

**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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2.	Anna University - Performance report on ETP of MPL- Unit-2	11B	588
3.	NGT appointed Joint Committee Report dt. 28-10-2020 (Final)	12A	646
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5.	PO Alternate Technology Proposal	13	725
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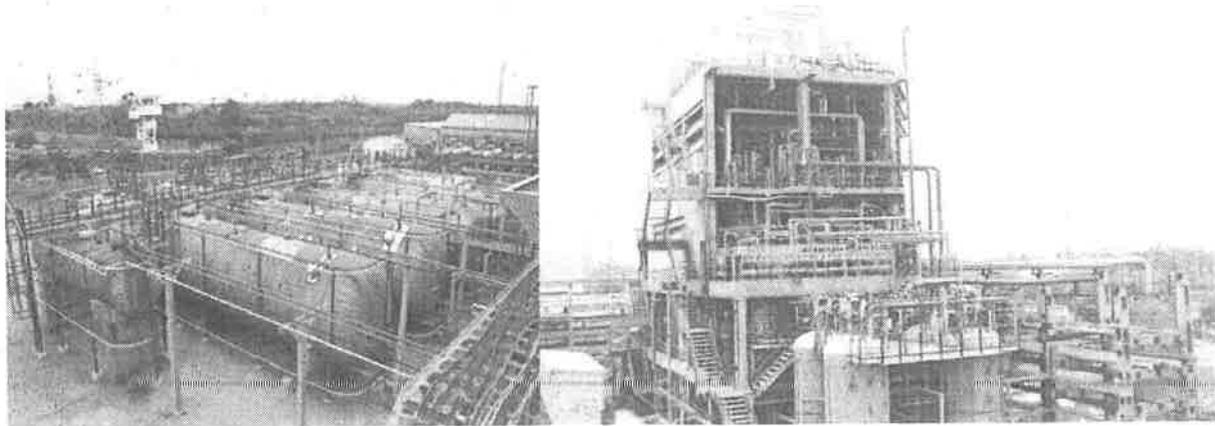
Dated at Chennai on this the 17th day of July, 2021.

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

M. Cel.

COUNSEL FOR RESPONDENTS

**PERFORMANCE EVALUATION OF
M/s. MANALI PETROCHEMICALS LIMITED (MPL)
EFFLUENT TREATMENT PLANT-I
MANALI CHENNAI**



Prepared by



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JUNE 2020**

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LIST OF SYMBOLS AND ABBREVIATIONS

BOD	-	Biological Oxygen Demand
CPCB	-	Central Pollution Control Board
CF	-	Cost function
°C	-	Degree Celsius
CPCL	-	Chennai Petroleum Corporation Ltd
ETP	-	Effluent Treatment Plant
HRT	-	High Rate Thickener
MLR	-	Multiple Linear Regression
MLSS	-	Mixed Liquor Suspended Solids
MPL	-	Manali Petrochemicals Limited
m/s	-	Meter per second
O&M	-	Operation and Maintenance
PG	-	Propylene Glycol
PO	-	Propylene Oxide
PPM	-	Parts per million
SCO	-	Secondary Clarifier Overflow
SCU	-	Secondary Clarifier Underflow
SPIC	-	Southern Petrochemical Industries Corporation
TNPCB	-	Tamil Nadu Pollution Control Board
TDS	-	Total Dissolved Solids
TSS	-	Total Suspended Solids
µg/m ³	-	Microgram per meter cube
RVDF	-	Rotary Vacuum Drum Filter

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530

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

Manali Petrochemicals Limited (MPL) operates two production plants at Manali near Chennai to manufacture Propylene Oxide (PO), Propylene Glycol (PG), PGMME and various grades of Polyol formulations. MPL was promoted by Southern Petrochemical Industries Corporation (SPIC) and incorporated in 1987. The Plant-I 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, France and the detailed engineering executed by Engineers India Ltd (EIL). The Polyol technology was provided BY ARCO, USA through Technip. Major supplier of the raw material is Chennai Petroleum Corporation Ltd (CPCL).

Manali Petrochemical Limited (MPL) Plant – I is located on the Ponneri High Road, Manali Industrial belt, Chennai (adjacent to Chennai Petroleum Corporation Ltd- CPCL) and is capable of manufacturing 18,000 MT of Propylene oxide (PO), 10,000 MT of Propylene Glycol (PG) and 25,000 MT of Polyol, 2,700MT of Propylene Glycol Mono Methyl Ether (PGMME). PO is an intermediate product produced and is utilized for conversion into PG ,PGMME and Polyol. PG is widely used for Pharmaceutical formulations, in Food Flavor and Fragrance industries and in the manufacture of unsaturated polyester Resins. Polyols are 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.

The unit has renewed the consent orders and it's valid till 31st March 2020. The company has applied for renewal of Consent and renewal is applied and the renewal is in progress for the year 2020-2021.

1.2. NEED FOR STUDY

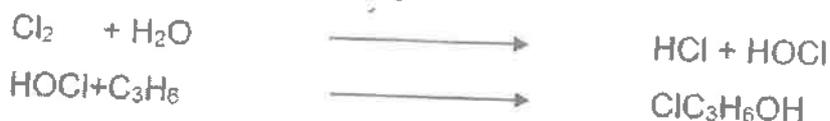
To monitor the performance evaluation of Manali Petrochemicals Limited (MPL) Effluent Treatment Plant-I.

CHAPTER 2

MANUFACTURING PROCESS DESCRIPTION

2.1 PROPYLENE OXIDE MANUFACTURING UNIT

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 chlorohydrins according to the following reaction.



The solution is then saponified with milk of lime to generate Propylene oxide



The vapor propylene oxide is stripped with steam and distilled to get the final product. The final product is sent to propylene oxide storage.

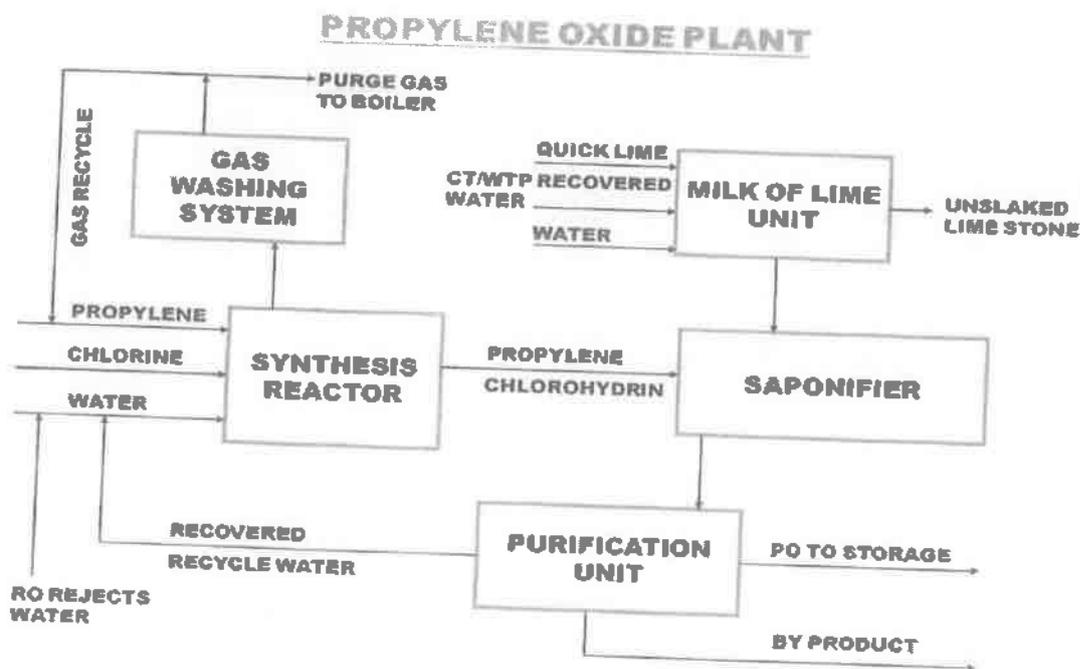


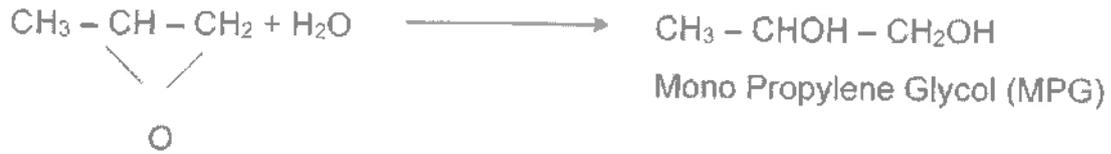
Fig 2.1 Process of Propylene Oxide plant

