations were located (Fig. 1) at 500m and 1000m distances along three transects to the north, east and south of outfall. The oceanography data were collected using Current Meter (RCM-9) and Veleport Tide Gauge (WTR) for 4 days in selected sampling locations during April 2015.

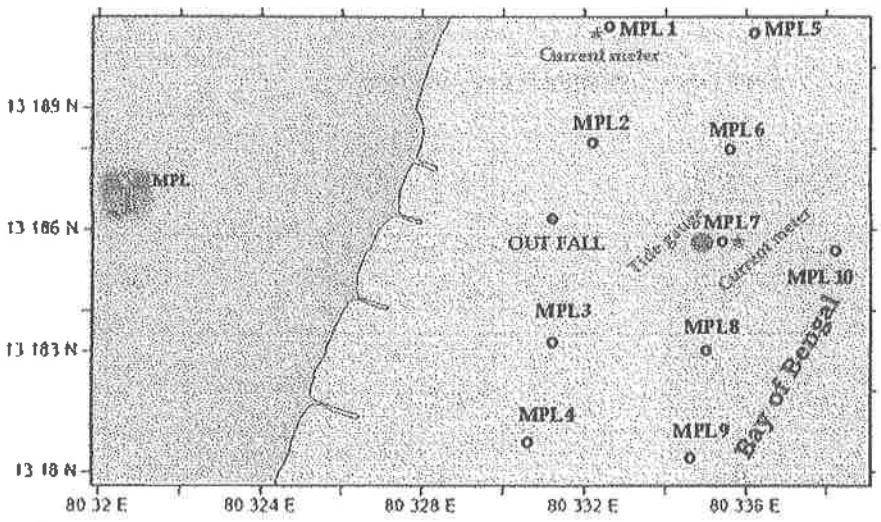


**Fig. 1** Sample collection, Current meter and Tide gauge locations near MPL outfall at Ennore coast, Chennai, East coast of India.

## 4. MATERIALS AND METHODS

Water samples were collected from 10 sampling locations nearby effluent outfall area (Table.1) for two days (April 2015) with respective tidal cycle. The polypropylene bucket was used to collect surface water samples and transferred to pre-cleaned 1 liter polypropylene bottles. The collected sample were stored at 4°C in ice box for nutrients, BOD other parameters analysis. Acid rinsed bottles used to collect the samples for metal analysis and amber bottles used for organic analysis. The collected water samples were analyzed for dissolved oxygen (DO), salinity, water temperature and pH under field condition using a multi-parameter water quality Probe (YSI Pro 2030). Water samples immediately transferred to laboratory for analyzing nutrients, Total suspended solids (TSS), metals and Petroleum Hydro Carbon (PHC). The analyses are followed standard methods (APHA, 2005; Grasshoff *et al.,* 1999).

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**Table 1.** The sampling locations near outfall area of MPL at Ennore coast, East coast of India.

| S No | Sampling locations | Longitude and Latitude | Remarks |
|---|---|---|---|
| 1 | MPL1 | 13°11'23.61"N 80°19'33.79"E | North of outfall |
| 2 | MPL2 | 13°11'06.27"N 80°19'29.36"E | North of outfall |
| 3 | MPL3 | 13°10'33.68"N 80°19'23.03"E | South of out fall |
| 4 | MPL4 | 13°10'17.42"N 80°19'19.52"E | South of out fall |
| 5 | MPL5 | 13°11'20.55"N 80°19'51.07"E | Northeast of outfall |
| 6 | MPL6 | 13°11'02.02"N 80°19'47.35"E | Northeast of outfall |
| 7 | MPL7 | 13°10'47.74"N 80°19'42.69"E | 500m away from out fall area (Eastern side) |
| 8 | MPL8 | 13°10'31.24"N 80°19'39.03"E | Southeast of out fall |
| 9 | MPL9 | 13°10'15.38"N 80°19'36.42"E | Southeast of out fall |
| 10 | MPL10 | 13°10'46.71"N 80°19'56.05"E | 1km away from the out fall (Eastern side) |

Samples were properly handled and all necessary quality assurance and quality control (QA/QC) measures such as preservation, storage, and labeling were followed. All sample containers were pretreated by washing in dilute hydrochloric acid and rinsed with distilled water.

The instruments were calibrated using NIST traceable standards and certified reference materials (CRM) before and after measurements.

## 5. RESULTS AND DISCUSSION

### 5.1 PHYSICAL OCEANOGRAPHY

#### 5.1.1 Tide

"The rhythmic rise and fall of seawater level due to gravitational force of sun and moon is called as tide".

In present study, the measurement of tides (High and low tide) in off Ennore coast are given below and Fig. 2.

| DATE | TIME | TIDE (m) | |
|---|---|---|---|
| 8-Apr-15 | 10:15 | 1.09 | HT |
| | 16:00 | 0.22 | LT |
| | 22:00 | 1.00 | HT |
| 9-Apr-15 | 4:15 | 0.15 | LT |
| | 11:15 | 1.11 | HT |
| | 16:45 | 0.30 | LT |
| | 22:30 | 0.97 | HT |
| 10-Apr-15 | 4:30 | 0.23 | LT |
| | 11:30 | 1.10 | HT |
| | 18:00 | 0.36 | LT |
| | 23:30 | 0.92 | HT |
| 11-Apr-15 | 5:45 | 0.27 | LT |
| | 12:00 | 1.02 | HT |

The tide levels ranged from 0.15 to 0.27 m in low and 1.02 to 1.11m in high tidal water near outfall location with respect to Chart Datum.

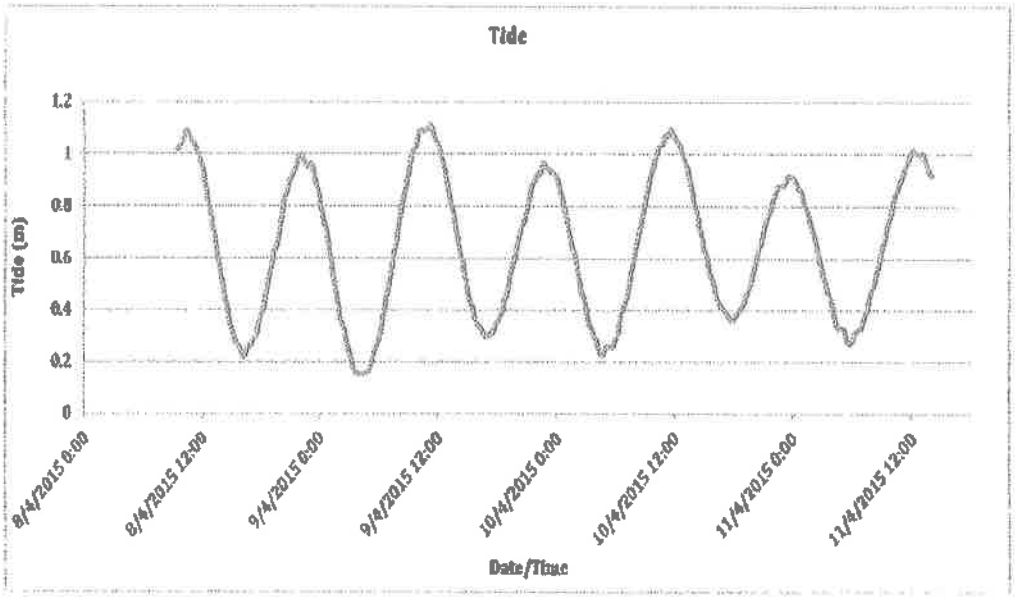


**Fig. 2** Variations of tide (m) near the MPL outfall

**5.1.2 Current**

Ocean current is a continuous, directed movement of seawater generated by forces acting upon this such as breaking waves, wind, Coriolis Effect, temperature and salinity differences. Ocean currents are important in the study of marine debris and vice versa.

The measurement of ocean current in study area at location MPL 1 and MPL 7 are presented in Fig. 3 and 4. During the study period, the ocean current speed varied from 0.29 cm/s to 21.99 cm/s with an average of 10.78 cm/s and current direction is north with predominant current direction being NNE (20°) at the location MPL1. For station MPL 7, it ranged from 6.16 cm/s to 32.26 cm/s with an average of 16.07 cm/s and predominant current direction being NNE (20°). In the study area, current direction was observed to be parallel to the coastline during the observation period.

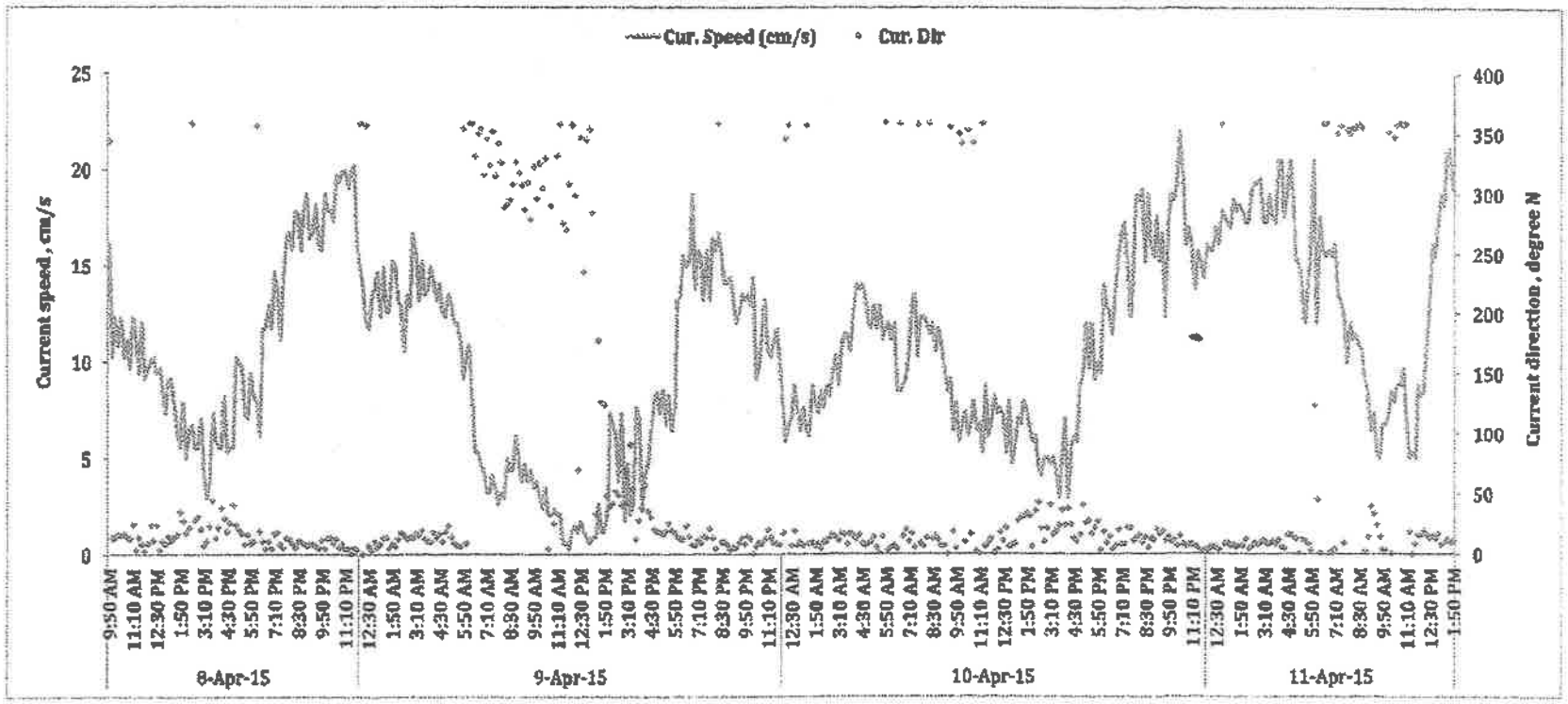


**Fig. 3** Variations of current speed and current direction at location MPL 1

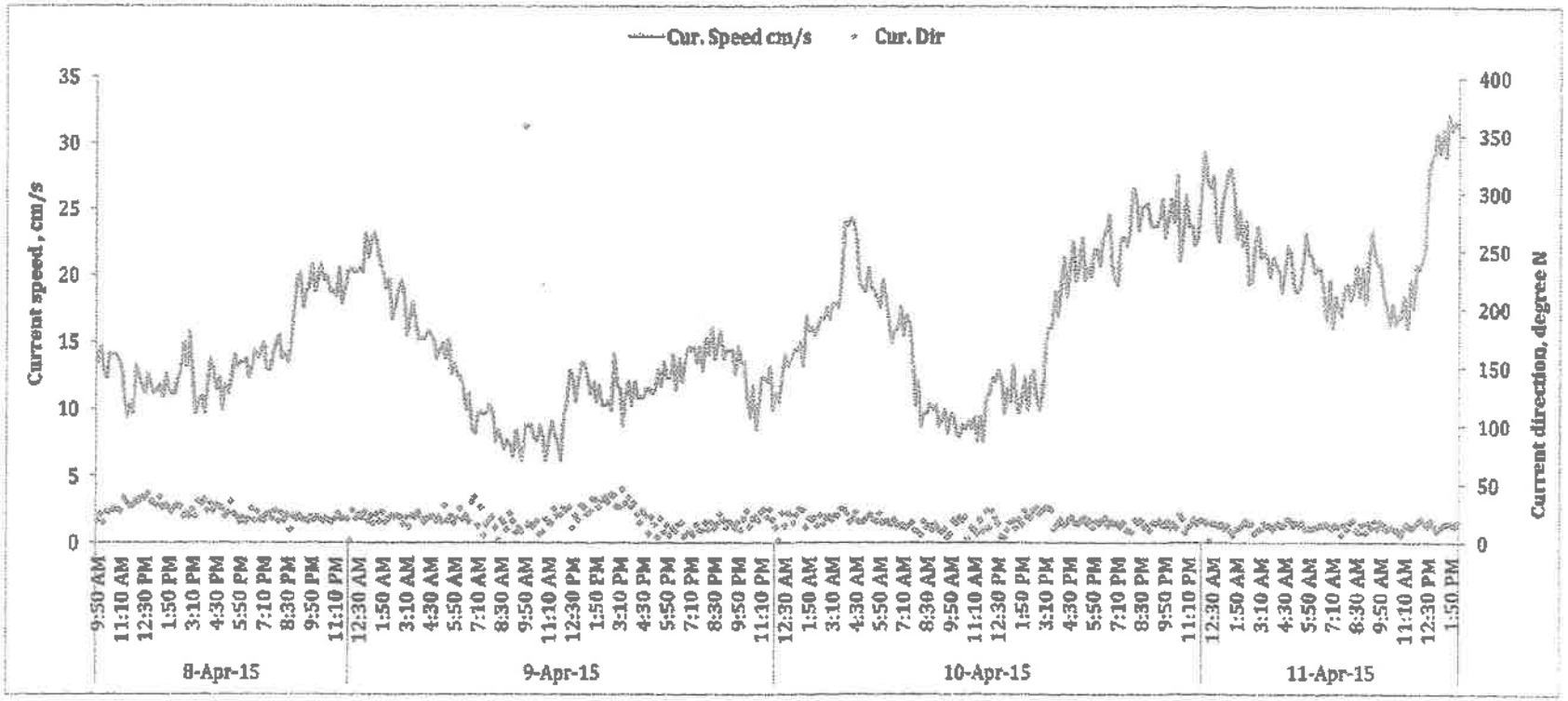


**Fig. 4 Variations of current speed and current direction at location MPL 7**

## 5.2 WATER QUALITY PARAMETERS

### 5. 2.1 Physico-chemical parameters

The study of water quality is useful in understanding the ecosystem changes / behavior. The water quality studies are likely to provide a measure of the influence of manmade activities on the ecosystem in terms of physico-chemical characteristics like pH, Salinity, DO, Nutrients and metals etc., in the aquatic ecosystem. The mean, minimum and maximum values of physio chemical characters are presented in the Table 2.

The Total Suspended Solids (TSS) ranged from 13.0 to 29.4 mg/l (Table 2) and the spatial variations of mean values are shown in Fig. 11. The pH, Dissolved oxygen (DO) and Salinity ranged from 7.8 to 8.1, 6.9 to 7.9 mg/l & 32.4 to 34.3 ppt respectively (Table 2) and spatial variation of mean values are presented in Figs. 7, 8 and 9.

The Biological Oxygen Demand (BOD) ranged from 0.2 to 2.40 mg/l (Table 2) and spatial variations of mean values are shown in Fig. 10. Nutrient concentration for nitrite, nitrate, ammonia and phosphate ranged from 0.1 to 0.28 µmol/l, 1.2 to 2.9 µmol/l, 0.1 to 7.5 µmol/l and 1.4 to 2.1 µmol/l respectively (Table 2). The spatial variations of mean values are shown in Figs. 12, 13, 14 and 15. Petroleum hydrocarbon ranged from 30.8 to 59.3 µg/l (Table 2) and the spatial variations of mean values are shown in Fig. 16.

The Mean tidal (low & high) variations of selected parameters are presented in Fig. 17 to 28. The water quality tide wise data are presented in the Annexure Table 1a for all parameters. The upstream and downstream locations values of selected parameters are not showing considerable variation between the locations. There is no trend in the observed values among the nearshore and offshore locations as well as near and off locations of the outfall. The present study values are compared with earlier studies of NIOT and MPL in the Ennore coastal waters ( Table 3).

### 5.2.2 Metals

The mean values with range of metal concentration are presented in Table 4. The range of metal concentrations are observed Cu (17.0 to 24.7 µg/l), Pb (13.3 to 20.1µg/l), Zn (64.3 to 90.3 µg/l), Ni (30.5 to 41.7 µg/l), Co (10.8 to 16.4µg/l), Mn (48.0 to 59.3µg/l), Cd (15.3 to 23.2 µg/l), Cr (16.0 to 26.4 µg/l ) and Hg (0.175 to 0.268 µg/l ) in the seawater. The lower concentration of all metals recorded in the offshore location MPL10. The higher concentration of Cu, Zn and Cd in the location MPL 6, MPL 4 and MPL 1 respectively but Ni and Hg in the site MPL 3 whereas Pb, Co, Mn and Cr in the location MPL 2 are recorded during the study period. The tidal variation of metals concentrations are presented in Annexure Table 1b. The results are not showing any trend among the location as well as tides.

### 5.3 SEDIMENTS

Sediments are seafloor materials which eroded from land to ocean through rivers or wind. The constituent of the sediments are depends upon the local geological condition and other anthropogenic activities. Sediments are major nutrient sources for the aquatic faunas. The present study monitors the quality of marine sediments in the Ennore coast. The selected metals concentrations of sediments are shown in Table 5.

The range of Ni (13.56 to 14.23 µg/g), Co (1.65 to 2.26 µg/g), Cu (22.40 to 25.34 µg/g), Cd (0.190 to 0.271 µg/g), Pb (21.50 to 26.35 µg/g), Cr (26.35 to 28.38 µg/g), Hg (0.023 to 0.031 µg/g), Fe (6.52 to 7.34 mg/g), Mn (0.102 to 0.138 mg/g) and Zn (0.152 to 0.200 mg/g) are observed in the sediment. The lower concentrations of all metals are found in the location MPL 10. The higher concentration of Ni, Co, Cu, Cd, and Fe at MPL 2 and Pb, Cr, Mn and Zn at MPL 3 and Hg at MPL4 are recorded respectively.

Petroleum hydrocarbon concentration of sediment varied from 1.477 to 2.677 mg/kg (Table 6). The lower concentration of petroleum hydrocarbon in the location MPL 9 and higher concentration in MPL 7 are found in the sediments.

**Table 2.** Observed variation of mean water quality parameters near the outfall area (brackets indicate the range)

| Parameters | Unit | MPL1 | MPL2 | MPL3 | MPL4 | MPL5 | MPL6 | MPL7 | MPL8 | MPL9 | MPL10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| W-TEMP | °C | 29.2 (29-29.3) | 29.1 (29-29.3) | 29 (28.8-29.2) | 29 (28.7-29.2) | 29 (28.8-29.2) | 29.1 (29.0-29.3) | 28.8 (28.5-29.1) | 28.8 (28.6-29.0) | 28.9 (28.6-29.1) | 28.9 (28.6-29.1) |
| TSS | mg/l | 22 (16.4-29.4) | 23.2 (17.6-28.6) | 21.1 (20- 22.2) | 18.9 (14.8-28.2) | 20.2 (18.4- 21) | 18.5 (15.6-21.2) | 22.45 (17.4-29.2) | 17.2 (14.8-19.6) | 15.45 (13.0-20.8) | 17.7 (15.2-19.6) |
| pH | | 7.93 (7.81-8.09) | 8.02 (7.88-8.12) | 8.01 (7.91-8.08) | 8.01 (7.93-8.08) | 8.04 (7.9-8.1) | 8.05 (7.9-8.1) | 8.04 (7.9-8.0) | 8.01 (7.9-8.0) | 8.01 (7.9-8.1) | 8.04 (7.99-8.11) |
| Salinity | PSU | 34.18 (34.1-34.2) | 34.18 (34.1-34.2) | 34.18 (34.1-34.2) | 34.23 (34.1-34.3) | 34.18 (34.1-34.2) | 34.18 (34.1-34.2) | 33.78 (32.4-34.3) | 34.18 (34.1-34.2) | 34.18 (33.9-34.3) | 34.18 (34.1-34.2) |
| DO | mg/l | 7.48 (7.2-7.6) | 7.23 (6.9-7.4) | 7.30 (7-7.8) | 7.33 (7-7.7) | 7.33 (7.1-7.6) | 7.38 (7.2-7.5) | 7.58 (7.2-7.9) | 7.33 (7..0-7.6) | 7.35 (7.0-7.7) | 7.2 (7.0-7.4) |
| BOD | mg/l | 0.50 (0.2-1.5) | 0.43 (0.2-1.3) | 0.55 (0.2-1) | 0.5 (0.2-0.9) | 0.55 (0.2-1) | 0.68 (0.2-1.6) | 1.13 (0.5-1.4) | 0.7 (0.2-1.1) | 1.05 (0.22-2..4) | 0.63 (0.2-1.0) |
| $NO_2$-N | µmol/l | 0.13 (0.1-0.17) | 0.18 (0.16-0.19) | 0.17 (0.13-0.19) | 0.18 (0.17-0.19) | 0.19 (0.12-0.23) | 0.19. (0.17-0.22) | 0.21 (0.17-.24) | 0.23 (0.19-0.25) | 0.22 (0.19-.28) | 0.21 (0.1-0.26) |
| $NO_3$-N | µmol/l | 1.83 (1.42-2.13) | 1.85 (1.29-2.26) | 1.76 (1.24-2.16) | 1.93 (1.4-2.31) | 1.77 (1.3-1.96) | 2.17 (1.76-2.53) | 2.62 (2.5-2.9) | 2.14 (2.49-2.9) | 1.68 (1.3-2.17) | 2.06 (1.8-2.52) |
| $NH_4^+$ | µmol/l | 0.31 (0.11-0.69) | 0.2 (0.14-0.33) | 0.36 (0.18-0.69) | 0.29 (0.12-0.59) | 0.15 (0.1-0.26) | 0.24 (0.18-0.39) | 0.3 (0.16-0.39) | 0.23 (0.15-0.39) | 0.21 (0.18-0.28) | 0.27 (0.18-0.47) |
| $PO_4$-P | µmol/l | 1.58 (1.55-1.62) | 1.6 (1.51-1.76) | 1.54 (1.46-1.66) | 1.60 (1.50-1.72) | 1.62 (1.5-1.77) | 1.57 (1.45-1.71) | 1.57 (1.45-1.82) | 1.72 (1.5-2.06) | 1.59 (1.46-1.77) | 1.71 (1.48-2.06) |
| PHC | µg/l | 46.12 (43.6-48.6) | 46.25 (36.2-48.3) | 47.38 (42.3-52.3) | 47.31 (33.3-49.2) | 44.8 (43.8-45.7) | 54.9 (53.5-56.3) | 55.86 (52.3-59.3) | 39.63 (34.4-45) | 35.77 (30.8-40.8) | 36.72 (33.1-40.4) |

**Table 3.** Data comparison between present study (2015) with earlier studies of NIOT ( 2004, 2005 & 2012 ) and MPL (2012) and at Ennore coastal waters, East coast of India.

| Parameters | Unit | NIOT, 2004** | NIOT, 2005** | MPL, 2012 | NIOT, 2012 # | NIOT, Present study 2015 | SW5* |
|---|---|---|---|---|---|---|---|
| W-TEMP | °C | 28.6 - 28.5 | 28.6 - 29 | 30.5 - 31 | 26.10 - 28.10 | 28.5 - 29.3 | -- |
| TSS | mg/l | 12.3 - 15.8 | 13 - 20.1 | 36.4 - 40 | 1.80 - 3.60 | 13.0 - 29.4 | -- |
| pH | | 8.21 - 8.32 | 8.23 - 8.3 | 8.1 - 8.2 | 8.07 - 8.18 | 7.8 - 8.1 | 6 - 9 |
| Salinity | PSU | -- | 33.8 - 34.4 | 33.9 - 34.2 | 34.1 - 34.4 | 32.4 - 34.3 | -- |
| DO | mg/l | 5.99 - 6.11 | -- | 5.19 | 6.7 - 8.46 | 6.9 - 7.9 | 3 |
| BOD | mg/l | -- | -- | 3.04 - 3.6 | 0.2 - 0.92 | 0.2 - 2.4 | -- |
| $NO_2$-N ## | µg/l | -- | -- | -- | 1.26 - 4.48 | 1.4 - 4.2 | -- |
| $NO_3$-N ## | µg/l | 22 - 45 | 20.35 - 35.37 | 2620 - 2900 | 74.3 - 165 | 16.8 - 40.6 | -- |
| $NH_4^+$ ## | µg/l | 15 - 25 | 14.37 - 18.14 | 570 - 700 | 65.5 - 153.8 | 1.4 - 6.58 | -- |
| $PO_4$-P ## | µg/l | 5 - 24 | 4.3 - 16.61 | 880- 1200 | 5.27 - 18.6 | 43.4 - 65.4 | -- |
| PHC | µg/l | -- | -- | 4.4 - 5.5 | -- | 30.8 - 59.3 | -- |

*: Central Pollution Control Board (CPCB) marine outfall standards; ** : Off Ennore port; # Off Ennore creek,
## Units converted to µg/l from present and earlier report

**Table 4.** Observed spatial variations of trace metal mean concentration (µg/l) in the seawater collected near MPL outfall (brackets indicate the range)

| Locations | Cu | Pb | Zn | Ni | Co | Mn | Cd | Cr | Hg |
|---|---|---|---|---|---|---|---|---|---|
| MPL1 | 20.6 (18.3-22.7) | 18.5 (17.3-19.7) | 80.6 (74.3-86.8) | 37.1 (34.4-39.5) | 14.7 (13.2-16.1) | 55.3 (51.4-58.9) | 20.8 (18.2-23.2) | 19.4 (15.9-22.9) | 0.235 (0.198-0.267) |
| MPL2 | 21.9 (19.7-24.4) | 19.0 (18.1-20.1) | 81.3 (75.1-87.8) | 38.2 (35.2-41.7) | 15.0 (13.3-16.4) | 55.8 (52.0-59.3) | 21.1 (19.3-22.7) | 23.1 (20.5-26.4) | 0.223 (0.197-0.268) |
| MPL3 | 20.9 (18.8-22.8) | 18.6 (17.7-19.3) | 80.7 (74.1-87.3) | 38.2 (34.8-41.6) | 14.6 (13.5-15.6) | 55.2 (52.1-58.1) | 21.0 (18.9-23.1) | 19.6 (17.0-22.6) | 0.244 (0.218-0.268) |
| MPL4 | 21.6 (19.3-24.1) | 18.1 (17.6-18.5) | 82.2 (73.6-90.3) | 38.2 (35.1-41.4) | 14.5 (13.6-15.6) | 54.7 (52.1-57.6) | 20.9 (19.2-22.5) | 20.5 (17.8-22.7) | 0.211 (0.191-0.229) |
| MPL5 | 20.4 (17.2-23.7) | 16.3 (14.9-17.7) | 75.9 (67.2-84.7) | 36.5 (32.0-40.7) | 14.0 (13.2-15.1) | 53.6 (50.3-57.0) | 19.7 (17.3-21.9) | 21.1 (16.9-25.4) | 0.230 (0.184-0.261) |
| MPL6 | 21.1 (18.1-24.7) | 16.7 (15.9-17.8) | 78.5 (72.3-85.0) | 37.3 (34.0-41.0) | 14.2 (13.6-15.3) | 54.7 (51.9-57.8) | 19.5 (17.6-21.3) | 22.2 (18.7-25.7) | 0.224 (0.193-0.261) |
| MPL7 | 20.4 (17.3-23.5) | 16.8 (15.5-18.1) | 79.0 (72.3-85.3) | 37.1 (33.3-40.9) | 14.0 (13.2-15.0) | 53.8 (50.9-56.8) | 19.6 (17.4-21.7) | 18.7 (16.9-20.8) | 0.242 (0.217-0.268) |
| MPL8 | 20.7 (17.9-23.7) | 16.9 (15.6-18.3) | 78.9 (72.9-84.5) | 36.6 (33.4-39.9) | 13.6 (13.3-14.1) | 53.3 (51.2-55.5) | 19.3 (17.6-20.8) | 19.9 (16.6-23.0) | 0.228 (0.214-0.240) |
| MPL9 | 20.2 (17.0-23.5) | 16.5 (14.8-18.1) | 78.0 (71.2-84.0) | 35.9 (32.5-39.3) | 13.1 (12.4-13.7) | 52.6 (50.5-54.8) | 18.7 (17.2-20.4) | 19.0 (17.4-20.7) | 0.209 (0.194-0.237) |
| MPL10 | 18.4 (14.8-22.1) | 14.8 (13.3-16.1) | 68.8 64.3-73.3) | 33.8 (30.5-36.7) | 11.4 (10.8-12.0) | 50.9 (48.0-53.1) | 17.4 (15.3-19.0) | 17.4 (16.0-19.0) | 0.192 (0.175-0.208) |

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Table 5. Observed spatial variations of trace metal concentration in sediments collected near MPL outfall

| Locations | Concentration (µg/g) | | | | | | | Concentration (mg/g) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Ni | Co | Cu | Cd | Pb | Cr | Hg | Fe | Mn | Zn |
| MPL1 | 14.12 | 2.15 | 25.20 | 0.268 | 26.05 | 28.15 | 0.026 | 7.28 | 0.124 | 0.192 |
| MPL2 | 14.23 | 2.26 | 25.34 | 0.271 | 26.32 | 28.35 | 0.027 | 7.34 | 0.134 | 0.198 |
| MPL3 | 14.21 | 2.22 | 25.28 | 0.27 | 26.35 | 28.38 | 0.029 | 7.32 | 0.138 | 0.200 |
| MPL4 | 14.15 | 2.12 | 25.00 | 0.263 | 26.12 | 28.22 | 0.031 | 7.26 | 0.128 | 0.19 |
| MPL5 | 13.98 | 2.02 | 24.60 | 0.25 | 25.81 | 27.86 | 0.030 | 6.95 | 0.118 | 0.185 |
| MPL6 | 14.02 | 2.05 | 25.12 | 0.25 | 26.1 | 28.00 | 0.024 | 7.12 | 0.114 | 0.172 |
| MPL7 | 13.88 | 2.04 | 25.20 | 0.21 | 22.8 | 27.3 | 0.021 | 6.75 | 0.112 | 0.162 |
| MPL8 | 13.90 | 1.91 | 24.88 | 0.22 | 25.1 | 27.86 | 0.023 | 6.95 | 0.112 | 0.168 |
| MPL9 | 13.78 | 1.98 | 23.00 | 0.22 | 22.3 | 27.28 | 0.026 | 6.78 | 0.110 | 0.16 |
| MPL10 | 13.56 | 1.65 | 22.40 | 0.19 | 21.5 | 26.35 | 0.023 | 6.52 | 0.102 | 0.152 |

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**Table 6.** Spatial variations of petroleum hydrocarbon (PHC, mg/kg) from sediments collected near MPL outfall

| Locations | Concentration (mg/kg) |
|---|---|
| MPL1 | 2.180 |
| MPL2 | 1.846 |
| MPL3 | 2.077 |
| MPL4 | 1.601 |
| MPL5 | 2.279 |
| MPL6 | 2.677 |
| MPL7 | 2.671 |
| MPL8 | 1.678 |
| MPL9 | 1.477 |
| MPL10 | 1.718 |

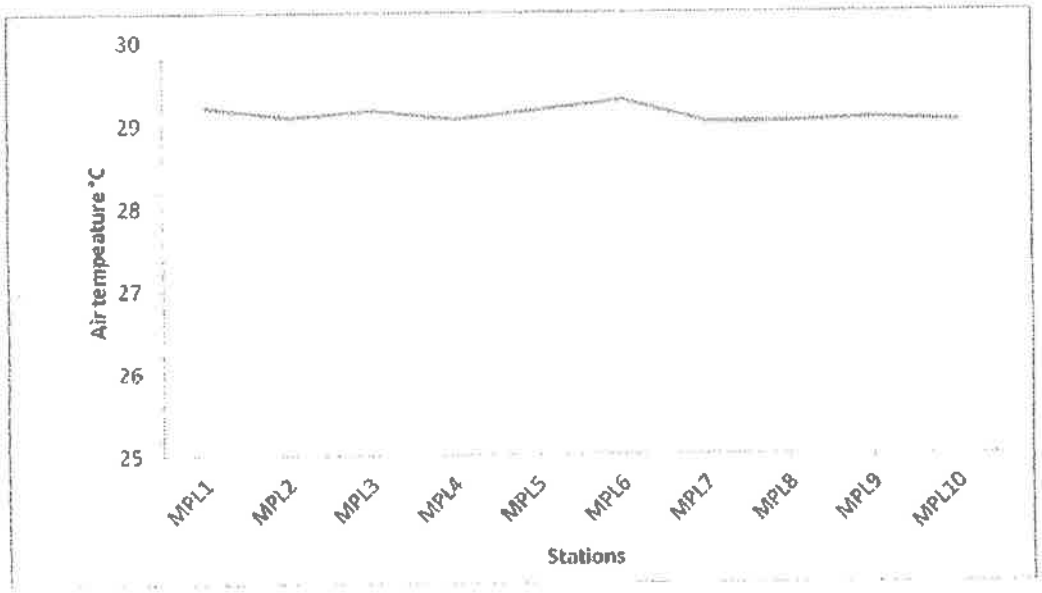


**Fig. 5 Spatial variations of atmospheric temperature (°C) near the MPL outfall**

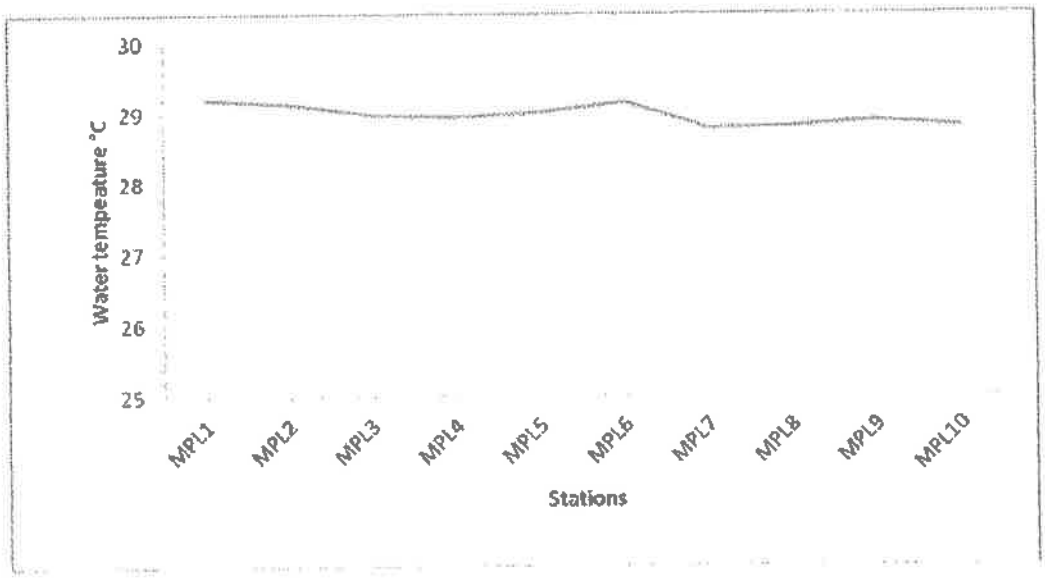


**Fig. 6 Spatial variations of water temperature (°C) near the MPL outfall**

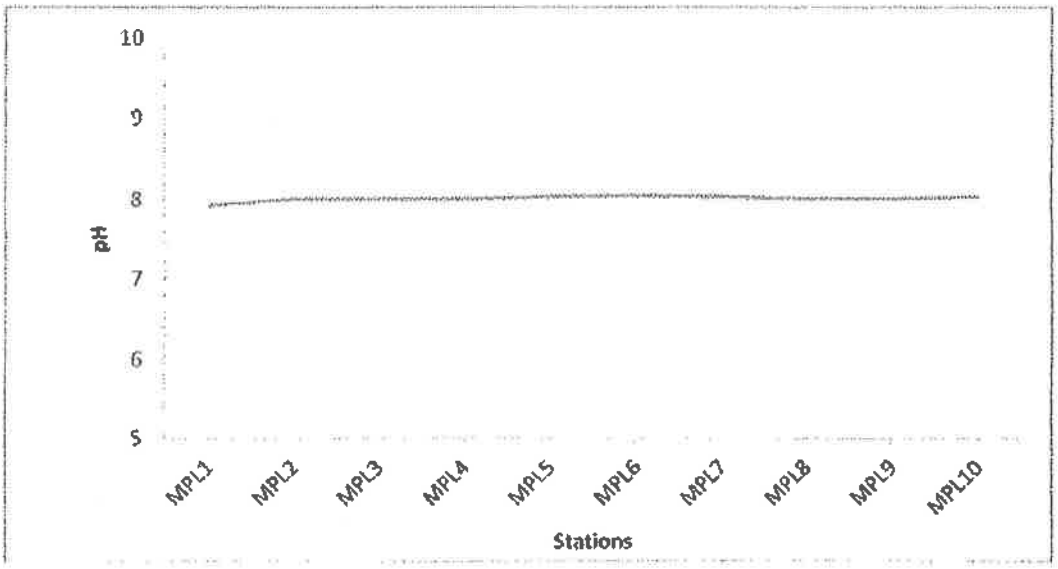


**Fig. 7** Spatial variations of pH near the MPL outfall

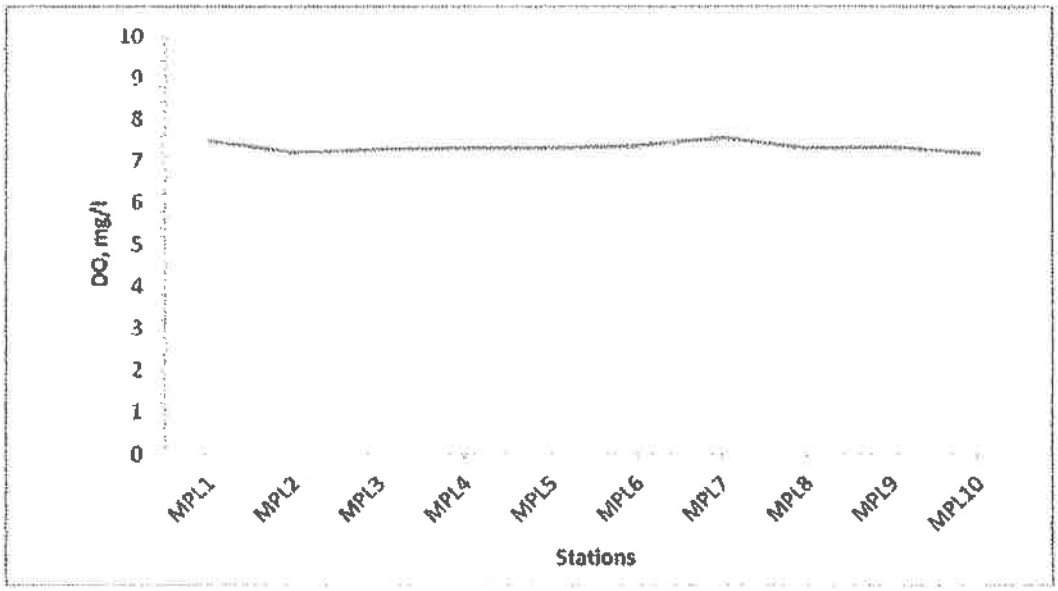


**Fig. 8** Spatial variations of dissolved oxygen (DO, mg/l) near the MPL outfall

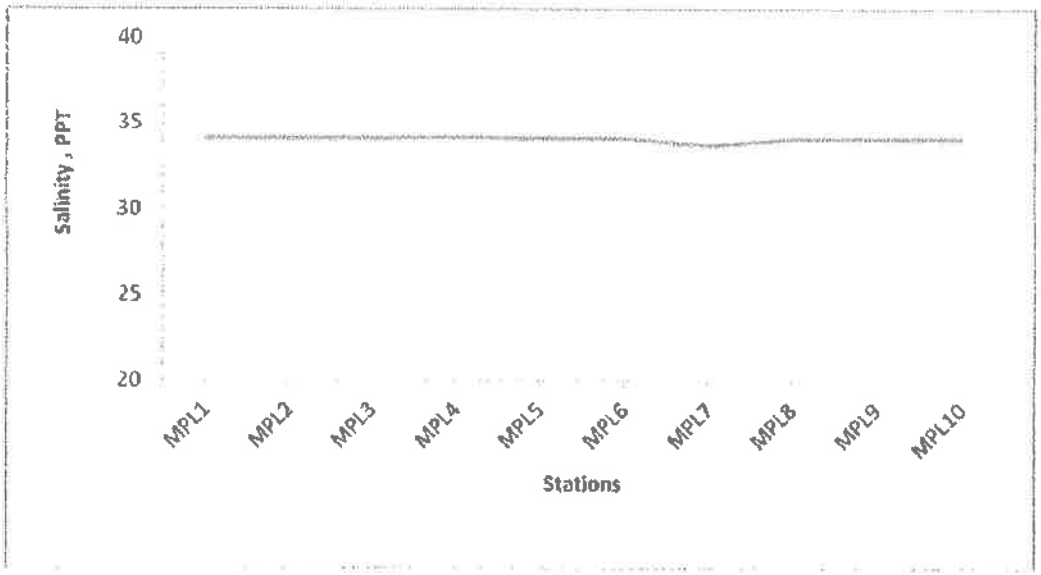


**Fig. 9** Spatial variations of salinity (PPT) near the MPL outfall

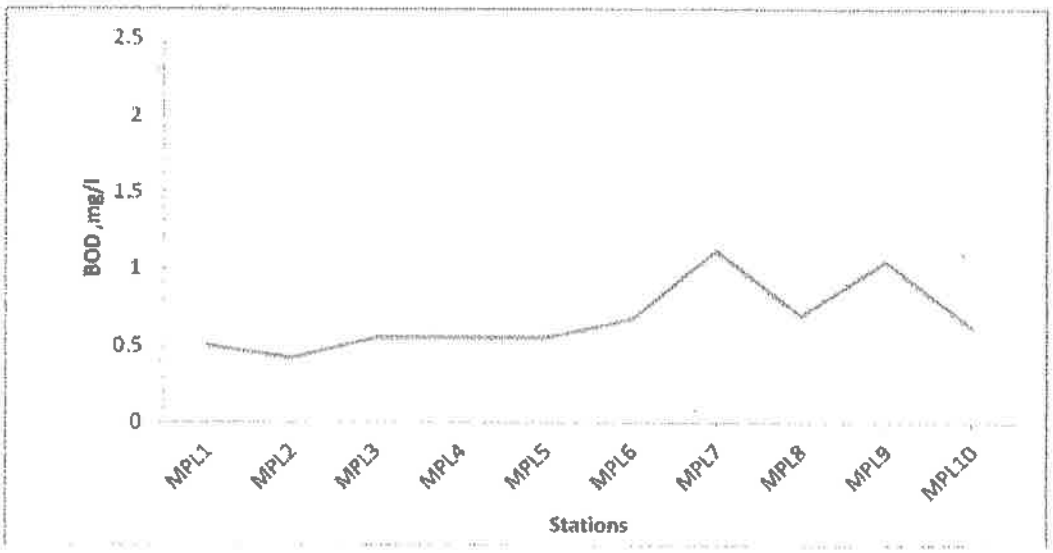


**Fig. 10** Spatial variations of biological oxygen demand (BOD, mg/l) near the MPL outfall

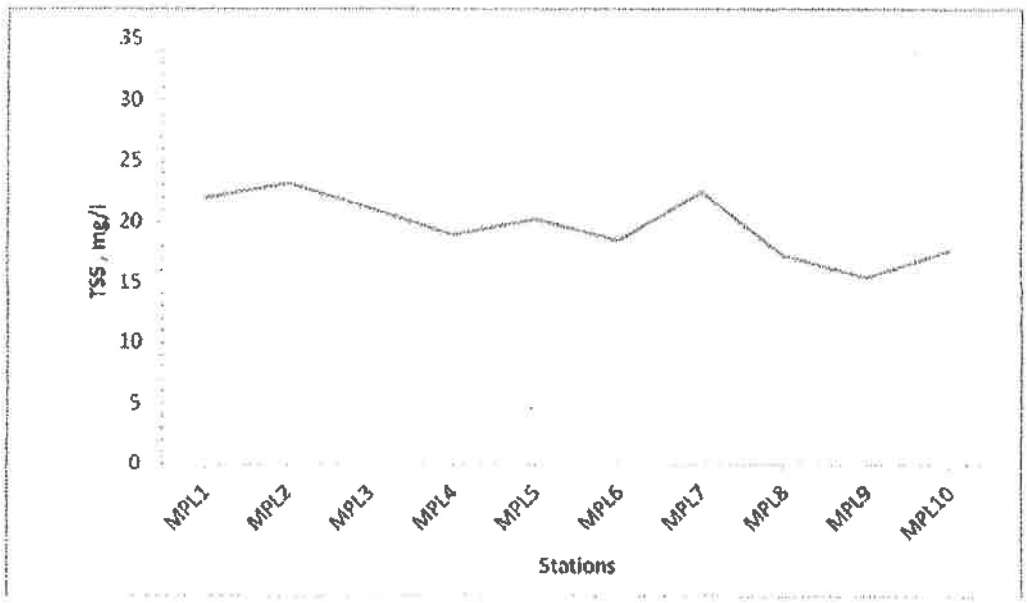


**Fig. 11** Spatial variations of Total Suspended Solids (TSS, mg/l) near the MPL outfall

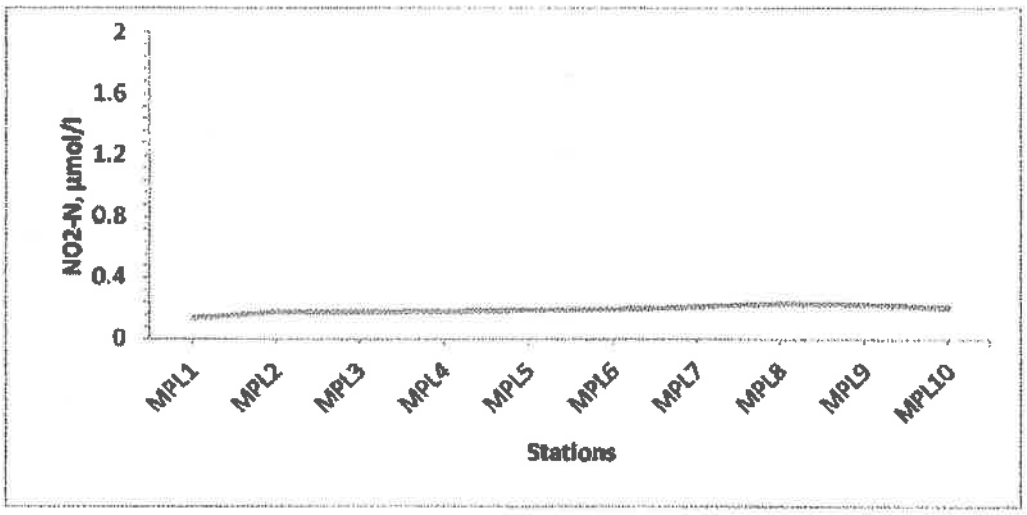


**Fig. 12** Spatial variations of nitrite-nitrogen ($NO_2$-N, µmol/l), near the MPL outfall

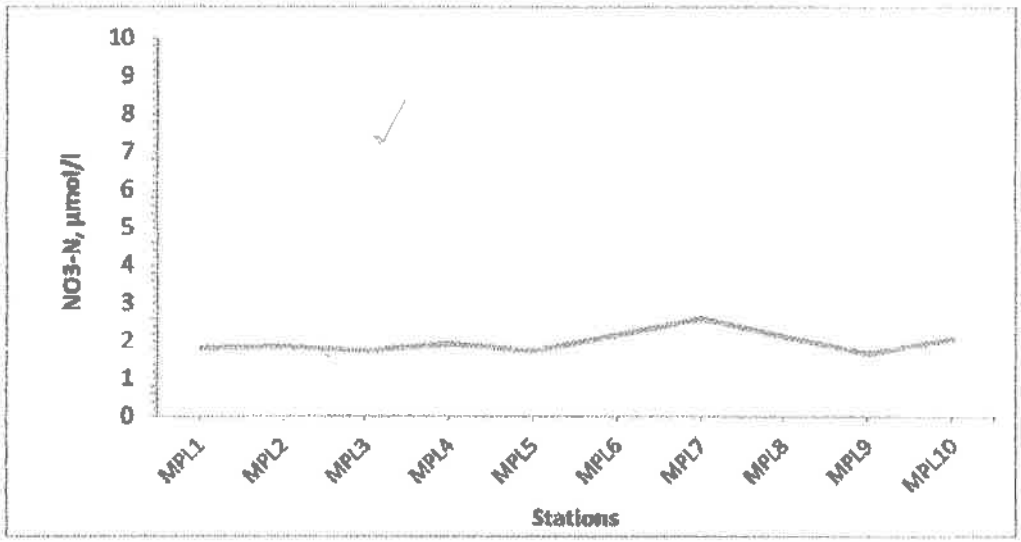


**Fig. 13** Spatial variations of nitrate-nitrogen ($NO_3$-N, µmol/l) near the MPL outfall

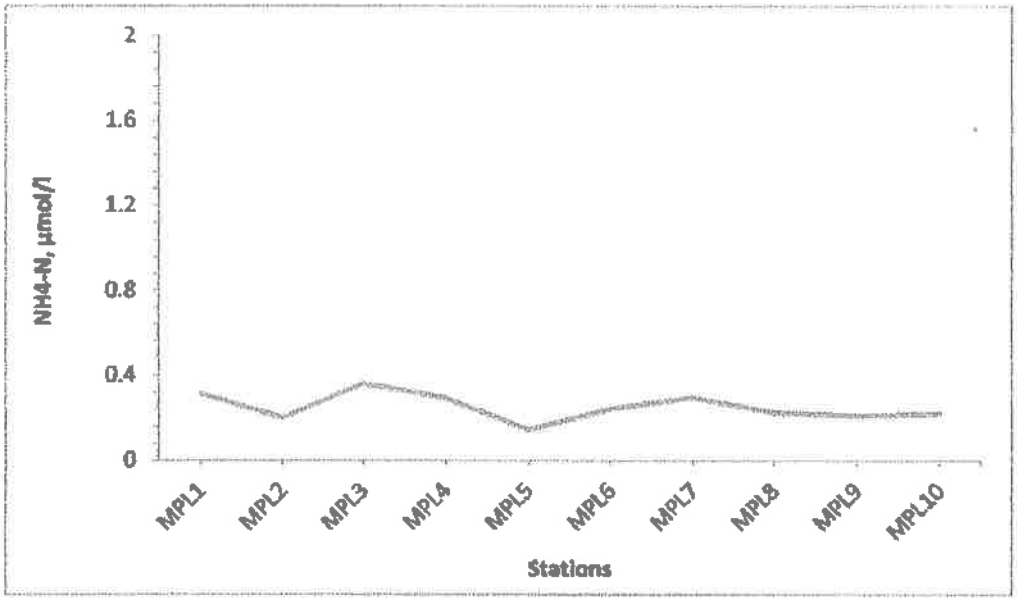


**Fig. 14** Spatial variations of Ammonia-nitrogen (NH4-N, µmol/l) near the MPL outfall

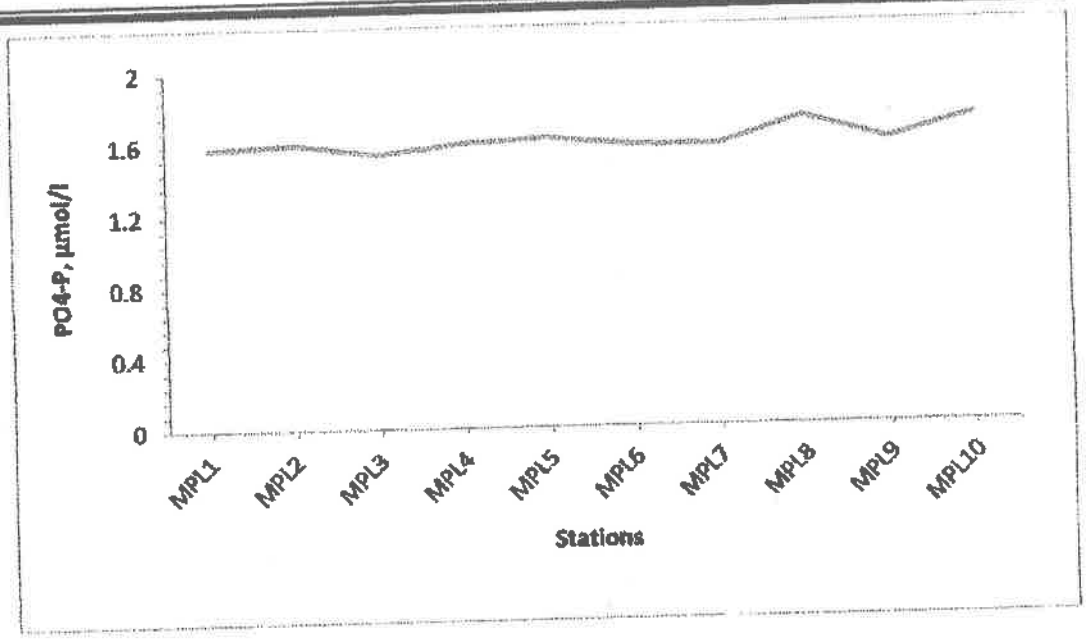


Fig. 15 Spatial variations of Phosphate ($PO_4$-P, µmol/l) near the MPL outfall

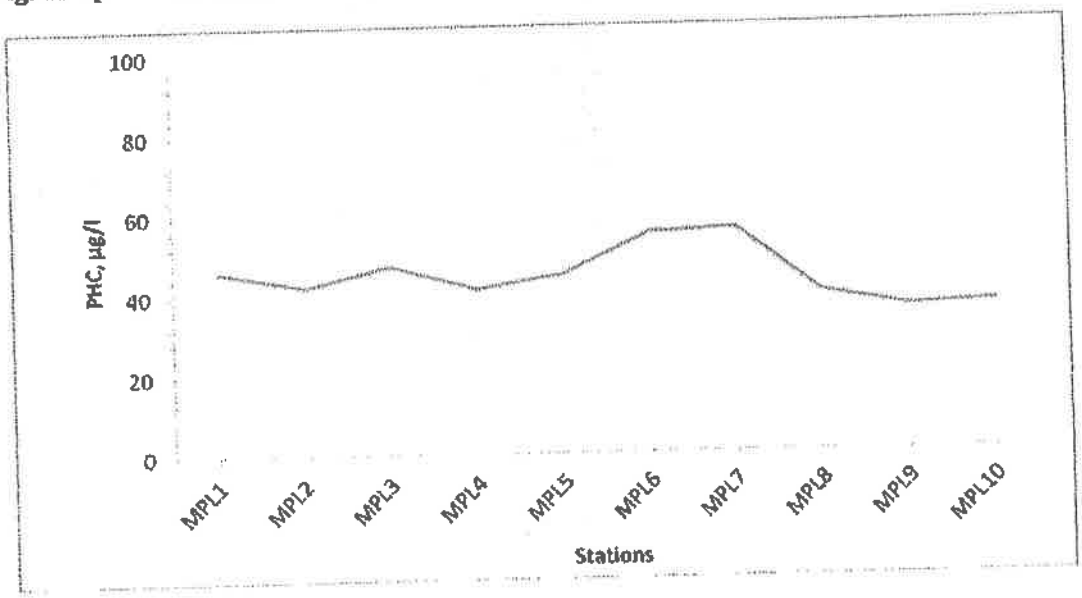


Fig.16 Spatial variations of Petroleum Hydro Carbon (PHC, µg/l) near the MPL outfall

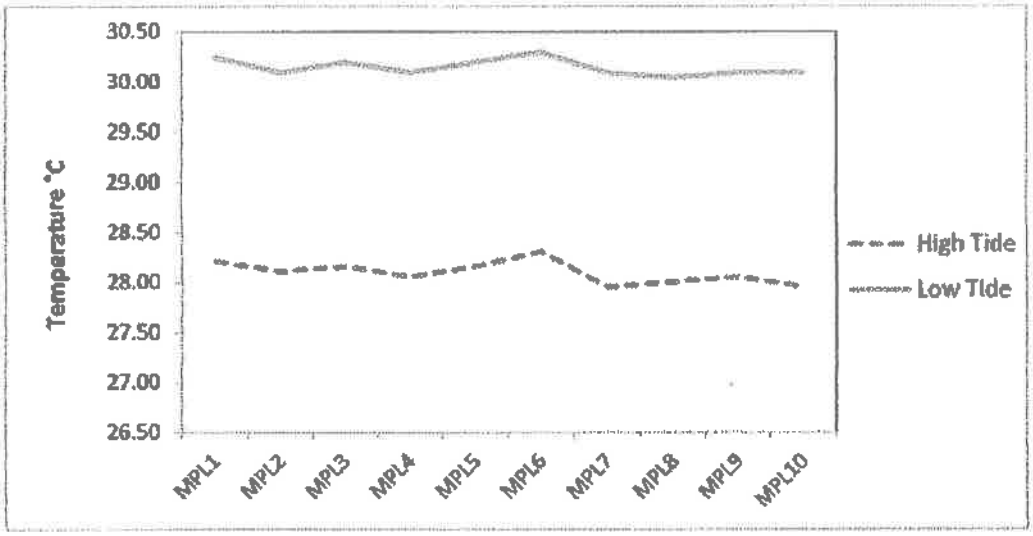


**Fig. 17** Spatial variations of atmospheric temperature (°C) in both high tide and low tide

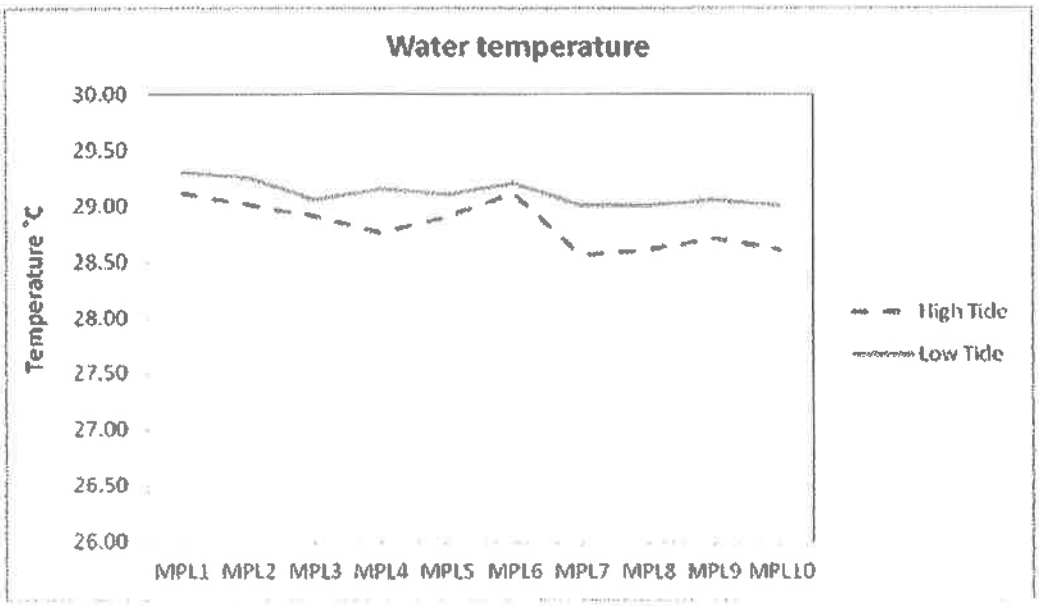


**Fig. 18** Spatial variations of water temperature (°C) ion both high tide and low tide

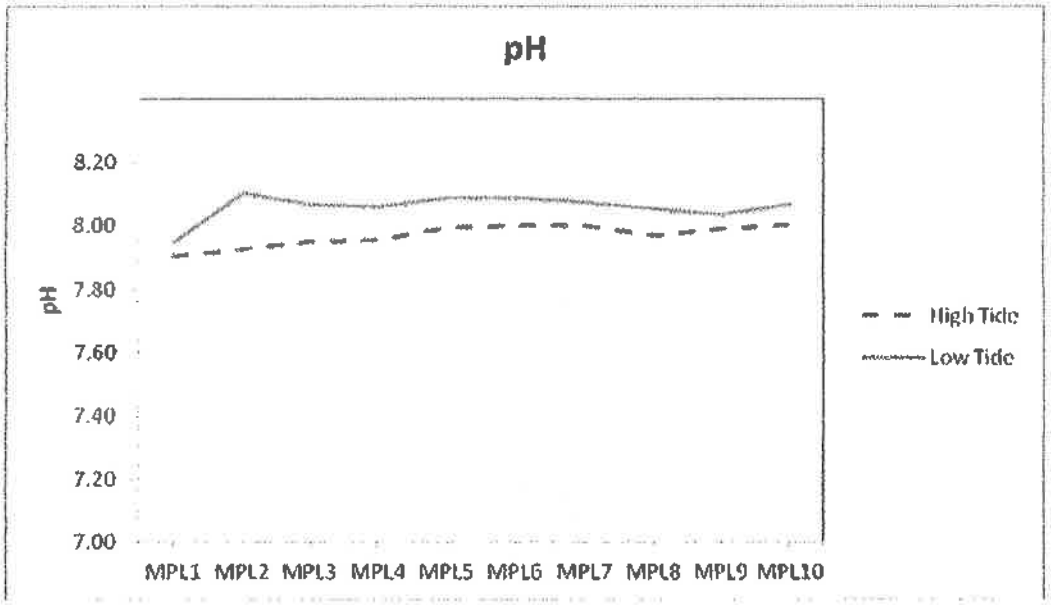


**Fig. 19** Spatial variations of pH in both high tide and low tide

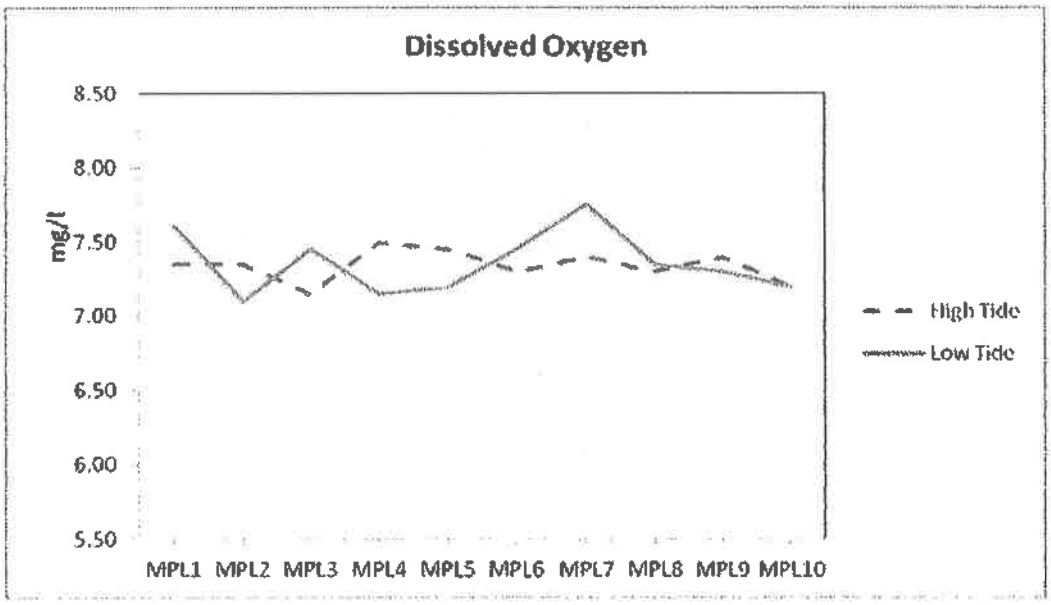


**Fig. 20** Spatial variations of dissolved oxygen (DO, mg/l) in both high tide and low tide

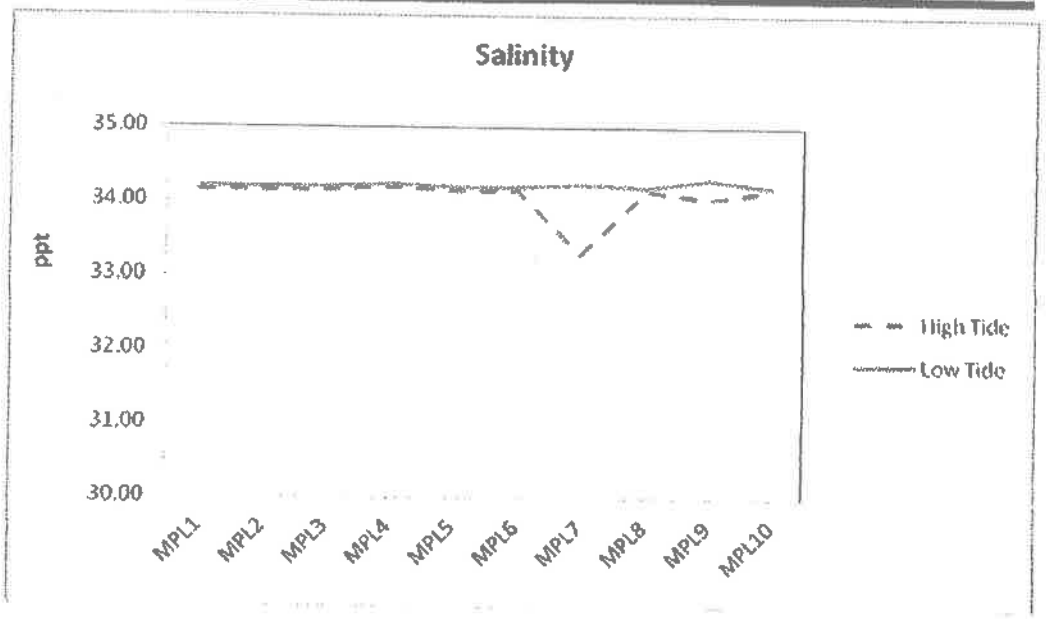


**Fig. 21** Spatial variations of salinity (ppt) in both high tide and low tide

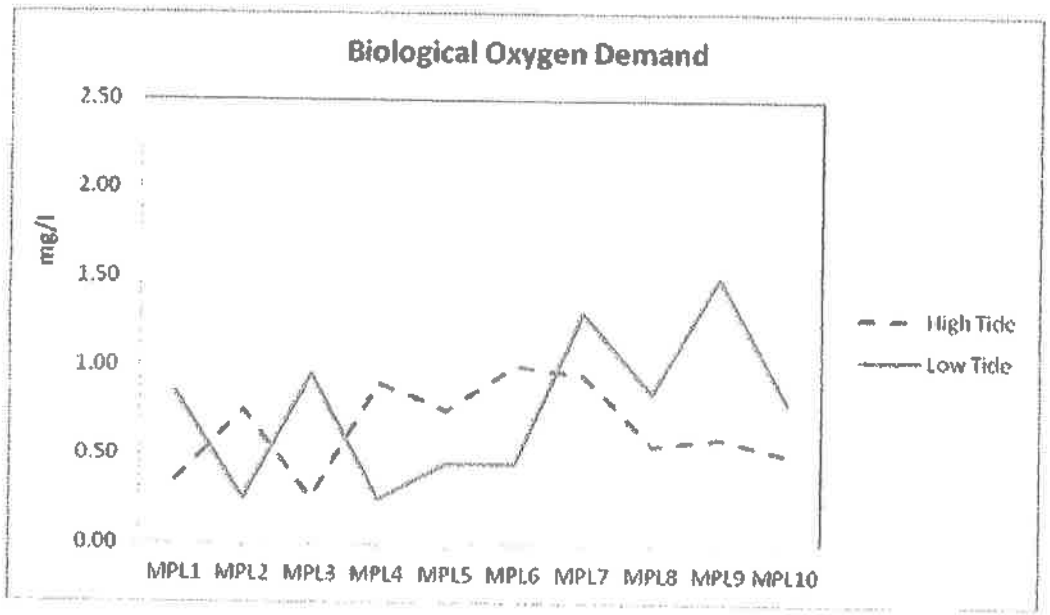


**Fig. 22** Spatial variations of biological oxygen demand (BOD, mg/l) in both high tide and low tide

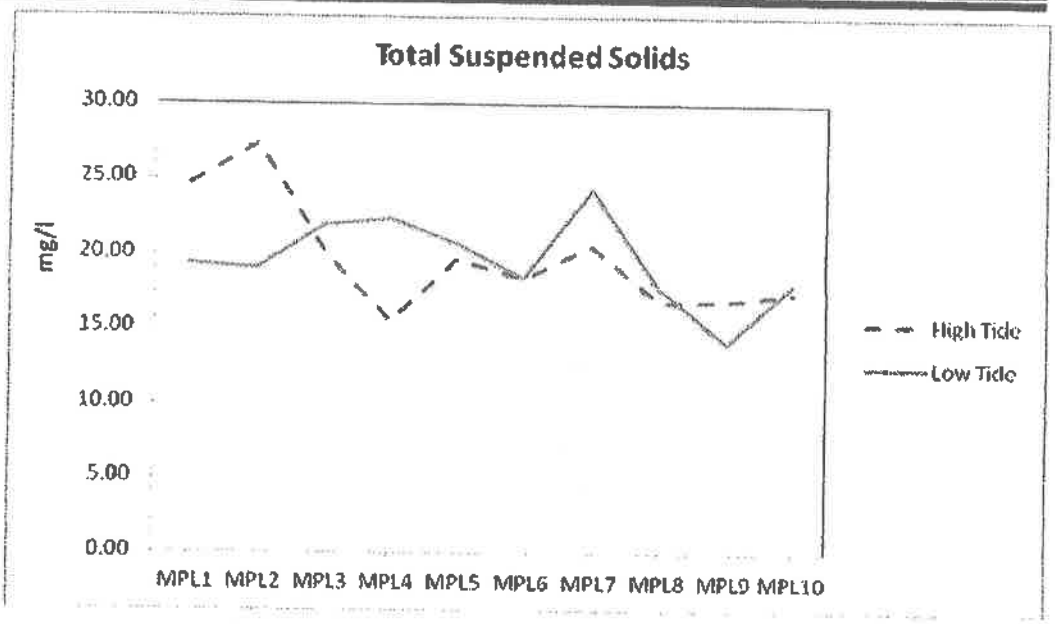


**Fig. 23** Spatial variations of total suspended solids (TSS, mg/l) in both high tide and low tide

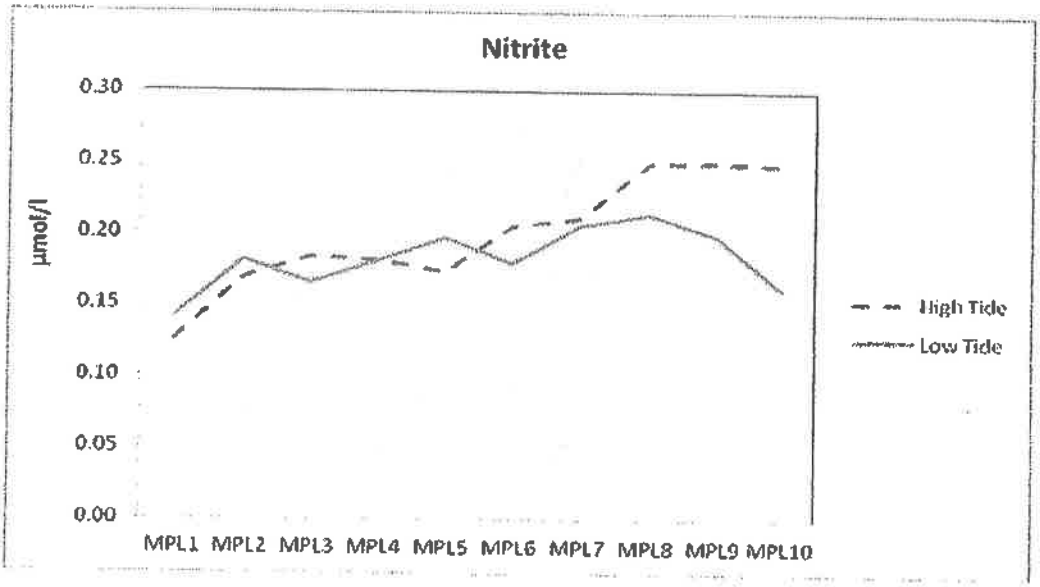


**Fig. 24** Spatial variations of Nitrite (µmol/l) in both high tide and low tide

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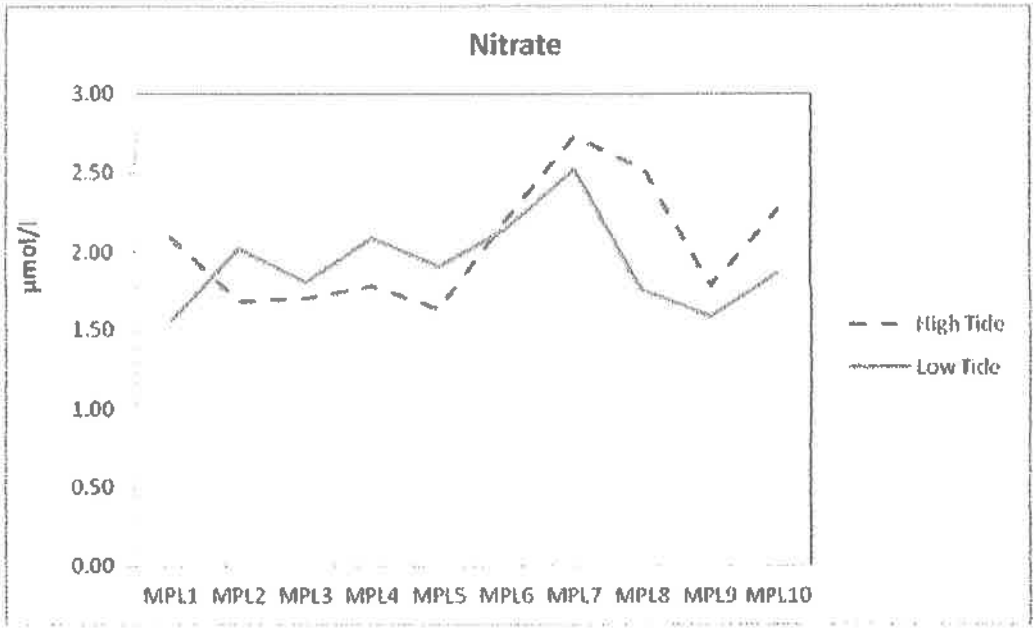


**Fig. 25** Spatial variations of Nitrate (µmol/l) in both high tide and low tide

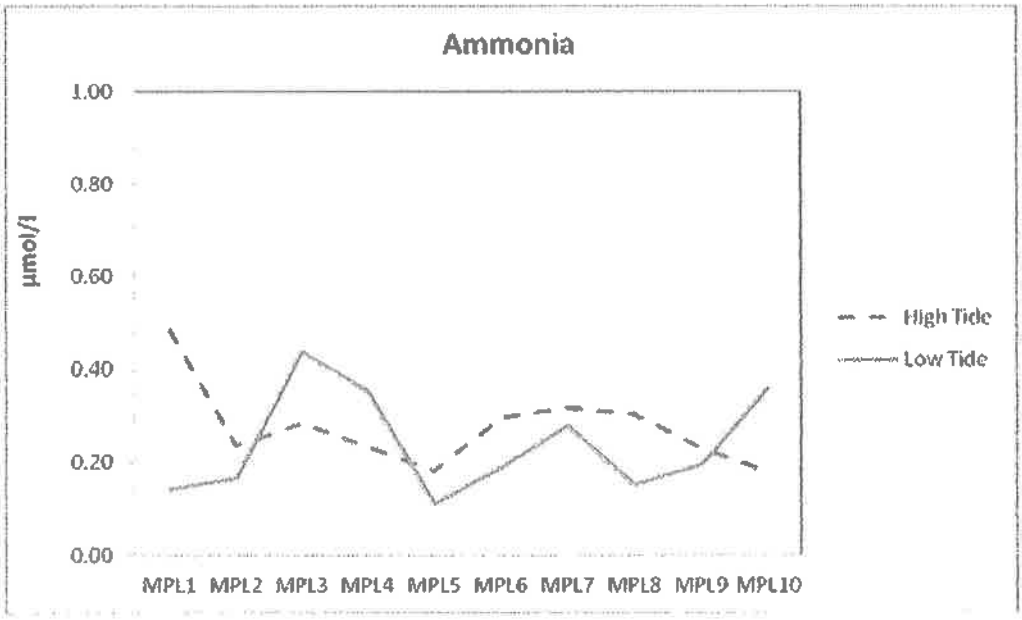


**Fig. 26** Spatial variations of ammonia (µmol/l) in both high tide and low tide

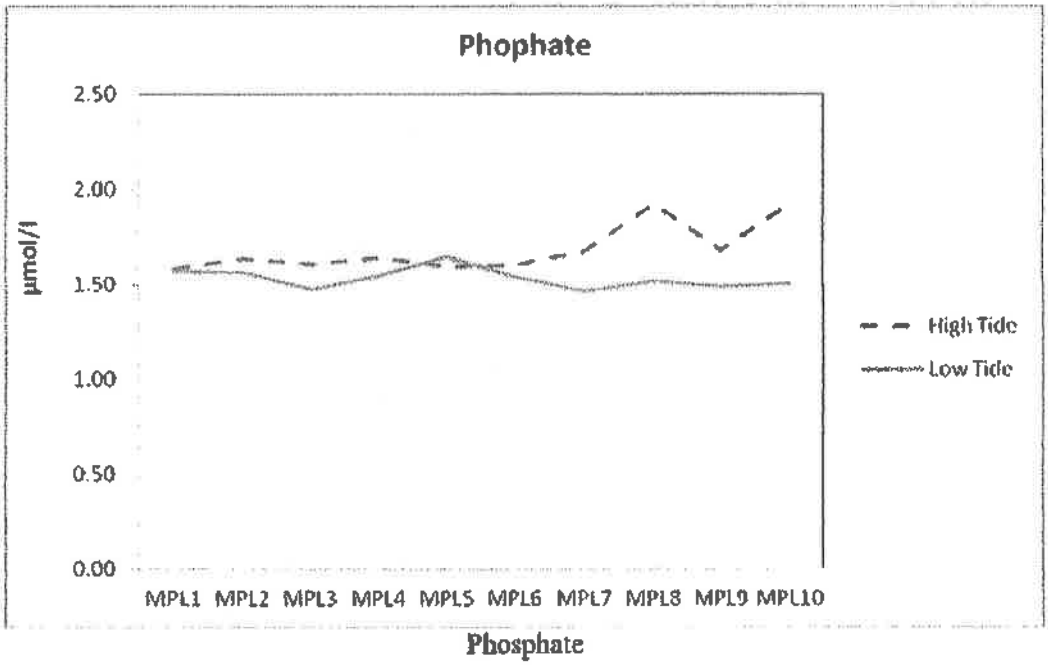


**Fig. 27** Spatial variations of phosphate (µmol/l) in both high tide and low tide

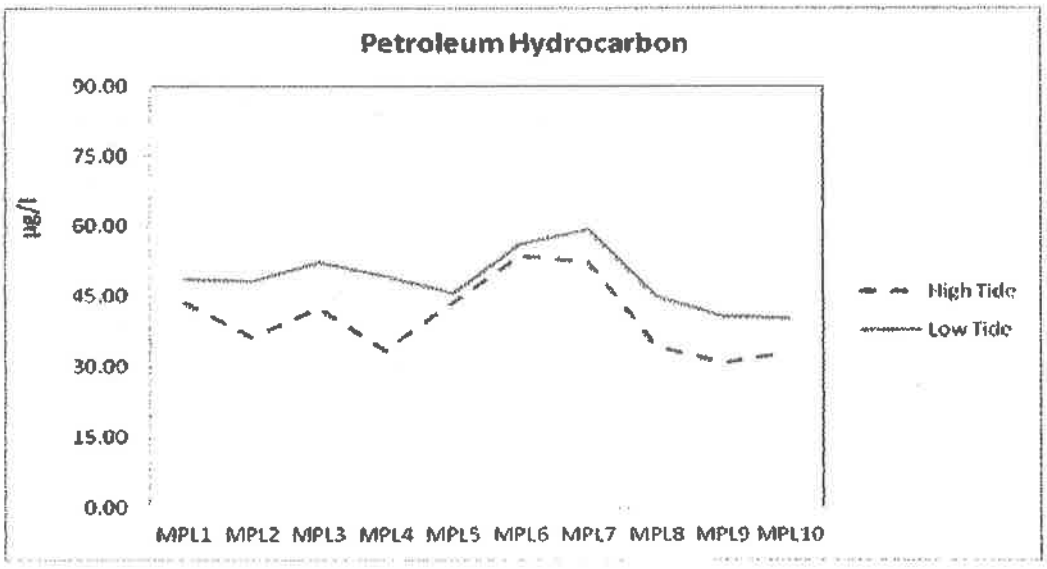


**Fig. 28** Spatial variations of petroleyum hydrocarbon (PHC, µg/l) in both high tide and low tide

ANNEXURE - 9D

# MARINE ENVIRONMENTAL IMPACT STUDY FOR THE COMBINED TREATED EFFLUENTS DISCHARGED INTO THE SEA

**Conducted for**

**M/s. TAMILNADU PETROPRODUCTS LTD**
**EXPRESS HIGHWAY, MANALI,**
**CHENNAI – 600 068.**

**and**

**M/s. MANALI PETROCHEMICALS LIMITED**
**PONNERI HIGHROAD, MANALI,**
**CHENNAI – 600 068.**

**By**

**ENVIRONMENTAL CONSULTANT**
**HUBERT ENVIRO CARE SYSTEMS (P) LTD.**
**CHENNAI – 600 083**
**December 2012**

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## EXECUTIVE SUMMARY

Marine outfall pipeline was installed by M/s. Manali Petrochemicals Limited and Tamilnadu Petroproducts Limited is utilizing this pipeline for ECH plant treated effluent disposal. The quantity of waste water discharged through the pipeline is 385 $m^3$/hr. Baseline data were collected at various sampling stations ie around the discharge points. Studies were carried out on physical parameters, water quality parameters, sediment quality and biological parameters. During April, May, June and December wind speeds were around 9-11 Knots. Remaining period it was varying between 7-9 Knots. The tides in the region are semi diurnal with an average spring tidal range of 1.0 m and heap tidal of 0.4m. The sea surface temperature varies between 29°C- 31°C. From the tide and wind result it is concluded that even during the calm sea, the waste water discharged at outfall point gets diluted to nearly ambient value. Examination of water quality at this region indicated that they do not differ substantially both in vertical and spatial directions. The marine flora and fauna also indicate the existence of diverse population. The wastewater discharged is reaching the ambient quality with in short distance and time. Also the outfall diffuser in cylindrical shape avoids interface with currents.

# MARINE IMPACT STUDY REPORT

## 1.0 INTRODUCTION

Marine outfall pipeline was installed by M/s. Manali Petrochemicals Limited and Tamilnadu Petroproducts Limited is utilizing this pipeline for ECH plant treated effluent disposal. TPL has appointed M/s.Hubert Enviro Care Systems Pvt Ltd. to conduct the marine impact study for the dispersion of effluent. The report contains the study conducted on Bathymetry, Echo sounder, physical parameters and water quality parameters.

## 2.0 OBJECTIVES AND SCOPE:

The objective of the study is to carry out the marine impact assessment for the outfall pipeline. The scope of the work is

a. Marine impact study for the combined treated effluent discharged to the sea.
b. To identify probable impact to the pipeline and to the aquatic life near the disposal area.
c. To suggest mitigation measures to reduce the impact, if any.
d. To suggest adequate plan for the management of marine environment.

## 3.0 WATER & WASTEWATER

**MPL Plant – I**

The wastewater generations from the following sources of the existing unit details are furnished below:

| S.No | Sources of Waste water generation | Total, $m^3$/day |
|---|---|---|
| 1. | Total waste water generation | 2165 (Min), 2414 (Max) |
| 2. | Domestic | 15 |
| 3. | Process & Utilities | 2150 (Min), 2399 (Max) |
| 4. | Recycled waste water | 600 |
| 5. | Effluent Discharged | 2165 (Min), 2414 (Max) |

The treated effluent from the ETP shall be sent to Marine disposal

**MPL Plant –II**

The waste water generations from the following sources of the existing unit details are furnished below:

| S.No | Sources of Waste water generation | Total, $m^3$/day |
|---|---|---|
| 1. | Total waste water generation | 2324 (Min), 2574 (Max) |
| 2. | Domestic | 15 |
| 3. | Process & Utilities | 2309 (Min), 2559 (Max) |
| 4. | Recycled waste water | 480 |
| 5. | Effluent Discharged | 2324 (Min), 2574 (Max) |

The treated effluent from the ETP shall be sent to Marine disposal

TPL – ECH Plant

Water requirements is met through fresh water from Metro water (M/s. CMWSSB) and treated effluents from M/s. TPL – Heavy Chemicals Division (HCD), Linear Alkyl Benzene plant (LAB) and M/s. Futura Polyester Limited (FPL) for process requirements. Total quantity of treated effluents utilized in ECH process is 208503$m^3$ (100270$m^3$ from TPL – LAB plant, 69769$m^3$ from TPL – HCD plant and 38464$m^3$ from M/s. FPL), thus by conserving equal amount of fresh water consumption.

The wastewater generations from the following sources of the existing unit details are furnished below

| S.No | Details (2011 – 2012) | Total |
|---|---|---|
| 1. | Treated effluent from TPL – LAB, HCD & Futura Polyester Ltd recycled for process purpose | 203968 $m^3$ |
| 2. | Fresh water for process purpose | 506460 $m^3$ |
| 3. | Fresh water for cooling purpose | 164050 $m^3$ |
| 4. | Fresh water for domestic purpose | 2300 $m^3$ |
| 5 | Total water consumption | 876778 $m^3$ |
| 6 | Total effluent generation | 596759 $m^3$ |

A full fledged Effluent Treatment Plant is provided for treating trade effluent with a capacity of 118m3/hr (2832 KLD).

ETP is adequate to treat wastewater generated from TPL – ECH plant and the quality of treated effluent is within the standards prescribed by TNPCB.

## 4.0 EFFLUENT WATER PUMP OUT SYSTEM TO SEA

M/s. MPL is operating two production plants at Manali near Chennai. These Plants produces significant quantity of propylene oxide, propylene glycol and various grades of Polyol as their main products. Each plant has two separate pipelines to dispose the treated effluent into the sea. The treated effluent confirms to the standards stipulated by TNPCB. The line is renewed with new pipeline for entire length and commissioned during September 2011. New line is only used

The effluent is pumped through, HDPE pipeline into the sea, with diffuser arrangement at the end. HDPE pipeline has 400 mm OD, PE 100, N 10. The length of pipeline between the LFP (Land Fall Point) and the diffuser is about 700 m. The LFP of the marine outfall is located 6 Km north of Kasimedu Fishing Harbor and 6Km south of Ennore Creek. The land fall point is located at Latitude 13° 10' 59" N and longitude 80° 18' 59" E. Total quantity of effluent discharged into the sea will be 385 $m^3$/ Hr.

## 5.0 EFFLUENT TREATMENT PLANTS (ETP)

### MPL Plant I - ETP

MPL plant – I is having well established effluent treatment plant. The effluent treatment plant is having the facility to treat process and sewage combined effluent. Combined effluent is pumped to the clariflocculator.

Process effluent generated from Propylene oxide, Propylene glycol and Polyol plants and sewage are pumped to clarifier where the effluent is concentrated at the bottom of the clarifier to 2%. The concentrated effluent is pumped to the sludge thickener and further concentrated to the level of 8% solids. The thickener under flow is taken to the Rotary vacuum filter. The solids are dried on the cloth-using vacuum. The dry solids are scrapped by scrapper and discharge into trucks, which is used for land filling in low lying areas and brick manufacturing and cement industries.

The overflow from the clarifier flows to the cooling tower and cooled to 40°C and pumped to series of Bio-Reactors. The COD is reduced from 2000 PPM to less than 250 PPM and BOD is reduced from 400 PPM to less than 100 PPM using the bacteria and aeration process. Surface aerators are in operation to maintain the dissolved oxygen level 3% to 4%. Treated effluent in the treated effluent tank which is analyzed once in a day is analyzed once in a day. After complete analysis, it is pumped to the sea.

The following equipment is in the ETP plant at MPL plant – I

1. Clariflocculator - 1 No
2. Thickener – 1 No
3. Rotary vacuum drum filter – 2 Nos

4. Cooling tower – 2 Nos
5. Bio reactors – 6 Nos
6. Mass culture tank – 1 No
7. Nutrient tank – 2 Nos
8. Floating aerators – 3 Nos
9. Surface Aeration Agitators – 4 Nos
10. High rate thickener – 1 No

**MPL Plant – II - ETP**

MPL plant –II is having well established effluent treatment plant. In the effluent treatment plant having facility to treat Process and sewage combined effluent is treated. Combined effluent is pumped to the high rate thickener.

Process effluent generated from Propylene oxide, Propylene glycol and Polyol plants and sewage are pumped to high rate thickener, where the effluent is concentrated at the bottom of the thickener to the level of 8% solids. The thickener underflow is taken to the Rotary vacuum filter. The solids are dried on the cloth using vacuum. The dry solids are scrapped by scraper and discharge into trucks, which is used for land filling in low-lying areas and brick manufacturing and cement industries.

The overflow from the thickener flows to Equalization tank it is cooled by cooling tower and pumped to flash mixer, primary clarifier and to aeration tank floating mixers at 40 °C in the aeration tank, COD is reduced to less than 250 ppm and BOD is reduced to less than 100 ppm using the bacteria and aeration process. Surface aerators are in operation to

maintain the dissolved oxygen level 3% to 4%. From aeration tank, treated effluent flows to secondary clarifier and to treated effluent sump.

Treated effluent in the treated effluent sump is analyzed once in a day. After complete analysis, it is pumped to the sea.

The following equipment is in the ETP plant at MPL plant – II

1. High rate thickener – 2 Nos
2. Clarifier – 2 Nos
3. Rotary vacuum drum filter – 2 Nos
4. Cooling tower – 2 Nos
5. Bio reactors – 2 Nos
6. Mass culture tank – 1 Nos
7. Nutrient tank – 2 Nos
8. Treated effluent tank -- 1 No
9. Floating aerators – 5 Nos
10. Equalizing tank – 2Nos

**TPL – ECH Plant - ETP**

ETP components

| | |
|---|---|
| Primary Clarifier | 01 |
| Cooling Tower | 01 |
| Equlisation Tank | 01 |
| Bio – Reactors | 10 |
| Secondary Clarifier | 01 |

| | |
|---|---|
| Filter press | 01 |
| Treated effluent pit | 02 |

Effluent source of TPL

The wastewater is generated at ECH plant from the following sources:

Process waste stream from column bottom,

Cooling tower blow down,

Water treatment plant effluent,

Boiler blow down,

Raw effluent from PAPL

Treatment method

The treatment scheme envisages the following stages:

Primary Clarification

Cooling

Flow Equalisation

pH control system

Biological treatment

Sludge Clarification

Thickening

Treated effluent disposal

Primary clarification

The effluent from ECH plant dehydrochlorination stream column bottom enters the primary clarifier. A flocculent of Magnofloc is added to the effluent. Sludge settles at the bottom and sent to rotary vacuum filter for separation. The clear effluent from clarifier overflow is sent for further treatment.

Cooling

The clear effluent from Primary Clarifier enters at the top of the induced draft cooling tower to reduce the temperature of the effluent. The cooled effluent collected at the bottom and pumped to Equalization Tank.

Equalization Tank

Effluent from the cooling tower, other process effluents like cooling tower blow down, water treatment plant effluents and effluent from PAPL plant are collected in the Equalization Tank. The treatment system incorporate flow equalization in order to have a more consistent blend of organics to the downstream biological treatment process.

The pH of the combined effluent from Equalization Tank is adjusted and enters the Bio reactors.

Biological Treatment: The Bio-reactors, Ten in Nos are the heart of this treatment process. The Bio-reactors are inoculated with specific culture developed to degrade the pollutants present in the combined effluent. Floating type Surface Aerators are provided

to ensure an optimum Dissolved Oxygen (DO) level of 2 ppm and to suit the BOD reduction profile in the Bioreactors. The required quantity of micro-organism (MLSS) is to be maintained in the Bio-reactor by recycling sludge from the secondary clarifier downstream of the Bio-reactor.

The overflows from Bio-reactors are collected in Bio-reactors overflow Tank and pumped to secondary clarifier.

Sludge Clarification, thickening and Dewatering

The effluents from Bio-reactors overflow tank enters secondary clarifier which is provided with a clarifying mechanism for settling the secondary solids.

The under flow is taken to a filter press for de-watering. In the filter press the sludge is further de watered from 2.5 % to solid cakes containing around 70 % moisture. The filtrate is recycled back to bio-reactor, while the solid cakes are disposed to authorized landfill facility.

Treated Effluent Tank

The over flow from the secondary clarifier flows to Treated effluent tanks. This is further pumped to sea after meeting the requirements of TNPCB norms for disposal by the existing treated effluent pumps.

Disposal of Treated Trade Effluent

The treated effluent collected in treated water tank is pumped to sea after meeting the norms of TNPCB.

The effluent is pumped through HDPE pipeline in to the sea with diffuser arrangements at the end. HDPE pipeline of 400 mm OD, PE 100, PN 10 is provided for the out fall pipe line. The length of the pipe line between the LFP and the diffuser in the sea is 700 m. Minimum clear velocity will be maintained continuously to avoid deposition and siltation in the pipe line.

## 6.0 QUALITY OF TREATED EFFLUENT

**Treated Effluent Results of Analysis - MPL Plant – I:**

| S.No. | Characteristics | Unit | Result | TNPCB Tolerance Limits for discharge into Marine Coastal area |
|---|---|---|---|---|
| 1 | pH | ——— | 7.8 | 6.5-8.5 |
| 2 | Oil and Grease | Mg/l | 1 | 20 Max |
| 3 | BOD (5 days) @ 20°C | Mg/l | 28 | 50 Max |
| 4 | COD | Mg/l | 186 | 250 Max |
| 5 | Sulphate | Mg/l | 110 | 1000 Max |
| 6 | Chloride | Mg/l | 27400 | —— |
| 7 | TSS | Mg/l | 82 | 100 Max |
| 8 | TDS | Mg/l | 42280 | —— |
| 9 | TRC | Mg/l | BDL | 1 Max |
| 10 | Phosphate | Mg/l | BDL | 5 Max |
| 11 | Calcium | Mg/l | 15400 | --- |
| 12 | Total chromium | Mg/l | BDL | 1Max |
| 13 | Hexavalent chromium | Mg/l | BDL | 0.1 Max |
| 14 | Phenolic compounds | Mg/l | BDL | 5 Max |
| 15 | Fluoride | Mg/l | BDL | 1.5 Max |
| 16 | Sulphide | Mg/l | BDL | 5 Max |

**Treated Effluent Results of Analysis - MPL Plant – I:**

| S.No. | Characteristics | Unit | Result | TNPCB Tolerance Limits for discharge into Marine Coastal area |
|---|---|---|---|---|
| 1 | pH | ——— | 7.8 | 6.5-8.5 |
| 2 | Oil and Grease | Mg/l | 1 | 20 Max |
| 3 | BOD (5 days) @ 20°C | Mg/l | 24 | 50 Max |
| 4 | COD | Mg/l | 178 | 250 Max |
| 5 | Sulphate | Mg/l | 122 | 1000 Max |
| 6 | Chloride | Mg/l | 26920 | —— |
| 7 | TSS | Mg/l | 82 | 100 Max |
| 8 | TDS | Mg/l | 41200 | —— |
| 9 | TRC | Mg/l | BDL | 1 Max |
| 10 | Phosphate | Mg/l | BDL | 5 Max |
| 11 | Calcium | Mg/l | 14900 | --- |
| 12 | Total chromium | Mg/l | BDL | 1 Max |
| 13 | Hexavalent chromium | Mg/l | BDL | 1 Max |
| 14 | Phenolic compounds | Mg/l | BDL | 5 Max |
| 15 | Fluoride | Mg/l | BDL | 1.5 Max |
| 16 | Sulphide | Mg/l | BDL | 5 Max |

**Treated Effluent Results of Analysis - MPL Plant – II:**

| S.No. | Characteristics | Unit | Result | TNPCB Tolerance Limits for discharge into Marine Coastal area |
|---|---|---|---|---|
| 1 | pH | ——— | 7.6 | 6.5-8.5 |
| 2 | Oil and Grease | Mg/l | 2 | 10 Max |
| 3 | BOD (5 days) @ 20°C | Mg/l | 24 | 50 Max |
| 4 | COD | Mg/l | 184 | 250 Max |
| 5 | Sulphate | Mg/l | 140 | 1000 Max |
| 6 | Chloride | Mg/l | 21396 | ——— |
| 7 | TSS | Mg/l | 82 | 100 Max |
| 8 | TDS | Mg/l | 33862 | ——— |
| 9 | TRC | Mg/l | BDL | 1 Max |
| 10 | Phosphate | Mg/l | BDL | 5 Max |
| 11 | Calcium | Mg/l | 12054 | --- |
| 12 | Total chromium | Mg/l | BDL | 2 Max |
| 13 | Hexavalent chromium | Mg/l | BDL | 1 Max |
| 14 | Phenolic compounds | Mg/l | BDL | 5 Max |
| 15 | Fluoride | Mg/l | BDL | 1.5 Max |
| 16 | Sulphide | Mg/l | BDL | 5 Max |

**Treated Effluent Results of Analysis - MPL Plant – II:**

| S.No. | Characteristics | Unit | Result | TNPCB Tolerance Limits for discharge into Marine Coastal area |
|---|---|---|---|---|
| 1 | pH | ---- | 7.8 | 6.5 - 8.5 |
| 2 | Oil and Grease | Mg/l | 2 | 10 Max |
| 3 | BOD (5 days) @ 20°C | Mg/l | 26 | 50 Max |
| 4 | COD | Mg/l | 190 | 250 Max |
| 5 | Sulphate | Mg/l | 96 | 1000 Max |
| 6 | Chloride | Mg/l | 21825 | ---- |
| 7 | TSS | Mg/l | 90 | 100 Max |
| 8 | TDS | Mg/l | 34532 | ---- |
| 9 | TRC | Mg/l | BDL | 1 Max |
| 10 | Phosphate | Mg/l | BDL | 5 Max |
| 11 | Calcium | Mg/l | 12295 | --- |
| 12 | Total chromium | Mg/l | BDL | 2 Max |
| 13 | Hexavalent chromium | Mg/l | BDL | 1 Max |
| 14 | Phenolic compounds | Mg/l | BDL | 5 Max |
| 15 | Fluoride | Mg/l | BDL | 1.5 Max |
| 16 | Sulphide | Mg/l | BDL | 5 Max |

BDL – Below detectable limit

**Treated Effluent Results of Analysis – TPL - ECH:**

| S.No. | Characteristics | Unit | Result | TNPCB Tolerance Limits for discharge into Marine Coastal area |
|---|---|---|---|---|
| 1 | pH | — | 8.23 | 6.5-8.5 |
| 2 | Oil and Grease | Mg/l | 3.4 | 10 Max |
| 3 | BOD (5days) @ 20°C | Mg/l | 24 | 50 Max |
| 4 | COD | Mg/l | 180 | 250 Max |
| 5 | Sulphate | Mg/l | 237.5 | 1000 Max |
| 6 | Chloride | Mg/l | 11581 | — |
| 7 | TSS | Mg/l | 16 | 100 Max |
| 8 | TDS | Mg/l | 24321 | — |
| 9 | TRC | Mg/l | < 1.0 | 1 Max |
| 10 | Total chromium | Mg/l | < 1.0 | 2 Max |
| 11 | Hexavalent chromium | Mg/l | < 1.0 | 1 Max |
| 12 | Phenolic compounds | Mg/l | < 0.001 | 5 Max |
| 13 | Fluoride | Mg/l | 2.9 | 1.5 Max |
| 14 | Sulphide | Mg/l | < 1.0 | 5 Max |

BDL – Below detectable limit

## 7.0 STUDIES CONDUCTED

### Geological Parameters

Sediment samples from the sea bed were collected from 9-18 m water depth in the study area and textural analysis was conducted as standard sieve and pipette analysis.

### Bathymetry Study

Bathymetry study was conducted at an area of 500m along the coast and 1500 m into the sea. Data has been collected along at 25 m interval perpendicular to the coast.

Bathymetry data in the area was reduced to chart Datum by applying tidal data during the survey period. The gradient between the depth contours 6 and 13 meters resembles steep gradient where as Sea floor gradient between 13 and 16 meters appears gentle.

The horizontal positioning of the mobile unit was carried out using the GPS 12xL and GBR 21 DGPS becon receiver. It gives the horizontal accuracy close to 1m. It collects reference station data in both automatic and manual modes. It's LCD display provides the navigational dta in graphical and numerical form. It has attached with 50m / mg cable and power with 12/24 V DC power.

The unit is a single frequency echo sounder with a standard transducer frequency of 200 KHz. It measures the depth ranging between 0-200m with the accuracy of 0.01m and resolution of 0.01m. the unit works on 9-18 VDC or 200 VDC power. The horizontal positioning was carried out by GBR 21 and GPS 12xL DGPS Beacon Reviver of USA. It is a 12 channel accuracy of 1.0m. it has two RS 422 serial ports with NMEA out put. It can be operated with 12/24 V DC power. It works with a frequency of 283.5-325 KHz

with a channel spacing of 500 Hz. It was operated at Pondicherry at 315 KHz for this survey.

**Echo Sounder**

An Echo sounder ODOM-EchoTrac-DF 3200MKII was used to measure the water depths in the survey area. The basic principle is to initiate a sound pulse at the source and to receive the reflected signals at the receiver. The time taken for initiation till its receiving was measured and recorded as the chart datum. The depths were computed based as these two way travel line.

**Physical Parameters**

Waves - The wave parameters were recorded for 20 min duration at every 3 hrs. Wave rider buoy consists of a spherical stainless steel ball designated to float on the sea surface. Accelerometers housed in the buoy measures no accelerations in all the time perpendicular axes. These accelerators were then digitally integrated to obtain spectral density, wave directions etc. The above statistical data were evaluated using the spectral movements as given below.

Wave height $Hs = 4\sqrt{m_0}$

Wave Period $T_2 = \sqrt{m_0/m_2}$

Spectral Width Parameter $\sum = \sqrt{1 - Cm_2^2/(m_0 m_4)}$

Where $m_n = \sum f^n s(f)\, df$, S(f) = the spectral density f= frequency.

The deep water wave length $L_0$ was calculated from $L_0 = 1.56\, T_z^2$ and the wavelength L is calculated from the dispersion relationship.

**Table-1 Wave Characteristics (2011)**

| Month | HS (m) | TZ(S) |
|---|---|---|
| February | 0.5-1.0 | 5-6 |
| March | 0.5-1.0 | 5-6 |
| April | 0.5-1.0 | 5-6 |
| May | 1.0-1.5 | 5-7 |
| June | 1.0-2.5 | 5-8 |
| July | 1.0-2.5 | 5-8 |
| August | 1.0-3.0 | 5-6 |

**Currents** - The current measurements were conducted using self recording current water RCM 7 and RCM 11 at 1000m of shore. The current is mainly influenced by wind. The wind has significant impact on the direction of flow. Currents flow parallel to the coast line with little tendency towards the shore. The range is 2 – 295 cm/s with an accuracy of ± 1cm/s.

**Temperature, Salinity and density** - Temperature and salinity profiles were collected using SBE19 plus seacat profiler. The measurements were made 2m below the sea surface at 20 min interval.

**Table-2: Distribution of Salinity and Temperature (2011)**

| Month | Temperature ($^0$C) | Salinity (ppt) |
|---|---|---|
| February | 27.0 | 32 |
| March | 27.5 | 34 |
| April | 29.0 | 34 |
| May | 30.0 | 34 |
| June | 29.0 | 34 |
| July | 28.0 | 34.5 |
| August | 28.0 | 34.5 |

**Seabed Sediments** - Textural analysis of the sea bed samples in the study region shows primarily comprised of medium to fine sand. It was observed from the overall distribution of scattered stone rubbles, shells fragments. Seabed sediment quality is given in Table -3

**Table-3: Seabed Sediment Quality**

| Parameters | Result (Average) |
|---|---|
| Sand | 0.198 mm |
| TOC (mg/g) | 0.75 |
| Total Nitrogen (mg/g) | 1.9 |
| Total Phosphate (µg/g) | 2.7 |
| Lead, (µg/g) | 0.8 |
| Mercury (µg/g) | BDL |
| Cadmium (µg/g) | 0.07 |
| Phenol (µg/g) | BDL |

## 8.0 ENVIRONMENTAL CONDITIONS

### Wind

The wind pattern prevailing in the project site, wind speed and direction available for Chennai region were compiled from the Bay of Bengal pilot (1978)

**Table- 4: Wind Speed and Direction (2011)**

| Month | Speed (Knots) | Predominant Direction | |
|---|---|---|---|
| | | 8.30 AM | 5.30 PM |
| February | 8 | NW | NE |
| March | 9 | W-NW | E-SE |
| April | 10 | S-SW | SE |
| May | 11 | S-SW | SE |
| June | 10 | SW-W | SE-S |
| July | 9 | SW-W | SE-S |
| August | 8 | SW-W | SE-S |

### Storm

Occasional occurrence of cyclonic storm data in this region is compiled from the Tracks of storms and depressions in the Bay of Bengal and the Arabian Sea published by IMD.

### Tides

Tides were measured by installing the tide gauge at Chennai fishing harbor. The data were recorded at 15 min interval for a period of 15 days. Measured tides were compared with the predicted tides reported for Chennai in Indian Tide Table surveyor General of India. Aanderea WTR9 a self recording Tide gauge manufactured in Norway was used.

**Table-5: Water Depth with distance from shore**

| Distance from Shore | Depth (m) |
|---|---|
| 1 | 30 |
| 2 | 70 |
| 3 | 150 |
| 4 | 180 |
| 5 | 210 |
| 6 | 290 |
| 7 | 370 |

**Biological Parameter**

The dilution of effluent released in the water body taking 2 stages of mixing. Initial dilution is due to get mixing and the secondary mixing due to turbulence. The initial dilution is controlled by the design of the diffuser. Once the effluent riser to the water surface or ceaser the negative acceleration, the subsequent dilution takes place by turbulent diffusion as the water moves away from the outfall location. This stage of dilution is controlled by the prevailing currents and turbulence that exists in the coastal region. This initial dilution is estimated using CORMIX model. In mixing zone the rising of plume to the surface will spread on both side of the diffuser. The effluent gets diluted at the mixing zone.