The Major equipments in the Propylene Oxide plant:-

- Propylene vaporizer
- Reactor
- Recycle gas system
- Recycle gas washing column
- Saponifier
- PO-Distillation column
- Vent gas washing column
- PO- Stripper
- Chlorine tonners/ vaporizer section
- DCP decanter
- PO-off spec storage
- PO- Reflux drum
- Waste heat recovery system
- Purge gas recovery to boiler

2.2 PROPYLENE GLYCOL MANUFACTURING UNIT

The Raw material for Propylene Glycol is Propylene oxide and Water. Propylene oxide from the storage is mixed with process water & DM water and sent to PG reactor. Mixture of glycols are formed inside the reactor as per following reactions.



The reaction products are concentrated in triple effect evaporator and distilled in two stages to separate Mono Propylene Glycol, Di-Propylene Glycol and Tri-Propylene Glycol. The products formed are checked for quality before being transferred to the respective storage.

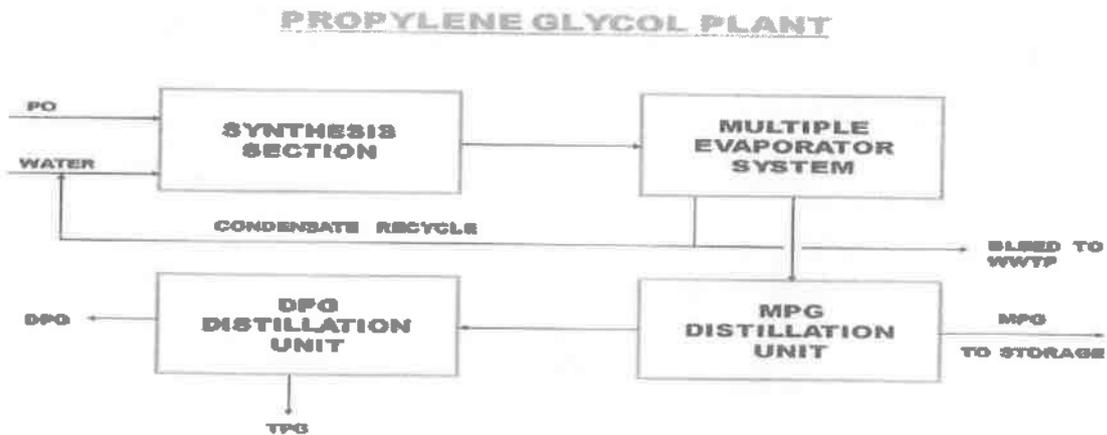


Fig 2.2 Process of Propylene Glycol plant

The Main equipments in the Propylene Glycol plant:-

- PO- Buffer storage drum
- Process water drum
- Reactor feed Pre Heaters
- Tubular Reactor
- Multiple effect evaporator.
- MPG distillation column
- Off spec storage drum
- DPG distillation column
- MPG storage
- DPG storage
- TPG storage
- Vacuum package system for 3 rd effect evaporator
- Vacuum package for MPG/DPG distillation section
- Condensate recovery drum

2.3 POLYETHER POLYOLS MANUFACTURING UNIT

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 Polyol

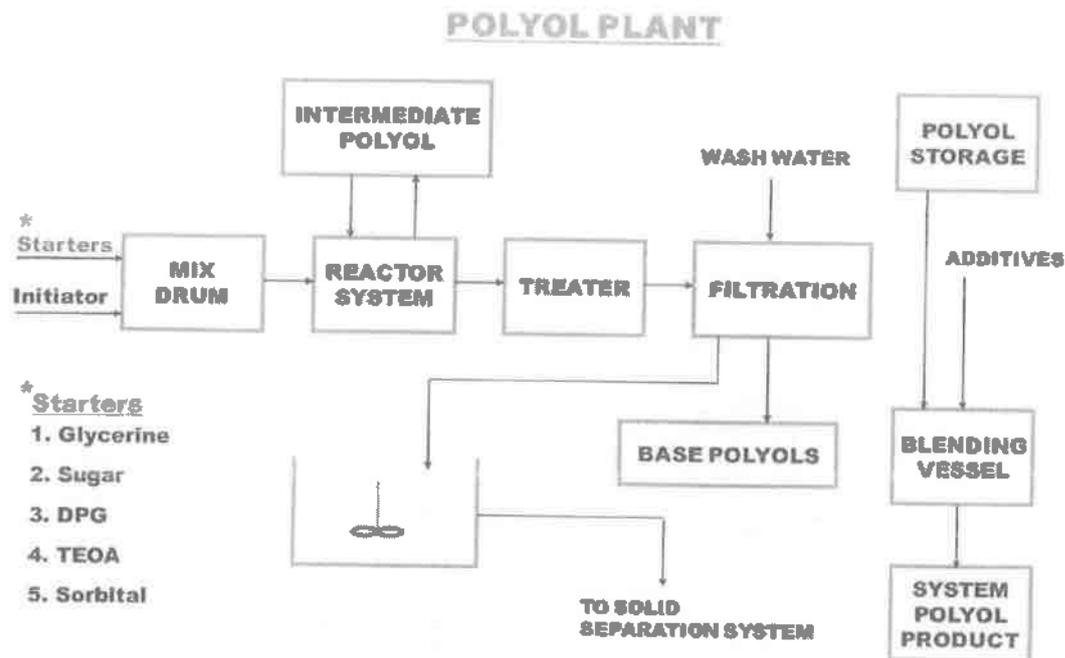


Fig 2.3 Process of Polyol plant

The Main equipments in the Polyol plant:-

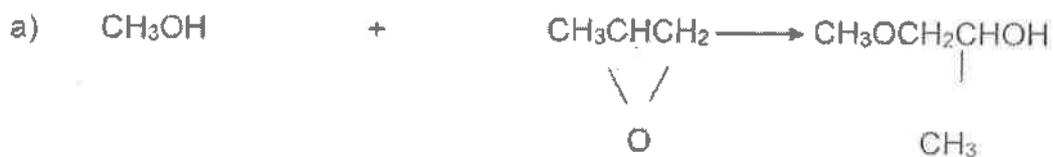
- Mix drum
- Pre Polymer storage drum
- Reactor
- Tempered water control system

- Vacuum package system
- Treator
- Filter
- Day drum
- Blend drum
- Polyol storage tanks
- Scrubber system

2.4 PROPYLENE GLYCOL MONOMETHYL ETHER MANUFACTURING UNIT

PGMME is produced by the reaction of Propylene Oxide and Methanol.

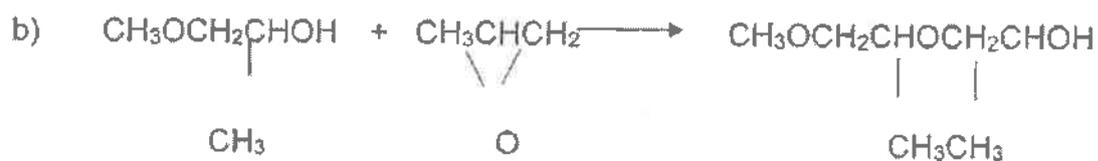
The main reaction involved are



Methanol

Propylene Oxide

Propylene Glycol
Mono methyl ether



Propylene
Glycol

+

Propylene Oxide

=

Di Propylene Glycol

Mono Methyl Ether

Mono Methyl Ether

The ratio of MPMME, DPMME, TPMME 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.

The Main equipments in the PGMME plant:-

- **Methanol storage**
- **PO storage**
- **Catalyst feed system**
- **PGMME tubular Reactor**
- **Methanol distillation column**
- **PGMME distillation column**
- **Distillation vacuum package system**
- **PGMME off spec storage**
- **PGMME product storage.**

CHAPTER 3

WATER CONSUMPTION & WASTEWATER GENERATION

3.1 WATER BALANCE SHEET

MPL PLANT-I
WATER EFFLUENT DETAILS
(ALL FIGURED CUM/DAY)

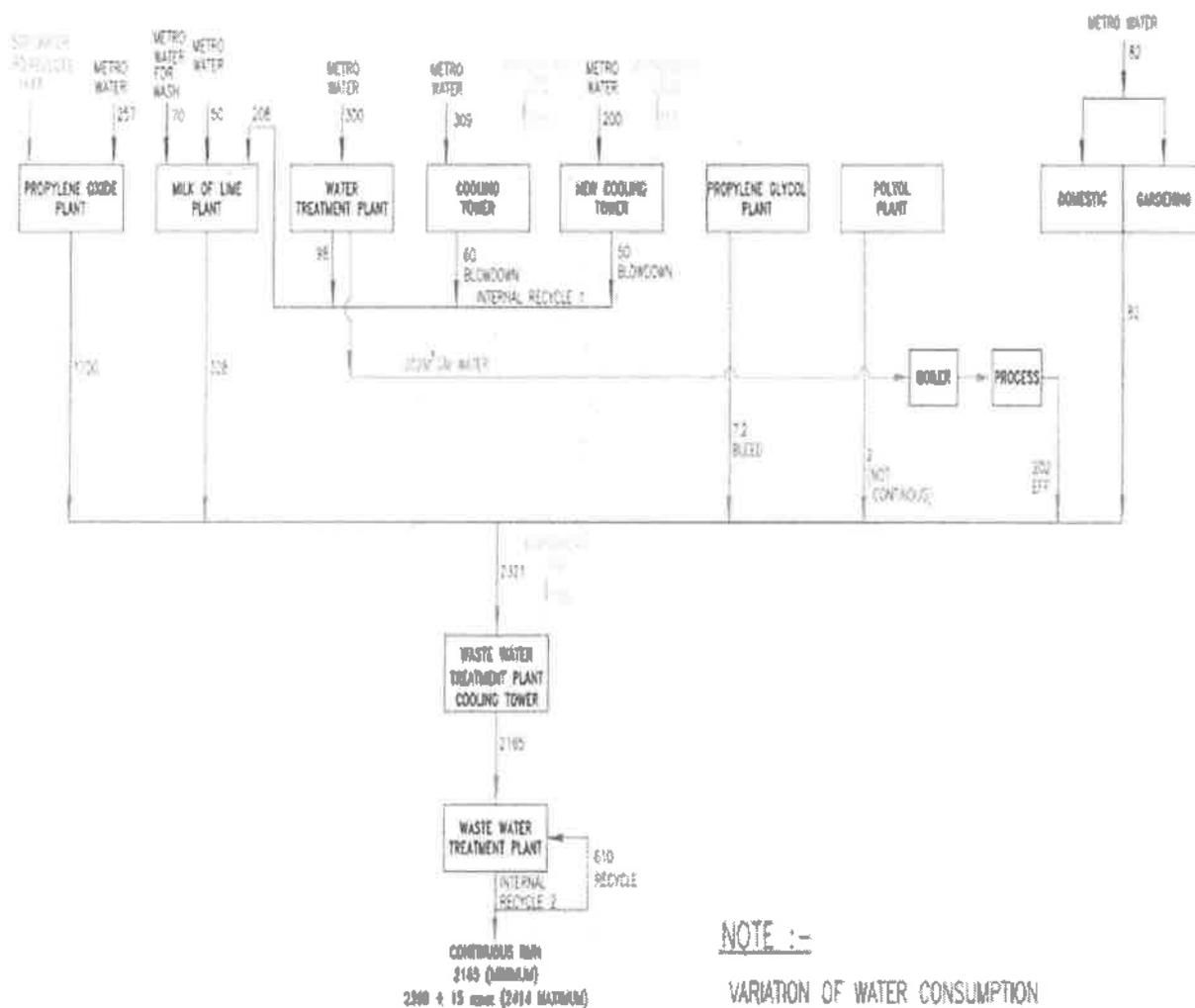


Fig 3.1 Water balance

3.2 WATER REQUIREMENT

Current consumption of water is 2711 KLD which is supplied by Metro water, Kodungaiyur STP water and RO reject. Whereas MPL will be using the fresh water around 1268 KLD and about 1443 KLD of STP water & RO reject. The details are furnished in table 3.1.

Table 3.1 Water Requirement

SNO	DESCRIPTION	REQUIREMENT IN KLD *
1	Propylene Oxide plant	1700
2	Milk of Lime plant	120
3	Water treatment plant	300
4	Cooling tower	309
5	New Cooling tower	200
6	Domestic & Gardening	82

*Reused water quantity excluded

3.3 WASTEWATER GENERATION DETAILS

The wastewater generated from Propylene Oxide plant, Milk of Lime plant, Propylene Glycol plant, Polyol plant, Water Treatment plant and Domestic & Gardening details is presented in the table 3.2.

Table 3.2 Details of Effluent Generation

SNO	DESCRIPTION	GENERATION IN KLD
1	Propylene Oxide plant	1700
2	Milk of Lime plant	328
3	Propylene Glycol plant	7.2
4	Polyol Plant	2
5	Domestic & Gardening	82
6	Water Treatment plant	202

3.4 WASTEWATER CHARACTERISTICS

Characteristics of Effluent is presented in table 3.3 shows 40,000 mg/L of Total Dissolved Solids, 400 mg/L of BOD, 1800 to 2300 mg/L of COD .

Table 3.3 Characteristics of Raw Effluent

Parameters	Raw Effluent
(A) GENERAL PARAMETERS :	
(i) pH:	10 -11
(ii) Color Units	N/A
(iii) Temperature °C	40 ° C
(iv) Suspended solids	
(a) Total mg/L	200
(b) Fixed mg/L	-
(c) Volatile mg/L	-
(v) Dissolved solids	
(a) Total mg/L	40,000
(b) Fixed mg/L	-
(c) Volatile mg/L	-
(vi) Total volatile solids mg/L	-
(vii) Dissolved Oxygen mg/L	<1
(viii) BOD ₅ days 27 ° C mg/L	400
(ix) COD , mg/L	1800 - 2300
(x) Oil & Grease mg/L	BDL
(B) CHEMICAL PARAMETERS	
(i) Ammonical Nitrogen, mg/L (as N)	BDL
(ii) Nitrates, mg/L (as N)	BDL
(iii) Chlorides, mg/L (as Cl)	26,000- 30,000
(iv) Phosphates, mg/L (as P)	1-50
(v) Phenolic Compounds, mg/L (as phenol)	BDL
(vi) Cyanides , mg/L (as CN)	BDL

(vii) Sulphides, mg/L (as S)	BDL
(viii) Sulphates, mg/L (as SO ₄)	100 - 400
(ix) Insecticides mg/l	BDL
(x) Total residual Chlorine mg/l (as Cl ₂)	BDL
(xi) Fluorides mg/L (as F)	BDL
(xii) Percent Sodium	0.01
(xiii) Pesticides mg/L	BDL