**Biological parameter:**

**Phytoplankton:** Phytoplankton sample were collected and preserved in 5% formalin. Preserved phytoplankton samplers were transferred in to sedimentation chamber for settlement. After settlement the sample was taken tot study the population analysis. This population mainly consists of amphipodes. Polychetes, Crustaceans, and Gastropodes. The abundance of their benthic fauna varied form 365-655 nos/m².

**Zooplankton:** Zooplankton samples were collected in zooplankton net towed at 0.5 m below the water surface for 10 minutes and preserved in 5% formalin. The preserved samples was taken to study the whole species diversity. Organism were counted and identified up to genus level under microscopic examination. The zooplankton data indicated the abundance varied form 623-1564 nos/m². this population mostly consists of copepod, Tintinids, Crustaceannauplii, Euphaurid larvae, Lucifer sp., Ananuram larvae, Foraminiferas and etc. The numerical abundance of the subtidal benthic fauna varied from 118-1378 nos/m². this population mainly consist of amphipods, polychaetes, crustaceam and Gastropods. The existence of inter tidal fauna seems to be very poor. The bacterial colonies in sea water were identified up to generic level. Organisms isolated were Eshcerichia coli, Vibiro, Parahaemolyticus organisms and proteus like organisms.

**Fisheries:** The information on fisheries was collected from local fisherman hamlet. The marine fish landing shows the species of chirocenturs, lesser, sardines, caranx, seerish, crabs, promphets etc. The marine flora and fauna also indicates the existence of diverse population.

**Dispersion**

Rhodomine –B was used to conduct the dispersion experiment near shore. The concentrated dye solution was released at 700m distance from the shore line along the outfall pipeline. This was conducted during a relatively calm sea conditions. The dye patch was allowed to spread without any external disturbance and the extent of spread was measured using DGPS. Dye samples were collected along and across the spread of the dye patch. Samples were analyzed using spectrophotometer. Based on the dye samples and spread of the dye patch, the dispersion coefficient (DX) has estimated as 5.5 $m^2/s$ and lateral dispersion coefficient were estimated (DY) as $0.9m^2/s$ during the study period. Dispersion characteristic was calculated using MIKE-21 model as given below. Flow module MIKE 21 a two dimensional 2D hydrodynamic flow simulation model is used for various environmental process in natural water bodies. This includes bottom shear stress, wind shear stress, barometric pressure gradients, carioles force, momentum dispersion, evaporation flooding, drying and wave radiation stressor. The concentration of substance is calculated by a rectangular grid covering the area of interest similar to the hydrodynamic computation. The MIKE 21 module determines the concentration of substance by solving the equation of conservation of mass for a dissolved or suspended substance using the finite difference scheme.

## 9.0 DESIGN OF OUTFALL PIPELINE

INPUT:

| | |
|---|---|
| Outer dia in m | 0.400 |
| Deepwater wave height in m | 0.75 |
| Wave period in s | 8.0 |
| Wave crest angle wrt. pipeline (deg) | 10.0 |
| Design depth in m | 9.4 |
| Current speed in m /s | 0.2 |
| Slop of sea bed in deg | 2.3 |
| Tk. Of conc. block in m | 0.34 |
| Outer dia.of conc. Block in m | 1.0 |
| Dia of hole in m | 0.41 |
| Specific gravity of HDPE | 0.955 |
| Specific gravity of effluent | 1.005 |
| Specific gravity of sea water | 1.025 |
| Sea water temperature ($^0$ C) | 25 |
| M .C. of pipe | HDPE PE100, PN10 |
| Soil type (1= clay,2=sand,3= gravel) | 2 |
| Buoyancy(50% air filled) | 50 |

OUTPUT

| | | |
|---|---|---|
| Buoyant force (100%) | kg | 120 |
| Buoyant Force (120%) | Kg | 144 |
| Buoyant Force (200%) | Kg | 240 |
| Volume of concrete | $m^3$ | 0.154 |
| Weight of concrete in air | kg | 370 |
| Weight f concrete in water | kg | 216 |
| Spacing between blocks (for 120% buoyancy) | m | 1.8 c/c (selected- 1.5c/c) |
| Spacing between blocks (for 200% buoyancy) | m | 0.9 c/c (selected 1.0 c/c) |

The pipeline in intertidal zone of first 50 m will be buried 2 m below the sea bed till the top of pipeline. For nest 100 m, the pipeline will be buried 1.0 m below the seabed till the top of the pipeline. The remaining portion of the pipeline will be laid on the seafloor which will be left for natural burial.

## 10.0 SEA WATER QUALITY

Water quality parameters such as pH, temp, salinity, DO, BOD, turbidity, ammonia-nitrogen, nitrate, phosphate, total suspended solids, cadmium, lead, mercury, phenol, petroleum hydrocarbon are given in Tables below.

**Table-6: Sea Water Analysis Report**

**Heavy metal Concentration**

| Sample | Depth | Lead (µg/l) | Cadmium (µg/l) | Mercury (ng/l) | Phenol (µg/l) | Petroleum Hydrocarbon (µg/l) |
|---|---|---|---|---|---|---|
| Middle Transect | Surface | 6.0 | 0.02 | 18.6 | BDL | 4.4 |
| | Middle | 6.6 | 0.04 | 14.0 | BDL | 3.7 |
| | Bottom | 5.7 | 0.06 | 15.0 | BDL | 4.5 |
| North Transect | Surface | 7.2 | 0.06 | 18.3 | BDL | 4.8 |
| | Middle | 2.8 | 0.07 | 15.1 | BDL | 6.8 |
| | Bottom | 4.4 | 0.06 | 14.9 | BDL | 4.2 |
| South Transect | Surface | 6.8 | 0.07 | 22.4 | BDL | 5.5 |
| | Middle | 5.2 | 0.04 | 18.4 | BDL | 3.4 |
| | Bottom | 5.8 | 0.01 | 20.4 | BDL | 2.1 |

**Table-7: Sea Water Analysis Report**

| Sample | Depth | pH | Temperature ($^0$ C) | Turbidity | Salinity (ppt) | DO (mg/l) | TSS (mg/l) | Nitrate (mg/l) | Phosphate (mg/l) | NH3-N (mg/l) | BOD (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Middle Transect | Surface | 8.1 | 30.5 | 2.0 | 34.2 | 5.19 | 38.7 | 2.99 | 0.88 | 0.57 | 3.6 |
| | Middle | 8.2 | 29.5 | 2.2 | 33.5 | 5.19 | 52.3 | 2.67 | 0.92 | 0.67 | 3.0 |
| | Bottom | 8.1 | 29.5 | 2.6 | 33.7 | 4.81 | 71.4 | 2.84 | 1.30 | 0.78 | 2.9 |
| North Transect | Surface | 8.2 | 30.5 | 1.6 | 34.0 | 5.19 | 40.0 | 2.62 | 1.2 | 0.7 | 3.12 |
| | Middle | 8.1 | 30.5 | 3.1 | 33.6 | 4.67 | 61.0 | 2.8 | 1.14 | 0.9 | 3.0 |
| | Bottom | 8.2 | 29.0 | 4.0 | 33.5 | 4.67 | 56.8 | 2.9 | 1.55 | 0.85 | 2.7 |
| South Transect | Surface | 8.2 | 31.0 | 2.6 | 33.9 | 5.19 | 36.4 | 2.67 | 1.19 | 0.6 | 3.04 |
| | Middle | 8.1 | 30.0 | 4.6 | 33.6 | 5.19 | 38.0 | 2.9 | 1.15 | 0.7 | 3.0 |
| | Bottom | 8.2 | 29.0 | 6.4 | 33.6 | 4.6 | 38.0 | 2.89 | 1.24 | 0.8 | 3.0 |

## 11.0 IMPACT ASSESSMENT:

The baseline data collected from the project region and review of the available information indicates that the water quality parameters are within the acceptable limits for the coastal waters. The coastal waters are well mixed remain clean and free from any pollution.

**Design of diffuser:**

| Discharge parameters | |
|---|---|
| Diffuser type | unidirectional |
| Diffuser length | 20m |
| Diffuser end point | 680m = 700m |
| Number of openings | 4 |
| Number of Risers | 6 |
| Ports/ Nozzles per Riser | 1 |
| Spacing between risers | 6.67 m |
| Port/ Nozzle diameter | 0.12 m |
| Equivalent slot width | 0.0023 m |
| Total area of openings | 0.0301 $m^2$ |
| Discharge velocity | 2.05 m/s |
| Total discharge flow rate | 0.1 $m^3/s$ |
| Discharge port height | 1.5 m |
| Nozzle arrangement | Unidirectional without fan |
| Diffuser alignment angle | 90 ° |
| Vertical discharge angle | 0 |
| Horizontal discharge angle | 0 |
| Discharge density | 1005 $kg/m^3$ |

The dilution of the waste water in the sea takes place in two stages e.g.,

a) Initial dilution due to Jet mixing

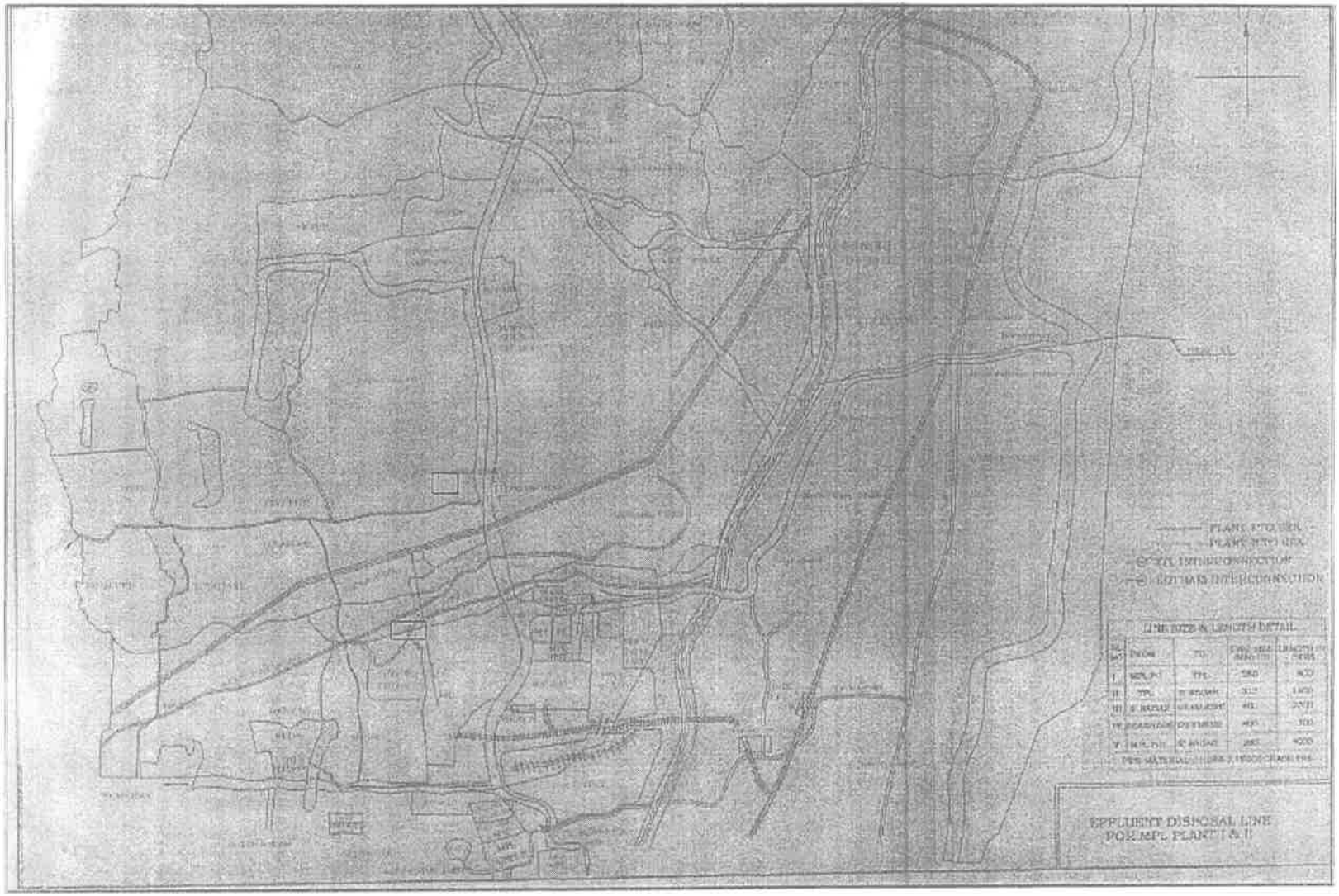
b) Secondary dispersion due to turbulence.

The efficiency of the initial dilution is controlled by the design of the diffuser. Once the waste water rises to the water surface the subsequent dilution taking place by turbulence diffusion as the water moves away from the outfall location. The second stage dilution takes place by the prevailing currents and turbulence existing in the coastal region. Outfall is fixed at 700 m distance from the shoreline at 9.4 m water depth and the diffuser ports are located at 1.5 m above the sea floor. The outfall diffuser has multiple port diffuser system provided with 4 Nos * 120mm dia and two Nos at 120 mm as spares. The ports are placed perfectly horizontal.

**Water outfall**

The outfall is designed with proper member and size of ports which enhance the jet mixing of the treated waste water discharge, the waste water discharged will reach the ambient quality with in a shorter distance and time. The outfall diffuser is placed well below the sea surface not to cause obstruction to the movements of boats to avoid while enroute.

Total quantity of effluent discharged into the sea is 385 m3/hr. The distance of the outfall diffuser from the coast line is about 700m and the depth is 9.4m CD. The pipeline is laid on the sea floor and allowed for natural burial. But it is buried below chart datum, manually from the coast and across the intertidal zone to avert damage caused by the seawall stone rubbles. The details are shown in figure


EFFLUENT DISPOSAL LINE
FOR MPC PLANT I & II

The details of the outfall pipeline are

| Description | HDPE PN10PE100 | Length (m) |
|---|---|---|
| Outfall pipeline off shore | 400mm OD | 700 |
| Flow rate | 385 $m^3$/hr | ---- |
| Water depth level at outfall distance | 9.4m | ---- |

## 12.0 DISCUSSION & CONCLUSION

This outfall is influenced by the 3 climatic conditions viz

a) Southern Monsoon (June – Sept)

b) North east Monsoon (Oct- March)

c) Fair weather from April – May.

Wave action prevails with during southwest and north east monsoon. The coastal current within 2 Km distance from the shore is influenced by wind. The distribution of temperatures and salinity indicates that the near shore water is well mixed.

Water quality test indicates that the water is well oxygenated nutrient rich and biologically productive at primary and secondary levels. The study on various oceanographic parameters indicates that the coastal water is clean and highly productive. Results shows that the wastewater undergoes dilution of the order of 500 times in 60m distance from the outfall and it further get diluted to 1000 times at a distance of 200m in shore normal direction.

Further it is concluded that the wastewater will not reach the shore and have negligible impact on the marine environment.

ANNEXURE - 10 A

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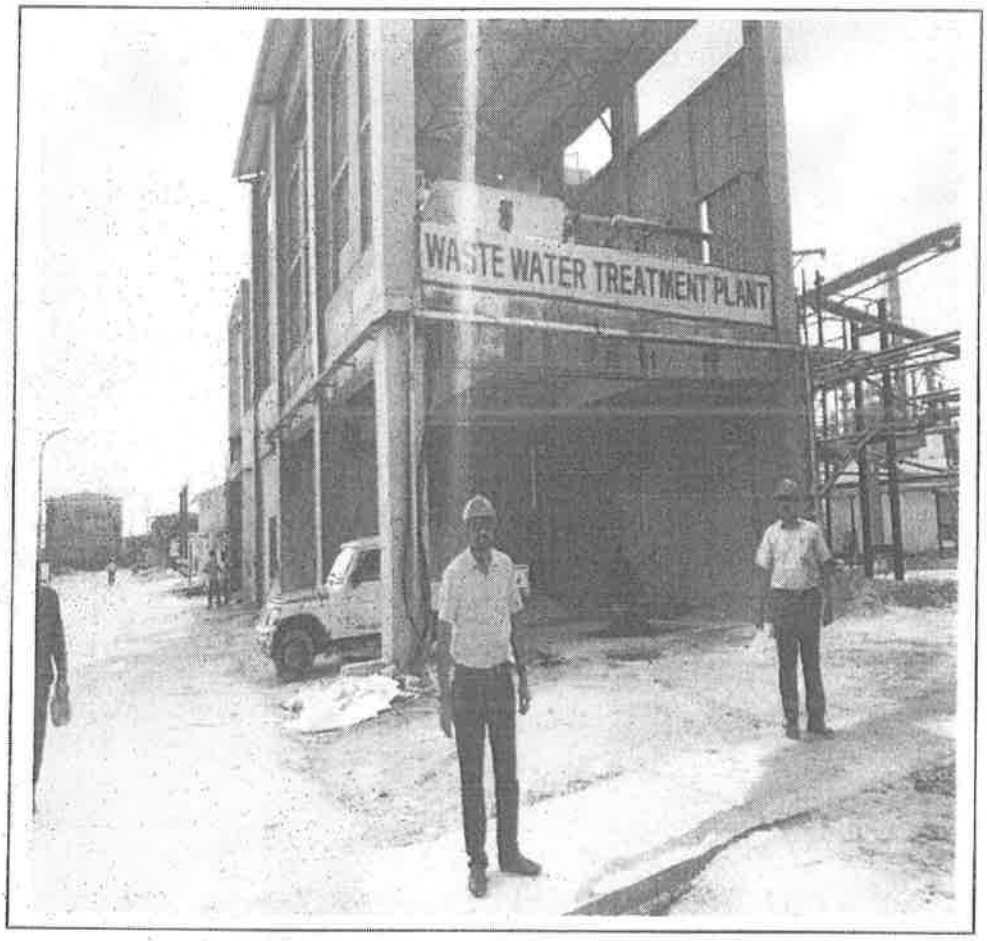
# Adequacy Report on Effluent Treatment operation

## of

## M/S.MANALI PETROCHEMICALS LTD-UNIT I

Ponneri High Road, Manali,
Chennai, Tamil Nadu 600068




APPLIED SCIENCE & TECHNOLOGY

A.C.TECH,

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INTRODUCTION

Manali Petrochemical Limited (MPL) operates two production plants at Manali near Chennai to manufacture Propylene Oxide (PO), Propylene Glycol (PG), PGMME and various grades of Polyol and formulations. MPL was promoted by Southern Petrochemical Industries Corporation (SPIC).

Plant - I located on the Ponneri High Road, Manali Industrial belt, Chennai (adjacent to Chennai Petroleum Corporation Ltd- CPCL) and is capable of manufacturing 18000 MT of Propylene oxide (PO), 10,000 MT of Propylene Glycol (PG) and 25000 MT of Polyol, 2700 MT of Propylene Glycol Mono Methyl Ether (PGMME).

PO is an intermediate product produced and is utilized for conversion into PG and Polyol.PG is widely used for Pharmaceutical formulations, in Food Flavor and Fragrance industries and in the manufacture of unsaturated polyester Resins. Polyol is the raw material for manufacture of Polyurethanes. Polyol of different grades are manufactured to meet the customer requirements for various applications.

The above plants generate effluents less than the originally designed and consented level and well below the norms prescribed by the CPCB/TNPCB.

**Plants Profile - Existing**

Plant-I was promoted By SPIC and incorporated in 1987. The construction of the plant commenced in 1988 and commercial production started in the year 1990. Plant -I was set up with the technology of Atochem for PO and PG, and the basic engineering was done by Technip of France and the detailed engineering executed by Engineers India Ltd. The Polyol technology was provided BY ARCO, USA through Technip.

Major supplier of the raw material is Chennai Petroleum Corporation Ltd (CPCL). There are no other manufacturers of PO, PG and Polyol in India

And the unit has renewed the consent orders and it's valid till 31st March 2019.

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CPCB has issued notice to M/S.MANALI PETROCHEMICALS LIMITED- UNIT I vide Proc.No.B-29016/04/06/IPC-I/13897, dated 17.12.2018 for sought of clarification referred in the letter.

In this context, M/S. MANALI PETROCHEMICALS LIMITED - UNIT I has entrusted the task of conducting Adequacy of their ETP plant and its control measures to Anna University, Chennai. The scope of the audit is

- To assess the adequacy of the ETP plant and new Biological treatment unit.
- To assess the control measures of the ETP plant and biological treatment system and its compliance.

A team headed by Dr.Sivanesan from Anna University, Chennai carried out the studies during FEBURUARY 2019(16th February till 28th February)) and the findings along with recommendations are presented with this report. The assessment was primarily based on the site visit, liquid effluent characteristics, effectiveness of the biological treatment system and secondary data provided by M/S. MANALI PETROCHEMICALS LIMITED - unit and their verification during site visits. Professional judgment expressed in this report is based on the available facts and data within the scope of work, budget and schedule.

2.0. Manufacturing Process:

2.1. Manufacture of Propylene Oxide

The major raw materials for this process is propylene, which is received through pipeline/road tankers and stored in bullets. Propylene from the storage bullets is drawn to the propylene oxide plant, vaporized and sent to the PO reactor. It reacts with chlorine and water to form propylene chlorohydrin according to the following reaction.

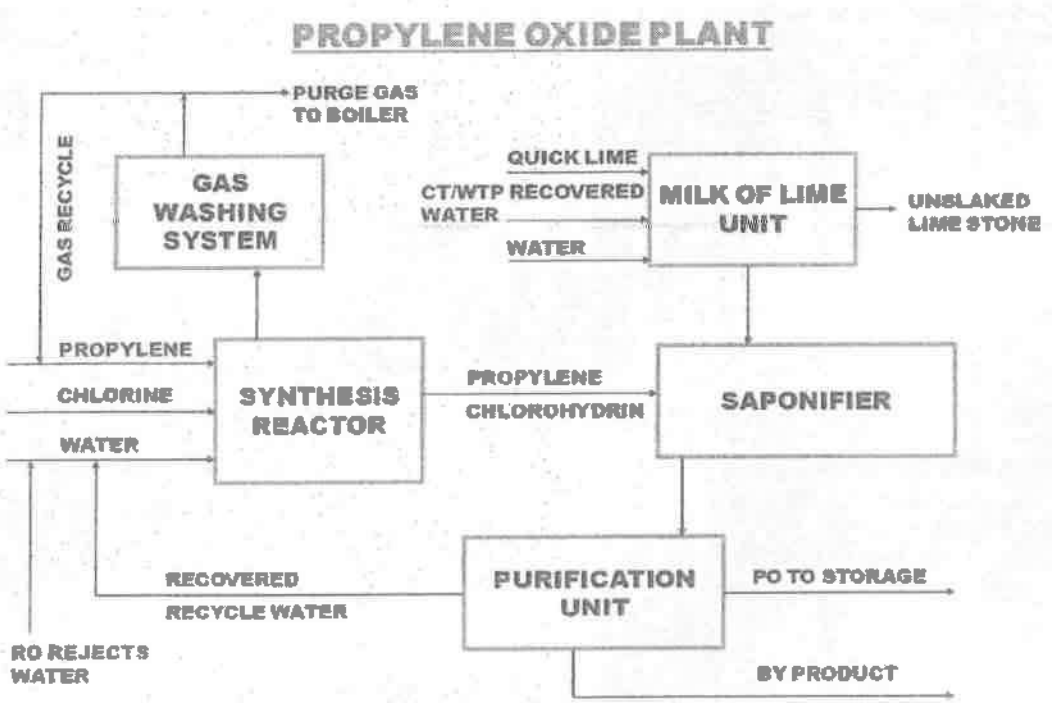
$$Cl_2 + H_2O \longrightarrow ClH + ClOH$$

$$ClOH + C_3H_6 \longrightarrow ClC_3H_6OH$$

**The solution is then saponified with milk of lime to generate Propylene oxide**

$$2ClC_3H_6OH + Ca(OH)_2 \longrightarrow 2C_3H_6O + CaCl_2 + 2H_2O$$

The vapour propylene oxide is stripped with steam and distilled to get the final product. The final product is sent to propylene oxide storage.



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## 2.2. Manufacture of Propylene Glycol

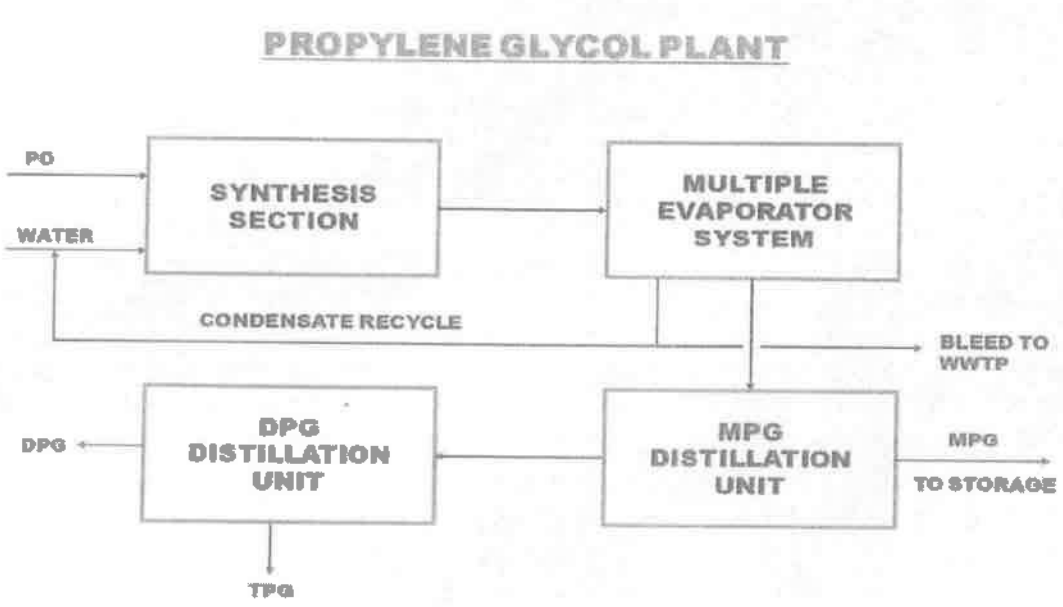
The Raw material for Propylene Glycol is Propylene oxide and Water. Propylene oxide from the storage is mixed with process water and sent to PG reactor. Mixture of glycol's are formed inside the reactor as per following reactions.

$CH_3 - CH - CH_2 + H_2O \longrightarrow CH_3 - CHOH - CH_2OH$
Monopropylene Glycol (MPG)

$CH_3 - CH - CH_2 + MPG \longrightarrow$ Dipropylene Glycol (DPG)

$CH_3 - CH - CH_2 + DPG \longrightarrow$ Tipropylene Glycol (TPG)

The reaction products are concentrated in triple effect evaporator and distilled in two stages to separate Monopropylene glycol, Di-propylene glycol and Tri-propylene glycol. The products formed are checked for quality before being transferred to the respective storage.



## 2.3. Manufacture of Propylene Glycol Monomethylether

PGMME is produced by the reaction of propylene oxide and methanol. The main reaction involved are.

a) $CH_3OH$ + $CH_3CHCH_2$ (O) $\longrightarrow$ $CH_3OCH_2CHOH$ ($CH_3$)

Methanol — Propylene Oxide — Propylene Glycol Mono Methyl Ether

b) $CH_3OCH_2CHOH$ ($CH_3$) + $CH_3CHCH_2$ (O) $\longrightarrow$ $CH_3OCH_2CHOCH_2CHOH$ ($CH_3$, $CH_3$)

Propylene Glycol Mono Methyl Ether — Propylene Oxide — Di propylene Glycol Mono Methyl Ether

The ratio of MPGMME, DPGMME, TPGMME and residue glycol ethers depends on the composition of the initial propylene oxide to methanol mole ratio.
The excess methanol is distilled out in the first stage of distillation column and recovered back to the reactor. The higher glycol ethers are fractionated from the product PGMME in the second stage of distillation column.

## 2.4. Manufacture of Polyether Polyols

Polyether polyols are manufactured through propoxylation/ethoxylation of polyhydric alcohol using liquid catalyst. Glycerin, di-propylene glycol, Tri Ethyl Amine (TEA) etc., are used as starters and KOH as catalyst. Propylene oxide/ethylene oxide is added to the starter mixture under controlled pressure, temperature conditions to form Polyether polyols. The crude polyol is then treated with chemicals to remove the used catalyst and filtered to get the final product.

Starter + Catalyst $\longrightarrow$ Initiator

Initiator + (Propylene oxide/Ethylene oxide) $\longrightarrow$ Polyols

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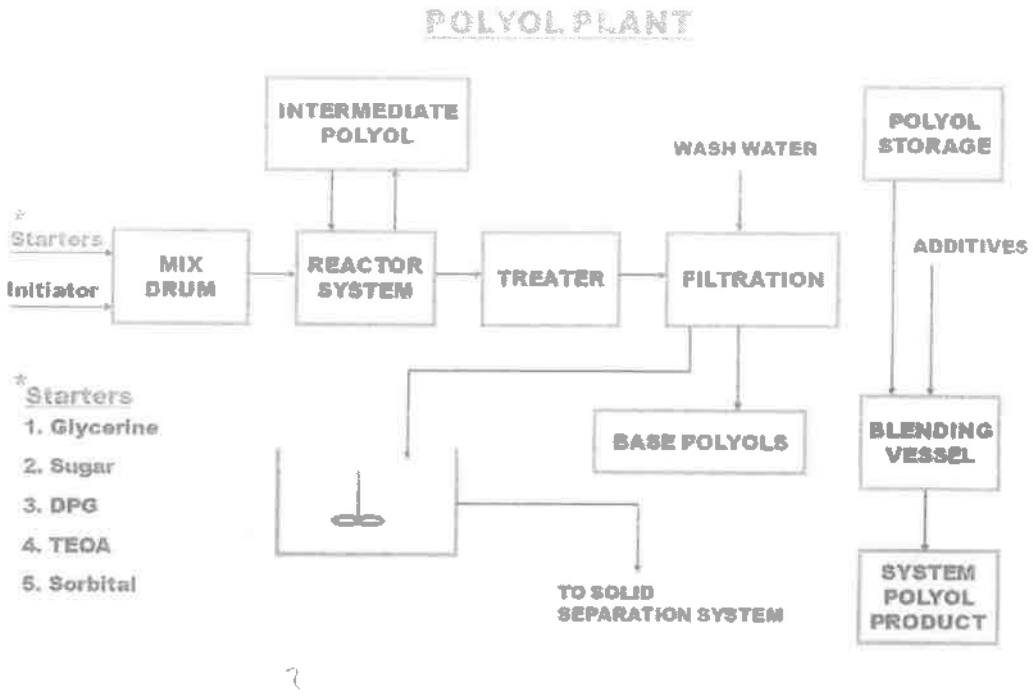
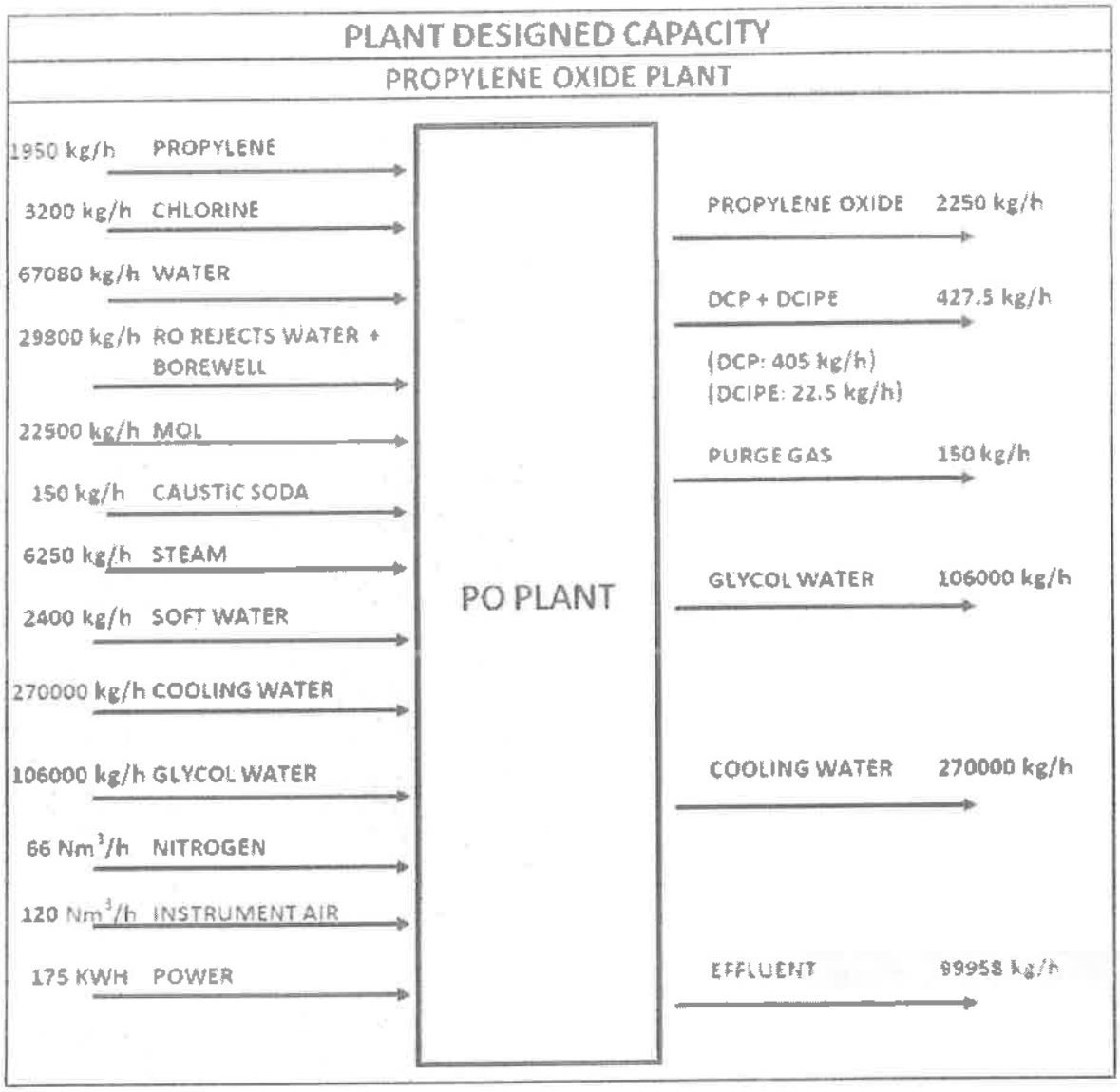



It could be noted that all product formations are polymeric condensation reactions and hence no process emission is envisaged in the manufacturing process. All storages with nitrogen blanketing system installed with split range controller, so only nitrogen is vented and no process emission.

## 2.5. Material Balance of the Propylene Oxide



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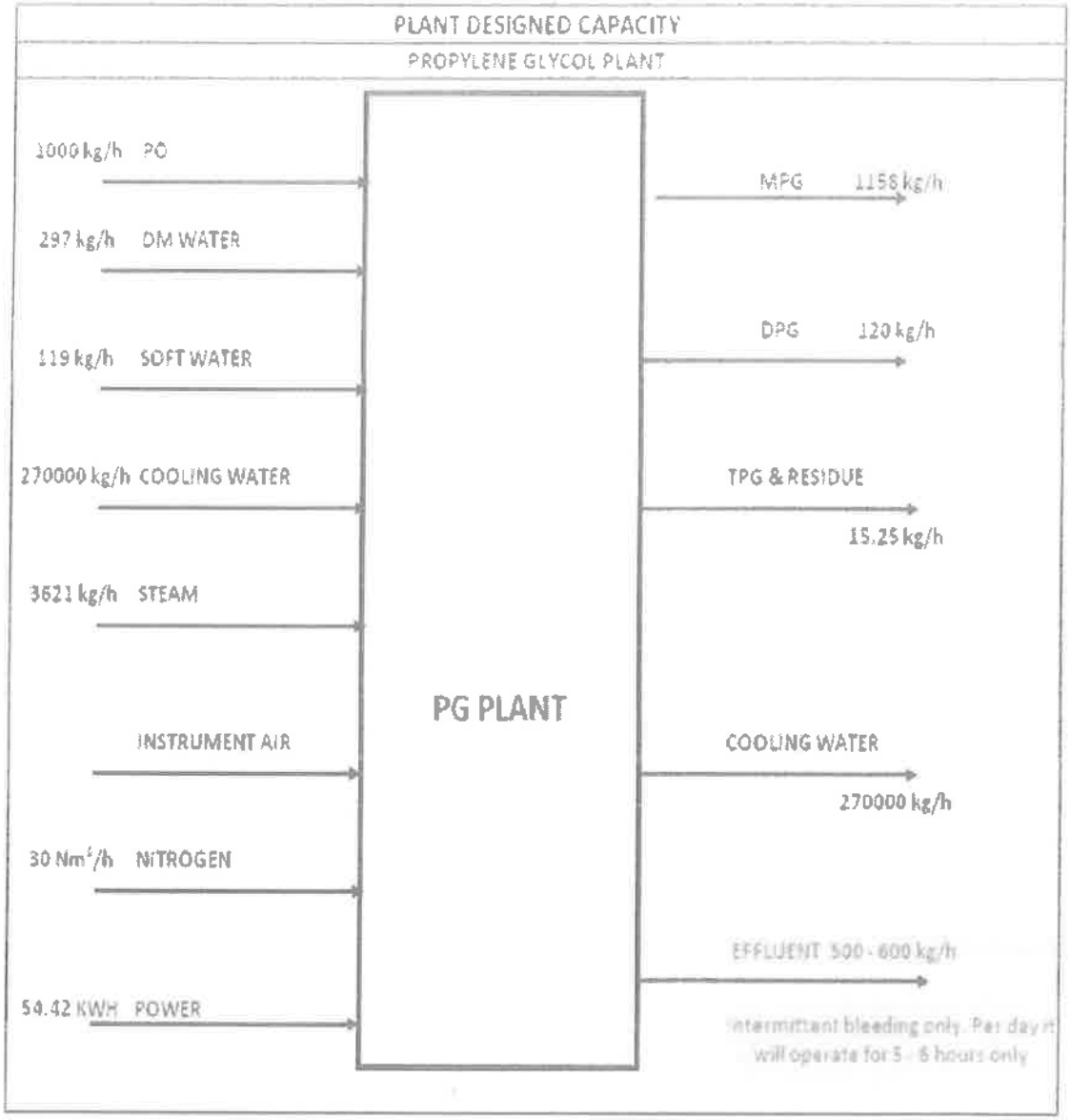
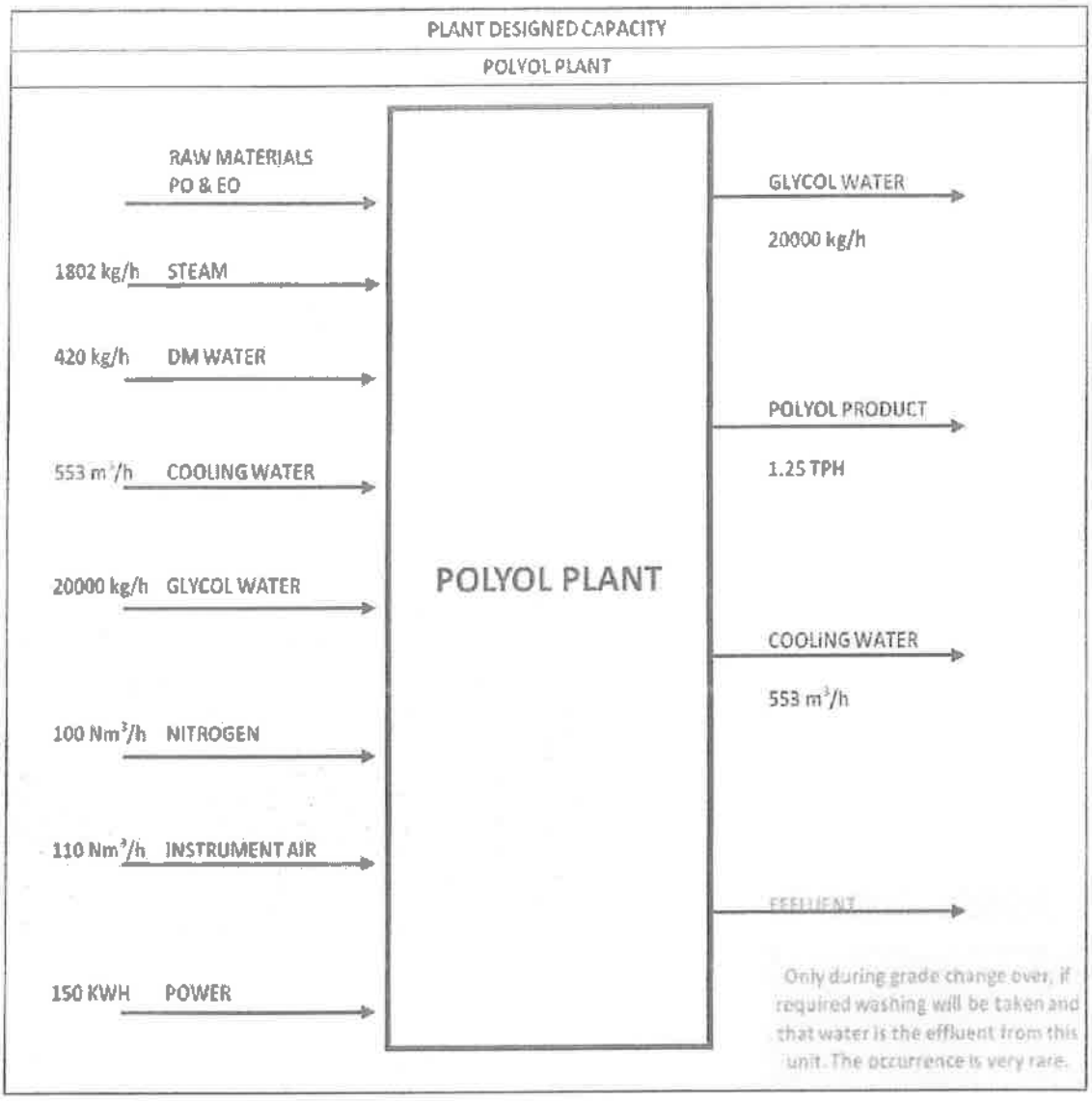
## 2.6. Material Balance of the Propylene Glycol



## 2.7. Material Balance of the POLYOL PLANT



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3.0. Details of Effluent Treatment Plant - Unit-I

3.1. Capacity of ETP plant installed in UNIT-I

ETP capacity installed - 150 $M^3$/ hour effluent

Current operating load - 100 to 120 $m^3$/hour effluent

| Design Basis: | |
|---|---|
| Total Design Capacity | 3600 $m^3$/day |
| Hours of Operation | 24 hours |
| Average Hourly flow Rate | 100 to 120 $m^3$/hour |
| Peak Flow Factor assumed | |
| Peak Flow | 120 $m^3$/day |

Advanced Bio Treatment Process using BIO Culture in the Bio Reactors

Six Bio Reactors with Mix Flow Diffuser system in the Bio Reactor A, B and OHR (Original Hydro Dynamic Reaction Technology) aerators in the Bio C, D, E, F

3.2.1

## EFFLUENT TREATMENT PLANT – PLANT – 1

## *EQUIPMENT DETAILS*

### 3.2. HIGH RATE SLUDGE THICKENER

| | | |
|---|---|---|
| Equipment Tag No. | : | T 3115 |
| Type | : | Cylindrical Tank |
| Diameter of the tank | : | 13 m |
| Side wall Depth | : | 3.5 m |
| Slurry handling rate | : | 150 $m^3/h$ |
| Material of Construction | : | Reinforced Cement Concrete |

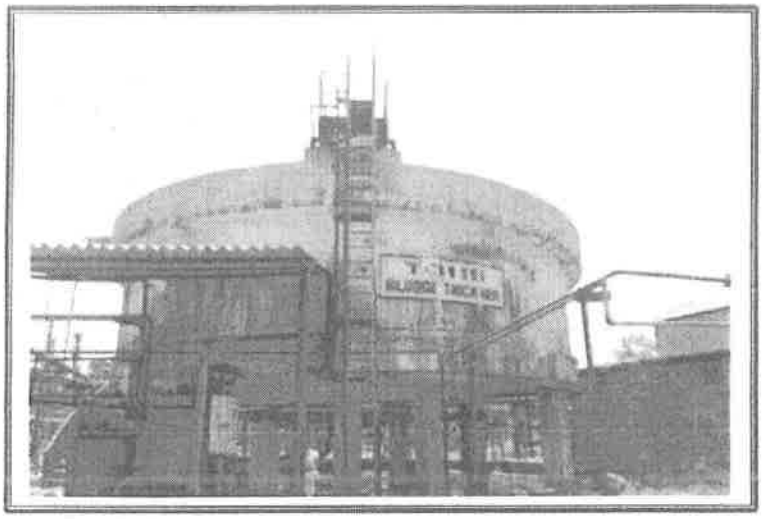

*FIG. 1 – HIGH RATE SLDUGE THICKENER*

### 3.3. THICKENER RACKER ARM UNIT WITH HYDRAULIC POWER PACK

| | | |
|---|---|---|
| Equipment Tag No. | : | M 3113 |
| Material of construction | : | Carbon Steel |

*FIG. 2 – THICKENER RAKER ARM UNIT WITH HYDRAULIC POWER PACK*



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### 3.4. HIGH RATE SLUDGE THICKENER BOTTOM PUMP

| | |
|---|---|
| Equipment Tag No. | : P 3115 A/B |
| Type | : Stork pump |
| Model | : Johnson 14-08 |
| Rated Flow | : 45 $m^3/h$ |
| Head | : 18.5 m |
| Motor Details | : 5.5 KW, 2900 RPM |
| Material of Construction | : Casing – Cast Iron, Impeller & Shaft – Cast Iron |

*FIG. 3 – HIGH RATE SLUDGE THICKENER BOTTOM PUMP*

### 3.5. FLOCCULANT PREPARATION TANK

| | | |
|---|---|---|
| Equipment Tag No. | : | T 3113 |
| Type | : | Cylindrical Tank |
| Diameter of the tank | : | 840 mm |
| Height of the tank | : | 1050 mm |
| Material of Construction | : | Stainless steel |

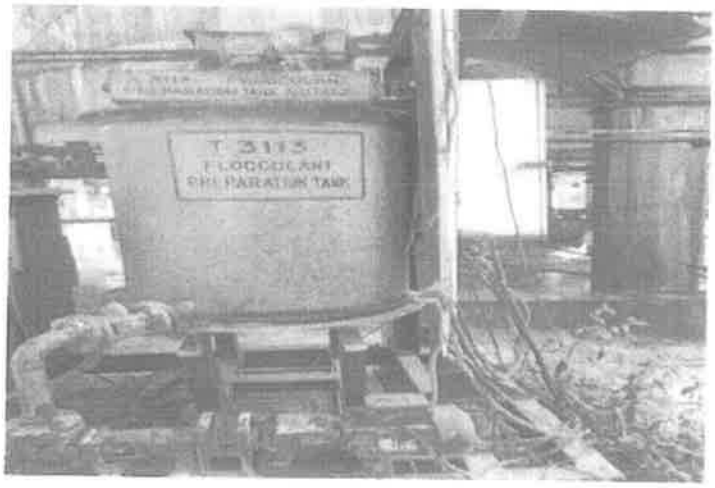


***FIG. 4 – FLOCCULANT PREPARATION TANK WITH AGITATOR & TRANSFER PUMP TO FLOCCULENT DOSING TANK***



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### 3.6. FLOCCULANT PREPARATION TANK AGITATOR

| | | |
|---|---|---|
| Equipment Tag No. | : | A 3113 |
| Material of Construction | : | Shaft and Blade assembly - Stainless steel<br>Gear box – Carbon steel |
| Motor Details | : | 1.5 HP |

### 3.7. EFFLUENT SETTLING CHAMBER

| | | |
|---|---|---|
| Equipment Tag No. | : | T 3127 |
| Outer Length & Width | : | 52.5 m & 47 m |
| Side Wall Depth | : | 2 m |
| Slope of the side wall | : | 2.828 m |
| Material of construction | : | Reinforced Cement Concrete |

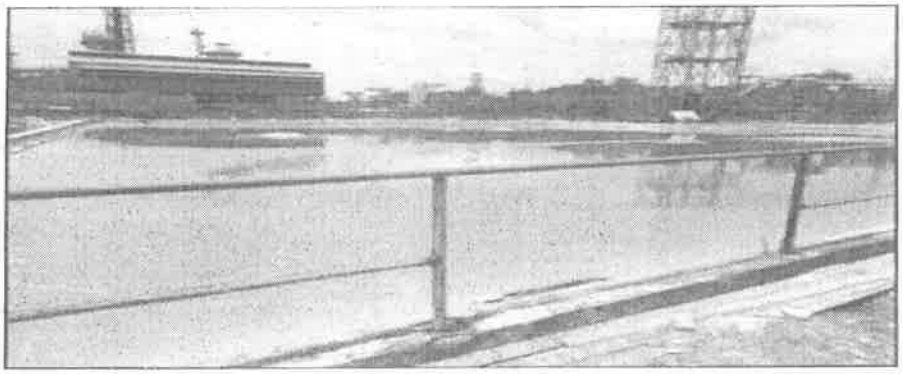

*FIG. 5 – EFFLUENT SETTLING CHAMBER*

### 3.8. PRIMING CHAMBER FOR SETTLING CHAMBER PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC 3127 A/B |
| Outer Diameter | : | 1000 mm |
| Thickness | : | 8 mm |
| Height | : | 1800 mm |
| Material of construction | : | Carbon steel |

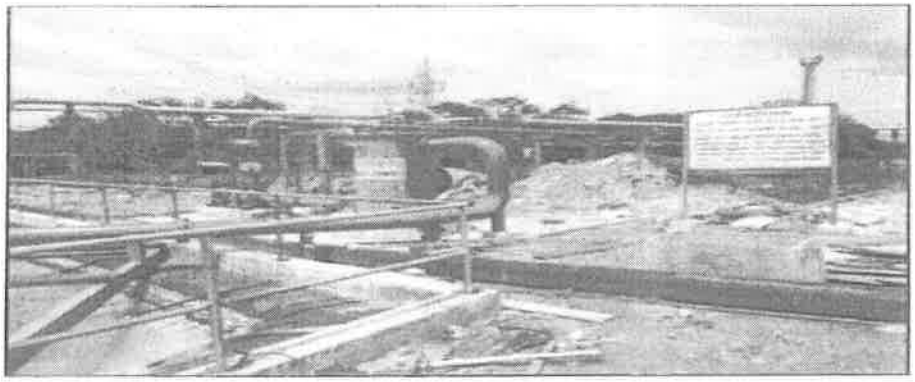

*FIG. 6 – PRIMING CHAMBER & SETTLING CHAMBER PUMP*

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### 3.9. SETTLING CHAMBER PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | P 3127 A/B |
| Rated Flow | : | 150 $m^3/h$ |
| Head | : | 30 m |
| Absorbed Power | : | 17.4 KW |
| Motor Details | : | 22 KW |
| Material of construction | : | Casing – Stainless steel, Shaft & Impeller - SS |

### 3.10. EFFLUENT COOLING TOWERS (2 Nos. Cell)

| | | |
|---|---|---|
| Equipment Tag No. | : | CT 3103 A/B |
| Make | : | SV cooling towers |
| Material of construction | : | Pultruded FRP |

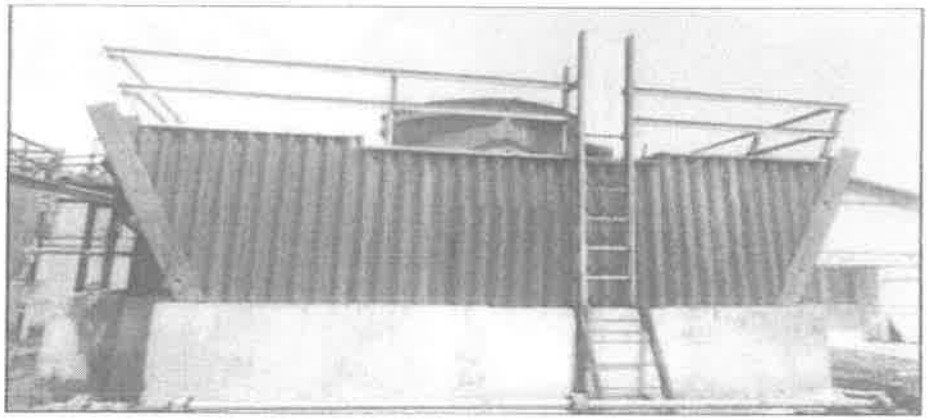

*FIG. 7 – ETP COOLING TOWER – 2 CELL TOWER*

### 3.11. EFFLUENT COOLING TOWERS (Single Cell)

| | | |
|---|---|---|
| Equipment Tag No. | : | CT 3103 C |
| Make & Model | : | Paharpur & 361 - 101 |
| Cell height | : | 3153 mm |
| Material of construction | : | Glass Reinforced Polyester (GRP) |

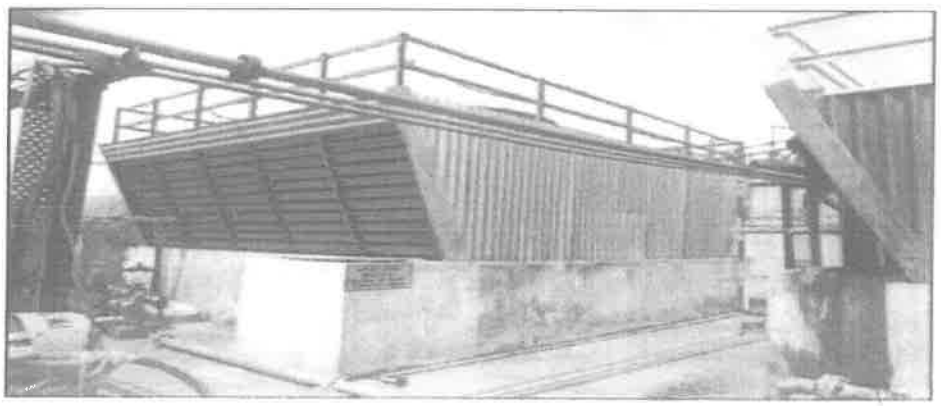

*FIG. 8 – ETP COOLING TOWER – SINGLE CELL TOWER*

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### 3.12. PRIMING CHAMBER FOR ETP COOLING TOWER PUMPS

| | | |
|---|---|---|
| Equipment Tag No. | : | PC 3103 A/B |
| Inner Diameter | : | 1000 mm |
| Height | : | 1750 mm |
| Material of Construction | : | Carbon Steel |