3.5 WASTEWATER CHARACTERISTICS - SECONDARY DATA

Table 3.4 WasteWater Characteristics - Secondary Data

Characteristics	plant-1
Date of Sampling	22.02.2019
BOD ₅ @ 27 °C	310
Calcium	15,390.72
Chloride	27,591.44
COD	1840
Fluoride	0.71
Hexavalent Chromium	BDL
Oil and Grease	7
pH	10.71
Phenolic compounds	BDL
Phosphate	8.79
Sulphate	549.28
Sulphide	1.6
Total chromium	0.062
TDS	46,670
TRC	BDL
TSS	86

All parameters are in mg/L except pH

CHAPTER 4

METHODOLOGY FOR PERFORMANCE EVALUATION OF EFFLUENT TREATMENT PLANT

4.1 EFFLUENT TREATMENT PLANT PROCESS DESCRIPTION

ETP PROCESS DESCRIPTION

Effluent generated by propylene oxide plant at saponifier bottom is pumped to High rate thickener at 75 °C Flocculent is added, for faster settling of suspended solids at the bottom. Underflow contains 6-7 % of suspended solids and withdrawn at 10 T/H. 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. The HRT overflow is a gravity flow to Effluent settling chamber. From the settling tank, it is pumped to Cooling Tower for maintaining effluent temperature 35 to 40 °C before pumping it to bioreactors (A to F) for biological treatment In bioreactor A & B, Initially Cultured Microorganisms (BIONIL) 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 Bio-degradation and increases the dissolved oxygen, level in effluent water and there will be Reduction of COD from the existing feed concentration.

Inside Bioreactor C to F, OHR aerators (diffuser) of 120 numbers are fixed at the bottom of the Bioreactors C to F and all are connected with the Air blowers (Two numbers) eachwith capacity of 4000 NM³/hr. In

Bioreactors, air and water are thoroughly mixed by hydrodynamics process to forcibly oxygenate the activated sludge. Also, Air blown from a hole of 30 mm diameter & extreme vortex are created by crossing plates and mushroom-shaped cutters to powerfully mix air and activated sludge which increases dissolved oxygen level. The treated wastewater from Bio F is sent to Secondary clarifier where the biological sludge flocs are separated from the water and allowed to settle at the bottom which is collected in a wet well from which the required quantity of Raw Activated sludge (RAS) is recycled back to bioreactors A, B, C to regulate the quantity of biological sludge necessary for treatment.

Excess Biosludge formed from secondary clarifier is pumped and routed to Plate and frame press in order to remove the excess water from the Bio sludge. The clarified over flow water is routed to the Treated Effluent tank. Finally the treated water from TET is pumped to Sea.

Capacity of ETP plant installed in UNIT-I

ETP capacity installed - 150 m³/hour effluent

Current operating load - 100 to 120 m³/hour effluent

Table 4.1 Design Basis

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	120 m ³ /day

The total design capacity of ETP-1 is 3600 m³/day and the average hourly flow rate is 100 to 120 m³/hour with peak flow rate of 120 m³/hour as shown in the table 4.1 Advanced Biotreatment Process using Bioculture in the Bioreactors Six Bioreactors with Mix Flow Diffuser system in the Bioreactor A, B and OHR (Original Hydro Dynamic Reaction Technology) aerators in the Bio C, D, E, F.

4.2 EFFLUENT TREATMENT PLANT SCHEME

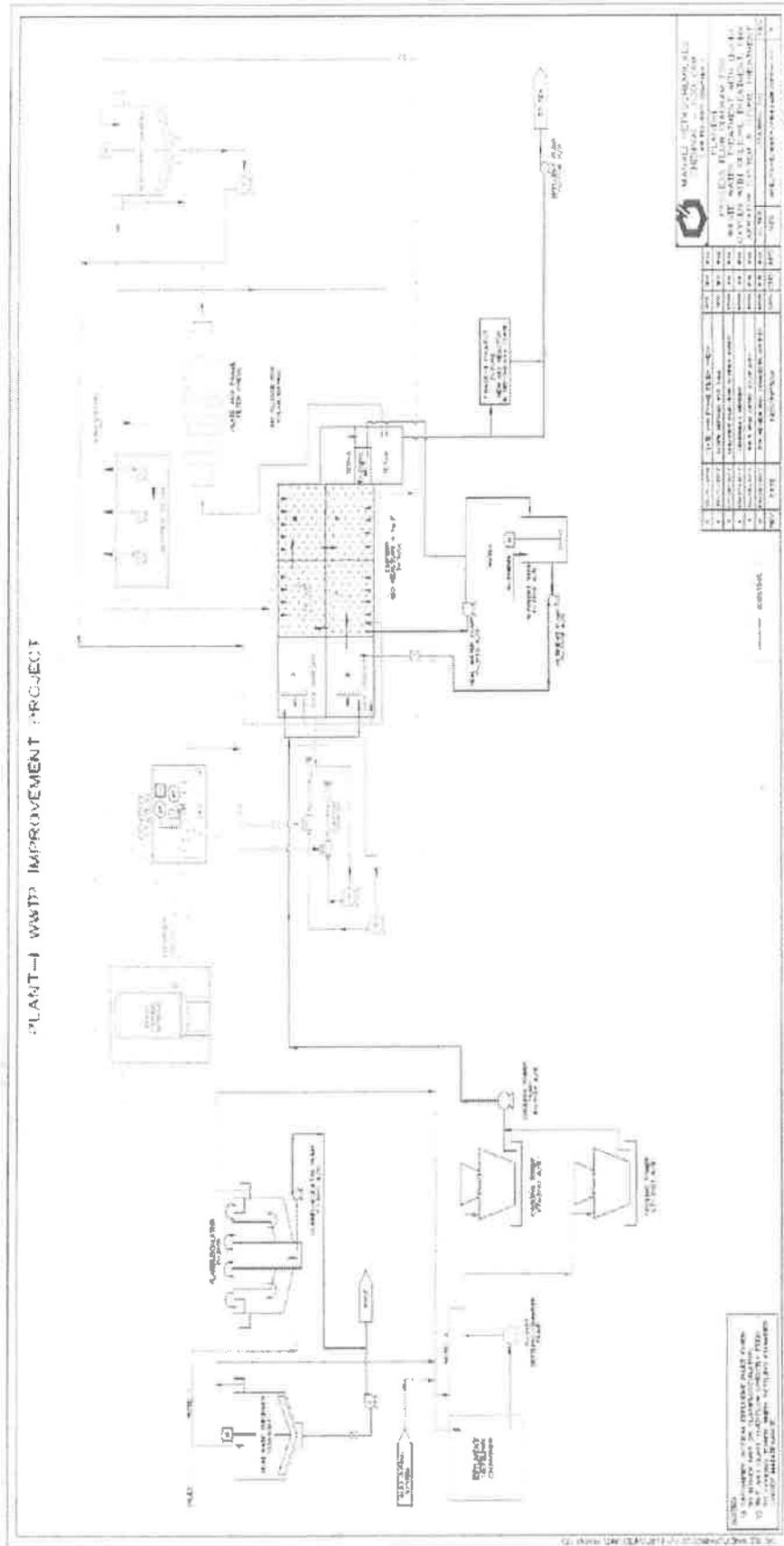


Fig 4.1 Effluent treatment plant scheme

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Details of Online monitoring equipments installed in the unit I – to measure TSS, COD, pH, Temperature and flow
Table 4.2 Details of Online Monitoring Equipment

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 (°C)	EFFLUENT	EFFLUENT TO SEA WATER	Temperature	Yokogawa	YTA	YOKOGAWA INDIA LIMITED,HOSUR ROAD,BANAGALORE-560100
3	Flow (m ³ /day)	EFFLUENT	EFFLUENT TO SEA WATER	Flow	SIEMENS	MAG310	K&N Automation Plot 7, Bhuvanewari Nagar First street Alapakkam Road Valasarvakkam Chennai - 600087
4	TSS (mg/L)	EFFLUENT	EFFLUENT TO SEA WATER	TSS	HACH	LXV404.99.00502	DHR HOLDING INDIA PVT LTD,SP COMPLEX (Gr.Floor), 16/1,LALBAGH RD, BANGALORE-560027
5	COD/BOD (mg/L)	EFFLUENT	EFFLUENT TO SEA WATER	COD/BOD	HACH	B7000i	DHR HOLDING INDIA PVT LTD,SP COMPLEX (Gr.Floor), 16/1,LALBAGH RD, BANGALORE-560027

4.3 LIST OF EQUIPMENTS

1) 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

2) THICKENER RACKER ARM UNIT WITH HYDRAULIC POWER PACK

Equipment Tag No.	:	M 3113
Material of construction	:	Carbon Steel

3) 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

4) HIGH RATE SLUDGE THICKENER BOTTOM PUMP

Equipment Tag No.	:	P 3115A/B
Type	:	Stork pump
Model	:	Johnson 14-08
Rated Flow	:	45 m ³ /h
Head	:	18.5 m
Motor Details	:	5.5 , 2900 RPM
Material of Construction	:	Casing – Cast Iron, Impeller & Shaft –Cast Iron

5) FLOCCULANT PREPARATION TANK AGITATOR

Equipment Tag No.	:	A 3113
Material of Construction	:	Shaft and Blade assembly Gear box – Carbon steel
Motor Details	:	1.5 HP

6) 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

7) PRIMING CHAMBER FOR SETTLING CHAMBER PUMP

Equipment Tag No.	:	PC 3127A/B
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Outer Diameter	:	1000 mm
Thickness	:	8 mm
Height	:	1800 mm
Material of construction	:	Carbon steel

8) 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

9) EFFLUENT COOLING TOWERS (2 Nos. Cell)

Equipment Tag No.	:	CT 3103 A/B
Make	:	SV cooling towers
Material of construction	:	Pultruded FRP

10) 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)

11) 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

12) 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

13) 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

14) 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

15) 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

16) VENTURI EJECTORS

Equipment Tag No.	:	EJ 3104 A/B
Material of construction	:	Carbon steel

17) EDUCTORS

Equipment Tag No.	:	EJ 3104 A1, A2, A3, A4, A5, A6 (6 No in Bioreactor – A) EJ 3104 B1, B2, B3, B4, B5, B6 (6 No in Bioreactor B)
Size	:	Suction – 369 mm, Discharge – 254 mm
Material of construction	:	Stainless steel

18) 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

19) 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 , 1485 RPM
Material of construction	:	Casing – Cast Iron, Lobe – Ductile Iron Shaft – Carbon Steel

20) 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

21) LIQUID OXYGEN VAPOURISER

Equipment Tag No.	:	E 3120 A/B
Material of construction	:	Stainless steel

22) 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

23) RVDF CONDENSERS

Inner Diameter	:	1070 mm
Overall Height	:	3140 mm
Material of construction	:	Carbon steel

24) RVDF VACUUM PUMP

Equipment Tag No.	:	K 3101 A/B
Motor details	:	90 kW
Material of construction	:	Cast iron

25) RVDF VACUUM RECEIVER

Equipment Tag No.	:	V 3102
Inner Diameter	:	1525 mm
Overall Height	:	2845 mm
Material of construction	:	Carbon steel

26) RVDF FILTRATE BOTTOM PUMP

Equipment Tag No.	:	P 3113 A/B
Make & Model	:	Johnson 14-08
Capacity	:	45 m ³ /h
Motor details	:	7.5 kW
Material of construction	:	Cast Iron

27) BIOMASS CULTURE PREPARATION TANK

Equipment Tag No.	:	T 3130
Capacity	:	5 m ³
Material of construction	:	HDPE

28) 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

29) PUMP FOR BIOMASS CULTURE PREPARATION

Equipment Tag No.	:	P 3130 (Pump)
Capacity	:	2 m ³ /h
Head	:	20 m
Material of construction	:	Cast Iron

30) NUTRIENT TANK

Equipment Tag No.	:	T 3109 A/B
Inner Diameter	:	2 m
Overall Height	:	2.006 m
Material of Construction	:	FRP

31) 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

32) NUTRIENT TANK PUMPS

Equipment Tag No.	:	P 3109 A/B
Flow rate	:	45 m ³ /h
Material of construction	:	Cast Iron

33) SECONDARY CLARIFIER

Equipment Tag No.	:	T 3121
Inner Diameter	:	14 m
Side Wall Depth	:	3.5 m
Material of construction	:	Reinforced Cement Concrete

34) SECONDARY CLARIFIER RACKER ARM

Equipment Tag No.	:	M 3121
Motor details	:	2.2 kW
Material of construction	:	Carbon Steel

35) 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

36) WET WELL TANK PUMP

Equipment Tag No.	:	P 3123 A/B
Make & Model	:	100 WQ-75-15-7.5
Motor details	:	7.5, 2900 RPM
Material of Construction	:	Stainless Steel

37) 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

38) 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

39) 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

40) 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

41) COD/BOD, TSS, TOC, pH ANALYSER and DO METER IN BIOREACTORS**42) CLARIFLOCCULATOR**

Equipment Tag No.	:	T 3101
Inner Diameter	:	14.35 m
Side Wall Depth	:	3.8 m
Material of Construction	:	Reinforced Cement Concrete

43) THICKENER

Equipment Tag No.	:	T 3105
Inner Diameter	:	10 m
Side Wall Depth	:	3.5 m
Material of Construction	:	Reinforced Cement Concrete