*FIG. 9 – PRIMING CHAMBER WITH BIO RERACTOR FEED PUMP FOR ETP COOLING TOWERS*

### 3.13. BIO REACTOR FEED PUMPS

| | | |
|---|---|---|
| Equipment Tag No. | : | P 3103 A/B |
| Rated Flow | : | 150 $m^3/h$ |
| Rated Head | : | 15 m |
| Motor details | : | 15 HP, 1460 RPM |
| Material of construction | : | Casing & Impeller – Stainless steel |

### 3.14. BIO – REACTORS

| | | |
|---|---|---|
| Equipment Tag No. | : | T 3104 – A, B, E & F |
| Type | : | Square tank |
| Length of the Tank | : | 15.46 m |
| Width of the tank | : | 15.46 m |
| Side wall Depth | : | 5.5 m |
| Material of Construction | : | Reinforced Cement Concrete |

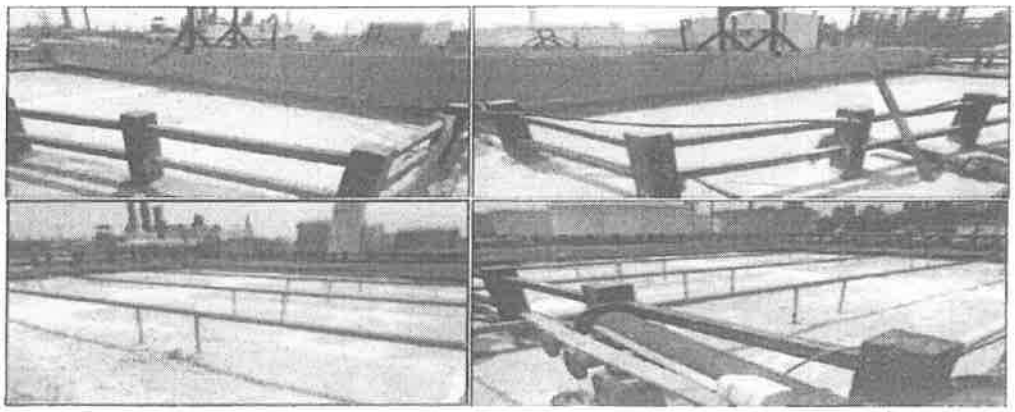

*FIG. 10 – BIO REACTORS – A, B, E & F*

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### 3.15. BIO – REACTORS

| | | |
|---|---|---|
| Equipment Tag No. | : | T 3104 – C & D |
| Type | : | Rectangular tank |
| Length of the Tank | : | 15.65 m |
| Width of the tank | : | 15.46 m |
| Side wall Depth | : | 5.5 m |
| Material of Construction | : | Reinforced Cement Concrete |

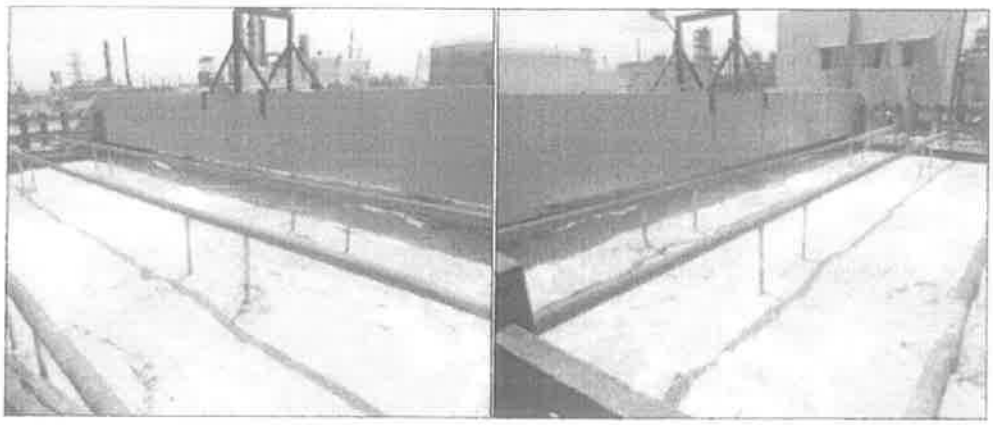

*FIG. 11 – BIO REACTORS – C & D*

### 3.16. MIX FLOW PUMPS

| | | |
|---|---|---|
| Equipment Tag No. | : | P 3104 A/B |
| Rated Flow | : | 350 $m^3/h$ |
| Rated Head | : | 32 m |
| Absorbed Power | : | 39.5 KW |
| Motor Power | : | 45 KW |
| Material of construction | : | Casing - CS |

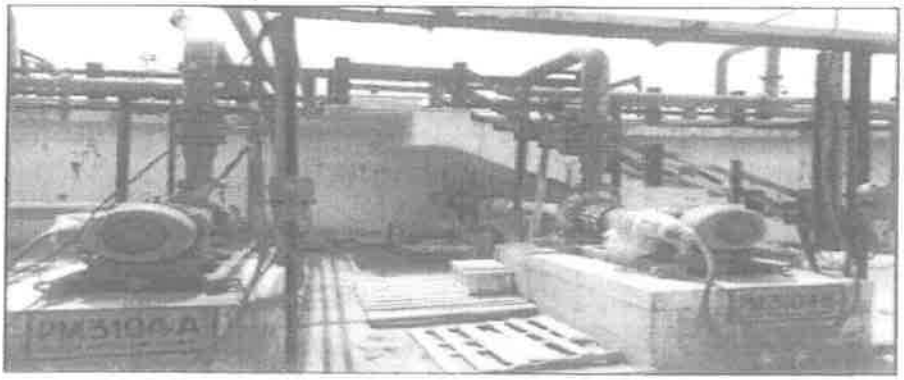

*FIG. 12 – MIX FLOW PUMPS*



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## 3.17. VENTURI EJECTORS

Equipment Tag No. : EJ 3104 A/B

Material of construction : Carbon steel

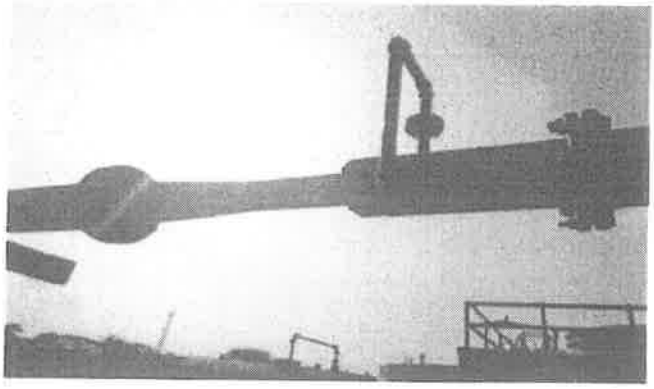

FIG. 13- VENTURI EJECTOR

## 3.18 EDUCTORS

Equipment Tag No. : EJ 3104 A1, A2, A3, A4, A5, A6 (6 Nos. in Bioreactor – A)
EJ 3104 B1, B2, B3, B4, B5, B6 (6 Nos. in Bioreactor – B)

Size : Suction – 369 mm, Discharge – 254 mm

Material of construction: Stainless steel

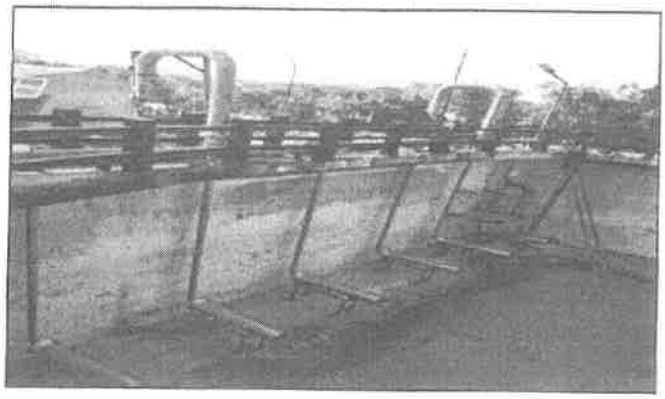

*FIG. 14 – EDUCTORS*

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### 3.19. OHR AERATORS

| | | |
|---|---|---|
| No. of aerators in Bioreactor C | : | 32 Nos. |
| No. of aerators in Bioreactor D | : | 32 Nos. |
| No. of aerators in Bioreactor E | : | 28 Nos. |
| No. of aerators in Bioreactor F | : | 28 Nos. |
| Air flow through single aerator | : | 55 $m^3/h$ |
| Material of construction | : | Polypropylene |

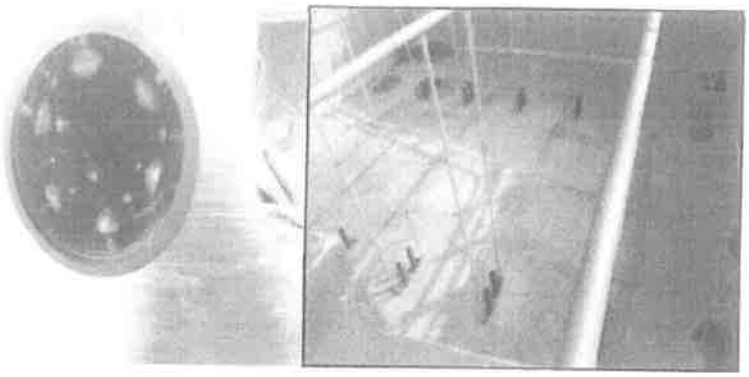

*FIG. 15 – OHR AERATORS*

### 3.20. BLOWERS

| | | |
|---|---|---|
| Equipment Tag No. | : | K 3104 A/B/C |
| Make & Model | : | Robuschi & EL-126/4P |
| Capacity | : | 4058 $Nm^3/h$ (or) 4778 $m^3/h$ |
| Differential pressure | : | 700 mbar |
| Absorbed power | : | 124 KW |
| Motor details | : | 160 KW, 1485 RPM |
| Material of construction | : | Casing – Cast Iron, Lobe – Ductile Iron<br>Shaft – Carbon Steel |

*FIG. 16 – BLOWERS FOR OHR AERATORS*

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### 3.21. LIQUID OXYGEN TANK

| | | |
|---|---|---|
| Equipment Tag No | : | T 3120 |
| Tank type | : | Vertical storage tank with cylindrical shell and dish ends |
| Shell Diameter | : | 1660 mm |
| Shell Height | : | 7600 mm |
| Dish height | : | 428 mm |
| Material of construction | : | Stainless steel |
| Licensed capacity | : | 19.21 $m^3$ |

*FIG. 17 – LIQUID OXYGEN TANK*

### 3.22. LIQUID OXYGEN VAPOURISER

| | | |
|---|---|---|
| Equipment Tag No. | : | E 3120 A/B |
| Material of construction | : | Stainless steel |

*FIG. 18 – LIQUID OXYGEN VAPOURISER*

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### 3.23. ROTARY VACUUM DRUM FILTER (RVDF)

| | | |
|---|---|---|
| Equipment Tag No. | : | J 3102 A/B |
| Drum Diameter | : | 2.44 m |
| Drum Length | : | 3.53 m |
| Material of construction | : | Carbon steel |

*FIG. 19 – ROTARY VACUUM DRUM FILTER*

### 3.24. RVDF CONDENSERS

| | | |
|---|---|---|
| Inner Diameter | : | 1070 mm |
| Overall Height | : | 3140 mm |
| Material of construction | : | Carbon steel |

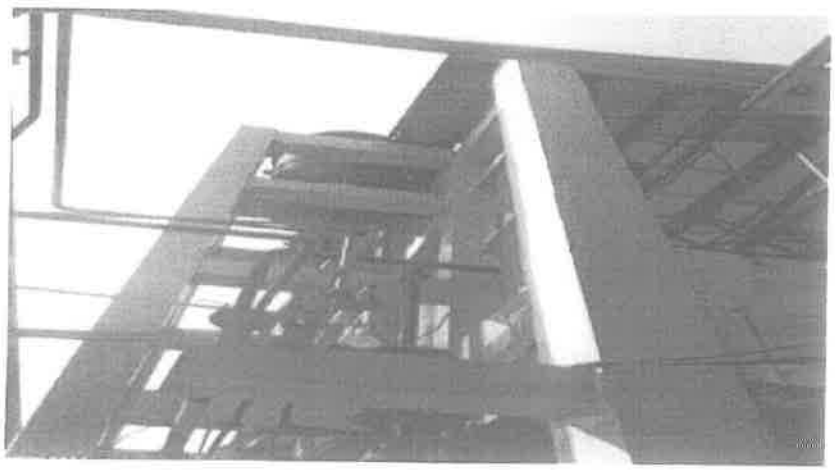

*FIG. 20 – RVDF CONDENSERS*



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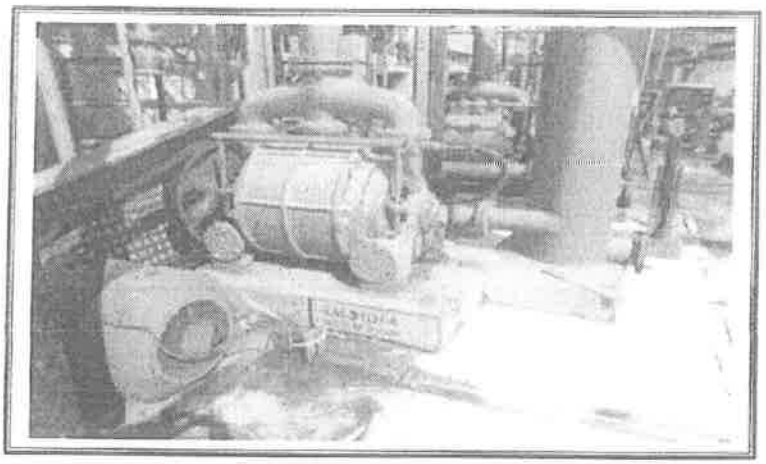
### 3.25. RVDF VACUUM PUMP

Equipment Tag No. : K 3101 A/B
Motor details : 90 KW



Material of construction : Cast iron

*FIG. 21 – RVDF VACUUM PUMP*

### 3.26. RVDF VACUUM RECEIVER

Equipment Tag No. : V 3102
Inner Diameter : 1525 mm
Overall Height : 2845 mm
Material of construction : Carbon steel

### 3.27. RVDF FILTRATE BOTTOM PUMP

Equipment Tag No. : P 3113 A/B
Make & Model : Johnson J4-08
Capacity : 45 $m^3/h$
Motor details : 7.5 KW
Material of construction : Cast Iron

### 3.28. BIOMASS CULTURE PREPARATION TANK

Equipment Tag No. : T 3130
Capacity : 5 m3
Material of construction : HDPE

*FIG. 22 – BIOMASS CULTURE PREPARATION TANK*

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### 3.29. BLOWER FOR BIOMASS CULTURE PREPARATION

| | | |
|---|---|---|
| Equipment Tag No. | : | K 3105 (Blower) |
| Capacity | : | 50 $m^3/h$ |
| Motor Details | : | 2 HP |
| Material of construction | : | Mild Steel |

*FIG. 23 – BIOMASS CULTURE PREPARATION TANK BLOWER*

### 3.30. PUMP FOR BIOMASS CULTURE PREPARATION

| | | |
|---|---|---|
| Equipment Tag No. | : | P 3130 (Pump) |
| Capacity | : | 2 $m^3/h$ |
| Head | : | 20 m |
| Material of construction | : | Cast Iron |

*FIG. 24 – BIOMASS CULTURE PREPARATION TANK PUMP*

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### 3.31. NUTRIENT TANK

| | | |
|---|---|---|
| Equipment Tag No. | : | T 3109 A/B |
| Inner Diameter | : | 2 m |
| Overall Height | : | 2.006 m |
| Material of Construction | : | FRP |

### 3.32. NUTRIENT TANK AGITATORS

| | |
|---|---|
| Equipment Tag No. | : A 3109 A/B |
| Motor details | : 1.5 HP, 1415 RPM |
| Material of Construction | : Shaft & Blade – Stainless steel, Housing – Cast Iron |

*FIG. 25 – NUTRIENT TANK WITH AGITATOR*

### 3.33. NUTRIENT TANK PUMPS

| | | |
|---|---|---|
| Equipment Tag No. | : | P 3109 A/B |
| Flow rate | : | 45 $m^3/h$ |
| Material of construction | : | Cast Iron |

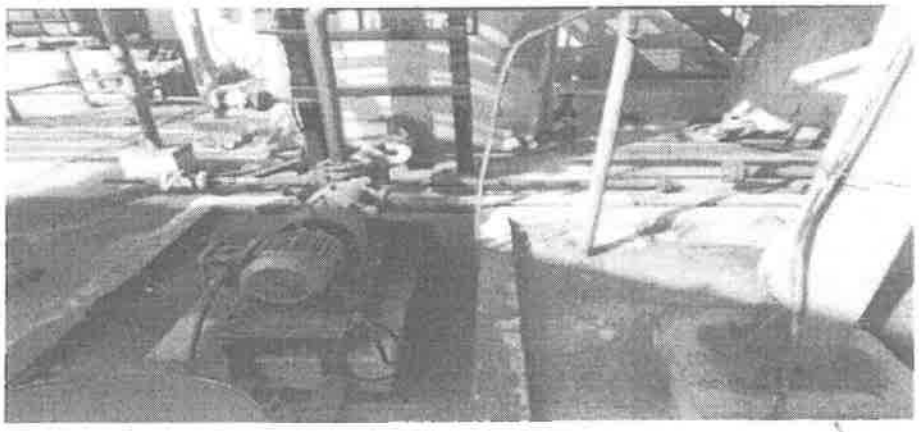

*FIG. 26 – NUTRIENT TANK PUMPS*

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### 3.34. SECONDARY CLARIFIER

| | | |
|---|---|---|
| Equipment Tag No. | : | T 3121 |
| Inner Diameter | : | 14 m |
| Side Wall Depth | : | 3.5 m |
| Material of construction | : | Reinforced Cement Concrete |

### 3.35. SECONDARY CLARIFIER RACKER ARM

| | | |
|---|---|---|
| Equipment Tag No. | : | M 3121 |
| Motor details | : | 2.2 KW |
| Material of construction | : | Carbon Steel |

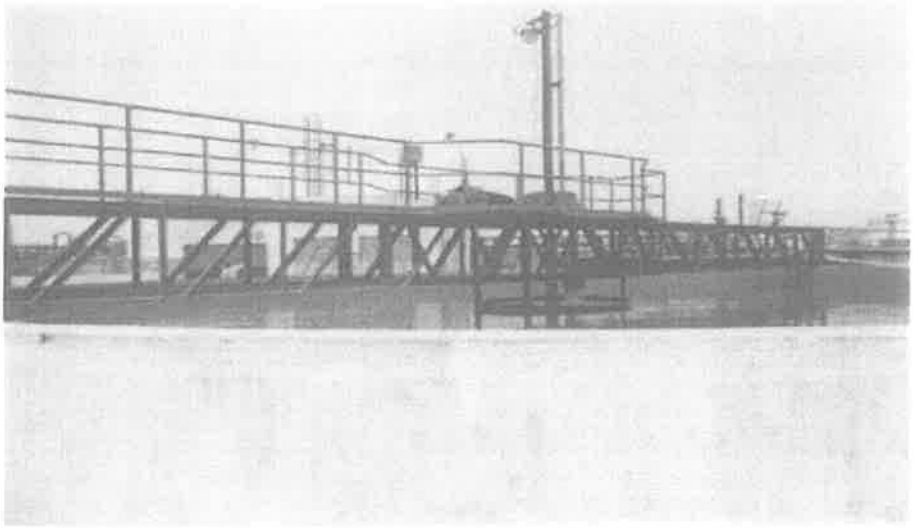

*FIG. 27 – SECONDARY CLARIFIER WITH RACKER ARM*

### 3.36. WET WELL TANK

| | | |
|---|---|---|
| Equipment Tag No. | : | T 3123 |
| Inner Diameter | : | 5 m |
| Height | : | 3.625 m |
| Side Wall Depth | : | 3.125 m |
| Material of Construction | : | Reinforced Cement Concrete |

*FIG. 28 – WET WELL TANK WITH PUMP*

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### 3.37. WET WELL TANK PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | P 3123 A/B |
| Make & Model | : | 100 WQ-75-15-7.5 |
| Motor details | : | 7.5 KW, 2900 RPM |
| Material of Construction | : | Stainless Steel |

### 3.38. SECONDARY CLARIFIER OVERFLOW PIT

| | | |
|---|---|---|
| Equipment Tag No. | : | T 3122 |
| Length | : | 4 m |
| Width | : | 4 m |
| Side Wall Depth | : | 2 m |
| Material of Construction | : | Reinforced Cement Concrete |

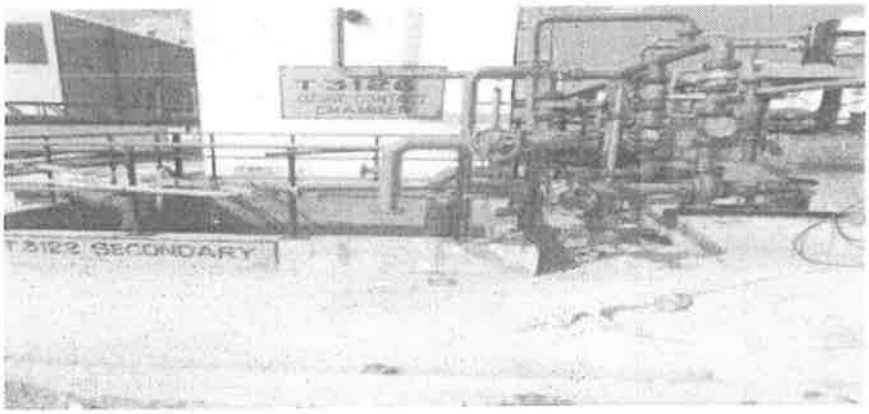


*FIG. 29 – SECONDARY CLARIFIER OVERFLOW PIT WITH PUMP*

### 3.39. SECONDARY CLARIFIER OVERFLOW PIT PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | P 3122 A/B |
| Rated Flow | : | 125 $m^3/h$ |
| Head | : | 20 m |
| Absorbed Power | : | 8.37 KW |
| Motor Details | : | 15 KW |
| Material of Construction | : | Stainless steel |

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*FIG. 30 – OXYGEN FLOW CONTROL PANEL*

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### 3.40. TREATED EFFLUENT TANKS

| | | |
|---|---|---|
| Equipment Tag No. | : | TET – A & TET – B |
| Length | : | 25.3125 m |
| Width | : | 15.615 m |
| Depth | : | 3.3 m |
| Material of construction | : | Reinforced cement concrete |

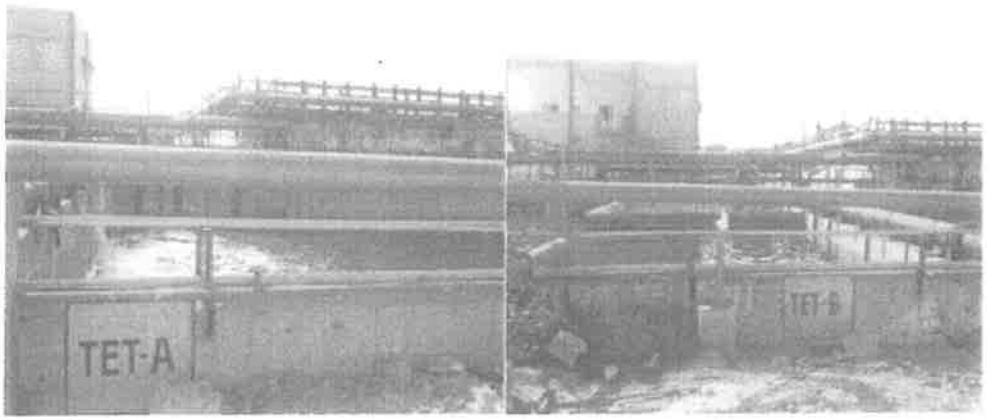


*FIG 31. TREATED EFFLUENT TANKS – A & B*

### 3.41. TET CIRCULATION PUMPS

| | | |
|---|---|---|
| Equipment Tag No. | : | P 3128 A/B/C/D (4 Nos.) |
| Make & Model | : | KSB & ETN 65-40 160GG |
| Capacity | : | 40 $m^3/h$ |
| Head | : | 35 m |
| Material of Construction | : | Cast Iron |

**FIG.32.TREATED EFFLUENT TANKS CIRCULATION PUMPS**



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### 3.42. EFFLUENT SEND OUT PUMPS WITH PRIMING CHAMBER

| | | |
|---|---|---|
| Equipment Tag No. | : | P 3106 A/B |
| Make & Model | : | KBL & KPD 125/40 |
| Capacity | : | 200 $m^3/h$ |
| Head | : | 45 m |
| Motor details | : | 45 KW |
| Material of construction | : | Stainless Steel |

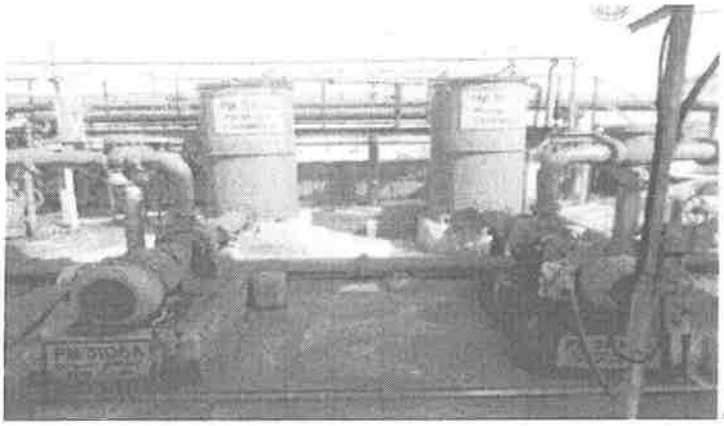

*FIG 33. TREATED EFFLUENT SEND OUT PUMPS WITH PRIMING CHAMBER*

### 3.43. COD/BOD, TSS, TOC, pH ANALYSER and DO METER IN BIOREACTORS

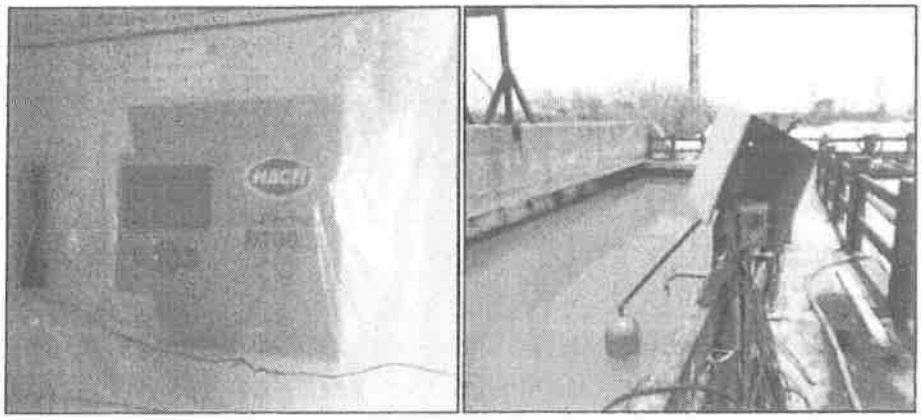


*FIG 34- TOC ANALYCER, DO METER*

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### 3.44. CLARIFLOCCULATOR

| | | |
|---|---|---|
| Equipment Tag No. | : | T 3101 |
| Inner Diameter | : | 14.35 m |
| Side Wall Depth | : | 3.8 m |
| Material of Construction | : | Reinforced Cement Concrete |

### 3.45. THICKENER

| | | |
|---|---|---|
| Equipment Tag No. | : | T 3105 |
| Inner Diameter | : | 10 m |
| Side Wall Depth | : | 3.5 m |
| Material of Construction | : | Reinforced Cement Concrete |

4.0. Site Audit

4.1. The unit has constructed dedicated storage area with wall for the lime storage area and the seepage collection system.

The dedicated lime storage construction and seepage collection system is adequate to store the current generation of lime sludge.

**Dr.S.Sivanesan inspecting the newly constructed Lime storage yard.**

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4.2. Dr.S.Sivanesan inspecting ETP solid separation UNIT.

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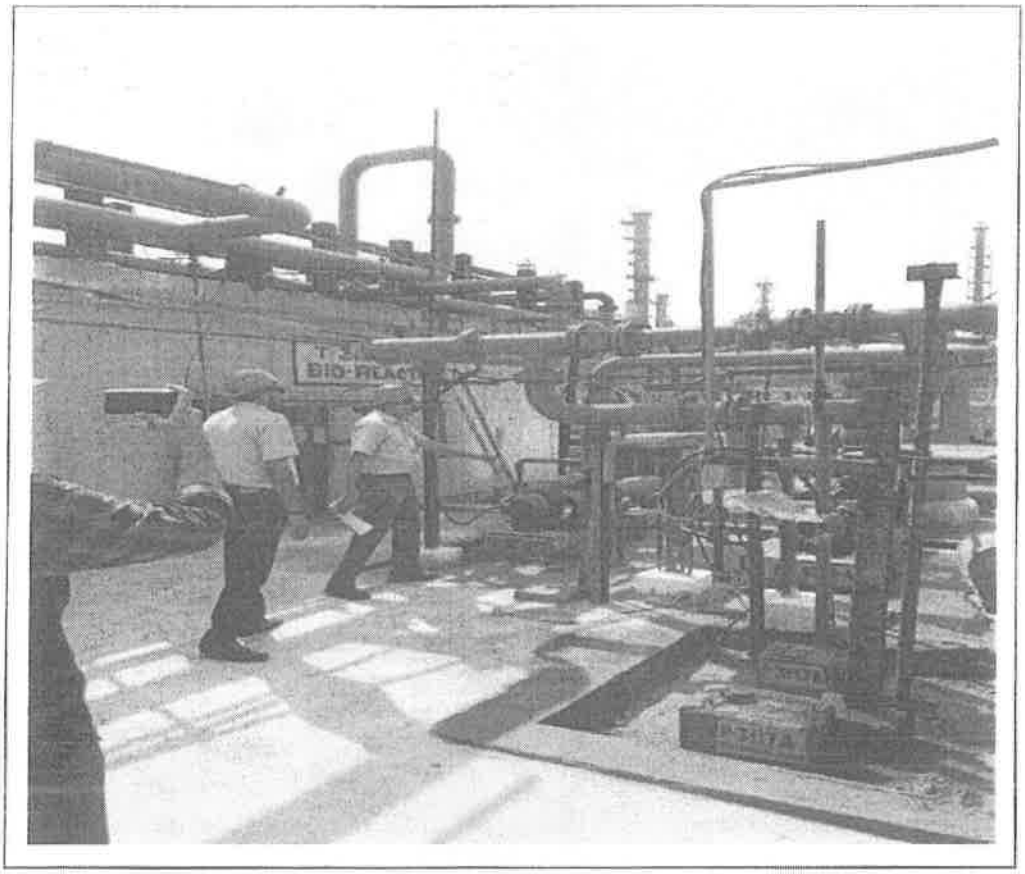
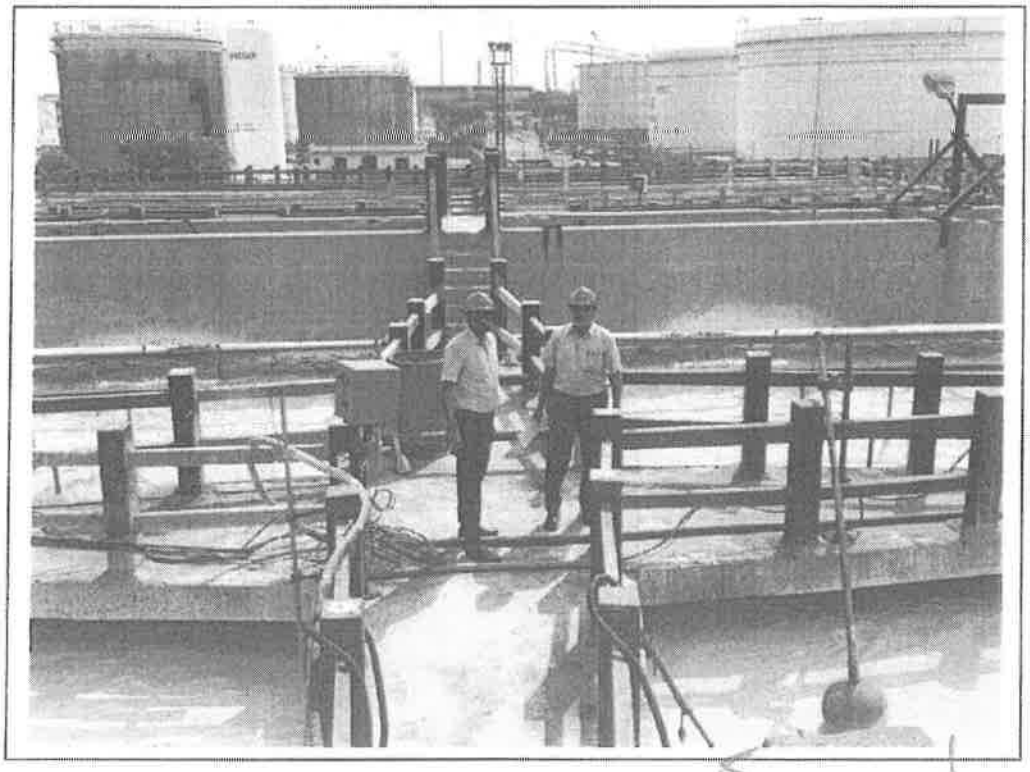
4.3. Auditing of MPL UNIT-I - BIO REACTOR FACILITY





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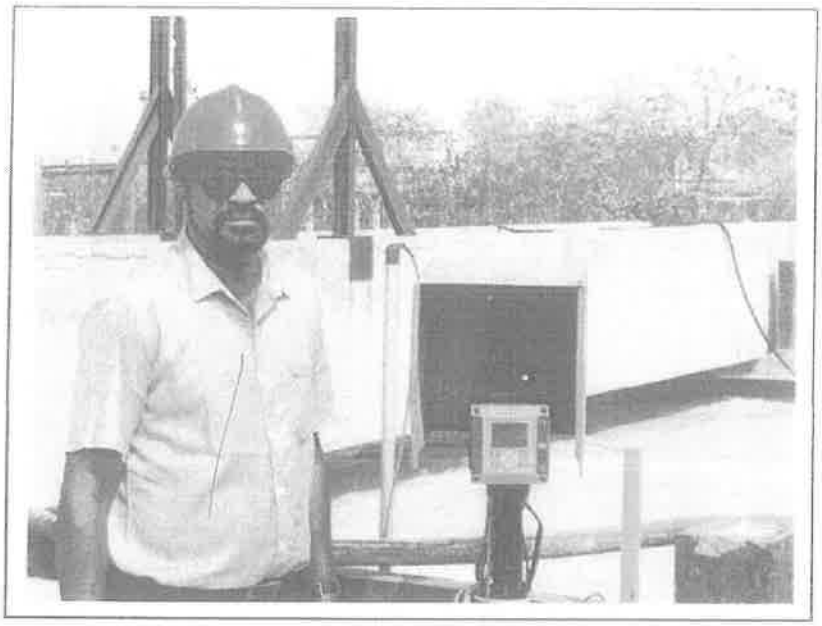
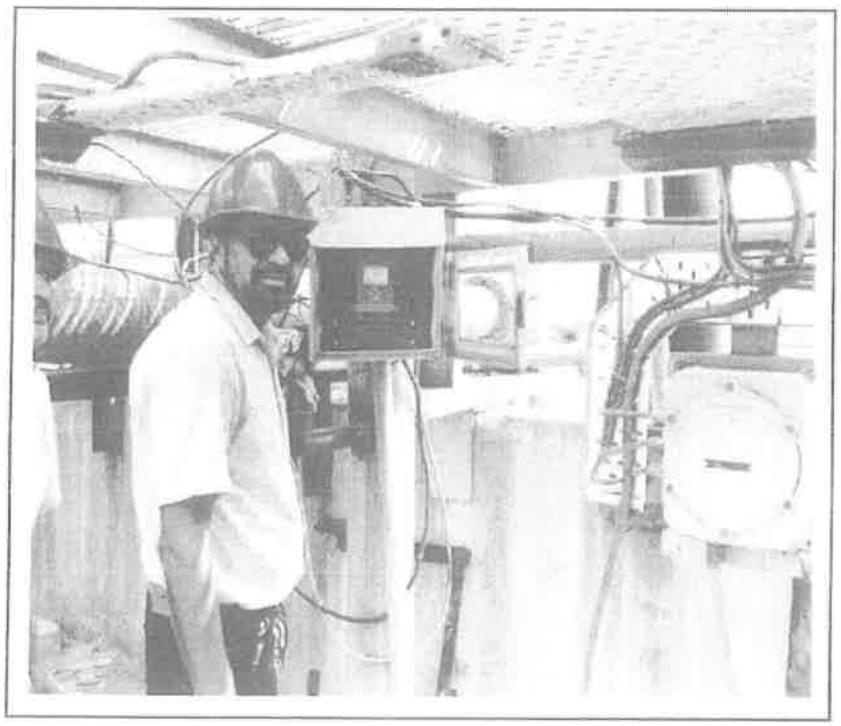
4.4. Auditing of DO & Magnetic flow meter installation in MPL UNIT-I





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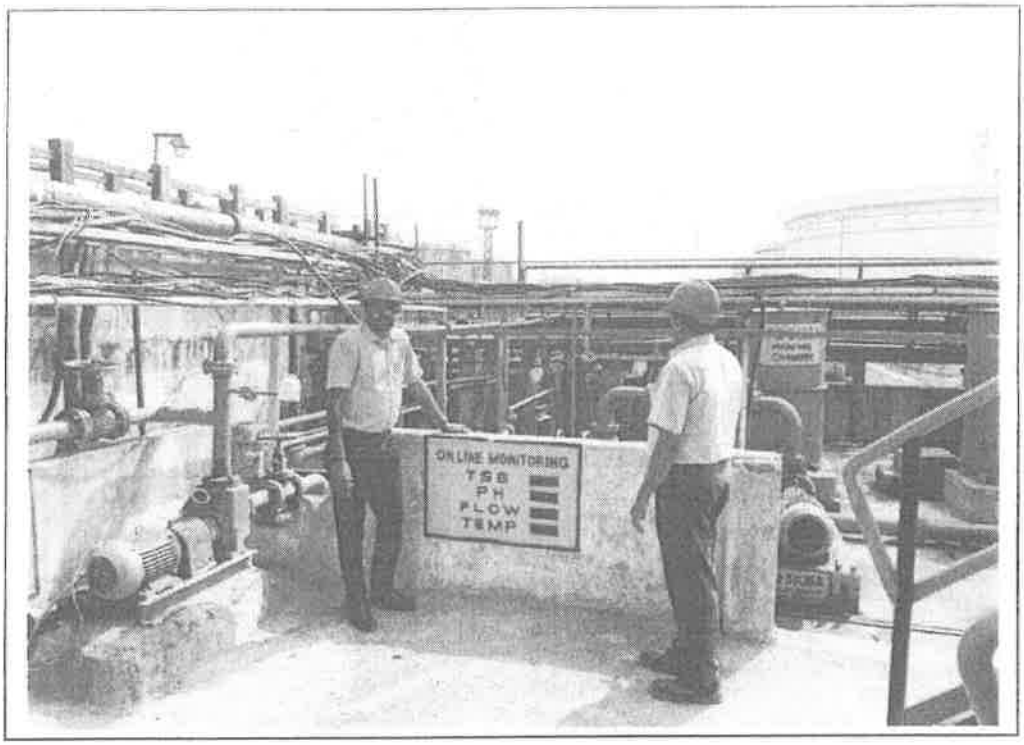
4.5. Auditing of Online monitoring system of TSS, pH, temperature BOD,COD and Flow installed in MPL - UNIT -I



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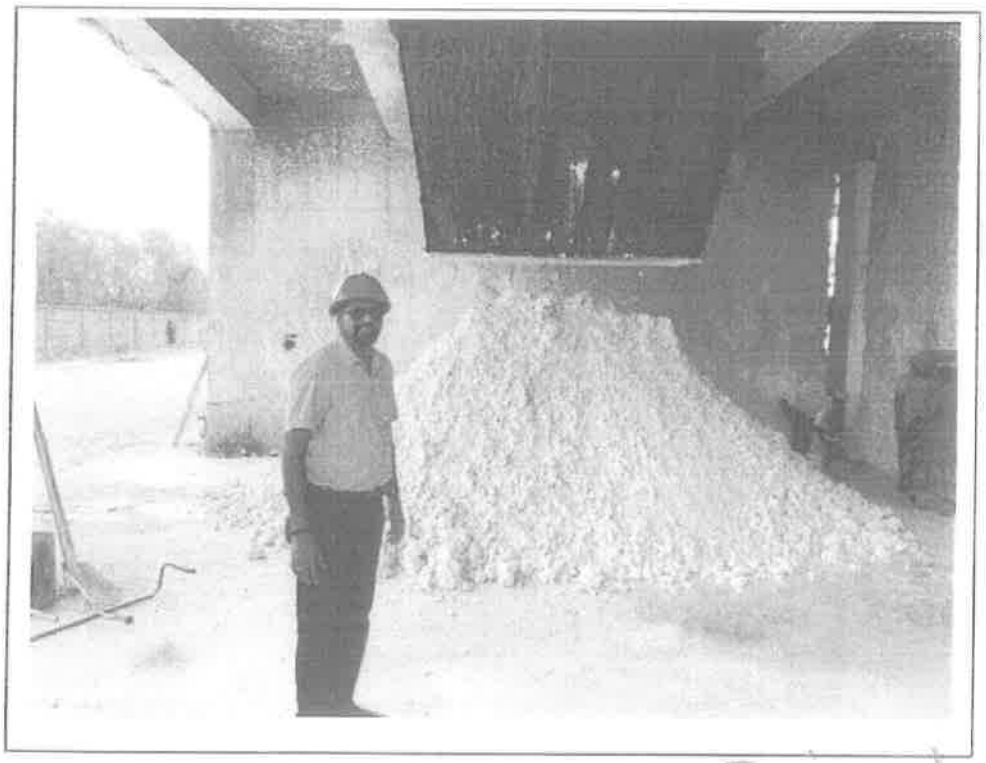
4.6. Liquid Oxygen storage & handling facility - MPL UNIT-I

## 4.7. LIME SLUDGE COLLCTION FROM ROTARY VACUUM DRUM FILTER (RVDF)



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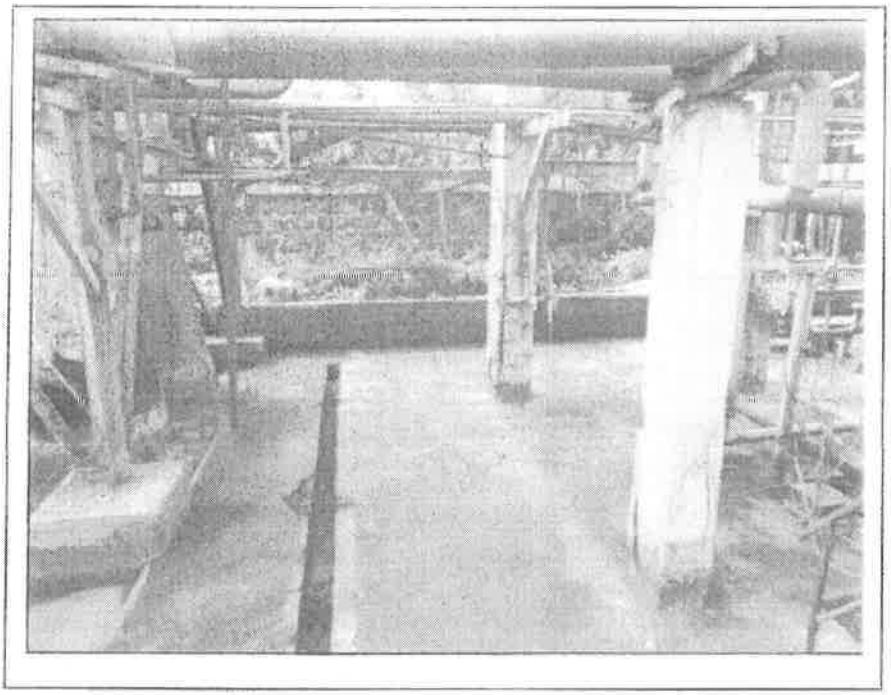
Department of Applied Science and Technology
Alagappa College of Technology
Anna University, Chennai-600 025

4.8. FLARE AREA COMPLETELY CLEANED AND DEWATERED



**4.9. OLD LOGOON FILLED WITH SAND AND CLOSED**

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## 5.0. ETP PROCESS DESCRIPTION

Effluent generated by propylene oxide plant at saponifier bottom is pumped to High rate thickener at 75 deg C at a flow rate of 110 m3/hr. Flocculent is added, for faster settling of suspended solids at the bottom. HRT Underflow contains 6-7 % of suspended solids and withdrawn at 10 T/hr and the corresponding underflow is pumped to rotary drum filter for the separation of effluent from suspended solids. The filtrate from RVDF is sent back to HRT. HRT overflow is a gravity flow to Effluent settling chamber. From the settling tank it is pumped to Cooling Tower for maintaining effluent temperature around 35 40 Deg C before pumping to bio reactors (A to F) for biological treatment.

In bioreactor A &B, Initially Cultured Microorganisms (BIO-NIL) are fed to promote biomass activity and pure oxygen injection is carried out to maintain DO. In Bioreactor A & B individual centrifugal pump with a capacity 400m3/hr at 32 m head is installed, Pure oxygen from liquid oxygen storage through Vaporizer and mix flow gas panel is connected to pump discharge with a venturi arrangement. Oxygen reacts directly over the sludge and drives most of the microorganisms to participate in the process of Biodegradation and increases the dissolved oxygen, level in effluent water and there will be Reduction of COD from the existing feed concentration.

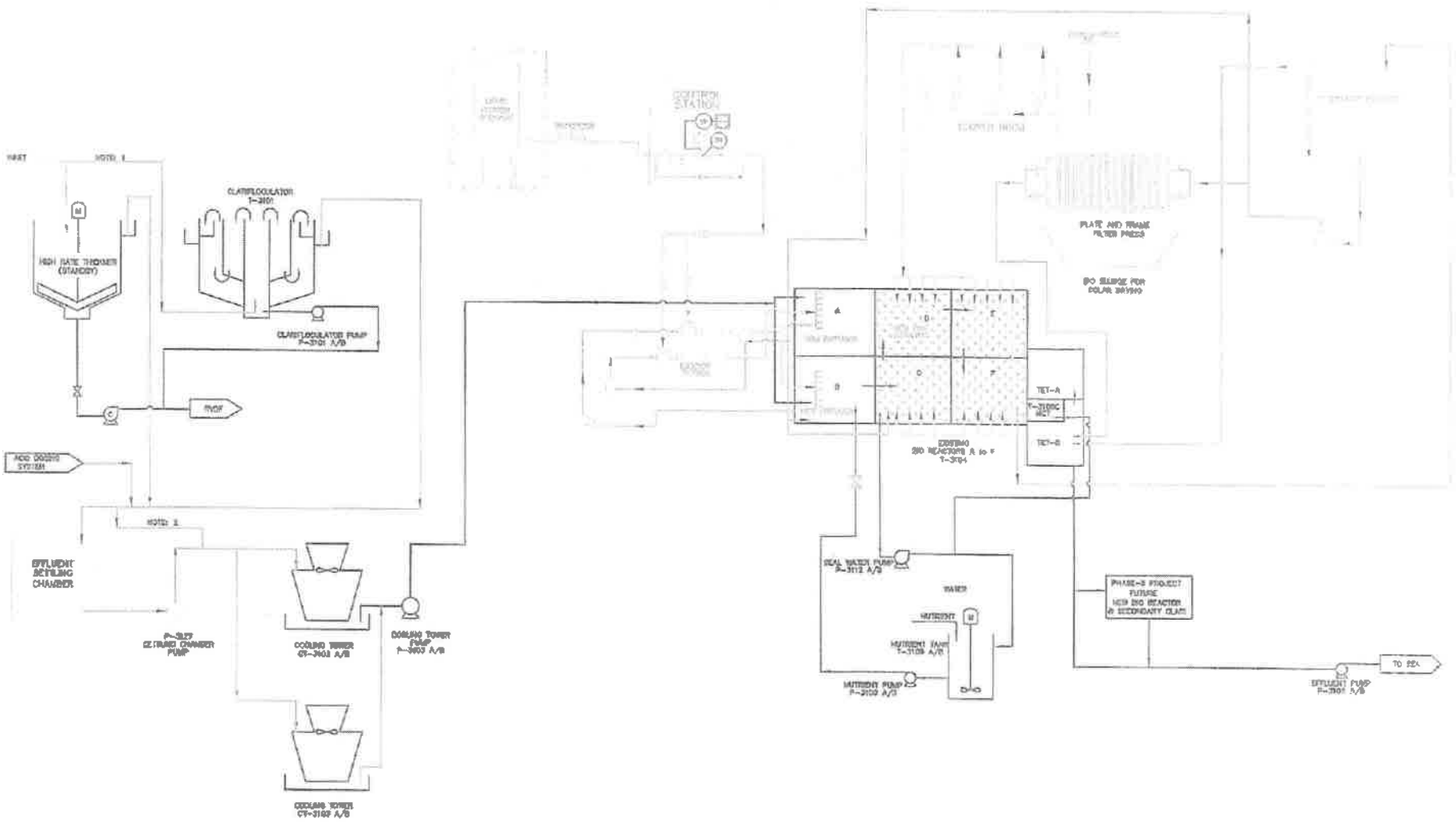
Inside Bio reactor C to F, OHR aerators (diffuser) of 120 numbers are fixed and all are connected with the Two numbers of Air blower with capacity each 4000 NM3, In Bioreactors, air and water are thoroughly mixed by hydrodynamics process to forcibly oxygenate the activated sludge. Also, Air blown form a large diameter hole of 30mm & extreme vortex are created by crossing plates and mushroom-shaped cutters to powerfully mix air and activated sludge which increases dissolved oxygen level. Bio F outlet is sent to Secondary clarifier where the biological sludge flocs separate from the water and settle at the bottom which is collected in a wet well from which the required quantity of sludge is recycled back to bioreactor A ,B,C to regulate the quantity of biological sludge necessary for treatment.

If Excess Bio sludge is formed from secondary clarifier is pumped and routed to Plate and frame press in order to remove the excess Bio sludge.

The clarified over flow water is routed to the Treated Effluent tank.

Finally the treated water from TET is pumped to Sea.

# PLANT-I WWTP IMPROVEMENT PROJECT




NOTES:
1) WASTEWATER BOTTOM EFFLUENT INLET GIVEN TO EITHER HRT OR CLARIFLOCCULATOR.
2) HRT AND CLARI. OVERFLOW DIRECTLY FEED TO COOLING TOWER WHEN SETTLING CHAMBER UNDER MAINTENANCE.

EXISTING

| REV | DATE | DESCRIPTION | DRN | CHD | APD |
|---|---|---|---|---|---|
| 5 | 03-11-2018 | PLATE AND FRAME FILTER PRESS | APK | SNR | SSN |
| 4 | 25-11-2017 | DOSING DEFINED FOR CWW | CHD | SNR | GVR |
| 3 | 01-09-2017 | OXYZONE REACTION SYSTEME ADDED | APKN | AM | PSN |
| 2 | 25-07-2017 | GENERALLY REVISED | APKN | AM | VRN |
| 1 | 20-05-2017 | WAS NOW RATED AT 2K/DAY | APKN | BJB | VRN |
| 0 | 23-02-2017 | FOR REVIEW AND COMMENTS (RFT-1) | APKN | KJh | GVR |

MANALI PETROCHEMICALS
CHENNAI - 600 068.
( AN TID-SCBA COMPANY )

PLANT-I
PROCESS FLOW DIAGRAM FOR WASTE WATER TREATMENT WITH LIQUID OXYGEN WITH CULTURE TREATMENT, OHR AERATOR SYSTEM & OZONE TREATMENT

| SCALE | DRAWING NO. | REV |
|---|---|---|
| NTS | MPL/PL-I/WWTP/PROCESS/PFD-001 | 5 |

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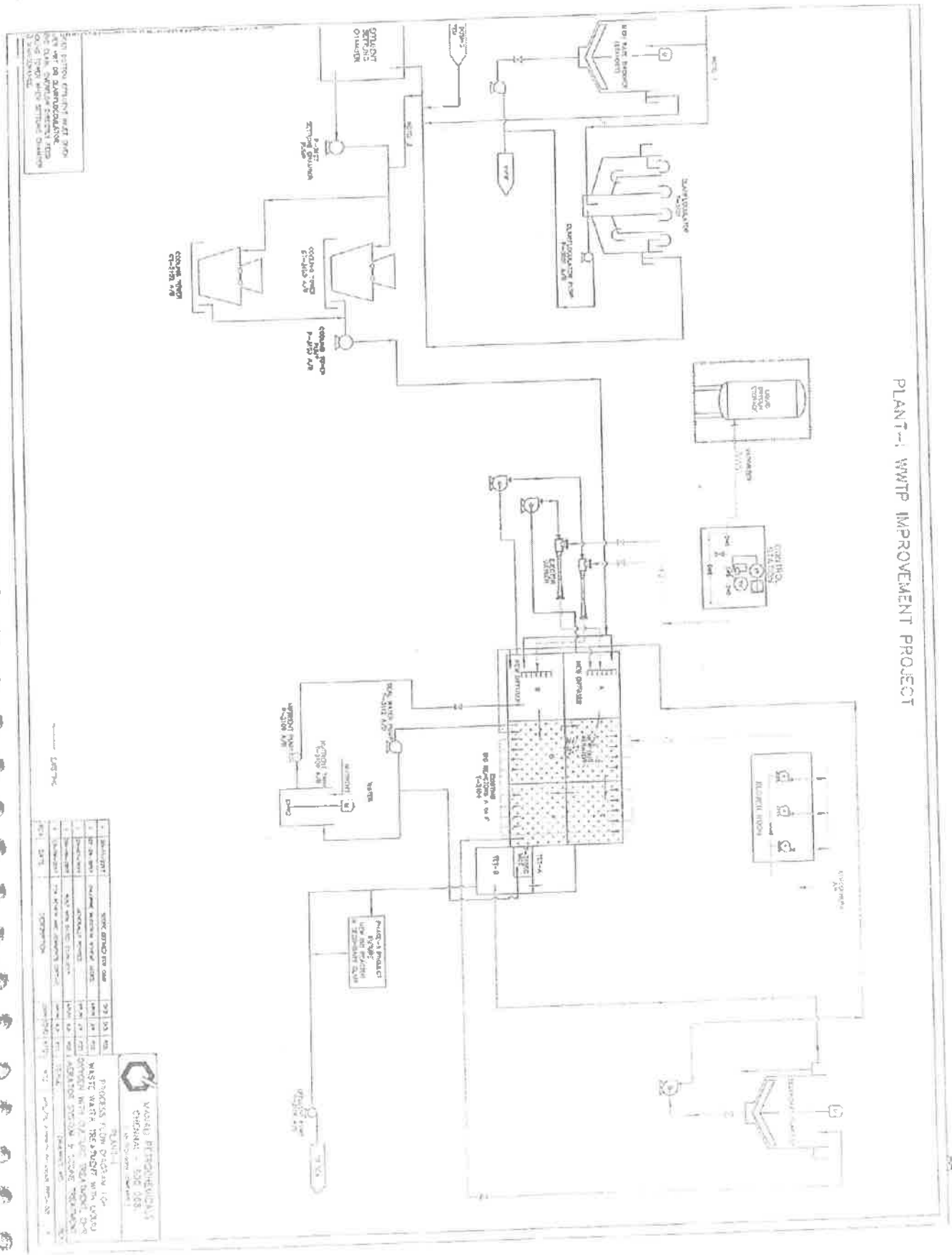
5.1. The ETP flow diagram (Annexure-1)

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5.2. The Liquid oxygen is used at Bioreactor-A & B with Mixed flow Diffuser system.

5.3. Environmental Status of the Plant - Water Balance

5.3.1. Raw water consumption - last 2 years

| Year | Annual water consumption $m^3$/day | | | Total | Daily consumption $m^3$/day |
|---|---|---|---|---|---|
| | Cooling | Processing | Domestic | | |
| 2017-18 | 295.578 | 930.627 | 66.569 | 1292.744 | 1292.744 * |
| 2016-17 | 275.046 | 878.942 | 64.145 | 1218.133 | 1218.133** |

* 2017-2018 *The above quantity excluded 1355 $m^3$/day RO Rejects water from MFL & CMWSSB kodungaiyur secondary treated sewage water used in Propylene oxide Plant.

** 2016-2017 *The above quantity excluded 1355 $m^3$/day RO Rejects water from MFL & CMWSSB kodungaiyur secondary treated sewage water used in Propylene oxide Plant.

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5.4 Effluent generation m3/day

| Month | Treated Effluent M3/ Day |
|---|---|
| January -2018 | 2413 |
| February -2018 | 2413 |
| March-2018 | 2374 |
| April-2018 | 2413 |
| May-2018 | 2412 |
| June-2018 | 2411 |
| July-2018 | 2412 |
| August-2018 | 2413 |
| September-2018 | 2412 |
| October-2018 | 2411 |
| November-2018 | 1535 |
| December-2018 | 1549 |
| Average Daily Effluent Generation/Day | 2264 |

5.5. Characteristic of trade effluent generated before treatment

| Parameters | Effluent before treatment |
|---|---|
| (A) GENERAL PARAMETERS : | |
| (i) pH : | 10 -11 |
| (ii) Colour Units | N/A |
| (iii) Temperature $^0C$ | 40 ° C |
| (iv) Supended solids | |
| (a) Total mg/l | 200 |
| (b) Fixed mg/l | - |
| (c) Volatile mg/l | - |
| (v) Dissolved solids | |
| (a) Total mg/l | 40000 |
| (b) Fixed mg/l | - |
| (c) Volatile mg/l | - |
| (vi) Total volatile solids mg/l | - |
| (vii) Dissolved Oxygen mg/l | <1 |
| (viii) B O D ,5 days 20 $^0$ C mg/l | 400 |
| (ix) C O D , mg/l | 1800 - 2300 |
| (x) Oil & Grease mg/l | NIL |
| (B) CHEMICAL PARAMETERS :in PPM | |
| (i) Ammonical Nitrogen,mg/l (as N) | NIL |
| (ii) Nitrates, mg/l (as N) | NIL |
| (iii) Chlorides, mg/l (as Cl) | 26000- 30000 |
| (iv) Phosphates,mg/l (as P) | NIL-50 PPM |
| (v) Phenolic Compounds, mg/l (as phenol) | NIL |
| (vi) Cyandies ,mg/l (as CN) | NIL |
| (vii) Sulphides, mg/l (as S) | NIL |
| (viii) Sulphates,mg/l (as $SO_4$) | 100 -400 PPM |
| (ix) Insecticides mg/l | NIL |
| (x) Total residual Chlorine mg/l (as $Cl_2$) | NIL |
| (xi) Flourides mg/l (as F) | NIL |
| (xii) Percent Sodium | 0.01 |
| (xiii) Pesticides mg/l | NIL |

| | MPL plant-1 Raw effluents sample (HRT OVER FLOW) Analysis report | | |
|---|---|---|---|
| | | | plant-1 |
| S.No. | Characteristics | Unit | 22.02.2019 |
| 1 | BOD (5 days) @ 20 0C | ----- | 310 |
| 2 | Calcium | mg/l | 15390.72 |
| 3 | Chloride | mg/l | 27591.44 |
| 4 | COD | mg/l | 1840 |
| 5 | Fluoride | mg/l | 0.71 |
| 6 | Hexavalent Chromium | mg/l | BDL |
| 7 | Oil and Grease | mg/l | 7 |
| 8 | pH | mg/l | 10.71 |
| 9 | Phenolic compounds | mg/l | BDL |
| 10 | Phosphate | mg/l | 8.79 |
| 11 | Sulphate | mg/l | 549.28 |
| 12 | Sulphide | mg/l | 1.6 |
| 13 | Total chromium | mg/l | 0.062 |
| 14 | TDS | mg/l | 46670 |
| 15 | TRC | mg/l | BDL |
| 16 | TSS | mg/l | 86 |
| BDL - Below Detectable Limit | | | |

**( Analysis Report Refer 13.0 Annexure- 1)**

## 5.6. Characteristic of treated effluent - from 15.2.2019 to 28.2.2019 (Refer 13.1 Annexure- 2)

| | MPL PLANT 1 Treated effluents sample (TET) ANALYSIS REPORT | | | | | | |
|---|---|---|---|---|---|---|---|
| S.No. | Characteristics | Unit | 12.02.2019 | 15.02.2019 | 20.02.2019 | 22.02.2019 | 25.02.2019 |
| 1 | BOD (5 days) @ 20 0C | ----- | 42.24 | 57.6 | 46.08 | 34.56 | 38.4 |
| 2 | Calcium | mg/l | 15711.36 | 15070 | 15390.72 | 16352.64 | 15230 |
| 3 | Chloride | mg/l | 29390.88 | 26991.63 | 27391.5 | 30590.51 | 29391 |
| 4 | COD | mg/l | 207.34 | 192 | 239.87 | 174.82 | 185.47 |
| 5 | Fluoride | mg/l | 0.65 | 0.78 | 0.55 | 0.44 | 0.85 |
| 6 | Hexavalent Chromium | mg/l | BDL | BDL | BDL | BDL | BDL |
| 7 | Oil and Grease | mg/l | 6 | 6 | 6 | 7 | 8 |
| 8 | pH | mg/l | 6.64 | 6.48 | 6.58 | 6.49 | 6.68 |
| 9 | Phenolic compounds | mg/l | BDL | BDL | BDL | BDL | BDL |
| 10 | Phosphate | mg/l | 3.62 | 3.86 | 4.75 | 11 | 6 |
| 11 | Sulphate | mg/l | 376.67 | 188.23 | 210.17 | 441 | 459.8 |
| 12 | Sulphide | mg/l | 1.2 | BDL | 1.2 | BDL | BDL |
| 13 | Total chromium | mg/l | 0.093 | 0.081 | 0.081 | 0.087 | 0.072 |
| 14 | TDS | mg/l | 47423 | 46426 | 47635 | 47400 | 48800 |
| 15 | TRC | mg/l | BDL | BDL | BDL | BDL | BDL |
| 16 | TSS | mg/l | 91 | 84 | 87 | 86 | 88 |
| BDL - Below Detectable Limit | | | | | | | |

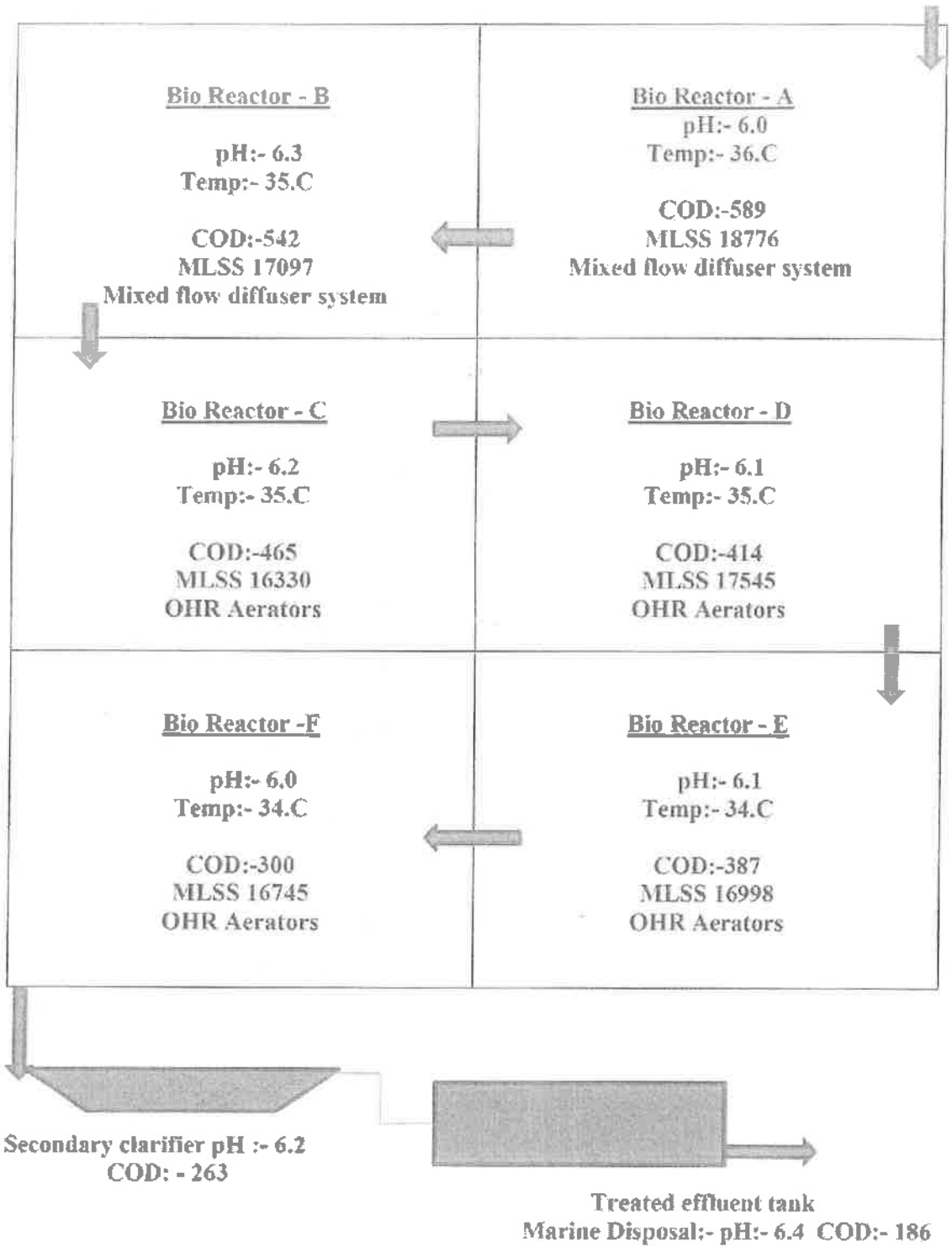
## 6.0. Details of Online monitoring equipments installed in the unit I - to measure TSS,COD, pH, Temperature and flow

Table-8

| S. No. | Station Name | Type of Monitoring System (Emission / Effluent / CAAQMS) | Process attached | Parameter monitored | NEW Device Vendor | NEW Device Model | SUPPLIER ADDRESS |
|---|---|---|---|---|---|---|---|
| 11 | PH | EFFLUENT | EFFLUENT TO SEA WATER | PH | Yokogawa | EXA | YOKOGAWA INDIA LIMITED,HOSUR ROAD,BANAGALORE-560100 |
| 12 | temperature | EFFLUENT | EFFLUENT TO SEA WATER | temperature | Yokogawa | YTA | YOKOGAWA INDIA LIMITED,HOSUR ROAD,BANAGALORE-560100 |
| 13 | flow | EFFLUENT | EFFLUENT TO SEA WATER | flow | SIEMENS | MAG310 | K&N Automation Plot 7, Bhuvaneswari Nagar First street Alapakkam Road Valasarvakkam Chennai - 600087 |
| 14 | TSS | EFFLUENT | EFFLUENT TO SEA WATER | TSS | HACH | LXV404.99.00502 | DHR HOLDING INDIA PVT LTD,SP COMPLEX (Gr.Fir), 16/1,LALBAGH RD, BANGALORE-560027 |
| 15 | COD/BOD | EFFLUENT | EFFLUENT TO SEA WATER | COD/BOD | HACH | 870001 | DHR HOLDING INDIA PVT LTD,SP COMPLEX (Gr.Fir), 16/1,LALBAGH RD, BANGALORE-560027 |

6.1 MPL Plant- I Bio- Reactors COD reduction, MLSS in the Bio Reactors

Cooling tower outlet: - ETP Feed
inlet to Bio Reactors
pH: - 11.2 COD:- 1349




Secondary clarifier pH :- 6.2
COD: - 263

Treated effluent tank
Marine Disposal:- pH:- 6.4 COD:- 186

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7.0. ETP sludge and Lime Sludge Analysis results

7.1. The third party analysis results of ETP sludge and Lime sludge as attached with this report as Annexure-4 & Annexure-5. (Refer 13.3,13.4)

8.0. Solid and Hazardous Waste Management

Details of Hazardous Waste generation by MPL UNIT -I and authorization conditions

| S.No | Details of processes Generating hazardous waste as listed in column 2 of schedule 1 of the amended rules | Details of waste stream as per column 3 of schedule 1 of the amended rules | Authorized Quantity per year. | Activity for which authorization is issued |
|---|---|---|---|---|
| 1. | Rotary equipment | 5.1 spent oil | 2000 | Collection / Storage and disposal to MOEF/TNPCB authorized recycler. |

8.1. Details of Hazardous wastes in Recycled

| S.No. | Type of Hazardous waste | Consented Quantity | Year | Quantity Generated | Quantity recycled | Quantity disposed | Mode of disposal | Quantity Sent Out |
|---|---|---|---|---|---|---|---|---|
| 1 | Spent oil | Tons/Year | 01.04 2017 to -31.03.2018 | 260 Litres | | NIL | | NIL |
| | | | 01.04 2016 to -31.03.2017 | 1160 | | 1050 * | To TNPCB approved waste oil reclaimers by drums | 1050 |

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9.0. Consented quantities of Products:

Table-10

| S.NO | Description | Quantity | Unit |
|---|---|---|---|
| PRODUCT DETAILS | | | |
| 1 | PROPYLENE OXIDE | 18000 | MT/YEAR |
| 2 | PROPYLENE GLYCOL | 10000 | MT/YEAR |
| 3 | POLYOL | 25000 | MT/YEAR |
| 4 | PROPYLENE GLYCOL MONO METHYL EHER | 2700 | MT/YEAR |
| BY PRODUCT DETAILS | | | |
| 1 | DCP- DICHLORO PROPANE | 3600 | MT/YEAR |
| 2 | TRI PROPYLENE GLYCOL | 120 | MT/YEAR |
| 3 | DIPROPYLENE GLYCOL MONO METHYLETHER-DPGMME | 460 | MT/YEAR |
| 4 | DIPROPYLENE GLYCOL | 1120 | MT/YEAR |

**10.0. Consent conditions under Air Act and its compliance status**

**Renewal of Water Consent Order No. : - 180819396042 Valid till 31.03.2019**

**10.1. Consent conditions:**

| | | | |
|---|---|---|---|
| Effluent | Sewage | 15 kl/Day | Combined with trade effluent, treated and discharged in to sea through pipe line |
| Effluent | Trade Effluent | 2399 KL/Day | Discharged in to sea through pipe line |

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10.2. Consent conditions as per Water Act and compliance status

| Conditions Mentioned in the Consent Order | Status of Compliance |
|---|---|
| The unit shall comply with the outcome of the order of the Honorable National Green Tribunal, Sothern Zone in the OA No:- 19 of 2013 and 52 & 53 of 2017 | We hereby undertake to comply with the directions, if any to be issued by the NGT. |
| The unit shall improve, operate and maintain the ETP efficiently and continuously and the treated trade effluent shall satisfy the Marine disposal standards prescribed by the Board before disposal in to sea. | MPL upgraded the ETP plant with Bio-Treatment system. operating and maintaining the ETP efficiently and continuously and the treated trade effluent meeting the Marine disposal standards prescribed by the Board before disposal in to sea. |
| The unit shall regularly analyze the treated effluent and furnish ROA of the same to the Board | As per Board advice we are regularly analyzing the treated effluent. Analysis report copy submitted every month to TNPCB. Regularly TNPCB also taking sample and ROA is enclosed for your reference and records. **(COMPLIED)** |
| The unit has to ensure that OLMS provided for the effluent parameters BOD, COD,and TSS and connected to the CAC of the Board shall be operated continuously. | OLMS provided for the effluent parameters BOD, COD,and TSS are connected to the CAC of the Board and operated continuously. **(COMPLIED)** |
| The unit shall ensure that connectivity of online monitors for the effluent parameter pH, Flow and temperature with CAC of TNPCB and provide proper data all times. | Ensured that the connectivity of online monitors for the effluent parameter pH, Flow and temperature with CAC of TNPCB and provided proper data all times. **(COMPLIED)** |
| The Hazardous waste generated shall be properly disposed as per Hazardous waste (MH&TM) Rules, 2008. | The Hazardous waste generated is disposed to TNPCB authorized recyclers as per Hazardous waste (MH&TM) Rules, 2008. **(COMPLIED)** |
| The unit shall dispose the lime sludge then and there for further beneficial use without accumulation of the same. | Lime sludge collected from the plant is then and there given to further beneficial use without accumulation of the same.Every month this details submitted to the Board. **(COMPLIED)** |
| The unit shall expedite the trial studies conducted by IIT, Madras and SASTRA University on the improved treatment of the effluent to discharge into the sea without affecting the Marine Eco system. | MPL upgraded the ETP plant with Bio-Treatment system. operating and maintaining the ETP efficiently and continuously and the treated trade effluent meeting the Marine disposal standards prescribed by the Board before disposal in to sea. **(COMPLIED)** |
| The unit shall ensure that there is no complaint arises due to operation of the plant. | As per Board advice we will strictly follow this requirement. **(COMPLIED)** |

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11.0. Conclusion:

10.1. The team headed by Dr.S.Sivanesan, audited the ETP area to check the effluent treatment plant operations stage wise and its control measures which were found to be adequate.

10.2. MPL unit -1 started its operations from 18.01.2019 as per the direction given by CPCB direction vide their letter No. B-29016/04/06/IPC-I /15156 dated 14/01/2019.

10.3. The unit restarted the P.O Plant operations on 18th January 2019 and full feed to the effluent treatment plant was established on 21st January. Since the Operations of the Biological system was kept online during the shutdown period, the analysis values were found to be within the specifications of CPCB from 21st January at full load operations.

10.4. The trade effluent generation and its analysis reports were verified from 15-02-2019 till 28-02.2019 and all pollutants (COD < 250 mg/Liter: BOD<100 mg/Liter: TSS <100 mg/Liter :) in the treated effluent are well within the limit. (Test results is attached). The pH and temperatures of the final effluents also have been verified for being well within the limits. (Refer 5.6 Page 42 & 13.1 Annexure-2)

10.5. The biological system adequacy was verified stage wise and found to be sufficient for treatment of the effluent and reduce the COD/BOD to prescribed limits. However the periodical dosing of nutrients (Urea, phosphoric acid and Ferrous sulphate) is essential for survival of the bacteria. (Refer 6.1 -Page 44)

10.6. The unit has installed online monitoring system to check the pH, TSS, Temperature, COD and effluent flow. The calibration of the online equipments were carried out with standards and found to be matching. The online system is checked for its functioning and are in running conditions and the readings for the period of 15.2.2019 to 28.2.2019 are verified and found ok.

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10.7. All the available equipments of ETP plant are in running conditions and the equipments have been verified stage wise and are adequate for continuous operation of solid separation and Biological treatment of the effluent and meet the prescribed standard.

10.9. As per the direction of CPCB, MPL UNIT-I has newly constructed the lime storage yard with dewatering system. The dedicated lime storage construction and seepage collection system is adequate to store the current generation of lime sludge.

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Professor
Department of Applied Science and Technology
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Anna University, Chennai-600 025

Dr. S. SIVANESAN
Professor,
Applied Science & Technology
A.C.Tech,
AnnaUniversity, Chennai-25

## 12.0. DISCLOSURE OF THE CONSULTANT ENGAGED

M/S.MANALI PETROCHEMICLAS LIMITED requested Anna University to assess their Performance of their Boiler plant and its control measures. Accordingly, a team from Anna university lead by Dr.S.Sivanesanaudited the entire site of M/S.MANALI PETROCHEMICALS LTD, UNIT-Iat Chennai.

The consultant has wide experience in EIA, Risk Analysis and Disaster Management. He has specialized in Environmental Science and Technology and has wide work experience with several international environmental agencies in abroad. He has also published several research papers in National / International Journals in the area of Environmental Science & Technology.

Expert member of TNPCB- POLLUTION LOAD ASSESSMENT COMMITTEE.

**The curriculum vitae of the consultant are furnished below.**


**Brief Resume** :**Dr.S.SIVANESAN.,Ph.D.,**
**Alagappa College ofTechnology,**
**AnnaUniversity,Chennai**

Designation and Affiliation :Professor
Department of Applied Science & Technology
AlagappaCollegeof Technology,
AnnaUniversity, Chennai-25.
Tel:-+91 9444960106
E. mail:siva@annauniv.edu, sivanesh1963@gmail.com

Date of birth : 05th May1963


EducationalQualification

| Degree | University | Year | Subjects | Class/Grade |
|---|---|---|---|---|
| Ph.D | Anna University | 1986-1992 | Atmospheric Science & Technology | Highly Commended |
| M.Sc | Madras University | 1983- 1985 | Environmental Chemistry | First |
| B.Sc | Madras University | 1980 -1983 | Chemistry | First |



Present Position

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| | | |
|---|---|---|
| Designation | Professor | |
| Organization | Department of Applied Science & Technology, Alagappa College of Technology, Anna University, Chennai-600 025. | |
| Date of appointment to the present post | October 2008 | |
| Total Experience (In Years and Months) | Present position experience: | 10 Years & 3Months |
| | Total experience: | 24 Years |

Details of Experience possessed as per Eligibility Criteria

| S.No. | Post held | Organization | Nature of duties | Experience (In Years and Months) |
|---|---|---|---|---|
| 1. | Professor<br>A. Anna University (9 Years & 11Months)<br>B. NIES Research Scientist (2 Years & 3 Months) | Department of Chemical Engineering& Applied Science and technology, Anna University Chennai, India<br>National Institute of Environmental Science (NIES), Govt. of Japan | Teaching and Research | 12 Years & 02 Months |
| 2. | Associate Professor (Erstwhile Assistant Professor) | Department of Chemical Engineering Anna University Chennai, India | Teaching and Research | 8 Years |
| 3. | Technical Specialist (Research) | National Institute for Research in Inorganic Materials, Japan | Teaching and Research | 9 Months |
| 4. | Visiting Scientist | Department of Atmospheric Chemistry Mainz University Germany | Teaching and Research | 11 Months |
| 5. | Marie Curie Post-Doctoral Research Scientist | InstitutoFisbat CNR, Bologna, Italy | Research | 10 Months |
| 6. | Research Associate | Department of Chemical Engineering Anna University Chennai, India | Research | 1 Year & 10 Months |

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Important MoUs formulated for academic collaborations

| S.No. | MoUs formulated | Name of Agencies/Departments Involved | Year of MoU |
|---|---|---|---|
| 1. | University & Industries | M/s. Vestas Wind Systems | 04.05.2013 |
| 2. | Safety issue in Industry and Academia | M/s. Safety Research Institute of Atomic Energy Regulatory Board (SRI-AERB), Govt. of India | 21.05.2013 |
| 3. | Technical Education for society | M/s. Indian Society for Technical Education, (ISTE) New Delhi | 31.05.2013 |
| 4. | University & Industries | M/s. Centre for Development of Advanced Computing (CDAC), Chennai | 05.06.2013 |
| 5. | University & Industries | M/s. Centre for Development of Advance Computing (C-DAC), GARUDA, Pune | 05.06.2013 |
| 6. | Faculty Training Programme with Eight Engineering Colleges in Tamil Nadu | Govt. college of Engineering atSalem, Bargur & Coimbatore, ACCET, Karaikudi, Thyagaraja College,Madurai, PSG & CIT at Coimbatore, BIT Tiruchirappalli | 07.10.2013 |

## Scholarly Achievements

| | |
|---|---|
| Total number of Publications | : 158 |
| Out of 149 Publications, UGC Listed Journals | : 139 |
| Author ID | : 8268081200 (Scopus) |
| h-index (google scholar) | : 41 |
| Total No. of Citations | : 5921 (06 January 2019) |
| No. of books (national) | : 08 |
| No. of books (International) | : 02 |
| Number of papers presented in International | : 20 |
| Number of papers presented in National | : 17 |
| Editor in peer reviewed International Journals | : 03 |
| Reviewer in peer reviewed International journals | : 26 |
| Editor-in-Chief | : 01 |

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Patents and Copyrighted Material

1. Title: "Passive flow field design for Polymer electrolyte membrane fuel cell"

   REF.No: 309111; C.B.R.No.23687

2. Title: "Patents Laser flash thermal diffusivity analyser for the measurement of thermal properties of solid materials"

   Status: Submitted

Research Projects

| S.No. | Client/Organization's name | Nature of Project | Duration of Project | Amount of Grant (Rupees) |
|---|---|---|---|---|
| 1. | University Grants Commission, New Delhi | A Sustainable and Green Approach for Biomethane Enrichment by Biogas Recirculation and Algae Bioscrubbing | 2018-20 (On Going) | 10,00,000.00 |
| 2. | Department of Science & Technology | Green building and energy efficient cooling system for sustainable buildings in India | 3 years | 60,22,300.00 |
| 3. | Science and Engineering Research Board, DST, New Delhi. | Differential effect of 20 HETE mediating VEGF and no induced changes in tissues by direct signaling mechanism | 3 Years | 54,53,000.00 |
| 4. | Department of Science and Technology, New Delhi. | Development of integrated membrane Bioreactor for waste water treatment and reuse | 3 Years | 26,30,000.00 |
| 5. | Department of Science and Technology, New Delhi. | Establishment of Environmental Laboratory in the Department of Engineering under FIST Programme. | 5 Years | 40,00,000.00 |
| 6. | University Grants Commission, New Delhi. | Hydrothermal synthesis of Mesoporous Carbon for effective removal of textile dye. | 3 Years | 8,43,800.00 |

| | | | | |
|---|---|---|---|---|
| 7. | University Grants Commission, New Delhi. | Synthesis of modified vinyl monomer grafted cellulose bearing functional containing donor atoms for the removal of heavy metals from industrial effluents. | 3 Years | 12,00,000.00 |
| 8. | Department of Science & Technology, New Delhi. | Investigation on the formation of Photochemical Ozone and it's with alkenes | 3 Years | 17,89,200.00 |
| 9. | Defence Research &Development Establishment | Development of membrane materials &membranes for gas & organic separation | 2 Years | 9,78,000.00 |
| 10. | Defence Research & Development Establishment | Studies on novel nano and ultra-filtration membranes for treatment | 4 Years | 7,81,800.00 |

Honors /Awards & Fellowships for Outstanding work

| S.No. | Name of Award or Fellowship | Awarded by | Year of Award |
|---|---|---|---|
| 1. | Mid-Career award | University Grants Commission (UGC) | 2017 |
| 2. | Best Environmental Engineer award | Indian Institute of Chemical Engineers | 2015 |
| 3. | Tamil Nadu Scientists (TANSA 2013) Award in Environmental Science | Government of Tamil Nadu | 2013 |
| 4. | 1st Rank in Co-ordinating with Iyarkai Mission 2012 | Government of Tamil Nadu | 2012 |
| 5. | Recipient of certificate of appreciation from American Chemical Society (ACS) for valuable contribution to ACS Journals. | Journal of the American Chemical Society | 2011 |
| 6. | Top Cited Papers for 2010 and 2011 Adsorption of dye from aqueous solution by cashew nut shell: Studies on equilibrium isotherm, kinetics and thermodynamics of interactions. | Desalination, Elsevier, Netherland | 2010 & 2011 |
| 7. | Nominated for International Educator of the year for 2008 | The International Biographical Center of Cambridge, England | 2008 |

| | | | |
|---|---|---|---|
| 8. | Ranked No 1. Top cited author 2004 & 2007 | The Colloid and Surface Science. Elsevier, Netherland | 2004 & 2007 |
| 9. | Ranked No 14. Top cited author 2007 | Process Biochemistry, Elsevier, Netherland | 2007 |
| 10. | STA Award (Science and Technology Agency, Japan) | Science and Technology Agency, Japan | 2000 |
| 11. | Marie Curie award | European Community | 1995 |

No. of Research Scholars successfully guided

| Name of Programs | Awarded (No.) (Under-Progress not to be included) |
|---|---|
| Ph. D | 26(Completed)<br>06(Currently Registered) |
| M.S | 03(Completed) |

# Annexures

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# 13.0 - Annexure – 1
# ETP Raw Effluent Analysis Report

# 13.4 -Annexure – 5
# Lime Sludge Analysis Report

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003529

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Saidapet, Chennai - 600 015. Phone : +91 44 2433 0882 to 85
E-mail : info@cvrlabs.com | Web : www.cvrlabs.com

## TEST REPORT

Issued To :

Manali Petrochemicals Limited
Ponneri High Road, Manali, Chennai - 600 068.

Date of report : 26/03/2018
Received on : 09/03/2018
Commenced on : 10/03/2018
Completed on : 26/03/2018

Report Number : 18030097.01

Sample Description : Sludge from PO plant waste water prior to waste water treatment plant,MPL plant-I

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 1 | 1,1 -Dichloroethylene | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.1) |
| 2 | 1,2 Dichloroethane | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.1) |
| 3 | 1,4 Dichlorobenzene | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.1) |
| 4 | 2,4 D | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 5 | 2,4 Dinitro Tolune | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 6 | 2,4,5 TP (SILVEX) | EPA 1311/EPA 8150B | mg/L | BDL(DL:0.1) |
| 7 | 2,4,5 Trichlorophenol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 8 | 2,4,6 Trichlorophenol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 9 | Arsenic as As | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 10 | Barium as Ba | EPA 1311/EPA 200.8 | mg/L | 0.19 |
| 11 | Benzene | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.01) |
| 12 | Cadmium as Cd | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |

For CVR Labs (P) Limited

Verified By

Authorised Signatory
K. Karthikeyan
Manger - Food

Recognized / Approved by : NABL, BIS , Ministry of Environment & Forests , ISO 9001 : 2008 , OSHAS 18001 : 2007

**Terms and Conditions:**

- The test results furnished relate only to the particular sample is submitted.
- The test results reflect to the sample tested on the above mentioned date and environments condition.
- The test report shall not be reproduced except in full without our written approval.
- The tested items will not be retained for more than 30 days from the date of issue of test report except in the case as required by the applicable regulations.

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# CVR Labs (P) Limited

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Dignity Centre, 2nd Floor, New No 2/9, Old No 21 Abdul Razack Street,
Saidapet, Chennai - 600 015. Phone : +91 44 2433 0382 to 85
E-mail : info@cvrlabs.com | Web : www.cvrlabs.com


003530

## TEST REPORT

1203009 7.01

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 13 | Carbon tetra chloride | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.01) |
| 14 | Chlordane | EPA 1311/EPA 8080B | mg/L | BDL(DL:0.1) |
| 15 | Chlorobenzene | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.01) |
| 16 | Chloroform | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.01) |
| 17 | Chromuium as Cr | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 18 | Endrin | EPA 1311/EPA 8080A | mg/L | BDL(DL:0.01) |
| 19 | Heptachlor (and its hydroxide) | EPA 1311/EPA 8080A | mg/L | BDL(DL:0.002) |
| 20 | Hexa chloro benzene | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 21 | Hexa chloro butadiene | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 22 | Hexa chloro ethane | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 23 | Lead as Pb | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 24 | Lindane | EPA 1311/EPA 8080A | mg/L | BDL(DL:0.1) |
| 25 | m-Cresol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 26 | Mercury as Hg | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 27 | Methoxychlor | EPA 1311/EPA 8080D | mg/L | BDL(DL:0.1) |
| 28 | Nitro Benzene | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |
| 29 | o-Cresol | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |

Verified By

For CVR Labs (P) Limited
Authorised Signatory

K. Karthikeyan
Manger - Food

Recognized / Approved by : NABL, BIS , Ministry of Environment & Forests , ISO 9001 : 2008 , OSHAS 18001 : 2007

Terms and Conditions:

1. The test results furnished relate only to the particular sample is submited.
2. The test results reflect to the sample tested on the above mentioned date and environments condition
3. The test report shall not be reproduced except in full without our written approval.
4. The tested items will not be retained for more than 30 days from the date of issue of test report except in the case as required by the applicable regulations

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Santhome, Chennai - 600 015. Phone : +91 44 2433 0332 to 35
E mail : info@cvrlabs.com | Web : www.cvrlabs.com

003531

# TEST REPORT

18030097.01

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 30 | p-Cresol | EPA 1311/EPA 8240D | mg/L | BDL(DL 0.1) |
| 31 | Pentachloro phenol | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) |
| 32 | Pyridine | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 33 | Selenium as Se | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 34 | Silver as Ag | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 35 | Tetrachloroethene | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 36 | Total Cresol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 37 | Toxaphene | EPA 1311/EPA 8080A | mg/L | BDL(DL:0.1) |
| 38 | Trichloro ethylene | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 39 | Vinyl Chloride | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |
| 40 | ZZDNU Methyl Ethyl Ketone | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |

BDL: Below Detection Limit; DL Detection Limit

***** END OF REPORT *****

For CVR Labs (P) Limited

Verified By

Authorised Signatory
K. Karthikeyan
Manger - Food

Recognized / Approved by : NABL, BIS , Ministry of Environment & Forests , ISO 9001 : 2008 , OSHAS 18001 : 2007

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2. The test results reflect to the sample tested on the above mentioned date and environments condition.
3. The test report shall not be reproduced except in full without our written approval.
4. The tested items will not be retained for more than 30 days from the date of issue of test report except in the case as required by the applicable regulations.

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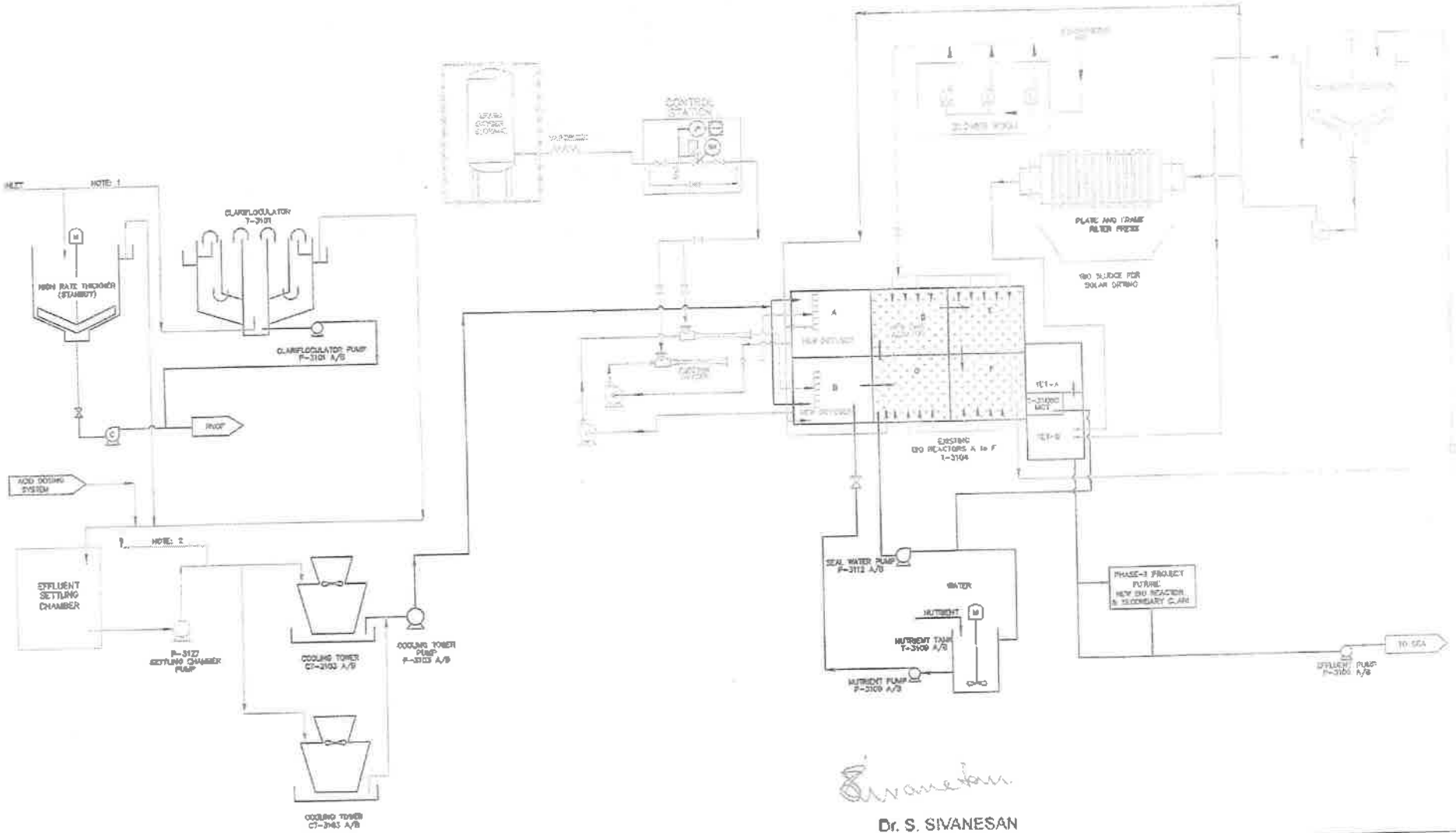
# PLANT–I WWTP IMPROVEMENT PROJECT





Dr. S. SIVANESAN
Professor
Department of Applied Science and Technology
Alagappa College of Technology
Anna University, Chennai


NOTES
1) SAPONIFIER BOTTOM EFFLUENT INLET GIVEN TO EITHER INT OF CLARIFLOCCULATOR.
2) INT AND CLARI. OVERFLOW DIRECTLY FEED TO COOLING TOWER WHEN SETTLING CHAMBER UNDER MAINTENANCE.

——— EXISTING

| REV | DATE | DESCRIPTION | DRN | CHD | APD |
|---|---|---|---|---|---|
| 5 | 06-11-2017 | PLATE AND FRAME FILTER PRESS | APK | TMS | KSS |
| 4 | 30-10-2017 | SCOPE REVISED FOR GAS | SMD | SKB | KSS |
| 3 | 07-09-2017 | CHLORINE INJECTION SCHEME ADDED | ARUN | JAN | KSS |
| 2 | 22-07-2017 | GENERALLY REVISED | ARUN | JAN | KSS |
| 1 | 20-06-2017 | SEAL WEIR DATED 22.05.2017 | ARUN | KJB | KSS |
| 0 | 25-05-2017 | FOR REVIEW AND COMMENTS (CPT-II) | ARUN | KJB | TMS |

MANALI PETROCHEMICALS
CHENNAI – 600 068.
( AN ISO-9001 COMPANY )

PLANT–I
PROCESS FLOW DIAGRAM FOR WASTE WATER TREATMENT WITH LIQUID OXYGEN WITH CULTURE TREATMENT, OMNI AERATOR SYSTEM & OZONE TREATMENT

| SCALE | DRAWING NO. | REV |
|---|---|---|
| N.T.S | MPL/PL–I/WWTP/PRAJAIR/PFD–501 | 5 |

CAD FILE NAME: C:\DRAWINGS\2017\P-I\PFD\SAP\EFF\WWTP PRAJAIR PFD

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# 13.4 -Annexure – 5
# Lime Sludge Analysis Report

# CVR Labs (P) Limited

CIN NO: U 74140TN1999PTC043582

003529

Dignity Centre, 2nd Floor, New No. 29, Old No. 21 Abdul Razack Street,
Santapet, Chennai - 600 015. Phone : +91 44 2433 0382 to 85
E-mail : info@cvrlabs.com | Web : www.cvrlabs.com


## TEST REPORT

Issued To :

Manali Petrochemicals Limited
Ponneri High Road, Manali, Chennai - 600 068.

Date of report : 26/03/2018
Received on : 09/03/2018
Commenced on : 10/03/2018
Completed on : 26/03/2018

Report Number : 18030097.01

Sample Description : Sludge from PO plant waste water prior to waste water treatment plantLMPL plant-I

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 1 | 1,1 -Dichloroethylene | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.1) |
| 2 | 1,2 Dichloroethane | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.1) |
| 3 | 1,4 Dichlorobenzene | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.1) |
| 4 | 2,4 D | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 5 | 2,4 Dinitro Tolune | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 6 | 2,4,5 TP (SILVEX) | EPA 1311/EPA 8150B | mg/L | BDL(DL:0.1) |
| 7 | 2,4,5 Trichlorophenol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 8 | 2,4,6 Trichlorophenol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 9 | Arsenic as As | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 10 | Barium as Ba | EPA 1311/EPA 200.8 | mg/L | 0.19 |
| 11 | Benzene | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.01) |
| 12 | Cadmium as Cd | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |

For CVR Labs (P) Limited

Verified By

Authorised Signatory
K. Karthikeyan
Manger - Food

Recognized / Approved by : NABL, BIS , Ministry of Environment & Forests , ISO 9001 : 2008 , OSHAS 18001 : 2007

**Terms and Conditions:**

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- The test results reflect to the sample tested on the above mentioned date and environments condition.
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# CVR Labs (P) Limited

003530

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Dignity Centre, 2nd Floor, New No 2/9, Old No 21 Abdul Razack Street,
Saidapet, Chennai - 600 015. Phone : 91 44 2433 0882 to 85
E-mail : info@cvrlabs.com | Web : www.cvrlabs.com

## TEST REPORT

18030097.01

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 13 | Carbon tetra chloride | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.01) |
| 14 | Chlordane | EPA 1311/EPA 8080B | mg/L | BDL(DL:0.1) |
| 15 | Chlorobenzene | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.01) |
| 16 | Chloroform | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.01) |
| 17 | Chromium as Cr | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 18 | Endrin | EPA 1311/EPA 8080A | mg/L | BDL(DL:0.01) |
| 19 | Heptachlor (and its hydroxide) | EPA 1311/EPA 8080A | mg/L | BDL(DL:0.002) |
| 20 | Hexa chloro benzene | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 21 | Hexa chloro butadiene | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 22 | Hexa chloro ethane | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 23 | Lead as Pb | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 24 | Lindane | EPA 1311/EPA 8080A | mg/L | BDL(DL:0.1) |
| 25 | m-Cresol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 26 | Mercury as Hg | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 27 | Methoxychlor | EPA 1311/EPA 8080D | mg/L | BDL(DL:0.1) |
| 28 | Nitro Benzene | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |
| 29 | o-Cresol | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |

Verified By

For CVR Labs (P) Limited
Authorised Signatory

K. Karthikeyan
Manger - Food

Recognized / Approved by : NABL, BIS , Ministry of Environment & Forests , ISO 9001 : 2008 , OSHAS 18001 : 2007

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3. The test report shall not be reproduced except in full without our written approval.
4. The tested items will not be retained for more than 30 days from the date of issue of test report except in the case as required by the applicable regulations

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003531

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Saidapet, Chennai - 600 015. Phone : +91 44 2433 0332 to 35
E mail : info@cvrlabs.com | Web : www.cvrlabs.com


## TEST REPORT

18030097.01

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 30 | p-Cresol | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |
| 31 | Pentachloro phenol | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) |
| 32 | Pyridine | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 33 | Selenium as Se | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 34 | Silver as Ag | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 35 | Tetrachloroethene | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 36 | Total Cresol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 37 | Toxaphene | EPA 1311/EPA 8080A | mg/L | BDL(DL:0.1) |
| 38 | Trichloro ethylene | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 39 | Vinyl Chloride | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |
| 40 | ZZDNU Methyl Ethyl Ketone | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |

BDL: Below Detection Limit; DL Detection Limit

***** END OF REPORT *****

**For CVR Labs (P) Limited**

Verified By

Authorised Signatory
K. Karthikeyan
Manger - Food

Recognized / Approved by : NABL, BIS , Ministry of Environment & Forests , ISO 9001 : 2008 , OSHAS 18001 : 2007

Terms and Conditions:

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- The test results reflect to the sample tested on the above mentioned date and environments condition.
- The test report shall not be reproduced except in full without our written approval.
- The tested items will not be retained for more than 30 days from the date of issue of test report except in the case as required by the applicable regulations.

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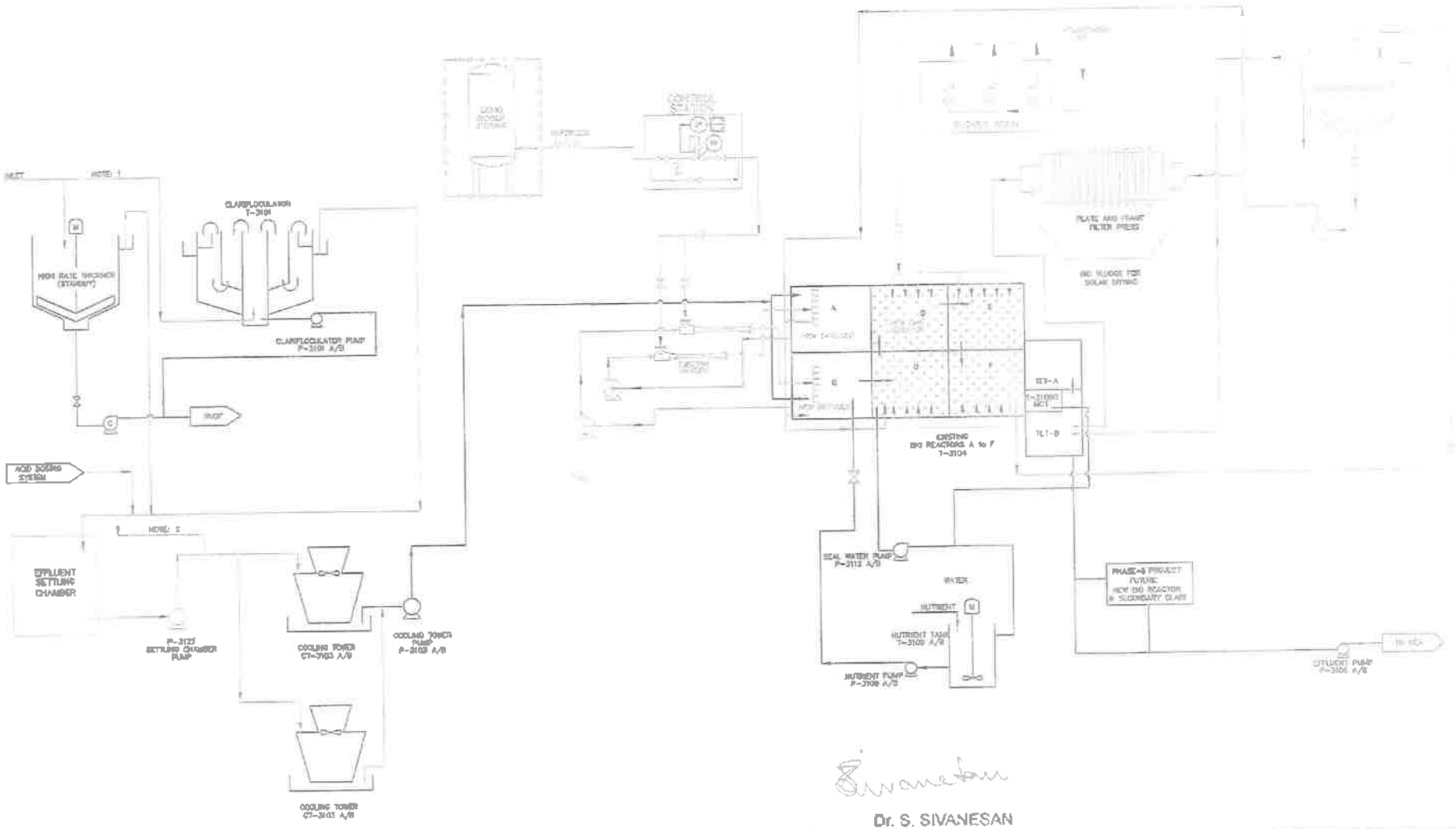
# PLANT–I WWTP IMPROVEMENT PROJECT




NOTES:
1) SAPONIFIER BOTTOM EFFLUENT INLET GIVEN TO EITHER INLET OF CLARIFLOCCULATOR.
2) HRT AND CLARI. OVERFLOW DIRECTLY FEED TO COOLING TOWER WHEN SETTLING CHAMBER UNDER MAINTENANCE.

Dr. S. SIVANESAN
Professor
Department of Applied Science and Technology
Alagappa College of Technology
Anna University, Chennai

| REV | DATE | DESCRIPTION | DRN | CHD | APD |
|---|---|---|---|---|---|
| 5 | 22-11-2018 | PLATE AND FRAME FILTER PRESS | MPM | TKSV | JSM |
| 4 | 30-11-2017 | SLUDGE DEPHOS FOR CMD | SMS | SVS | ABS |
| 3 | 27-09-2017 | CHLORINE INJECTION SCHEME ADDED | MSUR | JM | RBS |
| 2 | 23-07-2017 | GENERALLY REVISED | MSUR | JM | WSS |
| 1 | 20-06-2017 | ISSUE NEW DATED 22.06.2017 | MSUR | KJR | RBS |
| P | 31-05-2017 | FOR REVIEW AND COMMENTS (OPTI-C) | MSUR | KJR | RBS |

MANALI PETROCHEMICALS
CHENNAI – 600 068.
( AN SPIC-2021 COMPANY )

PLANT–I
PROCESS FLOW DIAGRAM FOR WASTE WATER TREATMENT WITH LIQUID OXYGEN WITH CULTURE TREATMENT, OHR AERATOR SYSTEM & OZONE TREATMENT

| SCALE | DRAWING NO. | REV |
|---|---|---|
| NTS | MPL/PL–I/WWTP/PRAXAIR/PFD–001 | 5 |

CAD FILE NAME: F:\DRAWINGS\2017\3-10\PFDS\MPL\WWTP\ PRAXAIR PFD

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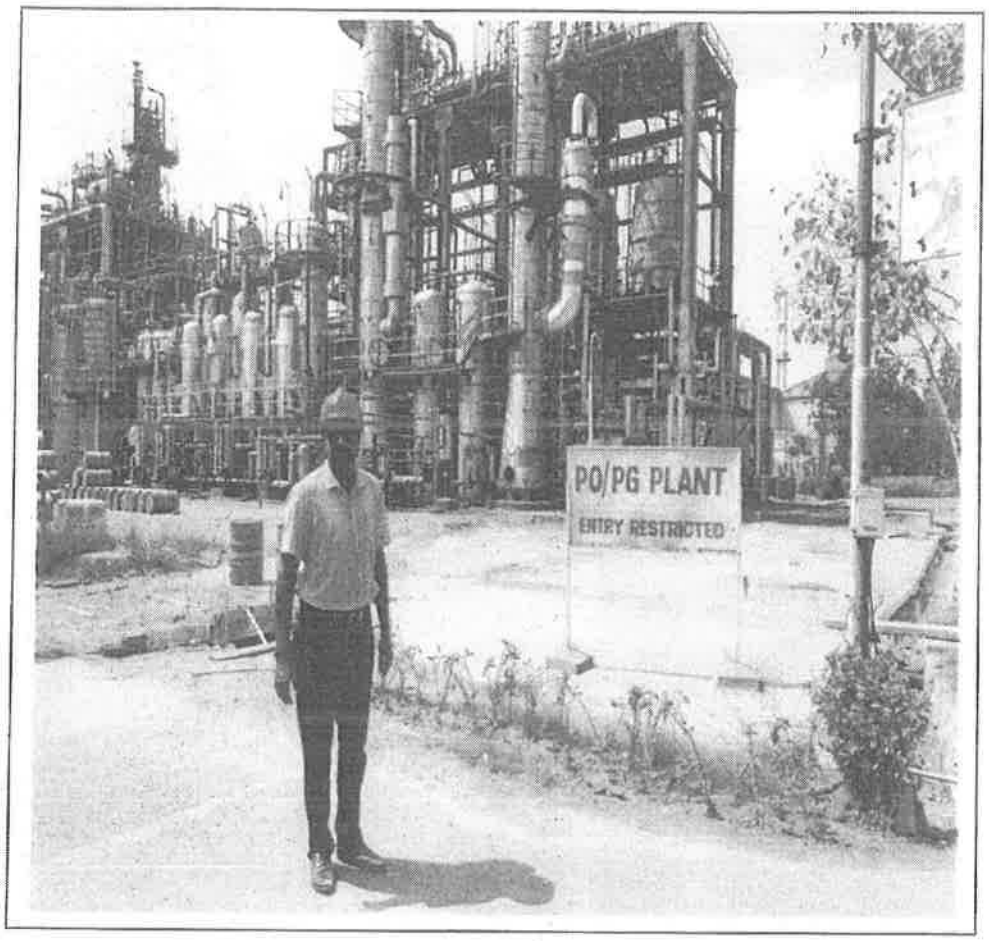
ANNEXURE - 10B

# Adequacy Report on Effluent Treatment operation

## Of

## M/S.MANALI PETROCHEMICALS LTD-UNIT II

Sathangadu, Manali,
Chennai, Tamil Nadu 600068




APPLIED SCIENCE & TECHNOLOGY
A.C.TECH,
ANNA UNIVERISITY
CHENNAI - 600 025

Dr. S. SIVANESAN
Professor
Department of Applied Science and Technology
Alagappa College of Technology
Anna University, Chennai-600 025.