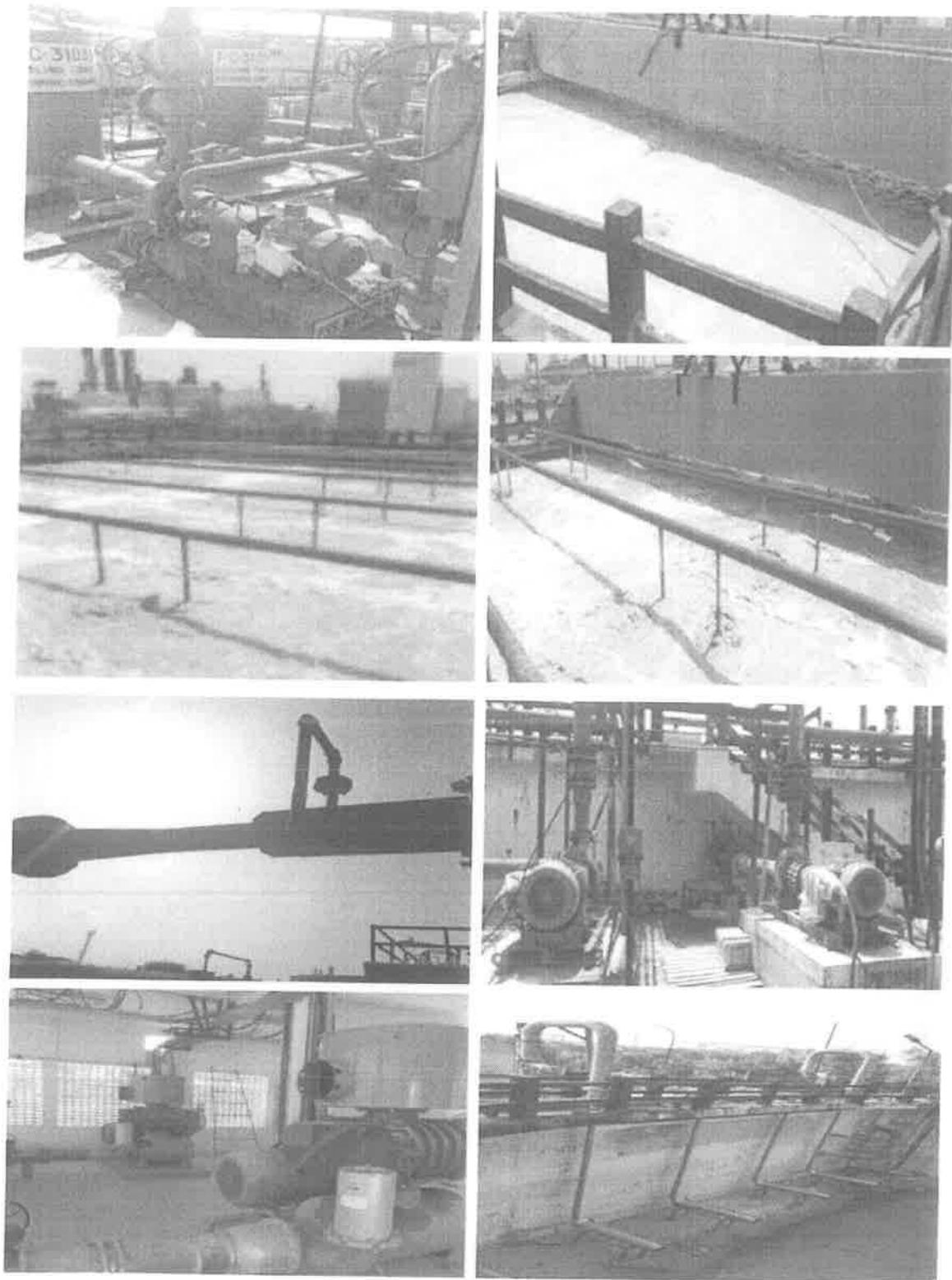


Fig 4.3 Set-II picture from ETP-I

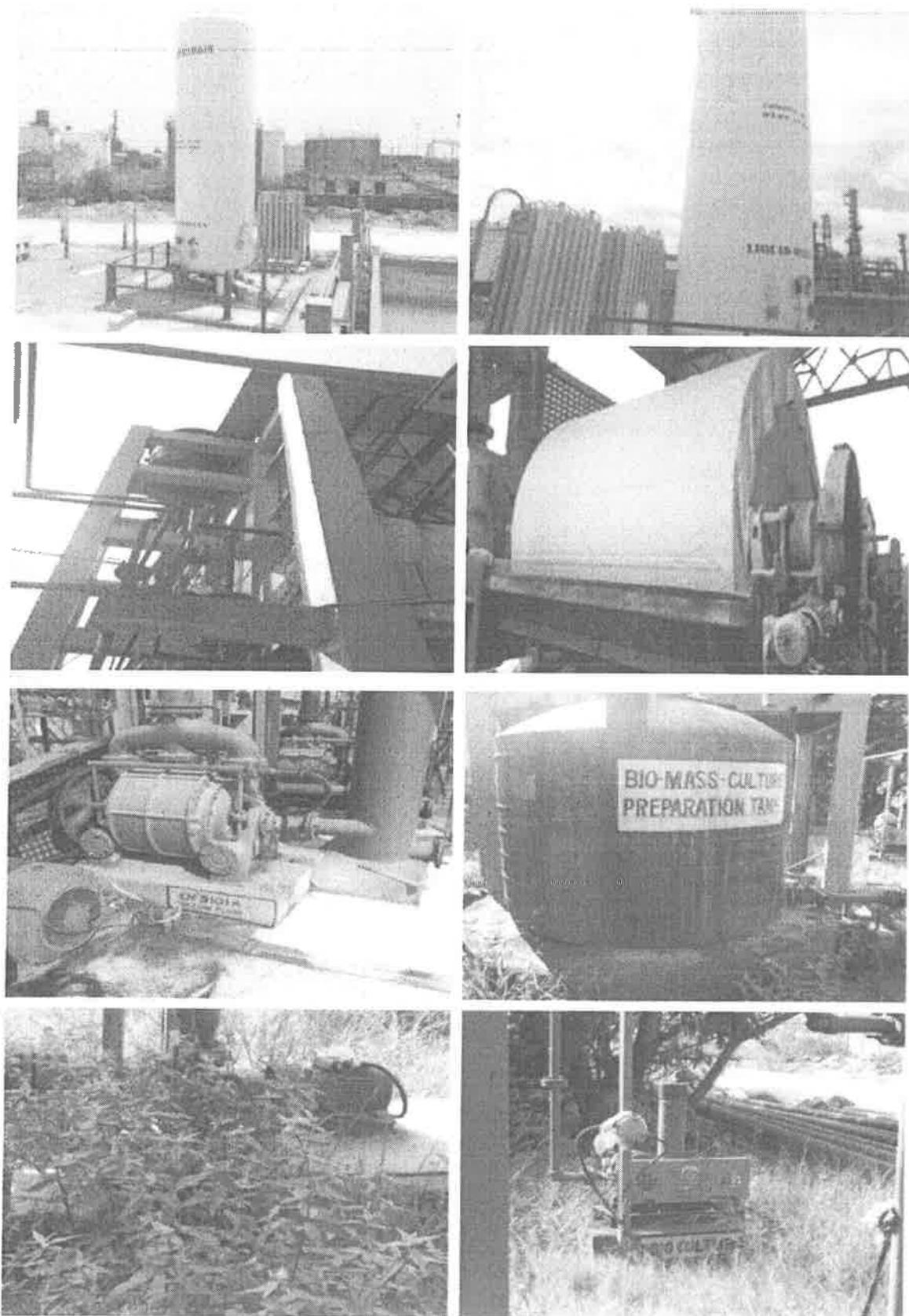


Fig 4.4 Set-III picture from ETP-I

CHAPTER 5

STUDY REPORT OF ENVIROKRAFT

5.1 COMPOSITION OF MICROBIAL CULTURE

BIONIL RS-1 contains selected bacterial strains to biodegrade a broader Spectrum of organic compounds like cresols, phenols, benzene; toluene; other aromatic hydrocarbons with hydroxylated, nitrogenated groups; ethane; other short-chain alkyl hydrocarbons and related aromatic compounds including catechol, cumene, ketones, recalcitrant organics and other organic acids present in the MPL effluent.

The effective environmental control in biological waste treatment is based on an understanding of basic principles governing growth of micro-organisms.

Bacteria can reproduce by binary fission that is by dividing; the original cell becomes two new organism the time required for each fission, which is termed as generation time, can vary from days to less than 20 minutes. For example if generation time is 30 minutes, one bacteria would yield 16,777,216 Bacteria after 12 hours. This is hypothetical figure, bacteria would not continue to divide indefinitely because of various environmental limitations, such as substrate concentration, nutrient concentration or even system size.

The general growth pattern of bacteria in a batch culture is as shown below. Initially, a small number of bacteria are inoculated in to a fixed volume of culture medium and a number of viable organism is recorded as a function of time. The growth pattern based on number of cells has four more or less distinct phases.

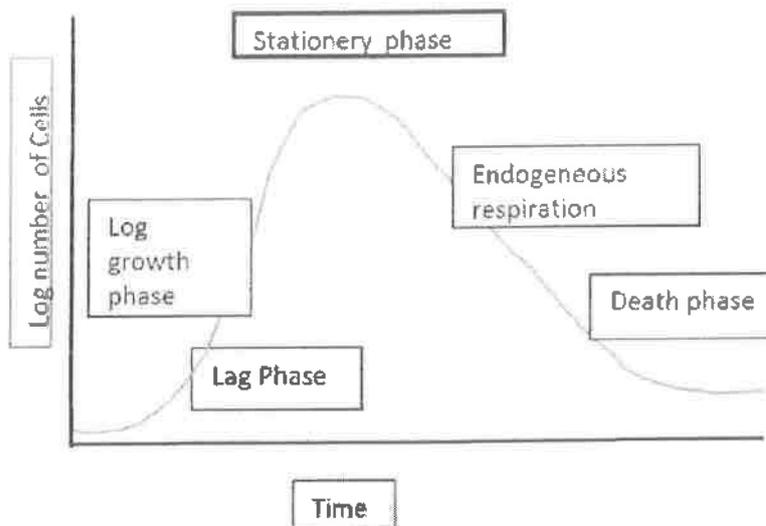


Fig 5.1 Typical Bacterial Population Growth

The lag phase - upon addition of an inoculation to a culture medium, the lag phase represents the time required for the organism to acclimate to their new environment.

The log growth phase - during this period, the cells divide at a rate determined by their generation time and their ability to process food (Constant percentage growth phase)

The stationery phase - Here the population remains stationary. Reasons advanced for this phenomenon are

- That the cells are exhausted the substrate or nutrients necessary for growth and
- That the growth of new cells offset by the death of old cells.

The log death phase - During this phase, the bacteria death rate exceeds the production of new cells. The death rate is usually a function of viable population and environmental characteristics. In some cases, the log death phase is the inverse of the log growth phase.

The growth pattern can be described in terms of variation in mass of active bacteria and time, below as per phases shown below.

1. The log growth phase. There is always an excess amount of food surrounding the micro-organism and the rate of metabolism and the growth is only a function of the ability of micro-organism to process the substrate.
2. Declining growth phase - the rate of growth, hence the mass of bacteria decrease because of limitations in food supply.
3. Endogenous phase - The micro-organism are forced to metabolize their own protoplasm without replacement, since concentration of food available is at minimum. During this phase, a phenomenon known as lysis can occur in which the nutrients remaining in the dead cells diffuse out to furnish the remaining cells with food (known as cryptic growth)

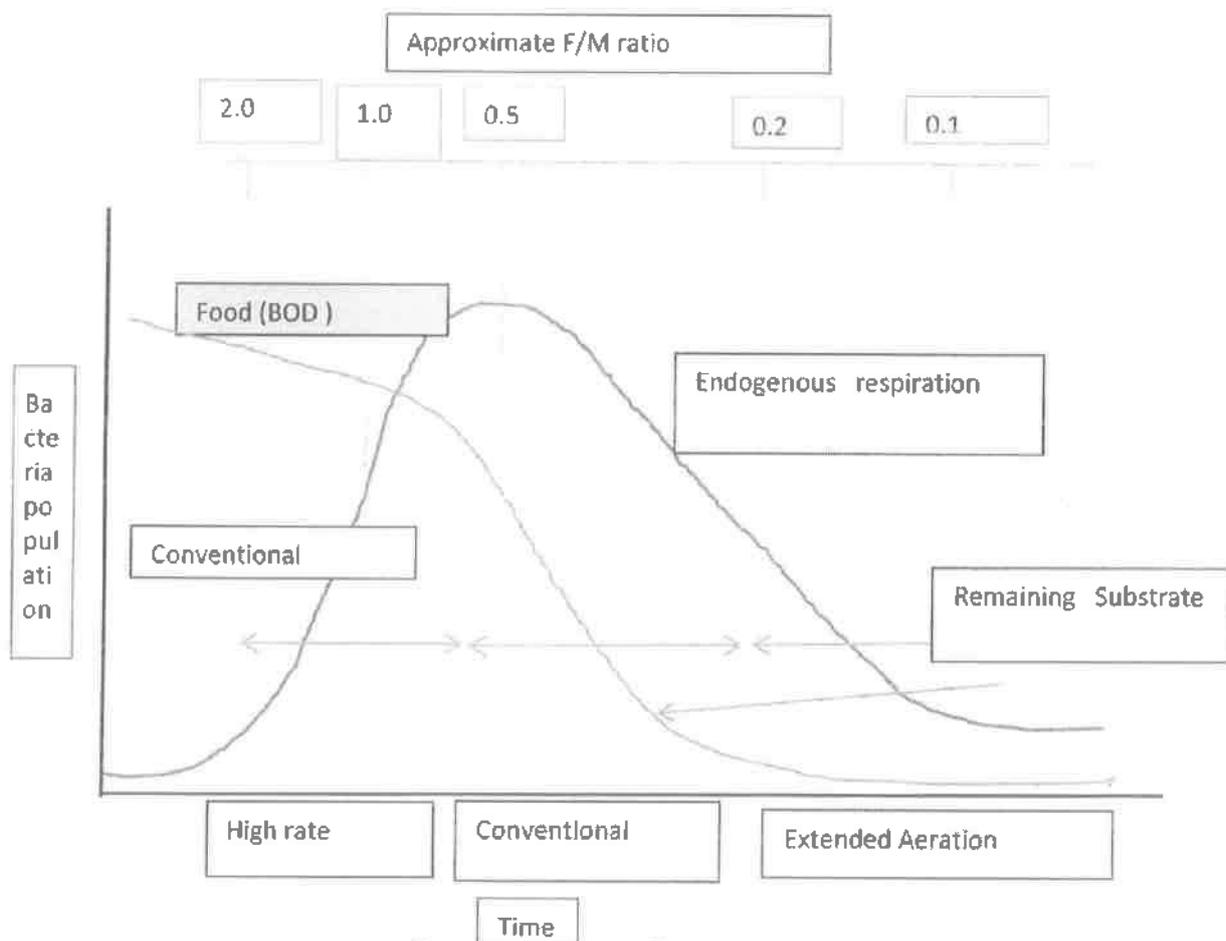


Fig 5.2 Relationship of Bacteria growth phase to food supply in an aerated system

Bacterial oxidation

The conversion of organic matter to gaseous end products and cell tissues can be accomplished aerobically, as per sketch shown below.

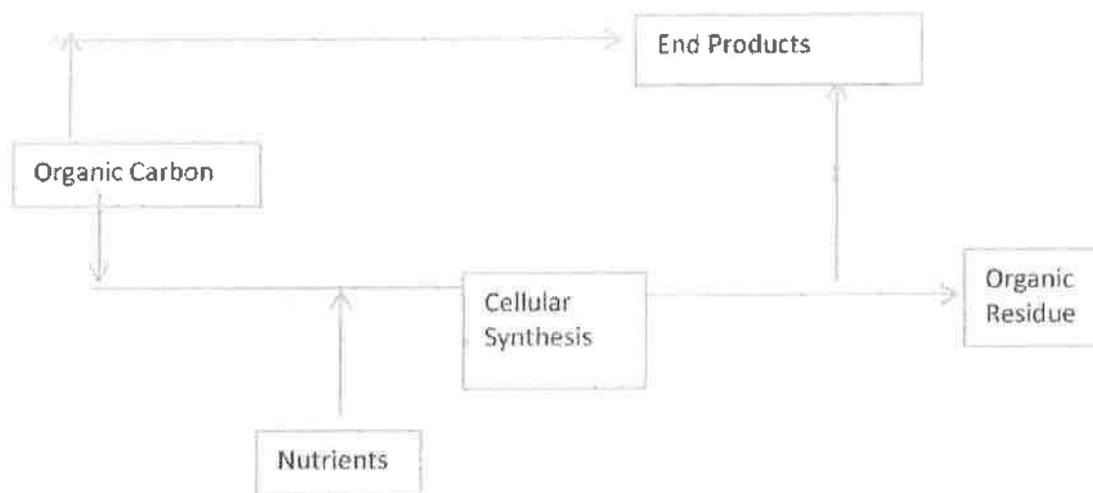


Fig 5.3 Schematic Re-Presentation of Bacterial Oxidation.

As shown, a portion of organic matter is oxidised to end products. This process is carried out to obtain the energy for synthesis of new cell tissue. In the absence of organic matter, the cell tissue will be endogenously respired to gaseous end products and a residual to obtain energy for maintenance in most biological treatment system, these processes occur simultaneously.



Endogenous respiration - Auto oxidation



In these equations, COHNS represents the Organic matter in wastewater. The formula $C_5H_7NO_2$, which represents cell is a generalized value obtained from experimental studies and was first suggested by Hoover and Porges in 1952. Although the endogenous respiration reaction is shown as resulting in relatively simple end products and energy, actually stable organic end products are also formed.