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| | | |
|---|---|---|
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## 1.0 INTRODUCTION

Manali Petrochemical Limited (MPL) operates two production plants at Manali near Chennai to manufacture Propylene Oxide (PO), Propylene Glycol (PG) and various grades of Polyol and formulations. MPL was promoted by Southern Petrochemical Industries Corporation (SPIC).

Plant - II located at Sathangadu Village, Chennai (adjacent to Balmer Lawrie Ltd) and is capable of manufacturing 18000 MT of PO, 10,000 MT of PG and 25000 MT of Polyol PO is an intermediate product produced and is utilized for conversion into PG and Polyol. PG is widely used for Pharmaceutical formulations, in Food Flavour and Fragrance industries and in the manufacture of unsaturated polyester Resins. Polyol is the raw material for manufacture of Polyurethanes. Polyol of different grades are reacted with Isocyanates of different grades to produce several of Polyurethane with distinctively different, desired properties.

The above plants generate effluents less than the originally designed and consented level and well below the norms prescribed by the CPCB/TNPCB.

**Plants Profile - Existing**

Plant-II was promoted By UB Group and TIDCO and this was incorporated in 1986. The commercial production started in the year 1990 and it was taken over by M/s. SPIC in 1995 and named as Spic Organics Limited and then merged with MPL in the year 2000. Renamed as Manali petrochemicals Limited Plant - II uses the technology of Enichem of Italy for PO and PG. The polyol technology was provided by Pressindustria (Scientific Design, USA) UHDE, India carried out the detailed engineering.

Major supplier of the raw material is Chennai Petroleum Corporation Ltd (CPCL). There are no other manufacturers of PO, PG and Polyol in India

And the unit has renewed the consent orders and it's valid **till 31st March 2019.**

CPCB has issued notice to M/S.MANALI PETROCHEMICALS LIMITED- UNIT II vide Proc.No.B-29016/04/06/IPC-I/12888, dated 22.11.2018 for sought of clarification referred in the letter.

In this context, M/S. MANALI PETROCHEMICALS LIMITED - UNIT II has entrusted the task of conducting Adequacy of their ETP plant and its control measures to Anna University, Chennai. The scope of the audit is

- **To assess the adequacy of the ETP plant.**
- **To assess the control measures of the ETP plant and its compliance.**

A team headed by Dr.Sivanesan from Anna University, Chennai carried out the studies during **FEBURUARY 2019(16/02/2019)** and the findings along with recommendations are presented with this report. The assessment was primarily based on the site visit, stack emission monitoring results and secondary data provided by **M/S. MANALI PETROCHEMICALS LIMITED - unit** and their verification during site visits. Professional judgment expressed in this report is based on the available facts and data within the scope of work, budget and schedule.

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## 2.0. Manufacturing Process:

### 2.1. Manufacture of Propylene Oxide

The major raw materials for this process is propylene, which is received through pipeline/road tankers and stored in bullets.Propylene from the storage bullets is drawn to the propylene oxide plant, vaporized and sent to the PO reactor. It reacts with chlorine and water to form propylene chlorohydrin according to the following reaction.

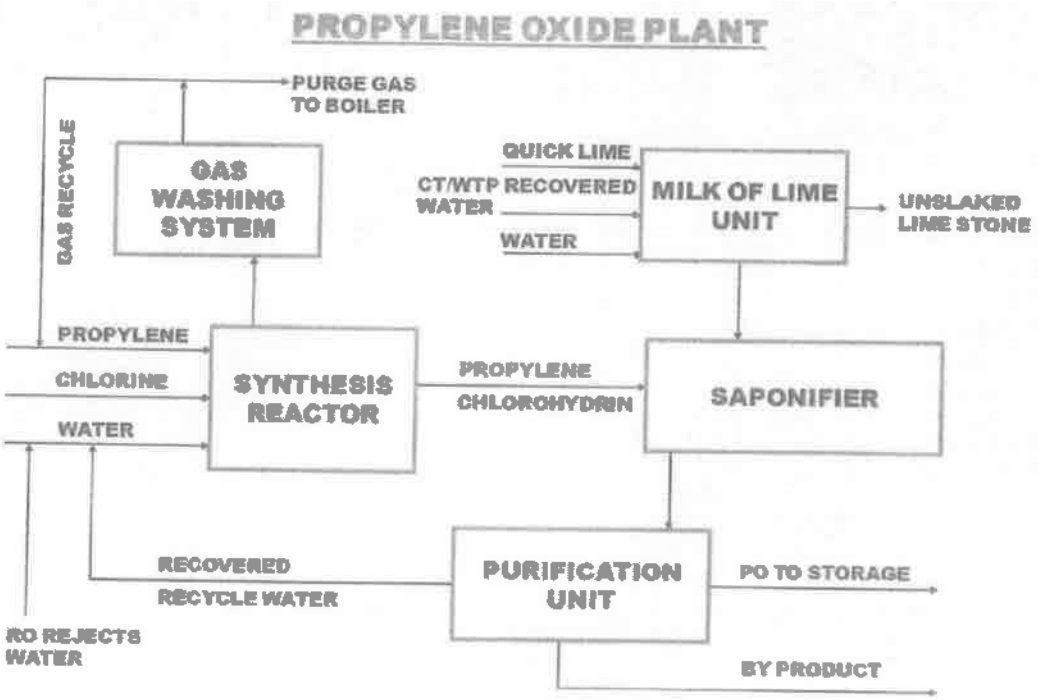
$$Cl_2 + H_2O \longrightarrow ClH + ClOH$$

$$ClOH + C_3H_6 \longrightarrow ClC_3H_6OH$$

**The solution is then saponified with milk of lime to generate Propylene oxide**

$$2ClC_3H_6OH + Ca(OH)_2 \longrightarrow 2C_3H_6O + CaCl_2 + 2H_2O$$

The vapour propylene oxide is stripped with steam and distilled to get the final product. The final product is sent to propylene oxide storage.



## 2.2. Manufacture of Propylene Glycol

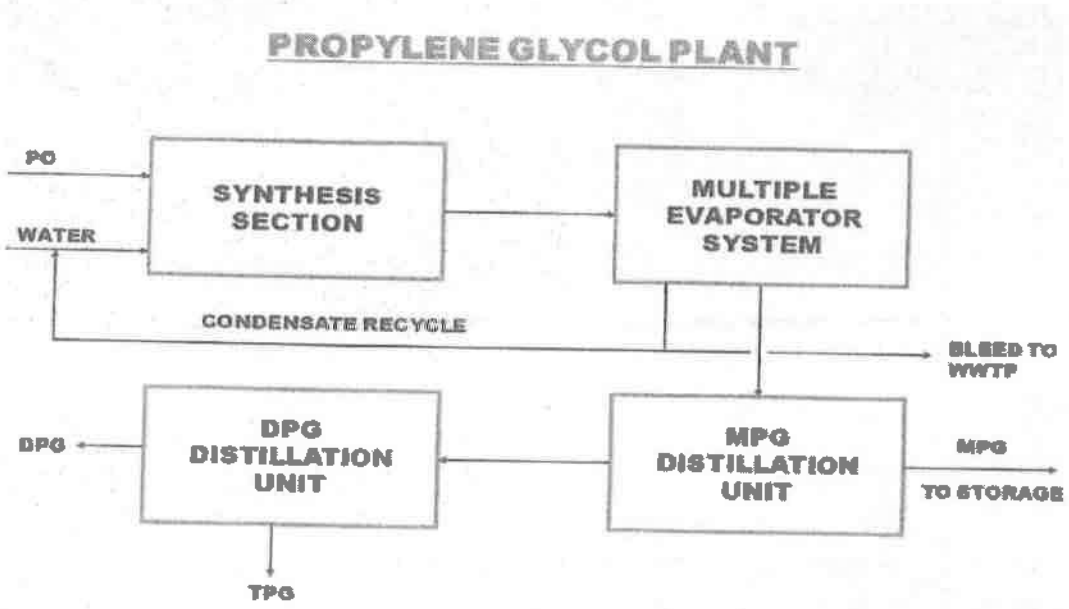
The Raw material for Propylene Glycol is Propylene oxide and Water. Propylene oxide from the storage is mixed with process water and sent to PG reactor. Mixture of glycol's are formed inside the reactor as per following reactions.

$CH_3 - CH - CH_2 + H_2O \longrightarrow CH_3 - CHOH - CH_2OH$ (Monopropylene Glycol (MPG))

$CH_3 - CH - CH_2 + MPG \longrightarrow$ Dipropylene Glycol (DPG)

$CH_3 - CH - CH_2 + DPG \longrightarrow$ Tipropylene Glycol (TPG)

The reaction products are concentrated in triple effect evaporator and distilled in two stages to separate Monopropylene glycol, Di-propylene glycol and Tri-propylene glycol. The products formed are checked for quality before being transferred to the respective storage.



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## 2.3. Manufacture of Propylene Glycol Monomethylether

PGMME is produced by the reaction of propylene oxide and methanol. The main reaction involved are.

a) $CH_3OH$ + $CH_3CHCH_2$ (O) $\longrightarrow$ $CH_3OCH_2CHOH$ ($CH_3$)

Methanol — Propylene Oxide — Propylene Glycol Mono Methyl Ether

b) $CH_3OCH_2CHOH$ ($CH_3$) + $CH_3CHCH_2$ (O) $\longrightarrow$ $CH_3OCH_2CHOCH_2CHOH$ ($CH_3$, $CH_3$)

Propylene Glycol Mono Methyl Ether — Propylene Oxide — Dipropylene Glycol Mono Methyl Ether

The ratio of MPGMME, DPGMME, TPGMME and residue glycol ethers depends on the composition of the initial propylene oxide to methanol mole ratio.

The excess methanol is distilled out in the first stage of distillation column and recovered back to the reactor. The higher glycol ethers are fractionated from the product PGMME in the second stage of distillation column.

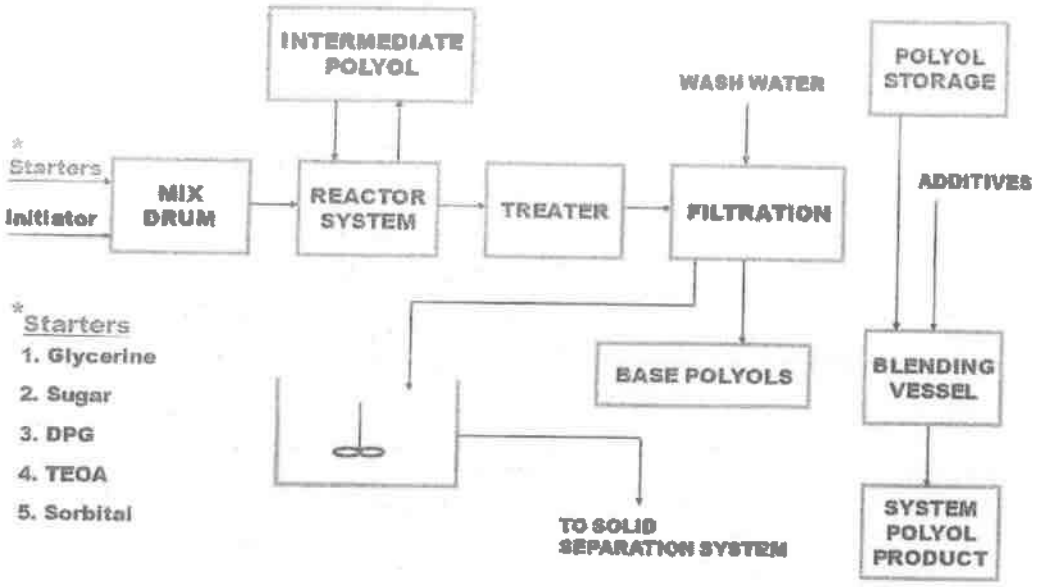
## 2.4. Manufacture of Polyether Polyols

Polyether polyols are manufactured through propoxylation/ethoxylation of polyhydric alcohol using liquid catalyst. Glycerine, di-propylene glycol, Tri Ethyl Amine (TEA) etc., are used as starters and KOH as catalyst. Propylene oxide/ethylene oxide is added to the starter mixture under controlled pressure, temperature conditions to form Polyetherpolyols. The crude polyol is then treated with chemicals to remove the used catalyst and filtered to get the final product.

Starter + Catalyst $\longrightarrow$ Initiator

Initiator + (Propylene oxide/Ethylene oxide) $\longrightarrow$ Polyols

## POLYOL PLANT




It could be noted that all product formations are polymeric condensation reactions and hence no process emission is envisaged in the manufacturing process. All storages with nitrogen blanketing system installed with split range controller, so only nitrogen is vented and no process emission.

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## 2.5. Material Balance of the Propylene Oxide

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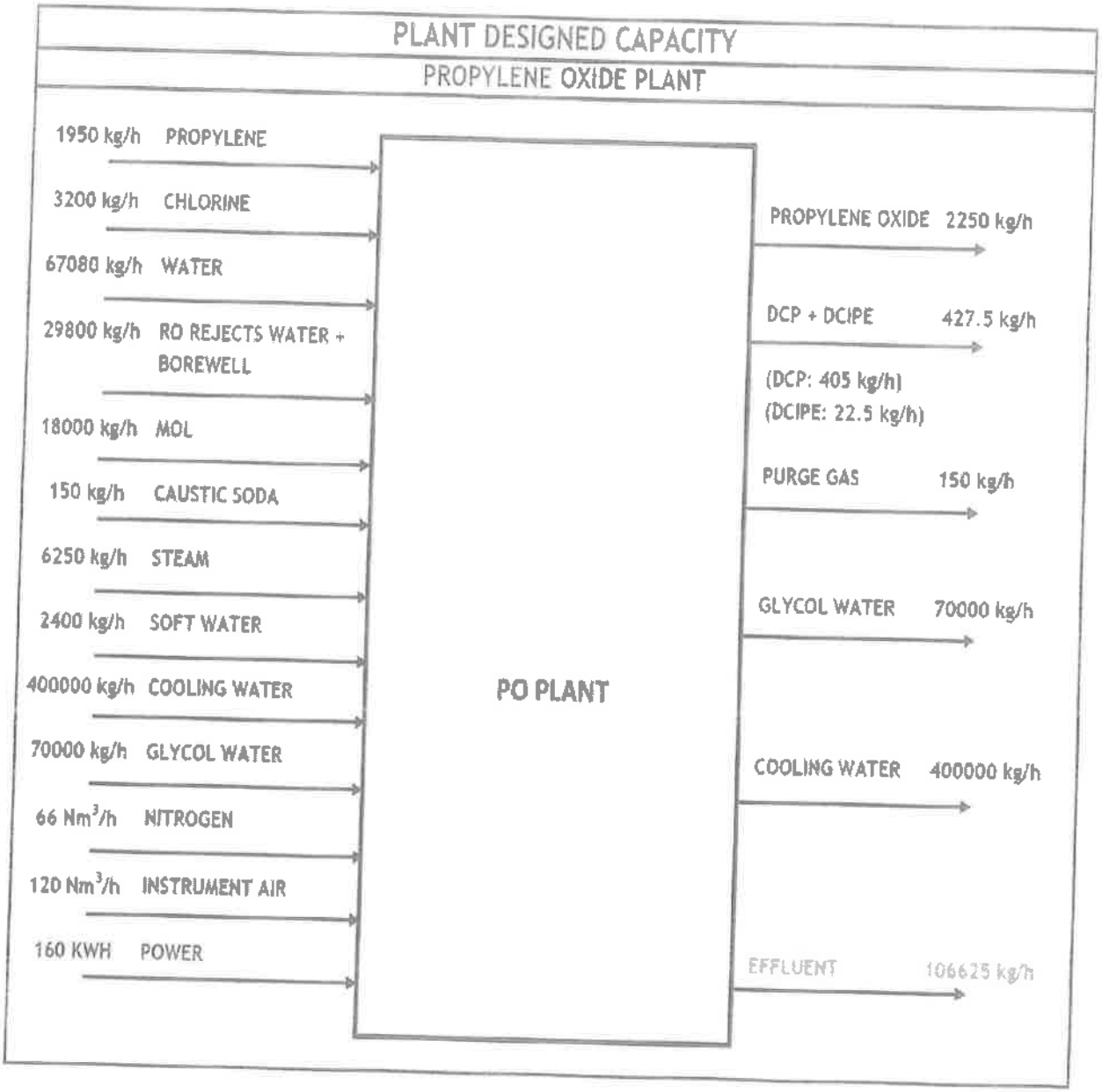
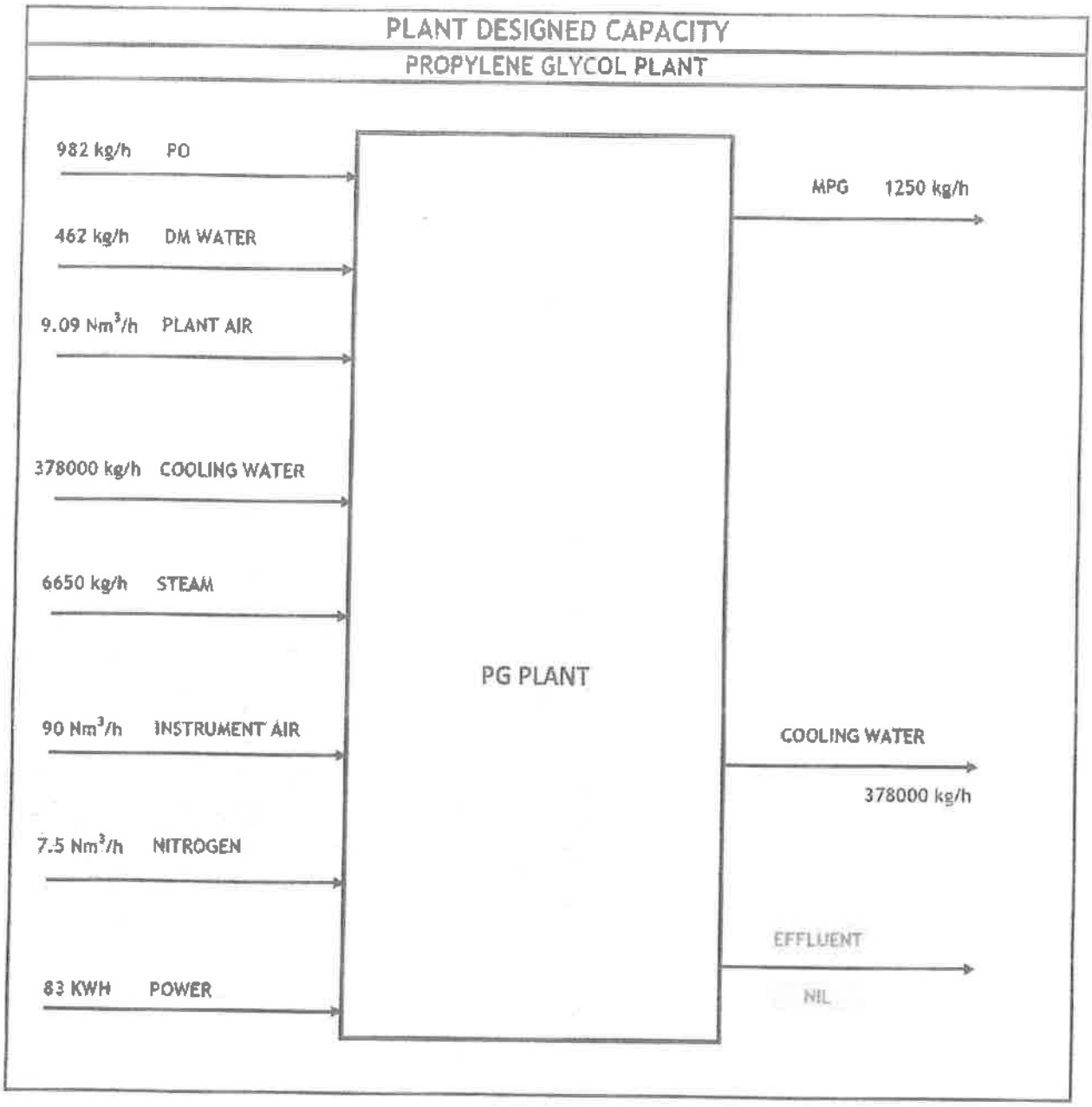


2.6. Material Balance of the Propylene Glycol



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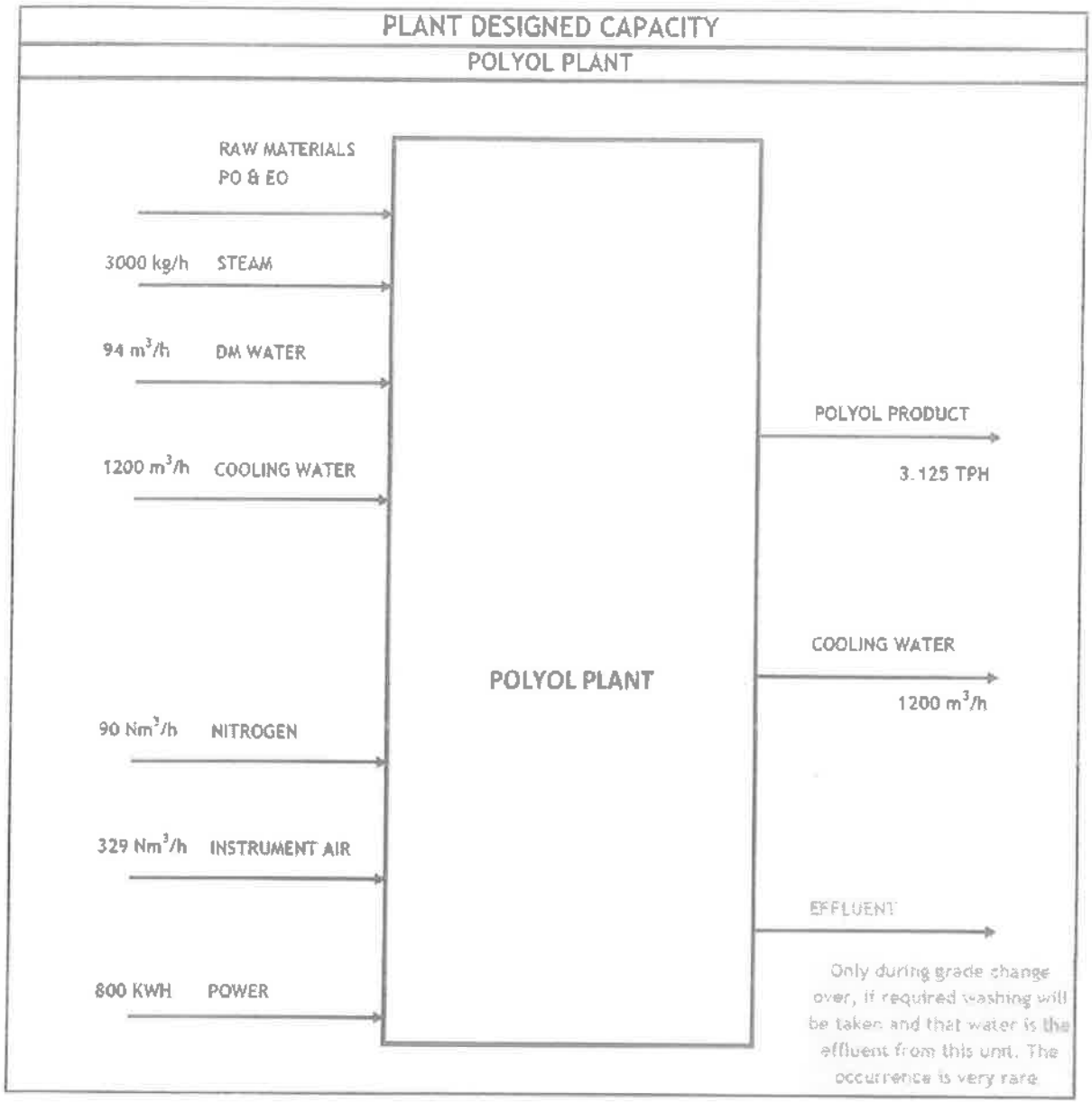
## 2.7. Material Balance of the POLYOL PLANT



## 3.0. Details of Effluent Treatment Plant - Unit-II

### 3.1. Capacity of ETP plant installed in UNIT-II

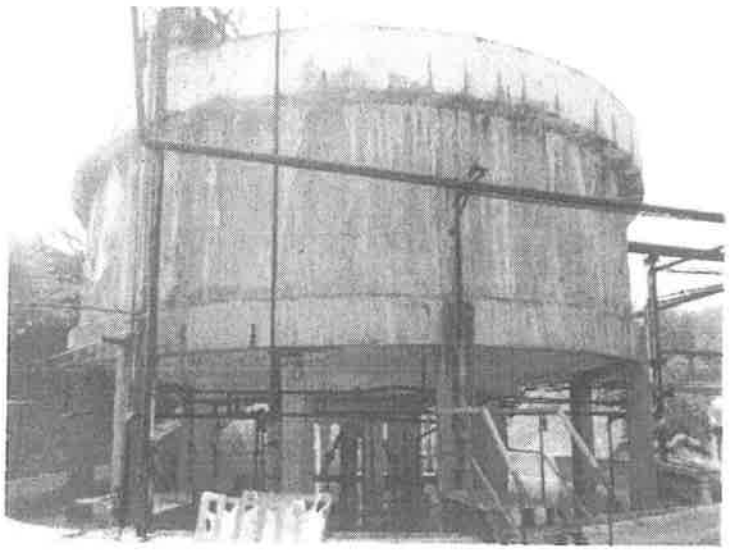
ETP capacity installed - 150 $M^3$/ hour effluent

Current operating load - 100 to 120 $m^3$/hour effluent

| Design Basis: | |
|---|---|
| Total Design Capacity | 3600 $m^3$/day |
| Hours of Operation | 24 hours |
| Average Hourly flow Rate | 100 to 120 $m^3$/hour |
| Peak Flow Factor assumed | |
| Peak Flow | 120 $m^3$/day |

### 3.2. HIGH RATE SLUDGE THICKENER

| | | |
|---|---|---|
| Type | : | Cylindrical Tank |
| Diameter of the tank | : | 13 m |
| Side wall Depth | : | 3.5 m |
| Material of Construction | : | Reinforced Cement Concrete |



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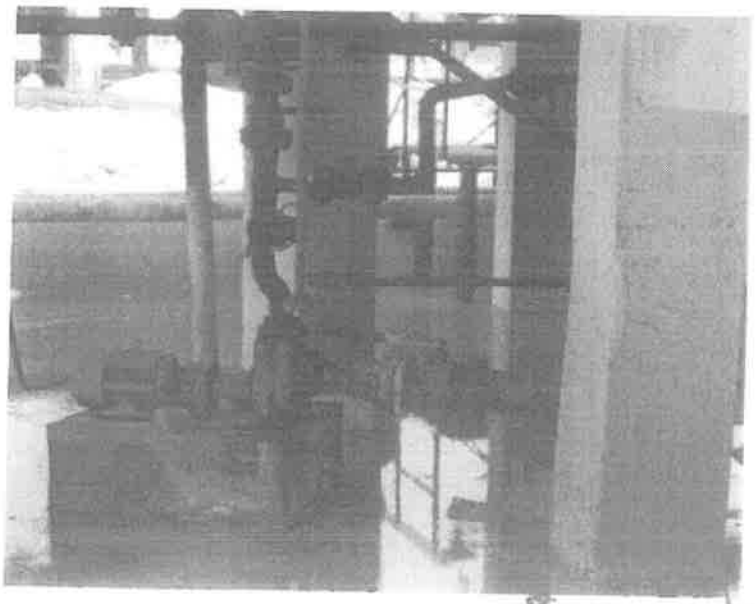
### 3.3. HRT RACKER ARM UNIT

| | | |
|---|---|---|
| Equipment Tag No. | : | X9402 |
| Motor rated power | : | 3.7 kW |
| Material of Construction | : | MILD STEEL |

### 3.4. HIGH RATE SLUDGE THICKNER BOTTOM PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC9402A/B |
| Motor rated power | : | 5.5 kW/7.5 Kw |
| Volumetric flowrate | : | 14 $m^3$/hr |
| Material of Construction | : | CAST IRON |





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### 3.5. NEW HRT FLOCCULANT AGITATOR

| | | |
|---|---|---|
| Equipment Tag No. | : | AG9402 |
| Motor rated power | : | 0.37 kW |
| Material of Construction | : | STAINLESS STEEL |

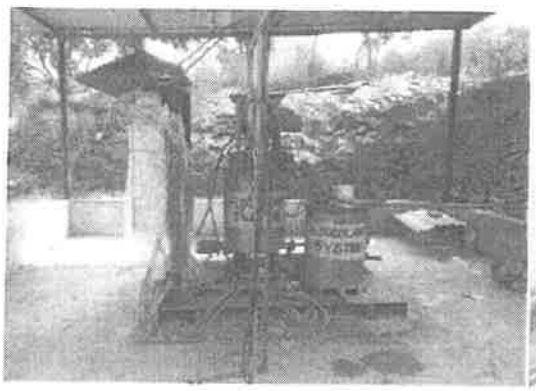
### 3.6. NEW HRT FLOCCULANT PREPARATION TANK &TRANSFER PUMP

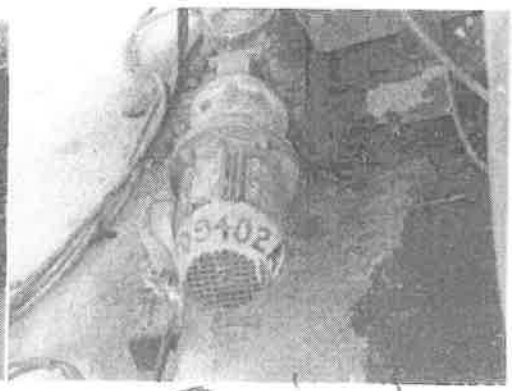
Flocculant dosing tank dimensions:

| | | |
|---|---|---|
| Internal Diameter | : | 500 mm |
| Height | : | 675 mm |

Flocculant Transfer pump details:

| | | |
|---|---|---|
| Equipment Tag No. | : | PD9402A |
| Motor rated power | : | 0.75 kW |
| Volumetric flowrate | : | 50 LPM |
| Material of Construction | : | STAINLESS STEEL |





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### 3.7. NEW HRT FLOCCULANT DOSING PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PD9402B |
| Motor rated power | : | 0.18 kW |
| Material of Construction | : | PP |

### 3.8. NEW HRT FLOCCULANT SCREW FEEDER

| | | |
|---|---|---|
| Equipment Tag No. | : | S9402 |
| Motor rated power | : | 0.18 kW |
| Material of Construction | : | STAINLESS STEEL |

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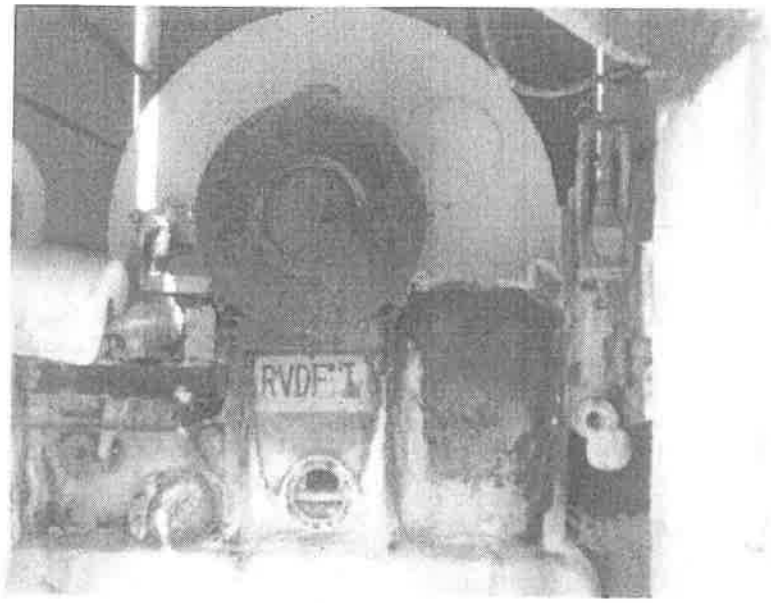
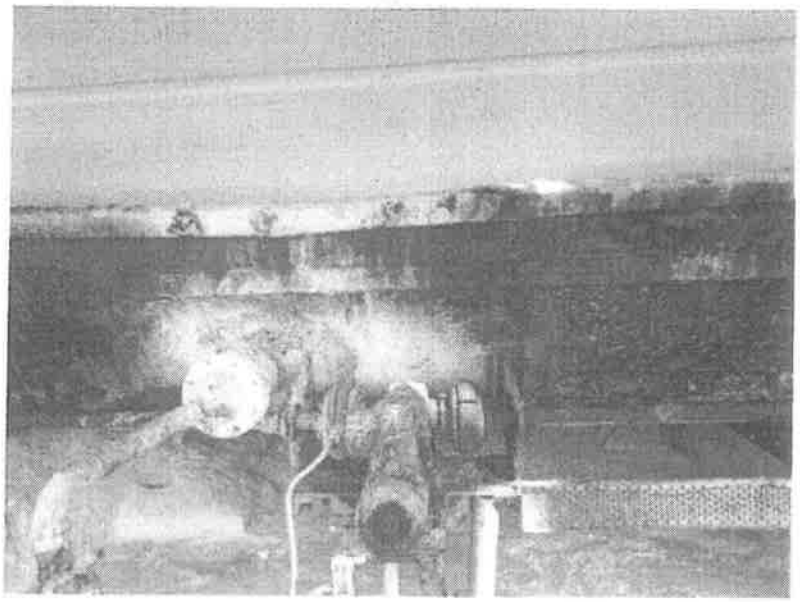
3.9. RVDF DRUM - I& II

| | | |
|---|---|---|
| Equipment Tag No. | : | X9501A/B |
| Motor rated power | : | 1.5Kw |
| Diameter | : | 2440 m |




**3.10. RVDF AGITATOR -I**

| | | |
|---|---|---|
| Equipment Tag No. | : | X9502A |
| Motor rated Power | : | 2.2 kW |
| Material of Construction | : | MILD STEEL |



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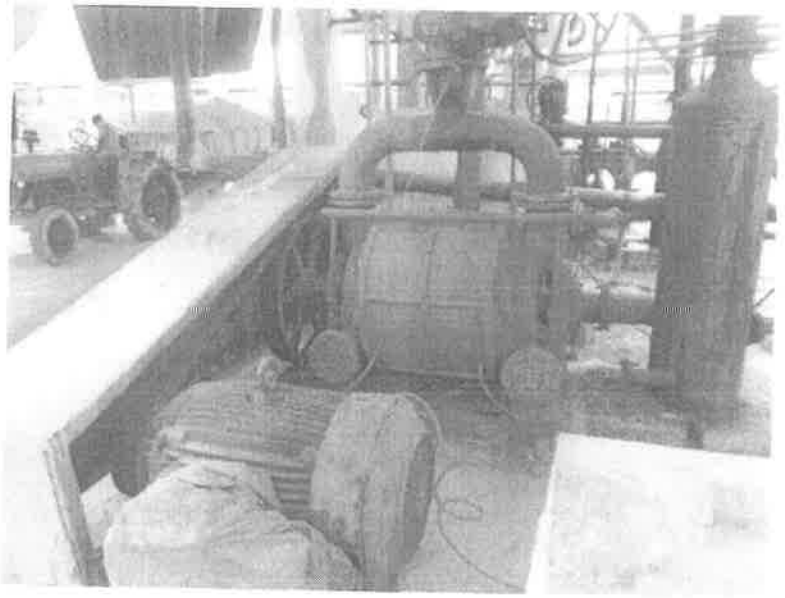
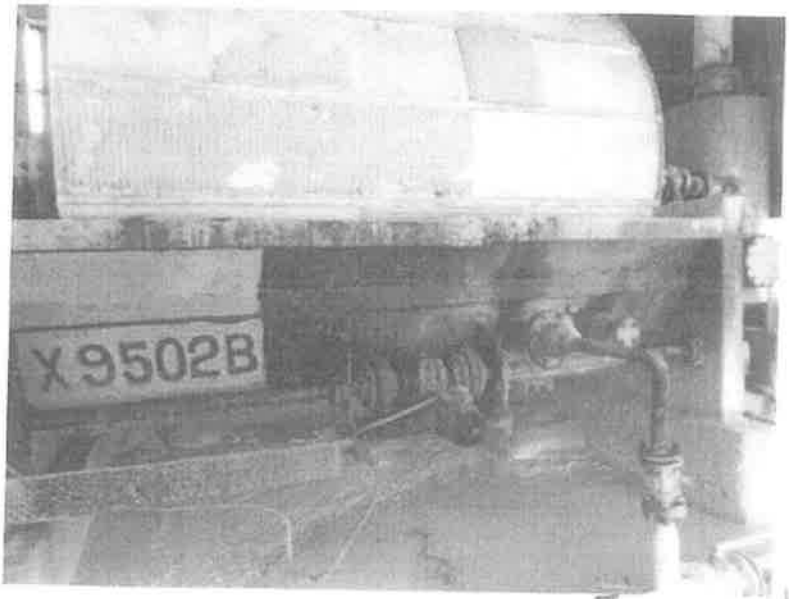
### 3.11. VACCUM PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC9501A/B |
| Pressure | : | 200 mm Hg |
| Motor rated power | : | 75/ 90 kW |
| Material of Construction | : | CAST IRON |



### 3.12. RVDF AGITATOR-2

| | | |
|---|---|---|
| Equipment Tag No. | : | X9502B |
| Motor rated power | : | 2.2 kW |
| Material of Construction | : | MILD STEEL |

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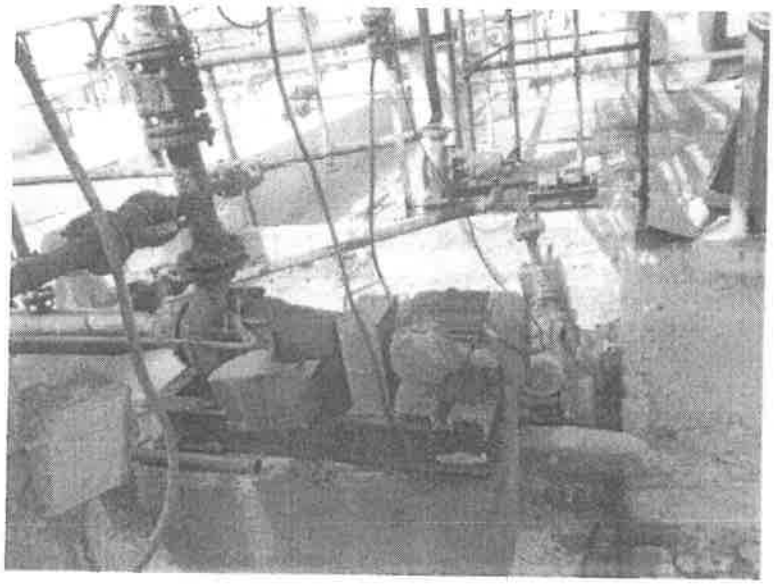
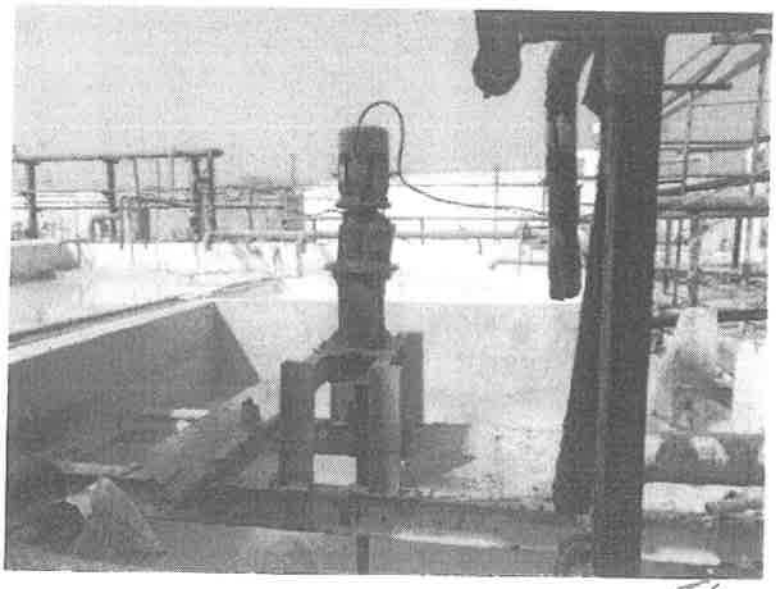
### 3.13. ET1 SMALL PIT PUMP (N)

| | | |
|---|---|---|
| Equipment Tag No. | : | PC9503A |
| Volumetric flowrate | : | 100 $m^3$/hr |
| Motor rated power | : | 3.7 kW |
| Speed | : | 1450 rpm |
| Material of Construction | : | CAST IRON |



### 3.14. ET1 SMALL PIT AGITATOR

| | | |
|---|---|---|
| Equipment Tag No. | : | AG9503 |
| Motor rated power | : | 4 kW |
| Material of Construction | : | MILD STEEL |





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### 3.15. COLLECTION CHAMBER

| | | |
|---|---|---|
| Type | : | Cylindrical Tank |
| Diameter of the tank | : | 12 m |
| Side wall Depth | : | 3.5 m |
| Material of Construction | : | Reinforced Cement Concrete |

### 3.16. COLLECTION CHAMBER UNDERFLOW PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC9404 |
| Make & Model | : | Johnson 14/8 |
| Flow rate | : | 14 $m^3/h$ |
| Motor rated power | : | 5.5 kW |
| Material of Construction | : | CAST IRON |

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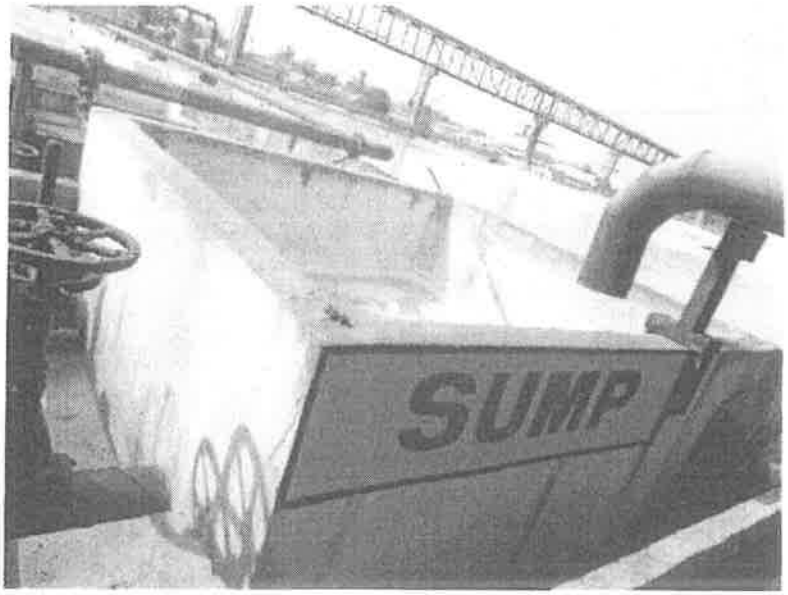
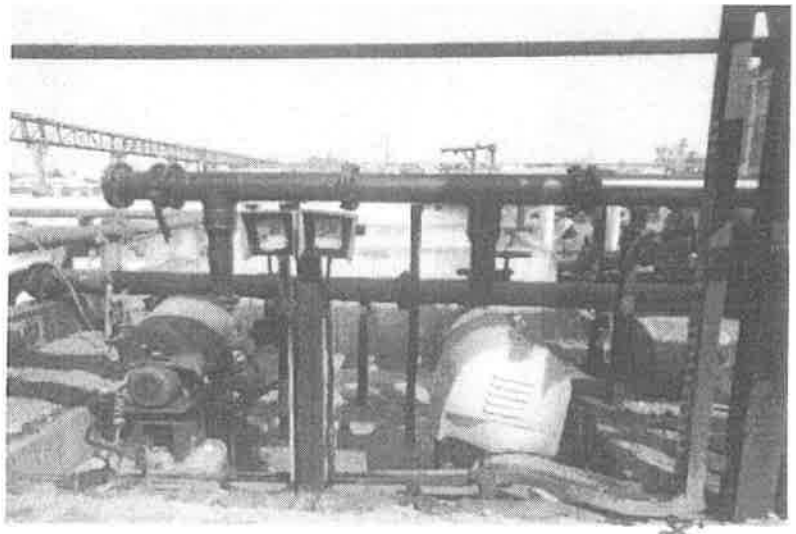
### 3.17. INTERMEDIATE SUMP

| | | |
|---|---|---|
| Type | : | Square |
| Length of the tank | : | 3 m |
| Breadth of the tank | : | 3 m |
| Height of the tank | : | 3 m |
| Material of Construction | : | Reinforced Cement Concrete |




### 3.18. NEW COOLING TOWER PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC9506A/B |
| Model | : | CN 80 - 200 |
| Flow rate | : | 100 $m^3/h$ |
| Motor rated power | : | 5.5 kW |
| Material of Construction | : | CAST IRON |



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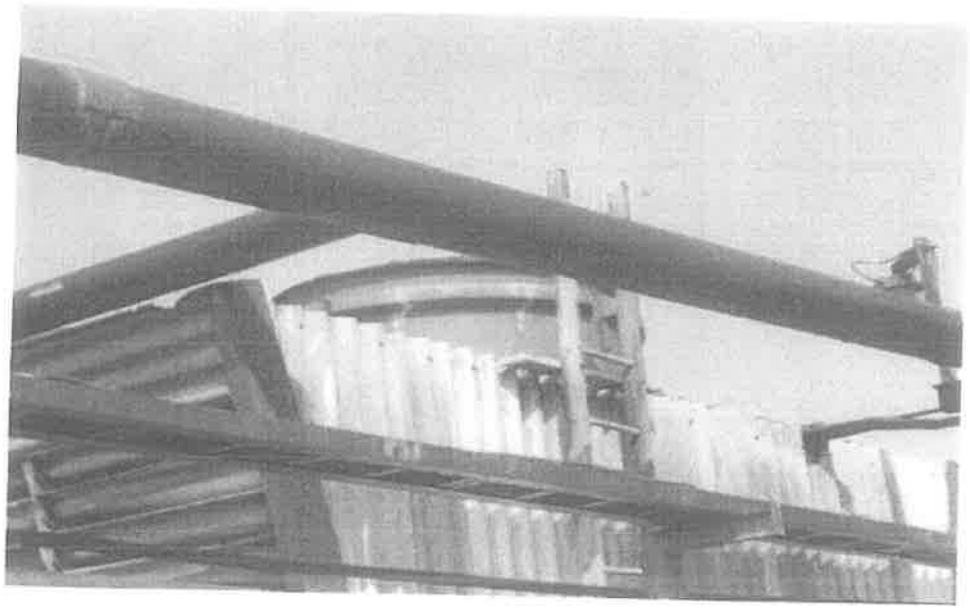
### 3.19. NEW COOLING TOWER FAN

| | | |
|---|---|---|
| Equipment Tag No. | : | E 9506-C & D |
| Motor rated power | : | 7.5Kw |
| Diameter | : | 1829 mm |
| Material of Construction: | | |
| Blade | : | Aluminum alloy |
| Hub | : | Aluminum |



### 3.20. COOLING TOWER SUMP

| | | |
|---|---|---|
| Type | : | Rectangular |
| Length of the tank | : | 4.5 m |
| Breadth of the tank | : | 3.95 m |
| Height of the tank | : | 0.8 m |
| Material of Construction | : | Reinforced Cement Concrete |

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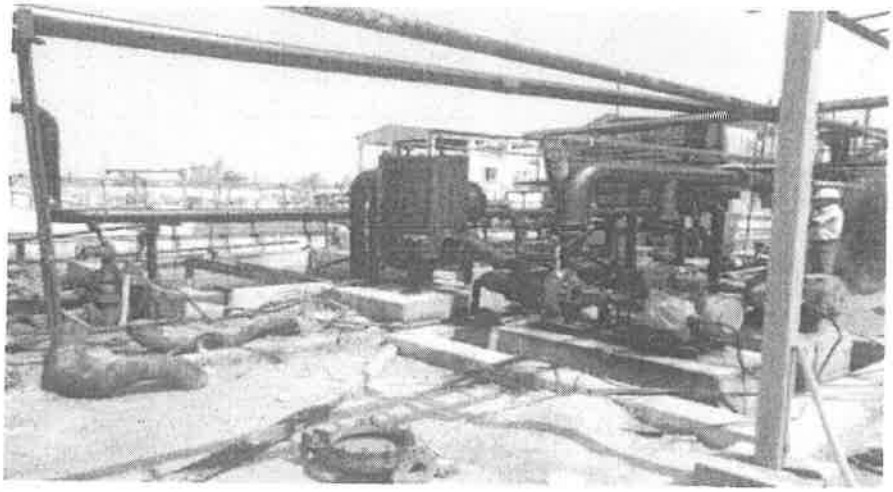
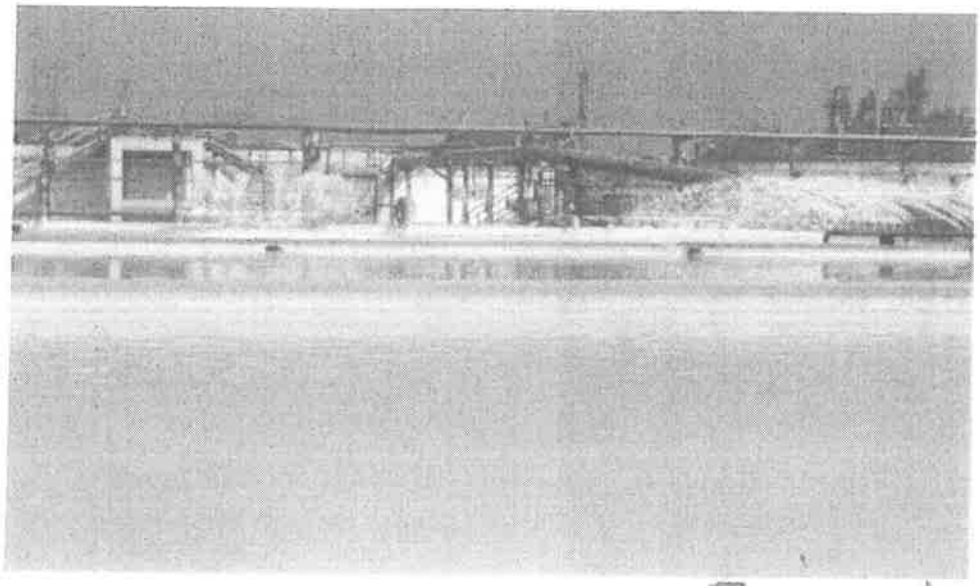
### 3.21. COOLING TOWER TO AT3 TRANSFER PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC 9703-A/B |
| Make & Model | : | MEGA - G100 - 315 |
| Flow rate | : | 200 $m^3/h$ |
| Head | : | 35 m |
| Motor rated power | : | 18.5 kW |
| Material of Construction | : | CAST IRON |



### 3.22. AERATION TANK 3/2/1

| | | |
|---|---|---|
| Type | : | Rectangular tank |
| Length of the tank | : | 13.1 m |
| Breadth of the tank | : | 21 m |
| Height of the tank | : | 3.5 m |
| Material of Construction | : | Reinforced Cement Concrete |





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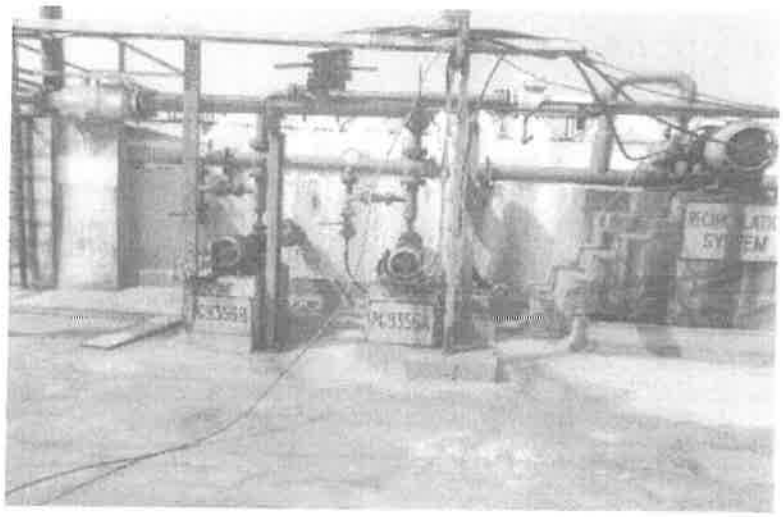
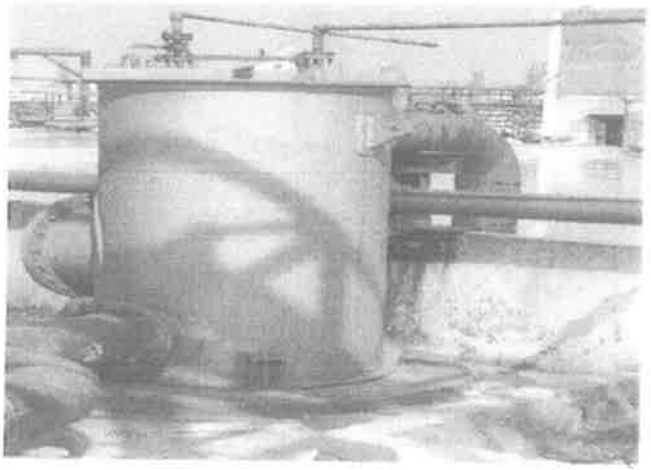
### 3.23. AERATION TANK 3 CIRCULATION PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC 9356-A/B/C/D |
| Head | : | 35 m |
| Motor rated power | : | 7.5 kW |
| Volumetric flowrate | : | 40 $m^3$/hr |
| Rated Speed | : | 2913 rpm |
| Material of Construction | : | CAST IRON |



### 3.24. AT1 TO EFFLUENT HOLDING TANK TRANSFER PUMP PRIMING CHAMBER

| | | |
|---|---|---|
| Equipment Tag No. | : | SR 9357 |
| Type | : | Cylindrical tank |
| Diameter of the tank | : | 1000 mm (OD) |
| Height of the tank | : | 1800 mm |
| Thickness | : | 8 mm |
| Material of construction | : | IS 2062 |





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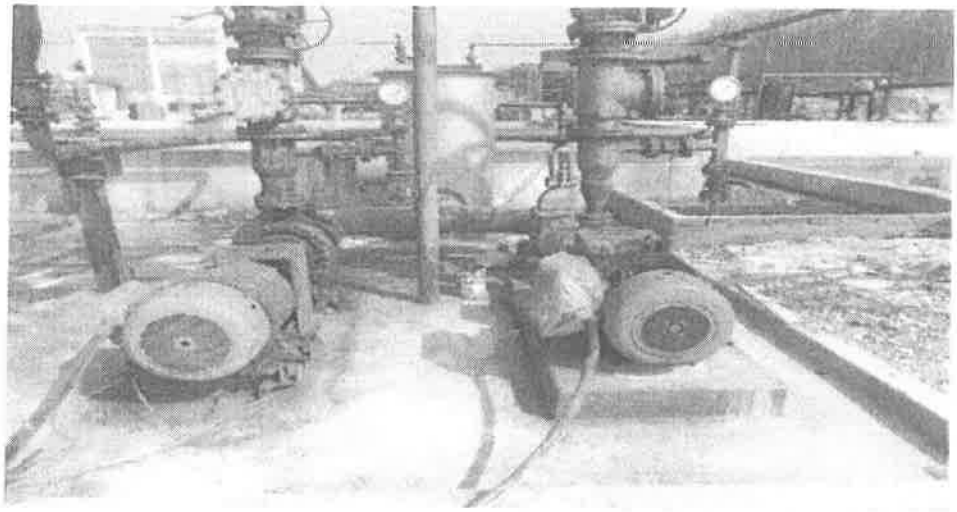
### 3.25. AT1 TO EFFLUENT HOLDING TANK TRANSFER PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC 9357-A/B |
| Head | : | 45 m |
| Volumetric flow rate | : | 200 $m^3/h$ |
| Rated Speed | : | 1450 rpm |
| Material of Construction | : | STAINLESS STEEL |



### 3.26. EFFLUENT HOLDING TANK

| | | |
|---|---|---|
| Type | : | Rectangular tank |
| Length of the tank | : | 40 m |
| Breadth of the tank | : | 15 m |
| Height of the tank | : | 1.5 m |
| Material of Construction | : | Reinforced Cement Concrete |

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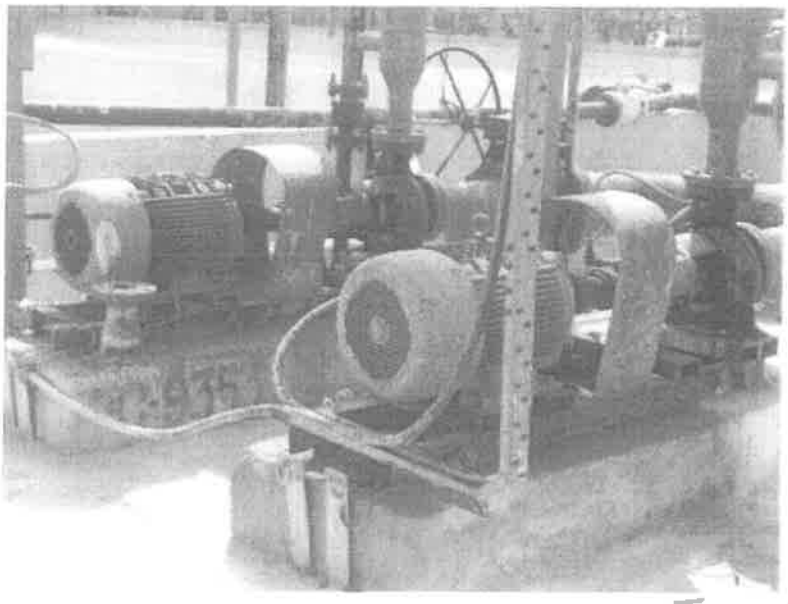
### 3.27. EFFLUENT HOLDING TANK TO BIO REACTOR TRANSFER PUMP PRIMING CHAMBER

| | | |
|---|---|---|
| Equipment Tag No. | : | SR 9353 |
| Type | : | Cylindrical tank |
| Diameter of the tank | : | 984 mm |
| Height of the tank | : | 1800 mm |
| Material of Construction | : | Carbon steel |

### 3.28. EFFLUENT HOLDING TANK TO BIO REACTOR TRANSFER PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC 9353-A/B |
| Head | : | 30 m |
| Motor rated power | : | 16.34 kW |
| Volumetric flowrate | : | 150 $m^3$/hr |
| Rated Speed | : | 2900 rpm |
| Material of Construction | : | STAINLESS STEEL316 |





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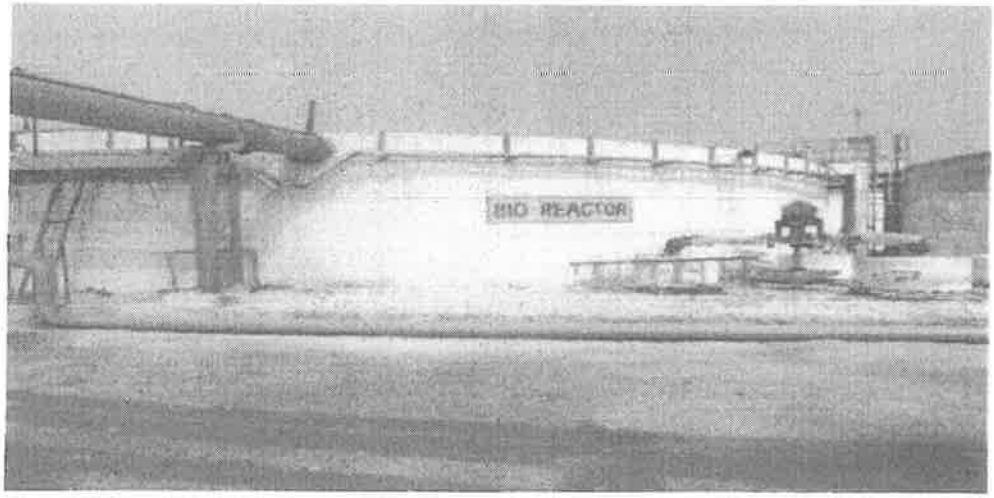
### 3.29. BIO-REACTOR CHAMBER

| | | |
|---|---|---|
| Type | : | Cylindrical Tank |
| Diameter of the tank | : | 33.3 m |
| Side wall Depth | : | 6.3 m |
| Material of Construction | : | Reinforced Cement Concrete |




### 3.30. TRITON JET AERATOR

| | | |
|---|---|---|
| Equipment Tag No. | : | JA 9351-A/B/C/D/E |
| Power | : | 70 HP |
| Material of Construction | : | STAINLESS STEEL |

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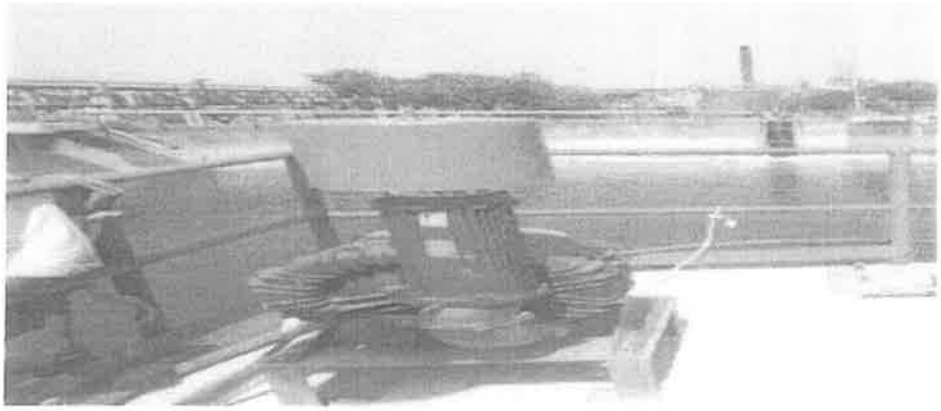
### 3.31. TRITON BLOWER-A

| | | |
|---|---|---|
| Equipment Tag No. | : | X 9352-A/B/C/D/E |
| Rated Speed | : | 2900 rpm |
| Power | : | 10 HP |
| Material of Construction | : | UPVC |



### 3.32. SECONDARY CLARIFIER CHAMBER

| | | |
|---|---|---|
| Type | : | Cylindrical Tank |
| Diameter of the tank | : | 14 m |
| Side wall Depth | : | 3.5 m |
| Material of Construction | : | Reinforced Cement Concrete |

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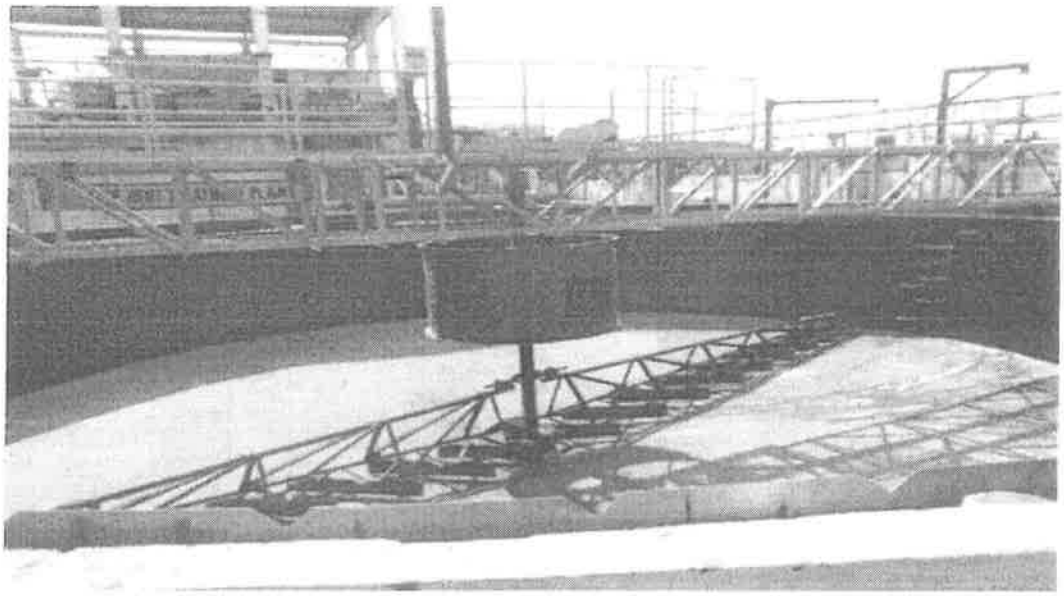
### 3.33. SECONDARY CLARIFIER RACKER ARM

| | | |
|---|---|---|
| Equipment Tag No. | : | X 9405 |
| Motor rated power | : | 1.5 kW |
| Material of Construction | : | Carbon steel epoxy painted |



### 3.34. SECONDARY CLARIFIER UNDERFLOW PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PD 9354-A/B |
| Head | : | 30 m |
| Motor rated power | : | 30 kW |
| Volumetric flowrate | : | 150 $m^3$/hr |
| Rated Speed | : | 194 rpm |
| Material of Construction | : | CAST IRON |

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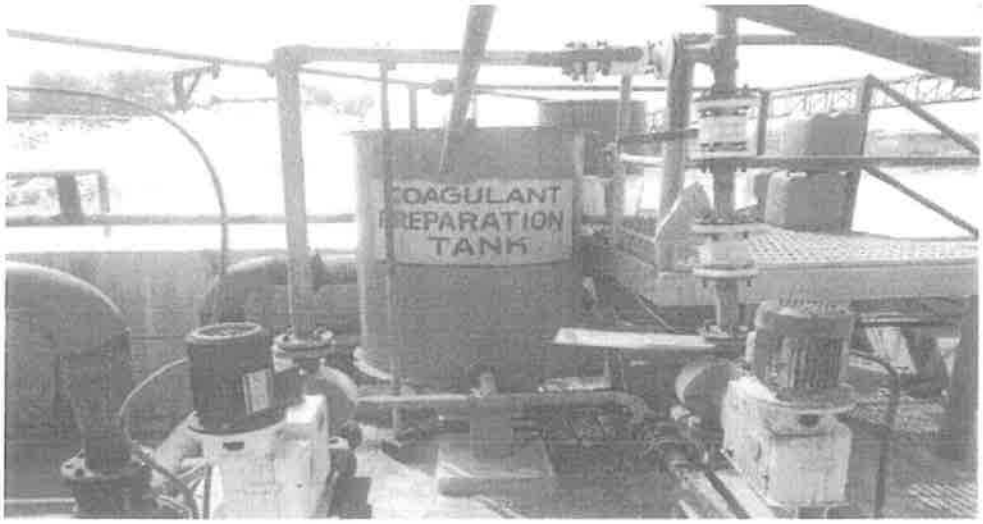
### 3.35. COAGULANT DOSING PUMP

| | | |
|---|---|---|
| Head | : | 5 kg/cm$^2$ |
| Volumetric flowrate | : | 25 LPH |
| Rated Speed | : | 1440 rpm |
| Material of Construction | : | CAST IRON |




### 3.36. TES TANK

| | | |
|---|---|---|
| Type | : | Rectangular tank |
| Length of the tank | : | 12 m |
| Breadth of the tank | : | 15 m |
| Height of the tank | : | 2 m |
| Material of Construction | : | Reinforced Cement Concrete |

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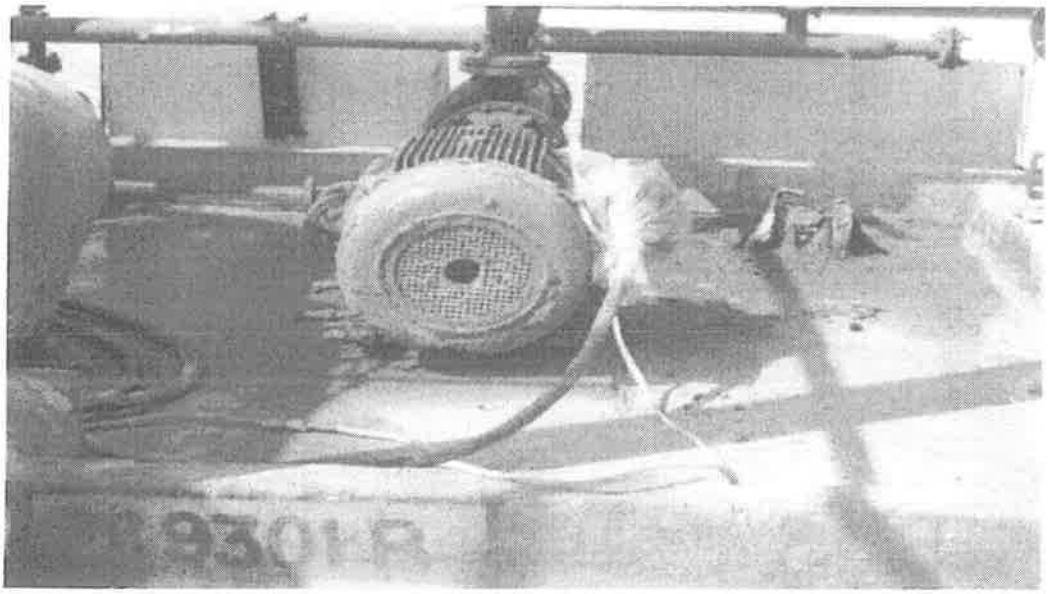
### 3.37. TES TRANSFER PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC 9301-A |
| Motor rated power | : | 45Kw |
| Head | : | 45 m |
| Volumetric flow rate | : | 55.5 LPS |
| Material of Construction | : | STAINLESS STEEL |

### 3.38. TES TRANSFER PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC 9301-B |
| Motor rated power | : | 37kW |
| Head | : | 67.5 m |
| Volumetric flow rate | : | 160 m3/hr |
| Material of Construction | : | STAINLESS STEEL |



### 3.39. TES TRANSFER PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC 9301-C |
| Motor rated power | : | 37kW |
| Head | : | 55 m |
| Volumetric flow rate | : | 254 m3/hr |
| Material of Construction | : | CAST IRON |

### 3.40. TES TRANSFER PUMP

| | | |
|---|---|---|
| Equipment Tag No. | : | PC 9301-D |
| Motor rated power | : | 18.5kW |
| Head | : | 58 m |
| Volumetric flow rate | : | 70 m3/hr |

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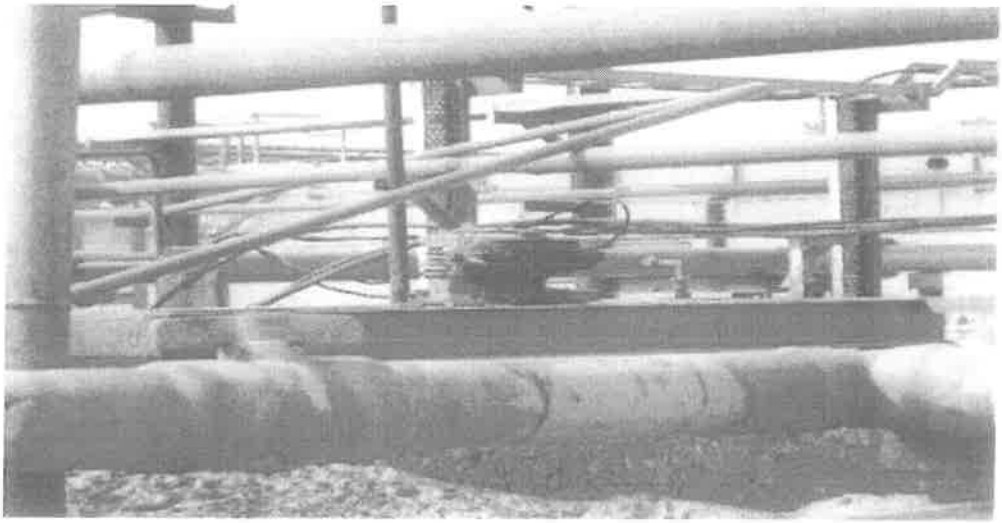
### 3.41. CULTURE PREPARATION TANK

| | | |
|---|---|---|
| Type | : | Rectangular tank |
| Length of the tank | : | 6 m |
| Breadth of the tank | : | 4.5 m |
| Height of the tank | : | 3.5 m |
| Material of Construction | : | Reinforced Cement Concrete |

### 3.42. CULTURE PREPARATION BLOWER

| | | |
|---|---|---|
| Volumetric flowrate | : | 3.67 $m^3$/min |
| Differential pressure | : | 14.92 psi |



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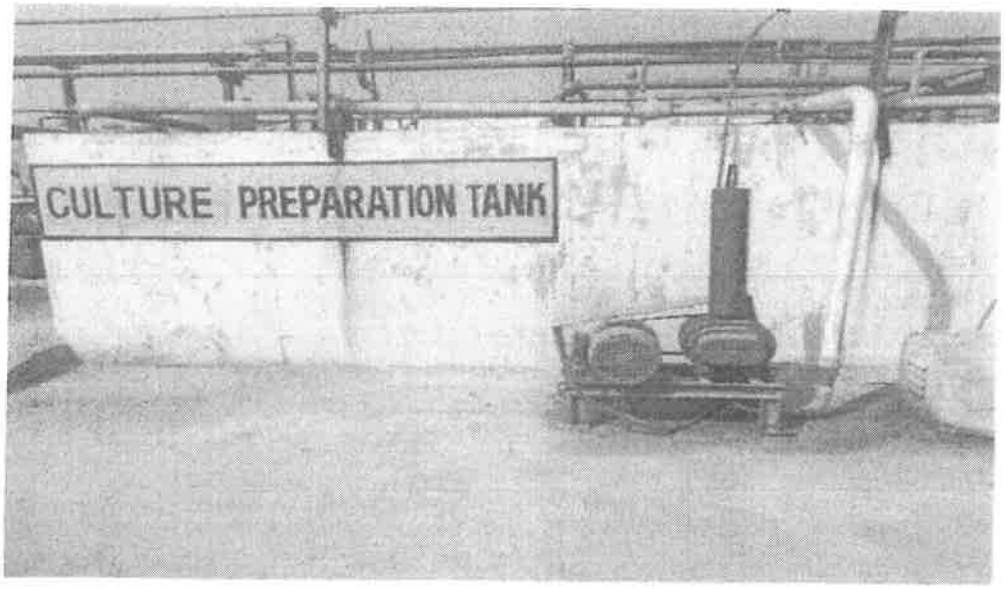
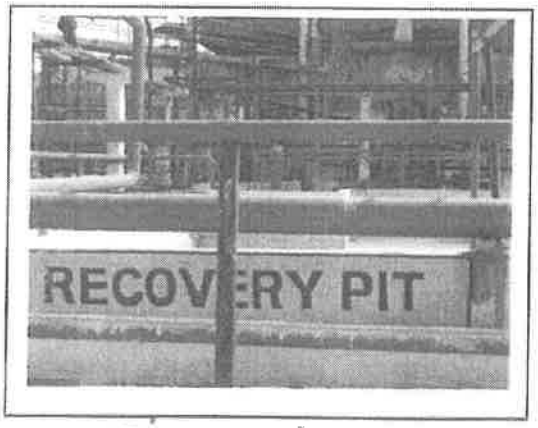
3.43. CULTURE PREPARATION PUMP

| | | |
|---|---|---|
| Volumetric flowrate | : | 14 $m^3$/hr |
| Material of Construction | : | CAST IRON |




3.44. RECOVERY PIT TANK (2)

| | | |
|---|---|---|
| Type | : | Rectangular tank |
| Length of the tank | : | 1 m |
| Breadth of the tank | : | 1 m |
| Height of the tank | : | 1 m |
| Material of Construction | : | Reinforced Cement Concrete |

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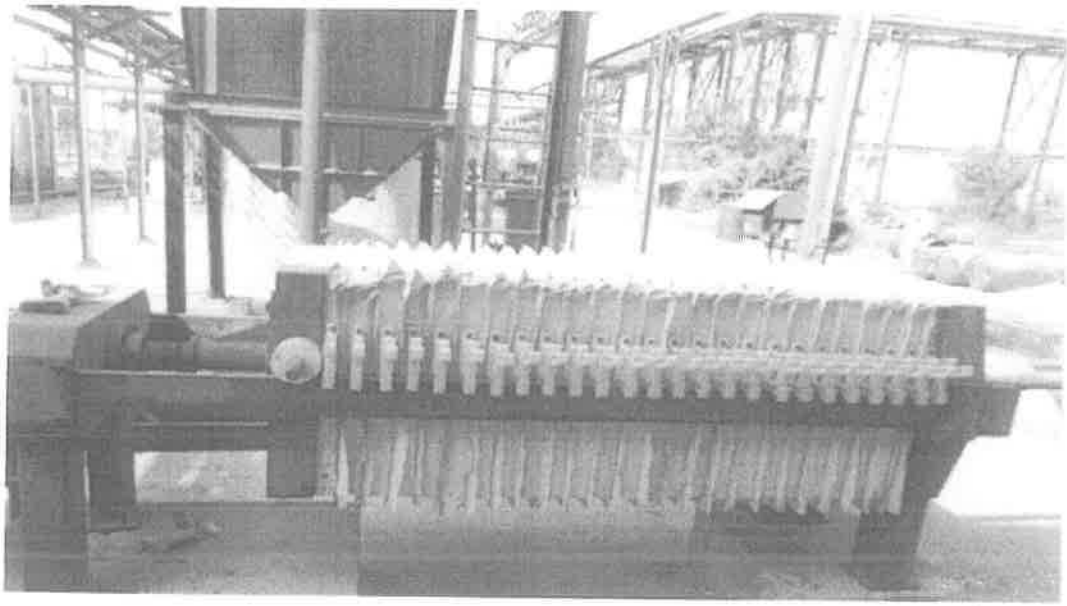
### 3.45. FILTER PRESS

| | | |
|---|---|---|
| Type | : | Recessed type |
| Volumetric flow rate: | | 10000 to 15000 LPH |
| Plate Size | : | 915mm x 915mm x 80mm thick |
| Design Pressure | : | 5bar |
| MOC of Filter Cloth | : | Polypropylene |



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4.0. Site Audit

**4.1. The unit has constructed dedicated storage area with wall for the lime storage area and the seepage collection system.**

The dedicated lime storage construction and seepage collection system is adequate to store the current generation of lime sludge.

**Dr.S.Sivanesan inspecting the newly constructed Lime storage yard.**

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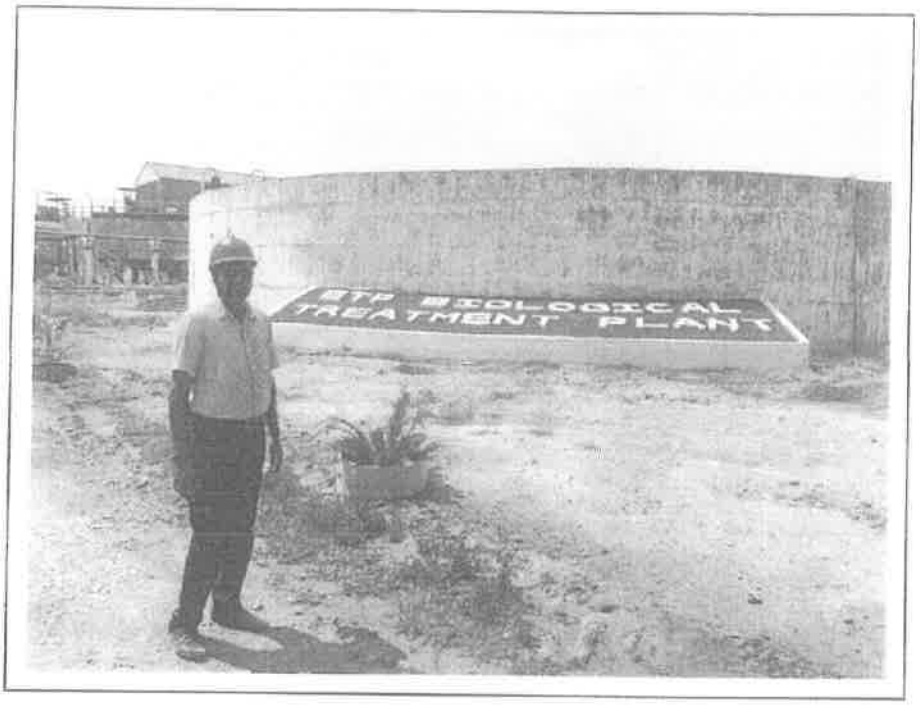
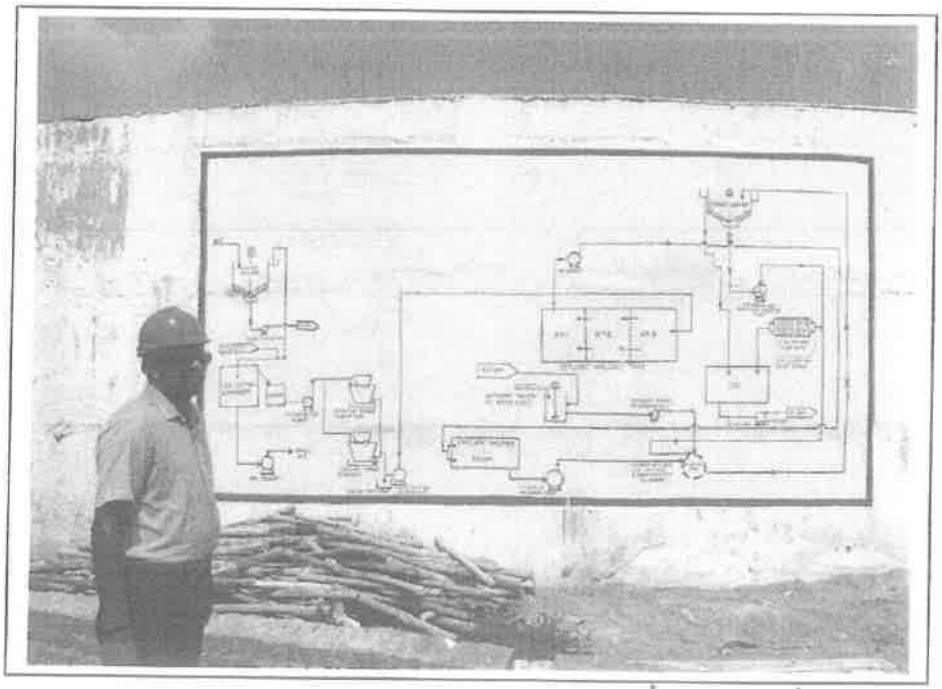
4.2. Dr.S.Sivanesan inspecting ETP Biological treatment plant-MPL-UNIT II



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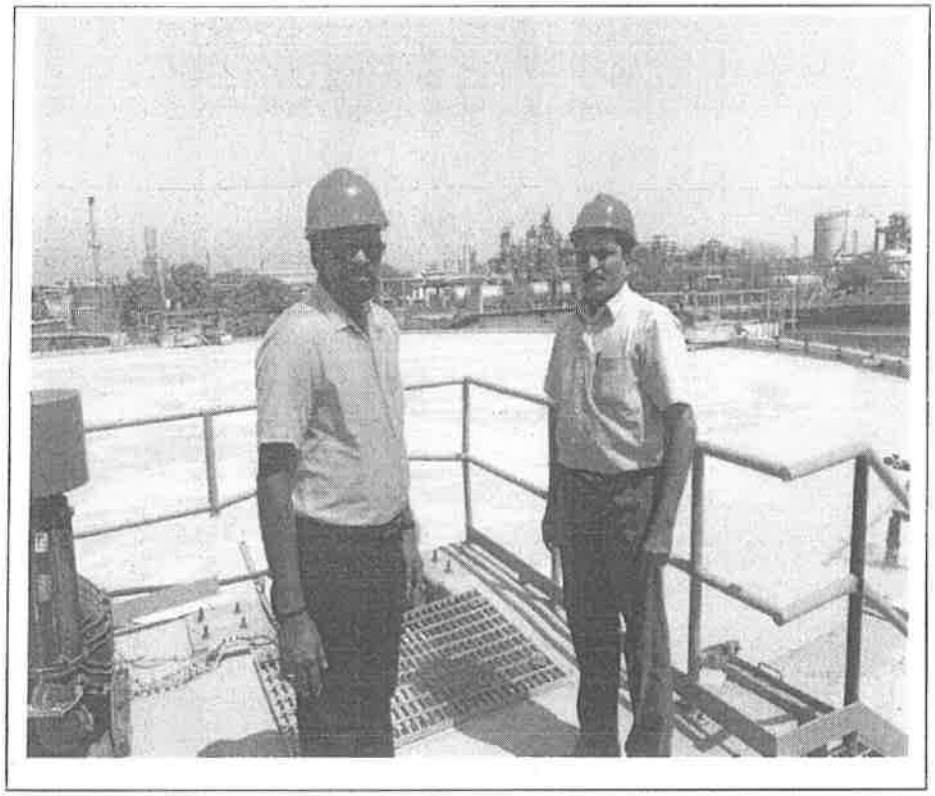
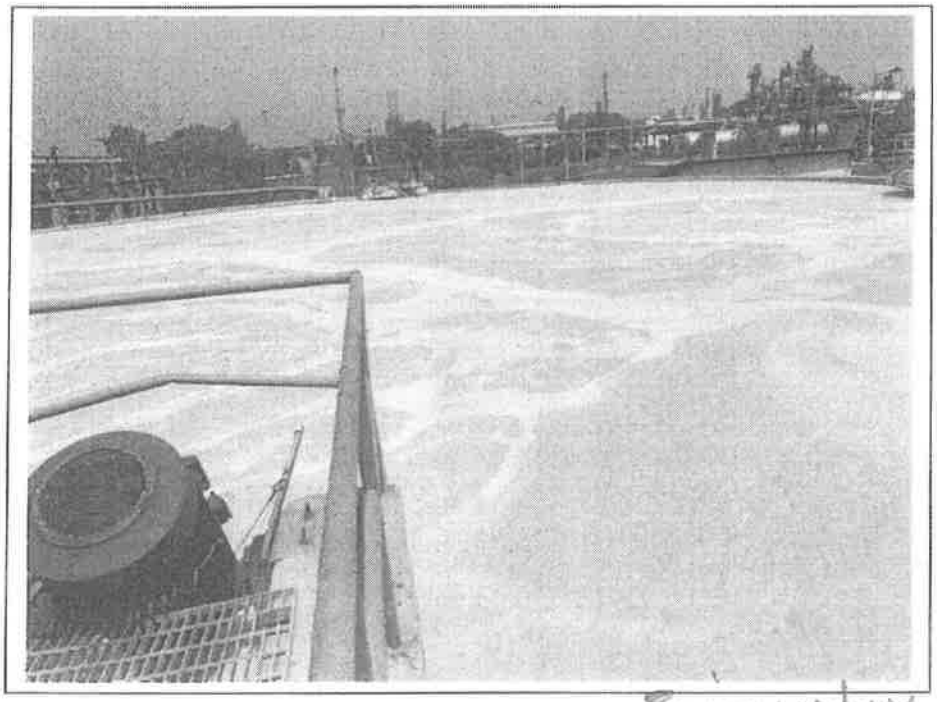
4.3. Auditing of MPL UNIT-II - BIOLOGICAL TREATMENT FACILITY





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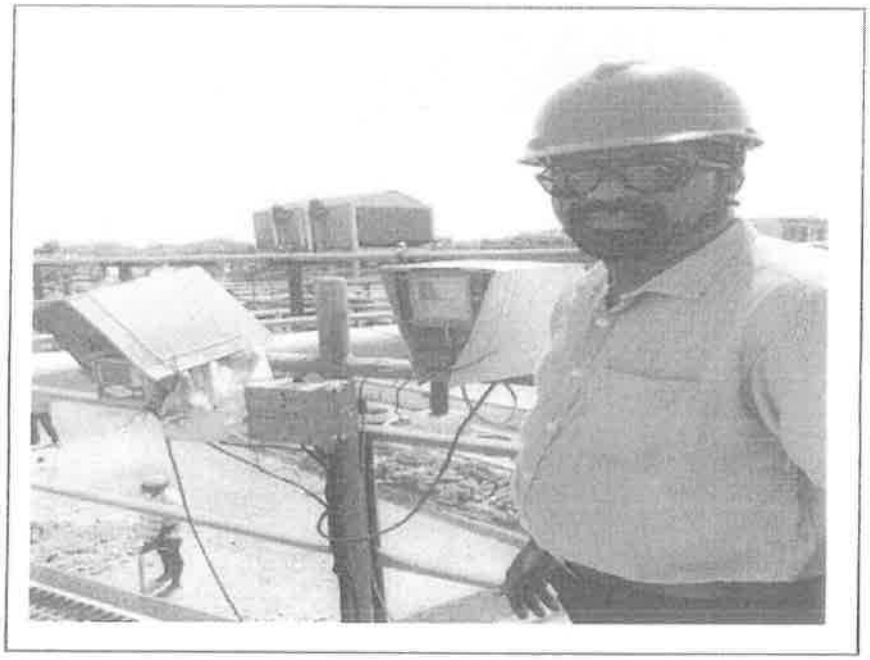
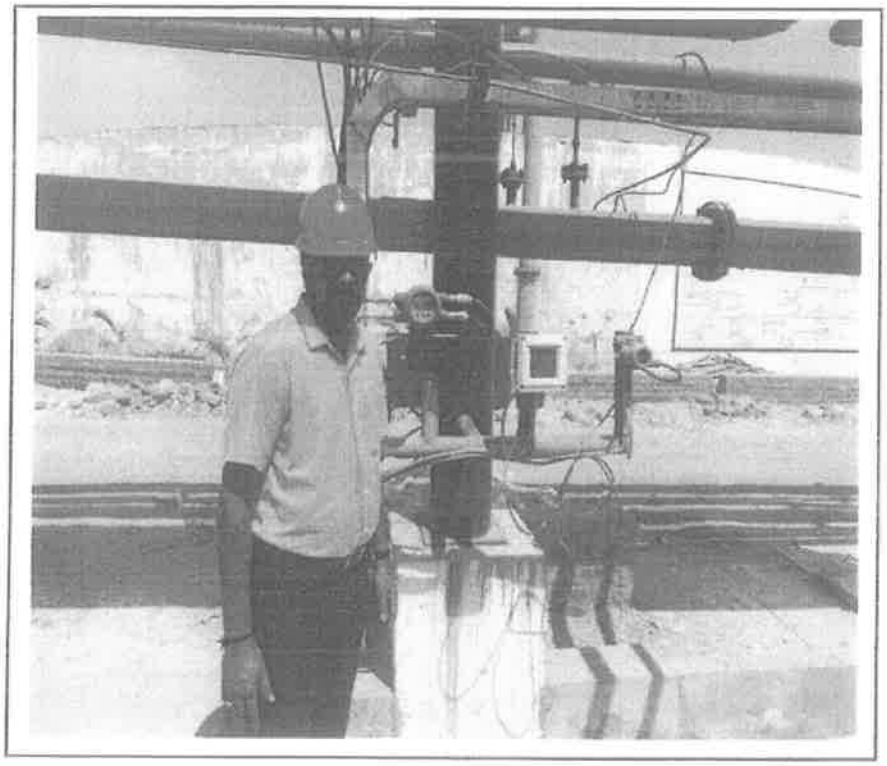
4.4. Auditing of Magnetic flow meter installation in MPL UNIT-II





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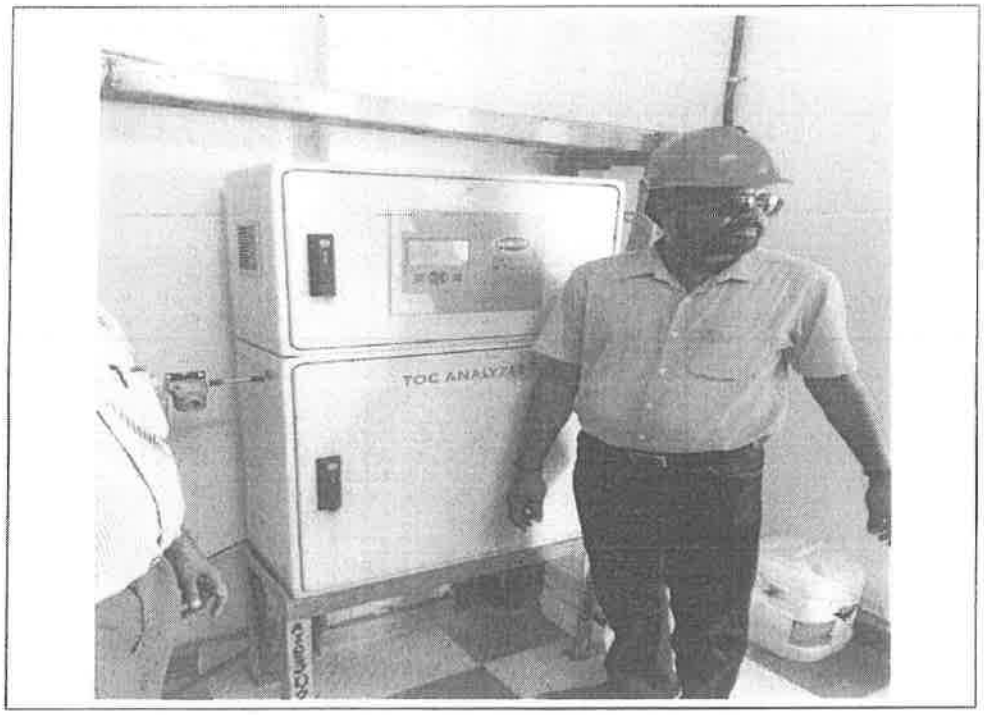
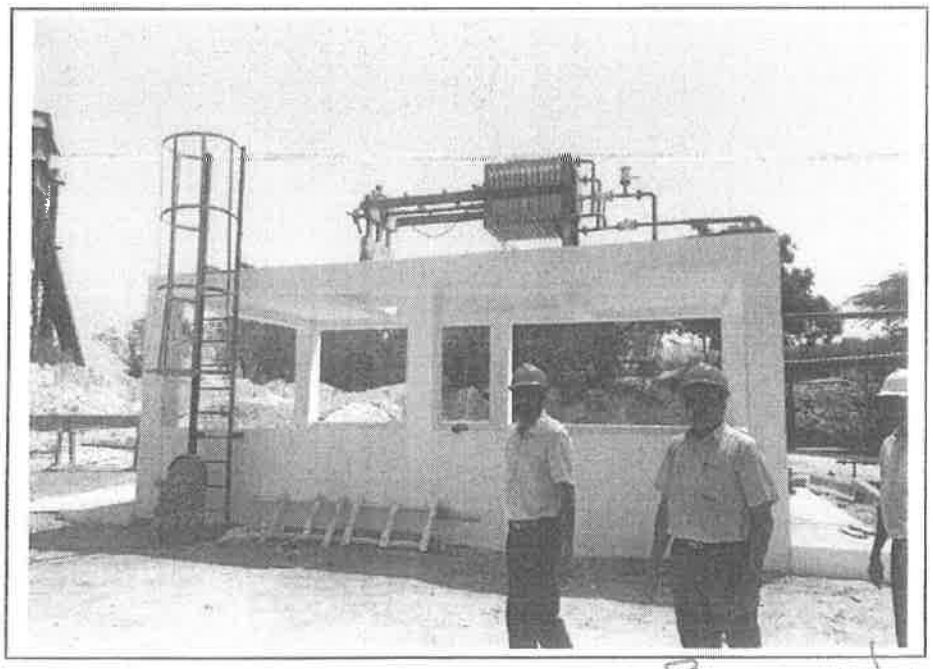
## 4.5. Auditing of Online monitoring system of TOC ANALYSER




## 4.6. AUDITING FILTER PRESS INSTALLATION - MPL-UNIT II



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## 5.0. ETP PROCESS DESCRIPTION

Effluent generated by propylene oxide plant at saponifier bottom is pumped to High rate thickener at 75 degC at a flow rate of 115 m3/hr. Flocculent is added, for faster settling of suspended solids at the bottom. HRT Underflow contains 6-7 % of suspended solids and withdrawn at 10 T/hr and the corresponding underflow is pumped to rotary drum filter for the separation of effluent from suspended solids. The filtrate from RVDF is sent back to HRT. HRT overflow is a gravity flow to collection basin . From collection basin effluent is pumped to the top of cooling tower reducing the temperature of the effluent from 65 to 40-35 (min) degC. The outlet of cooling tower sump is pumped to settling tank from which it is pumped to the bio reactor.

In bio reactor, at first, bio culture is developed using bio mass, urea and DAP and is aerated using jet aerators. Jet aerators play a major role in reduction of Chemical Oxygen Demand by enhancing oxygen transfer in liquids. Aerators inject air from atmosphere into liquid enhancing turbulence and overall Dissolved Oxygen necessary for activated sludge developed. Regenerative blower of power rated 18 kW sucks the air from the atmosphere. Bio reactors contain 5 jet aerators to provide Dissolved oxygen for the bacteria which breaks down the carbon in the organic compounds causing COD and BOD. Urea and DAP are timely added to provide nitrogen and phosphorous as macro nutrients for the growth of bacteria.

The outlet of bio reactor flows to secondary clarifier which clarifies the activated sludge from the treated effluent. Secondary clarifier bottom sludge is pumped back to the bio reactor to maintain MLSS. If Excess Bio sludge is formed from secondary clarifier is pumped and routed to Plate and frame press in order to remove the excess Bio sludge.

Clarified effluent is overflow to Treated Effluent Sump (TES).

Finally, COD/BOD and all other parameters reaching to the prescribed standard and treated effluent is pumped to the sea.

5.1. The ETP flow dig is attached as Annexure-1 and the Water balance is attached as Annexure-02.

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5.2. Environmental Status of the Plant - Water Balance

5.2.1. Raw water consumption - last 2 years

| Year | Annual water consumption $m^3$/day | | | Total | Daily consumption $m^3$/day |
|---|---|---|---|---|---|
| | Cooling | Processing | Domestic | | |
| 2017-18 | 302.873 | 620.046 | 68.965 | 991.884 | 991.884 * |
| 2016-17 | 285.263 | 1040.528 | 64.953 | 1390.744 | 1390.744** |

* 2017-2018 *The above quantity excluded 1829.95m3/day RO Rejects water from CMWSSB kodungaiyur secondary treated sewage water used in Propylene oxide Plant.

** 2016-2017 *The above quantity excluded 1093.989 m3/day RO Rejects water from CMWSSB kodungaiyur secondary treated sewage water used in Propylene oxide Plant.

5.3. Effluent generation - m3/day

| Month | Total effluent $m^3$/day |
|---|---|
| January -2018 | 2572 |
| February- 2018 | 2456 |
| March-2018 | 1986 |
| April-2018 | 2573 |
| May-2018 | 2572 |
| June-2018 | 2570 |
| July-2018 | 2571 |
| August-2018 | 2572 |
| September-2018 | 2570 |
| October-2018 | 2569 |
| November-2018 | 1605 |
| December-2018 | 2555 |
| Average Daily effluent generation / Day | 2431 |

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5.4. Characteristic of trade effluent generated before treatment

| S.No. | Characteristics | Unit | MPL-UNIT II |
|---|---|---|---|
| 1 | pH | - | 10 .5 to 11.5 |
| 2 | Total dissolved solid | mg/l | 40000 |
| 3 | Sodium | | 0.01 |
| 4 | Temperature | .C | 35 to 40 .c |
| 5 | Dissolved oxygen | mg/l | < 1 |
| 6 | Chloride (as Cl) | mg/l | 26000 |
| 7 | BOD | mg/l | 400 |
| 8 | Total suspended solid | mg/l | 200 |
| 9 | Sulphate (as SO4) | mg/l | 100 |
| 10 | COD | mg/l | 1800 to 2300 |

5.5. Characteristic of treated effluent - from 15.1.2019 to 15.2.2019 - (both MPL tested results & TNPCB tested results)

| MPL PLANT -2 Treated effluents sample (TES) ANALYSIS REPORT | | | | | | | |
|---|---|---|---|---|---|---|---|
| S.No. | Characteristics | Unit | 22.02.2019 | 25.02.2019 | 26.02.2019 | 27.02.2019 | 28.02.2019 |
| 1 | BOD (5 days) @ 20 0C | ----- | 49.9 | 42.24 | 36 | 34 | 32 |
| 2 | Calcium | mg/l | 14749.44 | 13948 | 13948 | 14589.12 | 14429 |
| 3 | Chloride | mg/l | 26791.69 | 26392 | 25192.2 | 26992 | 29792 |
| 4 | COD | mg/l | 235.8 | 221.76 | 230 | 190 | 217.7 |
| 5 | Fluoride | mg/l | 0.38 | 0.53 | 0.36 | 2.58 | 0.48 |
| 6 | Hexavalent Chromium | mg/l | BDL | BDL | BDL | BDL | BDL |
| 7 | Oil and Grease | mg/l | 8 | 5 | 8 | 4 | 6.2 |
| 8 | pH | mg/l | 6.32 | 6.34 | 6.64 | 6.7 | 6.75 |
| 9 | Phenolic compounds | mg/l | BDL | BDL | BDL | BDL | BDL |
| 10 | Phosphate | mg/l | 2.26 | 2.23 | 4.5 | 3.03 | 7.29 |
| 11 | Sulphate | mg/l | 205.63 | 235 | 275.5 | 329 | 329 |
| 12 | Sulphide | mg/l | BDL | BDL | BDL | BDL | BDL |
| 13 | Total chromium | mg/l | 0.069 | 0.055 | 0.031 | 0.035 | 0.035 |
| 14 | TDS | mg/l | 43656 | 46345 | 45056 | 46452 | 44556 |
| 15 | TRC | mg/l | BDL | BDL | BDL | BDL | BDL |
| 16 | TSS | mg/l | 88 | 76 | 92 | 76 | 80 |
| BDL - Below Detectable Limit | | | | | | | |

## 6.0. Details of Online monitoring equipments installed in the unit II - to measure TSS, COD, pH, Temperature and flow

Table-8 - Details to be checked and corrected

| S. No. | Station Name | Type of Monitoring System (Emission / Effluent / CAAQMS) | Process attached | Parameter monitored | NEW Device Vendor | NEW Device Model | SUPPLIER ADDRESS |
|---|---|---|---|---|---|---|---|
| 1 | PH | EFFLUENT | EFFLUENT TO SEA WATER | PH | Yokogawa | EXA | YOKOGAWA INDIA LIMITED,HOSUR ROAD,BANAGALORE-560100 |
| 2 | temperature | EFFLUENT | EFFLUENT TO SEA WATER | temperature | Yokogawa | YTA | YOKOGAWA INDIA LIMITED,HOSUR ROAD,BANAGALORE-560100 |
| 3 | flow | EFFLUENT | EFFLUENT TO SEA WATER | flow | SIEMENS | MAG310 | K&N Automation Plot 7, Bhuvaneswari Nagar First street Alapakkam Road Valasaravakkam Chennai - 600087 |
| 4 | TSS | EFFLUENT | EFFLUENT TO SEA WATER | TSS | HACH | LXV404.99.00502 | DHR HOLDING INDIA PVT LTD,SP COMPLEX (Gr.Flr), 16/1,LALBAGH RD, BANGALORE-560027 |
| 5 | COD/BOD | EFFLUENT | EFFLUENT TO SEA WATER | COD/BOD | HACH | B7000i | DHR HOLDING INDIA PVT LTD,SP COMPLEX (Gr.Flr), 16/1,LALBAGH RD, BANGALORE-560027 |

7.0. ETP sludge and Lime Sludge Analysis results

7.1. The third party analysis results of ETP sludge and Lime sludge as attached with this report as Annexure-3 & Annexure-4.

## 8.0. Solid and Hazardous Waste Management

Details of Hazardous Waste generation by MPL UNIT -II and authorization conditions

| S.No | Details of processes Generating hazardous waste as listed in column 2 of schedule 1 of the amended rules | Details of waste stream as per column 3 of schedule 1 of the amended rules | Authorized Quantity per year. | Activity for which authorization is issued |
|---|---|---|---|---|
| 1. | Rotary equipment | 5.1 spent oil | 4000 | Collection / Storage and disposal to MOEF/TNPCB authorized recycler. |

### 8.1. Details of Hazardous waste on storage

| S. No. | Description of Waste | Category No. | Source of waste | Details of storage container (Size / material) | Quantity in storage as on 16.02.2019 (Date of Audit) | Area provided for storage (m2) |
|---|---|---|---|---|---|---|
| 1 | Used / Spent Oil | 5.1 | Rotary equipment's | 200 Liters drum | 250 Liters | 32 $m^2$ |

### 8.2. Details of Hazardous wastes in Recycled

| S.No | Type of Hazardous waste | Consented Quantity | Year | Quantity Generated | Quantity recycled | Quantity disposed | Mode of disposal | Quantity Sent Out |
|---|---|---|---|---|---|---|---|---|
| 1 | Spent oil | Tons/Year | 01.04 2017 to -31.03.2018 | 350 Liters | -- | NIL | | NIL |
| | | | 01.04 2016 to -31.03.2017 | 730 | -- | 940 * | To TNPCB approved waste oil reclaimers by drums | 940 |

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9.0. Consented quantities of Products:

Table-10

| S.NO | Description | Quantity | Unit |
|---|---|---|---|
| PRODUCT DETAILS | | | |
| 1 | PROPYLENE OXIDE | 18000 | MT/YEAR |
| 2 | PROPYLENE GLYCOL | 10000 | MT/YEAR |
| 3 | POLYOL | 25000 | MT/YEAR |
| BY PRODUCT DETAILS | | | |
| 1 | DCP- DICHLORO PROPANE | 3600 | MT/YEAR |
| 2 | TRI PROPYLENE GLYCOL | 168 | MT/YEAR |
| 3 | DIPROPYLENE GLYCOL | 1320 | MT/YEAR |

10.0. Consent conditions under Water Act and its compliance stat

Renewal of Water Consent Order No. : - 180818016200 Valid till 31.

10.1. Consent conditions:

| | | | |
|---|---|---|---|
| Effluent | Sewage | 15 kl/Day | Combined with trade effluent, treated and discharged in to sea through pipe line |
| Effluent | Trade Effluent | 2599 KL/Day | Discharged in to sea through pipe line |

10.2. Consent conditions as per Water Act and compliance status

| Conditions Mentioned in the Consent Order | Status of Compliance |
|---|---|
| The unit shall comply with the outcome of the order of the Honorable National Green Tribunal, Sothern Zone in the OA No:- 19 of 2013 and 52 & 53 of 2017 | We hereby undertake to comply with the directions, if any to be issued by the NGT |
| The unit shall improve, operate and maintain the ETP efficiently and continuously and the treated trade ffluent shall satisfy the Marine disposal standards prescribed by the Board before disposal in to sea. | MPL upgraded the ETP plant with Bio-Treatment system. Operating and maintaining the ETP efficiently and continuously and the treated trade effluent meeting the Marine disposal standards prescribed by the Board before disposal in to sea. |
| The unit shall regularly analyze the treated effluent and furnish ROA of the same to the Board | As per Board advice we are regularly analyzing the treated effluent. Analysis report copy submitted every month to TNPCB. Regularly TNPCB also taking sample and ROA is enclosed for your reference and records. (COMPLIED) |
| The unit has to ensure that OLMS provided for the effluent parameters BOD, COD,and TSS and connected to the CAC of the Board shall be operated continuously. | OLMS provided for the effluent parameters BOD, COD,and TSS are connected to the CAC of the Board and operated continuously. (COMPLIED) |
| The unit shall ensure that connectivity of online monitors for the effluent parameter pH, Flow and temperature with CAC of TNPCB and provide proper data all times. | Ensured that the connectivity of online monitors for the effluent parameter pH, Flow and temperature with CAC of TNPCB and provided proper data all times. (COMPLIED) |

03.2019

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| Conditions Mentioned in the Consent Order | Status of Compliance |
|---|---|
| The Hazardous waste generated shall be properly disposed as per Hazardous waste (MH&TM) Rules, 2008. | The Hazardous waste generated is disposed to TNPCB authorized recyclers as per Hazardous waste (MH&TM) Rules, 2008. (COMPLIED) |
| The unit shall dispose the lime sludge then and there for further beneficial use without accumulation of the same. | Lime sludge collected from the plant is then and there given to further beneficial use without accumulation of the same. Every month this details submitted to the Board. (COMPLIED) |
| The unit shall expedite the trial studies conducted by IIT, Madras and SASTRA University on the improved treatment of the effluent to discharge into the sea without affecting the Marine Eco system. | MPL upgraded the ETP plant with Bio Treatment system. Operating and maintaining the ETP efficiently and continuously and the treated trade effluent meeting the Marine disposal standards prescribed by the Board before disposal in to sea. (COMPLIED) |
| The unit shall ensure that there is no complaint arises due to operation of the plant. | As per Board advice we will strictly follow this requirement. (COMPLIED) |

11.0. Conclusion:

10.1. The team headed by Dr.S.Sivanesan, audited the ETP area to check the effluent treatment plant operations and its measures are adequate.

10.2. The MPL unit-II has applied for renewal of Consent order under Air & Water Act for FY 2019-2020

10.3. CPCB direction vide their letter No. Proc.No.B-29016/04/06/IPC-I/12888, dated 22.11.2018 to sought clarification for the sludge disposal and ETP improvements. For the above direction letter necessary feedback given by the unit to CPCB. On request CPCB inspected the plant and revoked the direction vide their letter No. Proc.No.B-29016/04/06/IPC-I/16437, dated 11.02.2019

10.4. The unit has installed online monitoring system to check the pH, TSS, Temperature, COD and effluent flow. The online system is checked for its functioning and are in running conditions and the readings for the period of 15.1.2019 to 15.2.2019 are verified and found ok. The results are presented in chapter No.5.5 of this report.

**10.4. All the available equipment's of ETP plant of MPL-UNIT II are in running conditions and are adequate for continuous operation of solid separation and Biological treatment of the effluent.**

**10.5. As per the direction of CPCB, MPL UNIT-II has newly constructed the lime storage yard with dewatering system. The dedicated lime storage construction and seepage collection system is adequate to store the current generation of lime sludge.**

Sivanesan

**Dr. S. SIVANESAN**
**Professor,**
**Applied Science & Technology**
**A.C.Tech,**
**Anna University, Chennai-25**

Dr. S. SIVANESAN
Professor
Department of Applied Science and Technology
Alagappa College of Technology
Anna University, Chennai-600 025.

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## 12.0. DISCLOSURE OF THE CONSULTANT ENGAGED

M/S.MANALI PETROCHEMICLAS LIMITED requested Anna University to assess their Performance of their Boiler plant and its control measures. Accordingly, a team from Anna university lead by Dr.S.Sivanesanaudited the entire site of M/S.MANALI PETROCHEMICALS LTD, UNIT-Iat Chennai.

The consultant has wide experience in EIA, Risk Analysis and Disaster Management. He has specialized in Environmental Science and Technology and has wide work experience with several international environmental agencies in abroad. He has also published several research papers in National / International Journals in the area of Environmental Science & Technology.

**Expert member of TNPCB- POLLUTION LOAD ASSESSMENT COMMITTEE.**

**The curriculum vitae of the consultant are furnished below.**


**Brief Resume** :**Dr.S.SIVANESAN.,Ph.D.,**
**Alagappa College of Technology,**
**Anna University, Chennai**

Designation and Affiliation :**Professor**
Department of Applied Science & Technology
Alagappa College of Technology,
Anna University, Chennai-25.
Tel:-+91 9444960106
E. mail:siva@annauniv.edu, sivanesh1963@gmail.com

Date of birth : 05th May1963


**EducationalQualification**

| Degree | University | Year | Subjects | Class/Grade |
|---|---|---|---|---|
| Ph.D | Anna University | 1986-1992 | Atmospheric Science & Technology | Highly Commended |
| M.Sc | Madras University | 1983- 1985 | Environmental Chemistry | First |
| B.Sc | Madras University | 1980 -1983 | Chemistry | First |

Present Position

| | | |
|---|---|---|
| Designation | Professor | |
| Organization | Department of Applied Science & Technology,<br>Alagappa College of Technology, Anna University,<br>Chennai-600 025. | |
| Date of appointment to the present post | October 2008 | |
| Total Experience (In Years and Months) | Present position experience: | 10 Years & 3Months |
| | Total experience: | 24 Years |

Details of Experience possessed as per Eligibility Criteria

| S.No. | Post held | Organization | Nature of duties | Experience (In Years and Months) |
|---|---|---|---|---|
| 1. | Professor<br>A. Anna University (9 Years & 11Months)<br>B. NIES Research Scientist (2 Years & 3 Months) | Department of Chemical Engineering& Applied Science and technology, Anna University Chennai, India<br>National Institute of Environmental Science (NIES), Govt. of Japan | Teaching and Research | 12 Years & 02 Months |
| 2. | Associate Professor (Erstwhile Assistant Professor) | Department of Chemical Engineering Anna University Chennai, India | Teaching and Research | 8 Years |
| 3. | Technical Specialist (Research) | National Institute for Research in Inorganic Materials, Japan | Teaching and Research | 9 Months |
| 4. | Visiting Scientist | Department of Atmospheric Chemistry Mainz University Germany | Teaching and Research | 11 Months |
| 5. | Marie Curie Post-Doctoral Research Scientist | InstitutoFisbat CNR, Bologna, Italy | Research | 10 Months |
| 6. | Research Associate | Department of Chemical Engineering Anna University Chennai, India | Research | 1 Year & 10 Months |

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## Academic/Teaching Experience& Responsibilities

| S.No | Post | Organization/ University | Duration | | Experience (in Years &Months) |
|---|---|---|---|---|---|
| | | | From (Date) | To (Date) | |
| 1. | Dean | A.C. Tech Campus Anna University, Chennai | Jun 2013 | Jun 2018 | 5 Years |
| 2. | Registrar (i/c) | Anna University, Chennai | Dec 2012 | Jun 2013 | 7 Months |
| 3. | Dean | A.C. Tech Campus Anna University, Chennai. | Oct 2012 | Dec 2012 | 3 Months |
| 4. | Head of the Department | Department of Applied Science and Technology, Anna University, Chennai | Jan 2012 | Jun 2012 | 6 Months |
| 5. | Chairman | University Sports Board, Anna University, Chennai, India. | Jun 2011 | Sep 2013 | 2 Years & 3 Months |
| 6. | Head of the Department | Department of Chemical Engineering, Anna University,Chennai. | Jan 2011 | Jun 2011 | 6 Months |
| 7. | Professor | Department of Chemical Engineering, Anna University,Chennai. | Oct 2008 | Till date | 10 Years & 3 Months |
| 8. | Deputy Chairman | University Sports Board, Anna University, Chennai, India. | Jul 2008 | Jun 2011 | 2 Years & 11 months |
| 9. | Director | Centre for Entrepreneurship Development, Anna University, Chennai. | Aug 2005 | Jan 2012 | 6 Years & 6 Months |
| 10. | Assistant Professor | Department of Chemical Engineering, Anna University, Chennai, India | Oct 2000 | Nov 2008 | 8 Years |
| 11. | Technical Specialist (Research) | National Institute for Research in Inorganic Materials (NIRIM), Japan | Feb 2000 | Jun 2000 | 5 Months |
| 12. | Research Scientist | National Institute for Resources and Environment (NIRE), Japan | Jul 2000 | Oct 2000 | 4 Months |
| 13. | Science & Technology Agency- Research Fellow (Japan) | Post-Doctoral Research Program, Japan | Feb 1998 | Jan 2000 | 2 Years |
| 14. | Visiting Scientist | Department of Atmospheric Chemistry, Mainz University, Germany | Mar 1997 | Jan 1998 | 11 Months |
| 15. | Marie Curie Post-Doctoral Research Scientist | Instituto Fisbat, CNR, Bologna, Italy | Dec 1994 | Sep 1995 | 10 Months |
| 16. | Research Associate | Department of Chemical Engineering, Anna University, Chennai, India | Jan 1993 | Nov 1994 | 1 Year & 10 Months |

## Important MoUs formulated for academic collaborations

| S.No. | MoUs formulated | Name of Agencies/Departments Involved | Year of MoU |
|---|---|---|---|
| 1. | University & Industries | M/s. Vestas Wind Systems | 04.05.2013 |
| 2. | Safety issue in Industry and Academia | M/s. Safety Research Institute of Atomic Energy Regulatory Board (SRI-AERB), Govt. of India | 21.05.2013 |
| 3. | Technical Education for society | M/s. Indian Society for Technical Education, (ISTE) New Delhi | 31.05.2013 |
| 4. | University & Industries | M/s. Centre for Development of Advanced Computing (CDAC), Chennai | 05.06.2013 |
| 5. | University & Industries | M/s. Centre for Development of Advance Computing (C-DAC), GARUDA, Pune | 05.06.2013 |
| 6. | Faculty Training Programme with Eight Engineering Colleges in Tamil Nadu | Govt. college ofEngineering atSalem, Bargur&Coimbatore,ACCET, Karaikudi, Thyagaraja College,Madurai, PSG & CIT at Coimbatore, BIT Tiruchirappalli | 07.10.2013 |

## Scholarly Achievements

| | |
|---|---|
| Total number of Publications | : 158 |
| Out of 149 Publications, UGC Listed Journals | : 139 |
| Author ID | : 8268081200 (Scopus) |
| h-index (google scholar) | : 41 |
| Total No. of Citations | : 5921 (06 January 2019) |
| No. of books (national) | : 08 |
| No. of books (International) | : 02 |
| Number of papers presented in International | : 20 |
| Number of papers presented in National | : 17 |
| Editor in peer reviewed International Journals | : 03 |
| Reviewer in peer reviewed International journals | : 26 |
| Editor-in-Chief | : 01 |

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Patents and Copyrighted Material

1. Title: "Passive flow field design for Polymer electrolyte membrane fuel cell"

   REF.No: 309111; C.B.R.No.23687

2. Title: "Patents Laser flash thermal diffusivity analyser for the measurement of thermal properties of solid materials"

   Status: Submitted

Research Projects

| S.No. | Client/Organization's name | Nature of Project | Duration of Project | Amount of Grant (Rupees) |
|---|---|---|---|---|
| 1. | University Grants Commission, New Delhi | A Sustainable and Green Approach for Biomethane Enrichment by Biogas Recirculation and Algae Bioscrubbing | 2018-20 (On Going) | 10,00,000.00 |
| 2. | Department of Science & Technology | Green building and energy efficient cooling system for sustainable buildings in India | 3 years | 60,22,300.00 |
| 3. | Science and Engineering Research Board, DST, New Delhi. | Differential effect of 20 HETE mediating VEGF and no induced changes in tissues by direct signaling mechanism | 3 Years | 54,53,000.00 |
| 4. | Department of Science and Technology, New Delhi. | Development of integrated membrane Bioreactor for waste water treatment and reuse | 3 Years | 26,30,000.00 |
| 5. | Department of Science and Technology, New Delhi. | Establishment of Environmental Laboratory in the Department of Engineering under FIST Programme. | 5 Years | 40,00,000.00 |
| 6. | University Grants Commission, New Delhi. | Hydrothermal synthesis of Mesoporous Carbon for effective removal of textile dye. | 3 Years | 8,43,800.00 |
| 7. | University Grants Commission, New Delhi. | Synthesis of modified vinyl monomer grafted cellulose bearing functional containing donor atoms for the removal of heavy metals from industrial effluents. | 3 Years | 12,00,000.00 |

| | | | | |
|---|---|---|---|---|
| 8. | Department of Science & Technology, New Delhi. | investigation on the formation of Photochemical Ozone and it's with alkenes | 3 Years | 17,89,200.00 |
| 9. | Defence Research &Development Establishment | Development of membrane materials &membranes for gas & organic separation | 2 Years | 9,78,000.00 |
| 10. | Defence Research & Development Establishment | Studies on novel nano and ultra-filtration membranes for treatment | 4 Years | 7,81,800.00 |

Honors /Awards & Fellowships for Outstanding work

| S.No. | Name of Award or Fellowship | Awarded by | Year of Award |
|---|---|---|---|
| 1. | Mid-Career award | University Grants Commission (UGC) | 2017 |
| 2. | **Best Environmental Engineer** award | Indian Institute of Chemical Engineers | 2015 |
| 3. | **Tamil Nadu Scientists (TANSA 2013) Award in Environmental Science** | Government of Tamil Nadu | 2013 |
| 4. | **1st Rank in Co-ordinating with Iyarkai Mission 2012** | Government of Tamil Nadu | 2012 |
| 5. | Recipient of certificate of appreciation from American Chemical Society (ACS) for valuable contribution to ACS Journals. | Journal of the American Chemical Society | 2011 |
| 6. | Top Cited Papers for 2010 and 2011 Adsorption of dye from aqueous solution by cashew nut shell: Studies on equilibrium isotherm, kinetics and thermodynamics of interactions. | Desalination, Elsevier, Netherland | 2010 & 2011 |
| 7. | Nominated for International Educator of the year for 2008 | The International Biographical Center of Cambridge, England | 2008 |
| 8. | Ranked No 1. Top cited author 2004 & 2007 | The Colloid and Surface Science. Elsevier, Netherland | 2004 & 2007 |
| 9. | Ranked No 14. Top cited author 2007 | Process Biochemistry, Elsevier, Netherland | 2007 |

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| | | | |
|---|---|---|---|
| 10. | STA Award (Science and Technology Agency, Japan) | .Science and Technology Agency, Japan | 2000 |
| 11. | Marie Curie award | European Community | 1995 |

No. of Research Scholars successfully guided

| Name of Programs | Awarded (No.)<br>(Under-Progress not to be included) |
|---|---|
| Ph. D | 26(Completed)<br>06(Currently Registered) |
| M.S | 03(Completed) |

# Annexures

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# 13.0 - Annexure – 1
# ETP Raw Effluent Analysis Report

# CVR Labs (P) Limited

CIN NO: U 74140TN1999PTC043582

Dignity Centre, 2nd Floor, New No. 2/3, Old No. 21 Abdul Razack Street, Saidapet, Chennai - 600 015. Phone : +91 44 2433 0382 to 85

E-mail : info@cvrlabs.com | Web : www.cvrlabs.com


№ 22553

## TEST REPORT



Issued To :

Manali Petrochemicals Limited

Ponneri High Road, Manali, Chennai - 600 068.

SUBMITTED SAMPLE

Date of report : 01/03/2019
Received on : 23/02/2019
Commenced on : 25/02/2019
Completed on : 01/03/2019
Sample Description : Water

Report Number : 19020183.07
Sample Identification : HRT O/F P2(22.02.2019)

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 1 | BOD @20°C For 5 days | 5210 B APHA 23rd EDI: 2017 | mg/L | 307 |
| 2 | Calcium as Ca | 3500-Ca B APHA 23rd EDI: 2017 | mg/L | 14589.12 |
| 3 | Chloride as Cl | 4500-Cl B APHA 23rd EDI: 2017 | mg/L | 25592.06 |
| 4 | COD | 5220 B APHA 23rd EDI: 2017 | mg/L | 1512 |
| 5 | Fluoride as F | 4500 - F D APHA 23rd EDI: 2017 | mg/L | 0.78 |
| 6 | Hexavalent Chromium as Cr6+ | 3500-Cr B APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.01) |
| 7 | Oil & Grease | 5520 B APHA 23rd EDI: 2017 | mg/L | 8 |
| 8 | pH @ 25°C | 4500-$H^+$ B APHA 23rd EDI: 2017 | - | 11.29 |
| 9 | Phenolic compound (as C6H5OH) | 5530 C APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.1) |
| 10 | Phosphates as PO4 | 4500 - P D APHA 23rd EDI: 2017 | mg/L | 5.79 |
| 11 | Sulphate as SO4 | 4500-$SO_4^{2-}$ E APHA 23rd EDI: 2017 | mg/L | 309.8 |
| 12 | Sulphide as S | 4500-$S^{2-}$ F APHA 23rd EDI: 2017 | mg/L | 3.2 |
| 13 | Total Chromium as Cr | IS :3025-Part - 65(2014) | mg/L | 0.063 |
| 14 | Total Dissolved Solids @ 180° C | 2540 C APHA 23rd EDI: 2017 | mg/L | 44504 |
| 16 | Total Residual Chlorine | 4500 - Cl B APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.1) |
| 17 | Total suspended solids @ 105 ° C | 2540 D APHA 23rd EDI: 2017 | mg/L | 81 |

Verified By

***** END OF REPORT *****

For CVR LABS PVT. LTD.

Authorised Signatory

E.JANAKI
Asst. Quality Manager

Recognized / Approved by : NABL, FSSAI, BIS , Ministry of Environment & Forests , ISO 9001 : 2008 , OSHAS 18001

Terms and Conditions:

- The test results furnished relate only to the particular sample is submitted.
- The test results reflect to the sample tested on the above mentioned date and environments condition.
- The test report shall not be reproduced except in full without our written approval.
- The tested items will not be retained for more than 15 days from the date of issue of test report except in the case as required by the applicable regulations.

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# 13.1 - Annexure – 2
# ETP Treated Effluent Analysis Reports

ENVIRONMENTAL MONITORING • WATER TESTING • FOOD TESTING • IAQ • LDAR • INDUSTRIAL HYGIENE • MICRO BIOLOGY ANALYSIS • SOIL TESTING • OIL ANALYSIS


# CVR Labs (P) Limited

CIN NO: U 74140TN1999PTC043582

Dignity Centre, 2nd Floor, New No. 2/9, Old No. 21 Abdul Razack Street, Saidapet, Chennai - 600 015. Phone : +91 44 2433 0352 to 55

E-mail : info@cvrlabs.com | Web : www.cvrlabs.com


№ 22552

## TEST REPORT



Issued To

Manali Petrochemicals Limited

Ponneri High Road, Manali, Chennai - 600 068

SUBMITTED SAMPLE

Date of report : 01/03/2019

Received on : 23/02/2019

Commenced on : 25/02/2019

Completed on : 01/03/2019

Report Number : 19020183.05

Sample Identification : TES- P2 (22.02.2019)

Sample Description : Water

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 1 | BOD @20°C For 5 days | 5210 B APHA 23rd EDI: 2017 | mg/L | 49.9 |
| 2 | Calcium as Ca | 3500-Ca B APHA 23rd EDI: 2017 | mg/L | 14749.44 |
| 3 | Chloride as Cl | 4500-Cl B APHA 23rd EDI: 2017 | mg/L | 26791.69 |
| 4 | COD | 5220 B APHA 23rd EDI: 2017 | mg/L | 235.8 |
| 5 | Fluoride as F | 4500 - F⁻ D APHA 23rd EDI: 2017 | mg/L | 0.38 |
| 6 | Hexavalent Chromium as Cr6+ | 3500-Cr B APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.01) |
| 7 | Oil & Grease | 5520 B APHA 23rd EDI: 2017 | mg/L | 8 |
| 8 | pH @ 25°C | 4500-H⁺ B APHA 23rd EDI: 2017 | - | 6.32 |
| 9 | Phenolic compound (as C6H5OH) | 5530 C APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.1) |
| 10 | Phosphates as PO4 | 4500 - P D APHA 23rd EDI: 2017 | mg/L | 2.26 |
| 11 | Sulphate as SO4 | 4500-$SO_4^{2-}$ E APHA 23rd EDI: 2017 | mg/L | 205.63 |
| 12 | Sulphide as S | 4500-$S^{2-}$ F APHA 23rd EDI: 2017 | mg/L | BDL(DL:1.0) |
| 13 | Total Chromium as Cr | IS :3025-Part - 65(2014) | mg/L | 0.069 |
| 14 | Total Dissolved Solids @ 180° C | 2540 C APHA 23rd EDI: 2017 | mg/L | 43656 |
| 16 | Total Residual Chlorine | 4500 - Cl B APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.1) |
| 17 | Total suspended solids @ 105 ° C | 2540 D APHA 23rd EDI: 2017 | mg/L | 88 |

Verified By

For CVR LABS PVT. LTD.

Authorised Signatory

E.JANAKI

Asst. Quality Manager

***** END OF REPORT *****

Recognized / Approved by : NABL, FSSAI, BIS , Ministry of Environment & Forests , ISO 9001 : 2008 , OSHAS 18001

Terms and Conditions:

- The test results furnished relate only to the particular sample is submitted.
- The test results reflect to the sample tested on the above mentioned date and environments condition.
- The test report shall not be reproduced except in full without our written approval.
- The tested items will not be retained for more than 15 days from the date of issue of test report except in the case as required by the applicable regulations.

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# CVR Labs (P) Limited

CIN NO: U74140TN1999PTC043582

Dignity Centre, 2nd Floor, New No. 2/9, Old No. 21 Abdul Razack Street, Saidapet, Chennai - 600 015. Phone : +91 44 2433 0382 to 85

Email : info@cvrlabs.com | Web : www.cvrlabs.com


№ 22551

## TEST REPORT



Issued To :

Manali Petrochemicals Limited

Ponneri High Road, Manali, Chennai - 600 068

SUBMITTED SAMPLE

Date of report : 04/03/2019

Received on : 23/02/2019

Commenced on : 25/02/2019

Completed on : 04/03/2019

Report Number : 19020191.02

Sample Identification : TFT - P2(25.02.2019)

Sample Description : Water

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 1 | BOD @20°C For 5 days | 5210 B APHA 23rd EDI: 2017 | mg/L | 42.24 |
| 2 | Calcium as Ca | 3500-Ca B APHA 23rd EDI: 2017 | mg/L | 13948 |
| 3 | Chloride as Cl | 4500-Cl B APHA 23rd EDI: 2017 | mg/L | 26392 |
| 4 | COD | 5220 B APHA 23rd EDI: 2017 | mg/L | 221.76 |
| 5 | Fluoride as F | 4500 - F⁻ D APHA 23rd EDI: 2017 | mg/L | 0.53 |
| 6 | Hexavalent Chromium as Cr6+ | 3500-Cr B APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.01) |
| 7 | Oil & Grease | 5520 B APHA 23rd EDI: 2017 | mg/L | 5 |
| 8 | pH @ 25°C | 4500-H⁺B APHA 23rd EDI: 2017 | - | 6.34 |
| 9 | Phenolic compound (as C6H5OH) | 5530 C APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.1) |
| 10 | Phosphates as PO4 | 4500 - P D APHA 23rd EDI: 2017 | mg/L | 2.23 |
| 11 | Sulphate as SO4 | 4500-$SO_4^{2-}$ E APHA 23rd EDI: 2017 | mg/L | 235 |
| 12 | Sulphide as S | 4500-$S^{2-}$ F APHA 23rd EDI: 2017 | mg/L | BDL(DL:1.0) |
| 13 | Total Chromium as Cr | IS :3025-Part - 65(2014) | mg/L | 0.055 |
| 14 | Total Dissolved Solids @ 180° C | 2540 C APHA 23rd EDI: 2017 | mg/L | 46345 |
| 16 | Total Residual Chlorine | 4500 - Cl B APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.1) |
| 17 | Total suspended solids @ 105 ° C | 2540 D APHA 23rd EDI: 2017 | mg/L | 76 |

Verified By

For CVR LABS PVT. LTD.

Authorised Signatory

E.JANAKI
Asst. Quality Manager

***** END OF REPORT *****

Recognized / Approved by : NABL, FSSAI, BIS , Ministry of Environment & Forests , ISO 9001 : 2008 , OSHAS 18001

Terms and Conditions:

- The test results furnished relate only to the particular sample is submited.
- The test results reflect to the sample tested on the above mentioned date and environments condition.
- The test report shall not be reproduced except in full without our written approval.
- The tested items will not be retained for more than 15 days from the date of issue of test report except in the case as required by the applicable regulations.

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# CVR Labs (P) Limited

CIN NO: U 74140TN1999PTC043582

Dignity Centre, 2nd Floor, New No. 2/6, Old No. 21 Abdul Razack Street,
Sastapet, Chennai - 600 015. Phone : +91 44 2433 0352 to 55
E-mail : info@cvrlabs.com | Web : www.cvrlabs.com


№ 22550



## TEST REPORT

Issued To

Manali Petrochemicals Limited

Ponneri High Road, Manali, Chennai - 600 068

SUBMITTED SAMPLE

Date of report : 04/03/2019
Received on : 28/02/2019
Commenced on : 28/02/2019
Completed on : 04/03/2019

Report Number : 19020207.01
Sample Identification : TES- P2(26.02.2019)
Sample Description : Water

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 1 | BOD @20°C For 5 days | 5210 B APHA 23rd EDI: 2017 | mg/L | 36 |
| 2 | Calcium as Ca | 3500-Ca B APHA 23rd EDI: 2017 | mg/L | 13948 |
| 3 | Chloride as Cl | 4500-ClB APHA 23rd EDI: 2017 | mg/L | 25192.2 |
| 4 | COD | 5220 B APHA 23rd EDI: 2017 | mg/L | 230 |
| 5 | Fluoride as F | 4500 - F D APHA 23rd EDI: 2017 | mg/L | 0.36 |
| 6 | Hexavalent Chromium as Cr6+ | 3500-Cr B APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.01) |
| 7 | Oil & Grease | 5520 B APHA 23rd EDI: 2017 | mg/L | 8 |
| 8 | pH @ 25°C | 4500-$H^+$B APHA 23rd EDI: 2017 | - | 6.64 |
| 9 | Phenolic compound (as C6H5OH) | 5530 C APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.1) |
| 10 | Phosphates as PO4 | 4500 - P D APHA 23rd EDI: 2017 | mg/L | 4.5 |
| 11 | Sulphate as SO4 | 4500-$SO_4^{2-}$ E APHA 23rd EDI: 2017 | mg/L | 275.5 |
| 12 | Sulphide as S | 4500-$S^{2-}$ F APHA 23rd EDI: 2017 | mg/L | BDL (DL:1.0) |
| 13 | Total Chromium as Cr | IS :3025-Part - 65(2014) | mg/L | 0.031 |
| 14 | Total Dissolved Solids @ 180° C | 2540 C APHA 23rd EDI: 2017 | mg/L | 45056 |
| 16 | Total Residual Chlorine | 4500 - Cl B APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.1) |
| 17 | Total suspended solids @ 105 ° C | 2540 D APHA 23rd EDI: 2017 | mg/L | 92 |

Verified By

For CVR LABS PVT. LTD.

Authorised Signatory

E.JANAKI
Asst. Quality Manager

***** END OF REPORT *****

Recognized / Approved by : NABL, FSSAI, BIS , Ministry of Environment & Forests , ISO 9001 : 2008 , OSHAS 18001

**Terms and Conditions:**

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E mail : info@cvrlabs.com | Web : www.cvrlabs.com


№ 22549

## TEST REPORT



Issued To

SUBMITTED SAMPLE

Manali Petrochemicals Limited

Ponneri High Road, Manali, Chennai - 600 068

Date of report : 04/03/2019
Received on : 28/02/2019
Commenced on : 28/02/2019
Completed on : 04/03/2019

Report Number : 19020207.02

Sample Identification : TES- P2 (27.02.2019)

Sample Description : Water

| S No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 1 | BOD @20°C For 5 days | 5210 B APHA 23rd EDI: 2017 | mg/L | 34 |
| 2 | Calcium as Ca | 3500-Ca B APHA 23rd EDI: 2017 | mg/L | 14589.12 |
| 3 | Chloride as Cl | 4500-Cl B APHA 23rd EDI: 2017 | mg/L | 26992 |
| 4 | COD | 5220 B APHA 23rd EDI: 2017 | mg/L | 190 |
| 5 | Fluoride as F | 4500 - F⁻ D APHA 23rd EDI: 2017 | mg/L | 2.58 |
| 6 | Hexavalent Chromium as Cr6+ | 3500-Cr B APHA 23rd EDI: 2017 | mg/l | BDL(DL:0.01) |
| 7 | Oil & Grease | 5520 B APHA 23rd EDI: 2017 | mg/L | 4 |
| 8 | pH @ 25°C | 4500-H⁺ B APHA 23rd EDI: 2017 | - | 6.70 |
| 9 | Phenolic compound (as C6H5OH) | 5530 C APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.1) |
| 10 | Phosphates as PO4 | 4500 - P D APHA 23rd EDI: 2017 | mg/L | 3.03 |
| 11 | Sulphate as SO4 | 4500-$SO_4^{-2}$ E APHA 23rd EDI: 2017 | mg/L | 329 |
| 12 | Sulphide as S | 4500-$S^{-2}$ F APHA 23rd EDI: 2017 | mg/L | BDL(DL:1.0) |
| 13 | Total Chromium as Cr | IS :3025-Part - 65(2014) | mg/L | 0.035 |
| 14 | Total Dissolved Solids @ 180° C | 2540 C APHA 23rd EDI: 2017 | mg/L | 46452 |
| 16 | Total Residual Chlorine | 4500 - Cl B APHA 23rd EDI: 2017 | mg/l | BDL(DL:0.1) |
| 17 | Total suspended solids @ 105 ° C | 2540 D APHA 23rd EDI: 2017 | mg/L | 76 |

Verified By

For CVR LABS PVT. LTD.

Authorised Signatory

E.JANAKI
Asst. Quality Manager

***** END OF REPORT *****

Recognized / Approved by : NABL, FSSAI, BIS , Ministry of Environment & Forests . ISO 9001 : 2008 , OSHAS 18001

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№ 22548

## TEST REPORT



Issued To

SUBMITTED SAMPLE

Manali Petrochemicals Limited

Pioneer High Road, Manali, Chennai - 600 068

Date of report : 04/03/2019

Received on : 28/02/2019

Commenced on : 28/02/2019

Completed on : 04/03/2019

Report Number : 19020207.03

Sample Identification : TES- P2(28.02.2019)

Sample Description : Water

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 1 | BOD @27°C For 3 days | 5210 B APHA 23rd EDI: 2017 | mg/L | 32 |
| 2 | Calcium as Ca | 3500-Ca B APHA 23rd EDI: 2017 | mg/L | 14429 |
| 3 | Chloride as Cl | 4500-Cl B APHA 23rd EDI: 2017 | mg/L | 26792 |
| 4 | COD | 5220 B APHA 23rd EDI: 2017 | mg/L | 217.7 |
| 5 | Fluoride as F | 4500 - F D APHA 23rd EDI: 2017 | mg/L | 0.48 |
| 6 | Hexavalent Chromium as Cr6+ | 3500-Cr B APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.01) |
| 7 | Oil & Grease | 5520 B APHA 23rd EDI: 2017 | mg/L | 6.2 |
| 8 | pH @ 25°C | 4500-$H^+$ B APHA 23rd EDI: 2017 | - | 6.75 |
| 9 | Phenolic compound (as $C_6H_5OH$) | 5530 C APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.1) |
| 10 | Phosphates as PO4 | 4500 - P D APHA 23rd EDI: 2017 | mg/L | 7.29 |
| 11 | Sulphate as SO4 | 4500-$SO_4^{2-}$ E APHA 23rd EDI: 2017 | mg/L | 329 |
| 12 | Sulphide as S | 4500-$S^{2-}$ F APHA 23rd EDI: 2017 | mg/L | BDL(DL:1.0) |
| 13 | Total Chromium as Cr | IS :3025-Part - 65(2014) | mg/L | 0.035 |
| 14 | Total Dissolved Solids @ 180° C | 2540 C APHA 23rd EDI: 2017 | mg/L | 44556 |
| 16 | Total Residual Chlorine | 4500 - Cl B APHA 23rd EDI: 2017 | mg/L | BDL(DL:0.1) |
| 17 | Total suspended solids @ 105 ° C | 2540 D APHA 23rd EDI: 2017 | mg/L | 80 |

Verified By

For CVR LABS PVT. LTD.

Authorised Signatory

E.JANAKI

Asst. Quality Manager

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# 13.2 -Annexure – 3
# ETP Bio Treatment Process Flow Diagram

# 13.3- Annexure – 4
# ETP Sludge Analysis Report

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No.20955

## TEST REPORT

Issued To :

Manali Petrochemicals Limited
Ponneri High Road, Manali, Chennai - 600 068.

Date of report : 18/12/2018
Received on : 06/12/2018
Commenced on : 07/12/2018
Completed on : 18/12/2018

Report Number : 18120021.01

Sample Description : Secondary Clarifier Filter Press Sludge Sample

| S No | Parameters | Protocol | Unit | Result | As Per EPA Chapter-7 | |
|---|---|---|---|---|---|---|
| | | | | | Min | Max |
| 1 | 1,1 -Dichloroethylene | EPA 1311/EPA 8240B | mg/L | BDL (DL:0.1) | - | 0.7 mg/L |
| 2 | 1,2 Dichloroethane | EPA 1311/EPA 8240B | mg/L | BDL (DL:0.1) | - | 0.5 mg/L |
| 3 | 1,4 Dichlorobenzene | EPA 1311/EPA 8240B | mg/L | BDL (DL:0.1) | - | 7.5 mg/L |
| 4 | 2,4 D | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 10.0 mg/L |
| 5 | 2,4 Dinitro Tolune | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 0.13 mg/L |
| 6 | 2,4,5 TP (SILVEX) | EPA 1311/EPA 8150B | mg/L | BDL (DL:0.1) | - | 1.0 mg/L |
| 7 | 2,4,5 Trichlorophenol | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 400 mg/L |
| 8 | 2,4,6 Trichlorophenol | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 2.0 mg/L |
| 9 | Arsenic as As | EPA 1311 /EPA 200.8 | mg/L | BDL (DL:0.01) | - | 5.0 mg/L |
| 10 | Barium as Ba | EPA 1311 /EPA 200.8 | mg/L | 0.038 | - | 100 mg/L |
| 11 | Benzene | EPA 1311/EPA 8240B | mg/L | BDL (DL:0.01) | - | 0.5 mg/L |
| 12 | Cadmium as Cd | EPA 1311/EPA 200.8 | mg/L | BDL (DL:0.01) | - | 1.0 mg/L |

Verified By

For CVR Labs (P) Limited

Authorised Signatory
K. Karthikeyan
Manger - Food

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No.20954

## TEST REPORT

19120021.01

| S.No | Parameters | Protocol | Unit | Result | As Per EPA Chapter-7 | |
|---|---|---|---|---|---|---|
| | | | | | Min | Max |
| 13 | Carbon tetra chloride | EPA 1311/EPA 8240B | mg/L | BDL (DL:0.01) | - | 0.5 mg/L |
| 14 | Chlordane | EPA 1311/EPA 8080B | mg/L | BDL (DL:0.01) | - | 0.03 mg/L |
| 15 | Chlorobenzene | EPA 1311/EPA 8240B | mg/L | BDL (DL:0.01) | - | 100.0 mg/L |
| 16 | Chloroform | EPA 1311/EPA 8240B | mg/L | BDL (DL:0.01) | - | 6.0 mg/L |
| 17 | Chromium as Cr | EPA 1311/EPA 200.8 | mg/L | BDL (DL:0.01) | - | 5.0 mg/L |
| 18 | Endrin | EPA 1311/EPA 8080A | mg/L | BDL (DL:0.01) | - | 0.02 mg/L |
| 19 | Heptachlor (and its hydroxide) | EPA 1311/EPA 8080A | mg/L | BDL (DL:0.002) | - | 0.008 mg/L |
| 20 | Hexa chloro benzene | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 0.13 mg/L |
| 21 | Hexa chloro butadiene | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 3.0 mg/L |
| 22 | Hexa chloro ethane | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 0.5 mg/L |
| 23 | Lead as Pb | EPA 1311BY ICP-MS | mg/L | BDL (DL:0.01) | - | 5.0 mg/L |
| 24 | Lindane | EPA 1311/EPA 8080A | mg/L | BDL (DL:0.1) | - | 0.4 mg/L |
| 25 | m-Cresol | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 200 mg/L |
| 26 | Mercury as Hg | EPA 1311/EPA 200.8 | mg/L | BDL (DL:0.01) | - | 0.2 mg/L |
| 27 | Methoxychlor | EPA 1311/EPA 8080D | mg/L | BDL (DL:0.1) | - | 10 mg/L |
| 28 | Nitro Benzene | EPA 1311/EPA 8240D | mg/L | BDL (DL:0.1) | - | 2.0 mg/L |
| 29 | o-Cresol | EPA 1311/EPA 8240D | mg/L | BDL (DL:0.1) | - | 200 mg/L |

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For CVR Labs (P) Limited

Authorised Signatory

K. Karthikeyan

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No.20953

## TEST REPORT

18120021.01

| S.No | Parameters | Protocol | Unit | Result | As Per EPA Chapter-7 | |
|---|---|---|---|---|---|---|
| | | | | | Min | Max |
| 30 | p-Cresol | EPA 1311/EPA 8240D | mg/L | BDL (DL:0.1) | - | 200 mg/L |
| 31 | Pentachloro phenol | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 100 mg/L |
| 32 | Pyridine | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 5.0 mg/L |
| 33 | Selenium as Se | EPA 1311/EPA 200.8 | mg/L | BDL (DL:0.01) | - | 1.0 mg/L |
| 34 | Silver as Ag | EPA 1311/EPA 200.8 | mg/L | BDL (DL:0.01) | - | 5.0 mg/L |
| 35 | Tetrachloroethene | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 0.7 mg/L |
| 36 | Total Cresol | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 200 mg/L |
| 37 | Toxaphene | EPA 1311/EPA 8080A | mg/L | BDL (DL:0.1) | - | 0.5 mg/L |
| 38 | Trichloro ethylene | EPA 1311/EPA 8270D | mg/L | BDL (DL:0.1) | - | 0.5 mg/L |
| 39 | Vinyl Chloride | EPA 1311/EPA 8240D | mg/l | BDL (DL:0.1) | - | 0.2 mg/L |
| 40 | Methyl Ethyl Ketone | EPA 1311/EPA 8240D | mg/L | BDL (DL:0.1) | - | 200 mg/L |

Remarks : Toxicity Parameter analyzed in TCLP extract, TCLP extracted as per EPA 1311.

The above sample Complies as per EPA Chapter 7 for Toxicity Characteristic.

BDL: Below Detection Limit; DL Detection Limit

For CVR Labs (P) Limited

Verified By

Authorised Signatory
K. Karthikeyan
Manager - Food

***** END OF REPORT *****

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# 13.4 -Annexure – 5
# Lime Sludge Analysis Report

520

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# CVR Labs (P) Limited

003532

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## TEST REPORT

Issued To :

Manali Petrochemicals Limited
Ponneri High Road, Manali, Chennai - 600 068.

Date of report : 26/03/2018
Received on : 09/03/2018
Commenced on : 10/03/2018
Completed on : 26/03/2018

Report Number : 18030097.02

Sample Description : Sludge from PO plant waste water prior to waste water treatment plant MPL Plant-II

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 1 | 1,1 -Dichloroethylene | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.1) |
| 2 | 1,2 Dichloroethane | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.1) |
| 3 | 1,4 Dichlorobenzene | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.1) |
| 4 | 2,4 D | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 5 | 2,4 Dinitro Tolune | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 6 | 2,4,5 TP (SILVEX) | EPA 1311/EPA 8150B | mg/L | BDL(DL:0.1) |
| 7 | 2,4,5 Trichlorophenol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 8 | 2,4,6 Trichlorophenol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 9 | Arsenic as As | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 10 | Barium as Ba | EPA 1311/EPA 200.8 | mg/L | 0.14 |
| 11 | Benzene | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.01) |
| 12 | Cadmium as Cd | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |

For CVR Labs (P) Limited

Verified By

Authorised Signatory
K. Karthikeyan
Manger - Food

Recognized / Approved by : NABL, BIS , Ministry of Environment & Forests , ISO 9001 : 2008 , OSHAS 18001 : 2007

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003533

## TEST REPORT

18030097.02

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 13 | Carbon tetra chloride | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.01) |
| 14 | Chlordane | EPA 1311/EPA 8080B | mg/L | BDL(DL:0.1) |
| 15 | Chlorobenzene | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.01) |
| 16 | Chloroform | EPA 1311/EPA 8240B | mg/L | BDL(DL:0.01) |
| 17 | Chromium as Cr | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 18 | Endrin | EPA 1311/EPA 8080A | mg/L | BDL(DL:0.01) |
| 19 | Heptachlor (and its hydroxide) | EPA 1311/EPA 8080A | mg/L | BDL(DL:0.002) |
| 20 | Hexa chloro benzene | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 21 | Hexa chloro butadiene | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 22 | Hexa chloro ethane | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 23 | Lead as Pb | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 24 | Lindane | EPA 1311/EPA 8080A | mg/L | BDL(DL:0.1) |
| 25 | m-Cresol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 26 | Mercury as Hg | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 27 | Methoxychlor | EPA 1311/EPA 8080D | mg/L | BDL(DL:0.1) |
| 28 | Nitro Benzene | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |
| 29 | o-Cresol | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |

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For CVR Labs (P) Limited

Authorised Signatory

K. Karthikeyan
Manger - Food

Recognized / Approved by : NABL, BIS , Ministry of Environment & Forests , ISO 9001 : 2008 , OSHAS 18001 : 2007

Terms and Conditions:

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E-mail : info@cvrlabs.com | Web : www.cvrlabs.com


003534

## TEST REPORT

18030097.02

| S.No | Parameters | Protocol | Unit | Result |
|---|---|---|---|---|
| 30 | o-Cresol | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |
| 31 | Pentachloro phenol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 32 | Pyridine | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 33 | Selenium as Se | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 34 | Silver as Ag | EPA 1311/EPA 200.8 | mg/L | BDL(DL:0.1) |
| 35 | Tetrachloroethene | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 36 | Total Cresol | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 37 | Toxaphene | EPA 1311/EPA 8080A | mg/L | BDL(DL:0.1) |
| 38 | Trichloro ethylene | EPA 1311/EPA 8270D | mg/L | BDL(DL:0.1) |
| 39 | Vinyl Chloride | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |
| 40 | ZZDNU Methyl Ethyl Ketone | EPA 1311/EPA 8240D | mg/L | BDL(DL:0.1) |

BDL: Below Detection Limit; DL Detection Limit

***** END OF REPORT *****

For CVR Labs (P) Limited

Verified By

Authorised Signatory
K. Karthikeyan
Manger - Food

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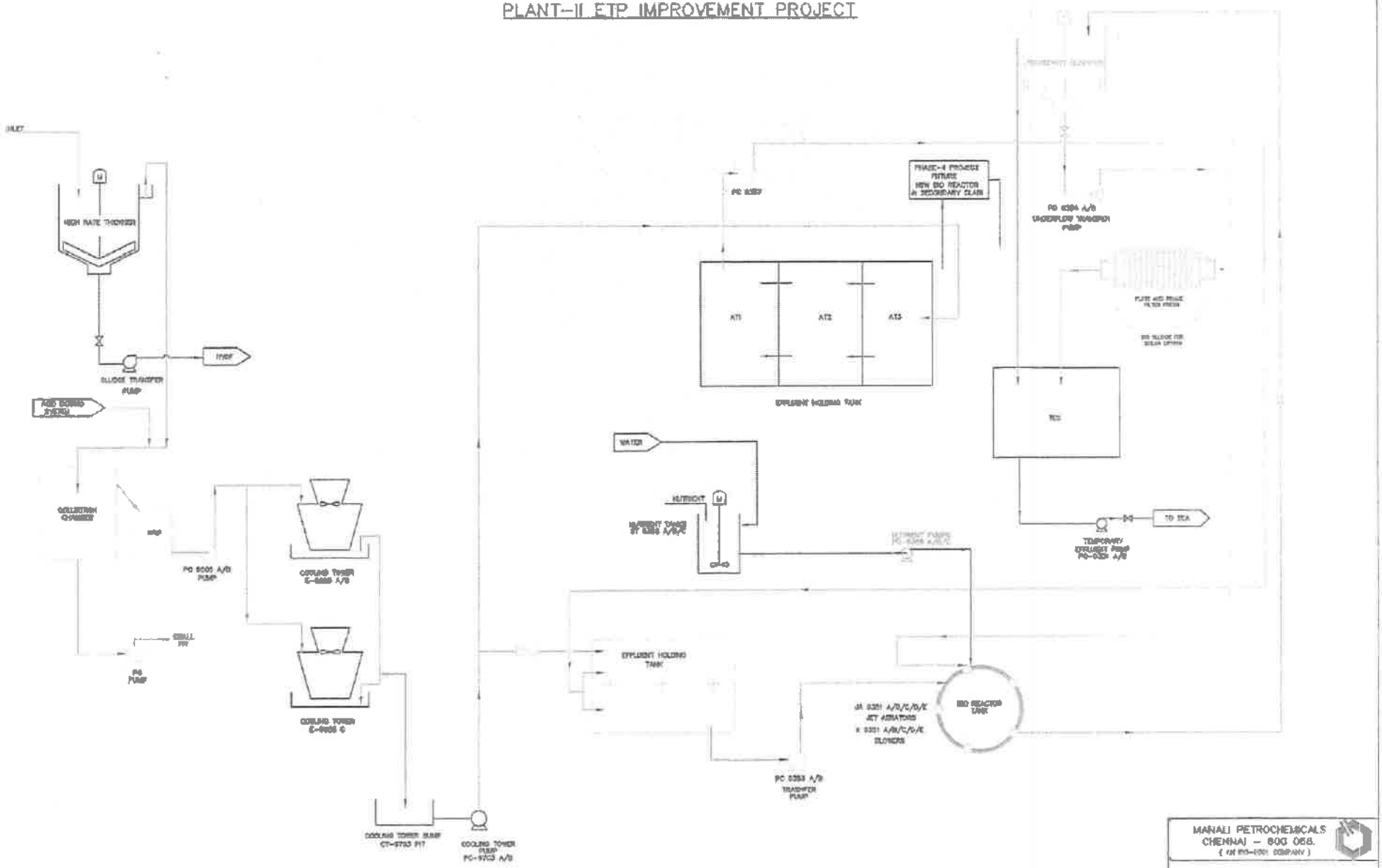
Terms and Conditions:

# PLANT–II ETP IMPROVEMENT PROJECT




| REV | DATE | DESCRIPTION | DRN | CHD | APD |
|---|---|---|---|---|---|
| 5 | 06-11-2017 | PLATE AND FRAME FILTER PRESS ADDED | AHK | DCP | KCC |
| 3 | 20-11-2017 | SCOPE DEFINED FOR DAN | DCP | DCP | KCC |
| 4 | 13-11-2017 | BASED ON CHLORINATION NEW P& ID ISSUED | AHK | KJR | KCK |
| 3 | 29-09-2017 | PRELIMINARY SKETCH TILL REV 03 | KJR | KJR | KBR |

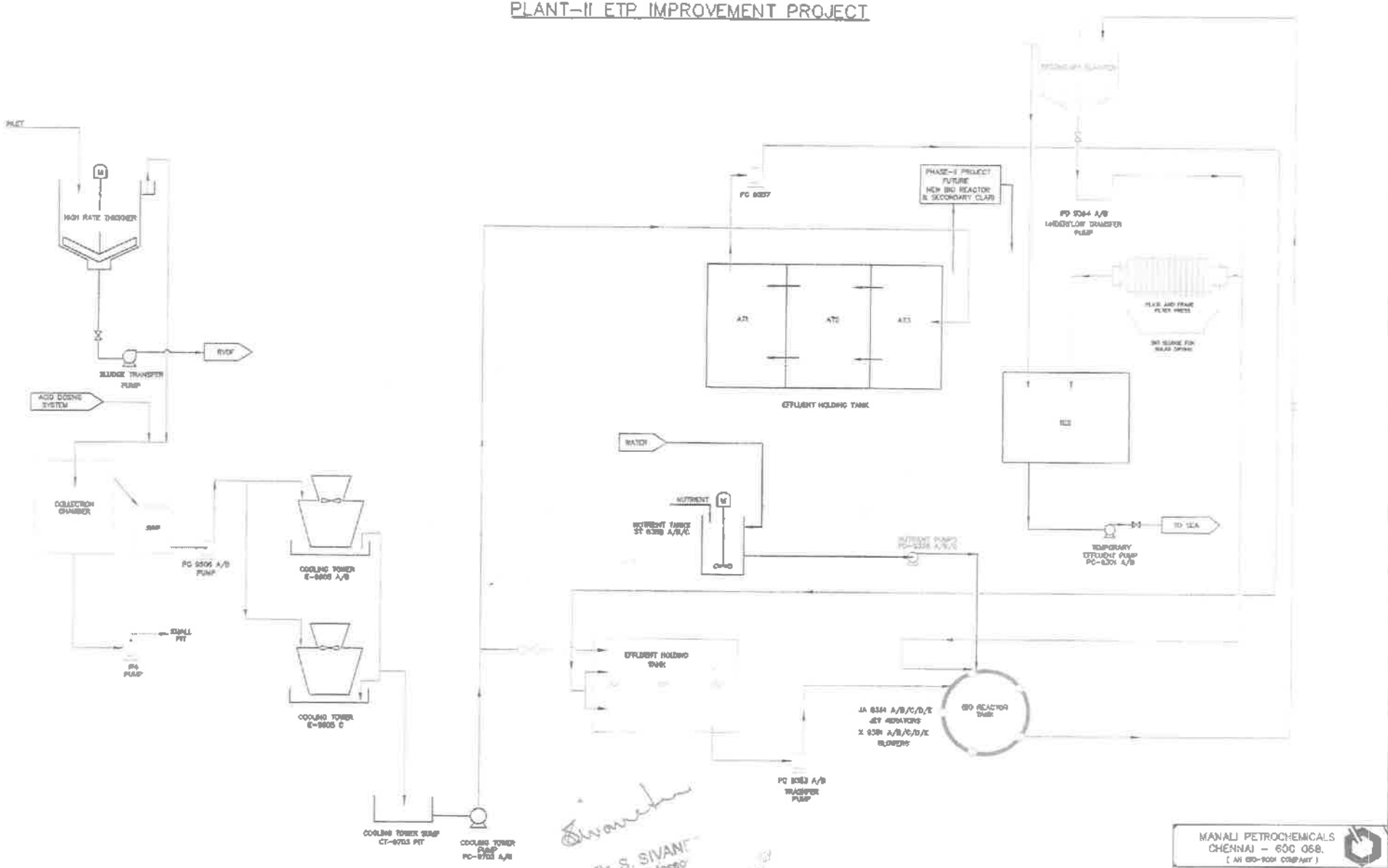
MANALI PETROCHEMICALS
CHENNAI – 600 068.
( AN EID–PARRY COMPANY )

PLANT–II
PROCESS FLOW DIAGRAM FOR EFFLUENT TREATMENT PLANT

| SCALE | DRAWING NO. | REV |
|---|---|---|
| NTS | MPL/PL-II/ETP/PFD-001 | 5 |

CAD FILE NAME:\DRAWINGS\ETP-II\PDF\MAPS\ETP-II PFD.DWG

# PLANT–II ETP IMPROVEMENT PROJECT




| REV | DATE | DESCRIPTION | DRN | CHD | APD |
|---|---|---|---|---|---|
| B | 05-11-2017 | PLATE AND FRAME FILTER PRESS ADDED | PPK | SKB | RMP |
| A | 20-10-2017 | SLUDGE METHOD FOR SALE | SKB | SKB | PSS |
| 3 | 17-11-2017 | BASED ON CHLORINATION REV 33 SOFAC | AVK | KJB | RSS |
| 2 | 29-08-2017 | PRELIMINARY SKETCH TILL REV 02 | KJB | KJB | RSS |

MANALI PETROCHEMICALS CHENNAI – 600 068.
( AN IOL-BCCL COMPANY )

PLANT–II
PROCESS FLOW DIAGRAM FOR EFFLUENT TREATMENT PLANT

| SCALE | DRAWING NO. | REV |
|---|---|---|
| NTS | MPL/PL-II/ETP/PFD-001 | B |

Dr. S. SIVANESAN
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5.24

**BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL**
**(SOUTHERN ZONE) CHENNAI.**

**O.A.No.19 of 2013,**
**O.A.No.248 of 2016 and**
**O.A.No.224 of 2016**

Meenavargal Mempattu Sangam

..Applicant

-Vs-

The Chief Secretary,
Government of Tamil Nadu,
Chennai and others

..Respondents

**LIST OF ANNEXURES FILED BY RESPONDENTS 5 (In O.A. No. 19/2013) AND 7 (In O.A. No. 248/2016) - VOLUME I**

**M/S. AL. GANTHIMATHI**
**COUNSEL FOR RESPONDENT**