5.3 LAB SCALE TREATABILITY STUDY BY ENVIROKRAFT

Table 5.1 Lab Scale Treatability Study by Envirokraft

Day	DATE	PARAMETER									
		COD (mg/L)	TDS (mg/L) on metre	pH	SV30 (mL/L)	DO(mg/L)	MLSS (mg/L)	REMARKS			
	28.04.2017	1824	20,300	11.5				pH neutralize with sulphuric acid, in 11 litre effluent added 1.5 Litre Biomass & 2 gm. bio culture, Airing continue.			
				5.3				While adding Sulphuric acid the pH reduces to 5.3.			
	29.04.2017	1824	20,300	8.15				Added 200 ml lime solution to maintain pH at alkaline range.			
Day 0	30.04.2017	1728	19,800	7.51	120	4.0	3280	300 ml biomass & 100 ml lime solution is added.			
Day 1	01.05.2017	1030	20,500	7.25				---			
Day 2	02.05.2017	528	21,100	7.35	160	3.8		2 Litre of effluent is added to avoid substrate limitation.			
Day 3	03.05.2017	1008	21,100	7.26							
Day 4	04.05.2017	464	21,400	7.27	160		3800	1.5 Litre effluent added to reactor by fed batch mode. Feeding continue 10:00 a.m. From 5:00 p.m. onwards the reactor is operated in continuous mode by feeding 2.5 litre of			

											effluent per day.
Day 5	05.05.2017	480	21,800	7.24		2.8					
Day 6	06.05.2017	416	22,500	7.28	150		3630				
		448	23,200	7.06							
Day 7	07.05.2017	464	23,300	6.98		2.7	3845				
Day 8	08.05.2017	448	23,700	7.11							
Day 9	09.05.2017	420	24,700	7.14	160		3995				12 Litre per day of effluent is added to aeration tank.
Day 10	10.05.2017	389	24,700	6.65	160	2.3					No effluent addition. To neutralize acid Lime is added for pH.
Day 11	11.05.2017	443	24,500	6.90							12 Litre per day effluent is added to aeration tank.
Day 12	12.05.2017	415	24,600	7.10	165	1.9					24 Litre per day effluent is added to aeration tank. Feeding continue 24 hrs. Lime is added for to keep pH within the range.
Day 13	13.05.2017	390	24,700	7.05	165	1.2	3920				24 Litre per day effluent is added to aeration tank.
Day 14	14.05.2017	330	24,600	7.02		0.50					No effluent addition.
Day 15	15.05.2017	212	26,000	7.45							R & D stop

Details of study:

1. Envirokraft collected effluent samples from industry and conducted in house tests to gauge its treatability through technologies available at their laboratories. like conventional primary treatment, chemical oxidation, Fenton treatment, biological treatability, distillation, tertiary treatment whatever is possible & feasible.
2. Experiment's had been conducted at Envirokraft laboratories, Ankleshwar, Gujarat for biological COD-BOD removal on 28.04.2017, for initial set-up of 12 litre of bioreactor having fish tank aerators for mixing & oxygen supply with initially on batch mode & after achieved maximum COD-BOD removal then start it on continual feed base to check the efficiency of biomass, required retention time etc. data generation.
3. During treatability study they observed that effluent pH reduced drastically from 12 to below 6, after some studies done on primary treated effluent with plain aeration of effluent & observed same phenomenon of pH reduction. During testing of probable cause free chlorine is detected, hence its needed to elimination of free chlorine for survival of biomass in bioreactor. with only plain aeration for 40 hour time total free chlorine reduces up to BDL level & pH reduced up to 6. Hence, pH correction & maintain pH with lime solution during the study was required as shown in table 5.1.
4. From 4th Day onwards no change in COD even after adding 7 L of fresh wastewater having COD 1824 mg/L. It means the COD was reduced from 1824 to 450 mg/L with available bio mass culture.
5. Fresh waste water feeding rate 7 litres in 24 hours at a rate of 1.5ml / min from feed source.
6. COD was consistent at 450 mg/L in the Aeration tank
7. Fresh waste water feed rate being increased slowly observe the COD variation in overflow of aeration tank.

8. Aeration tank outlet over flow being tested for BOD, to identify whether any biodegradable organic matter present or not? If present to what extent?
9. Aeration tank over flow having COD approx. 450 mg/L was further treated until COD reduction to 250 mg/L or below. The distillation of Biological treated water having COD value of 450 mg/L- distillate COD is was mg/L, indicates the most the COD was non volatile & TDS 70 mg/L.

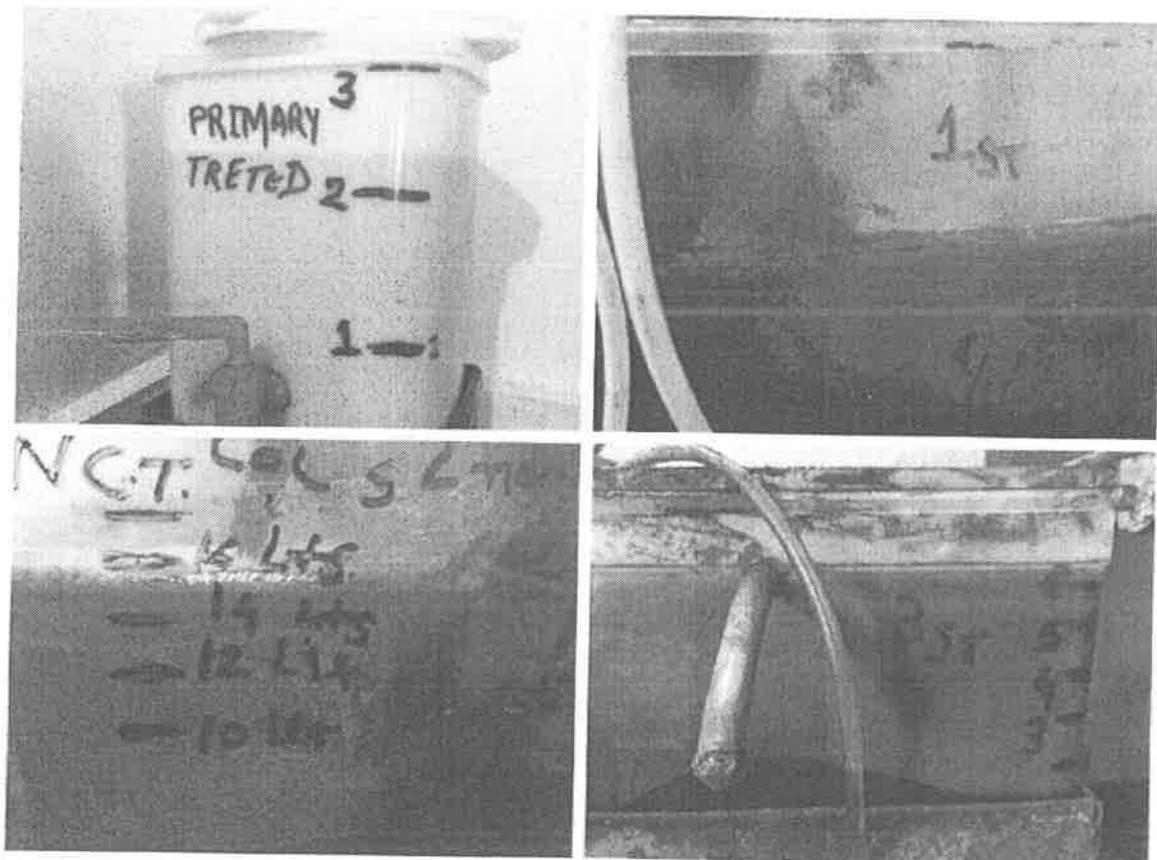


Fig 5.4 Laboratory scale setup used for treatability study by Envirokraft

CHAPTER 6

PERFORMANCE MONITORING

The photographs of the samples collected for Performance evaluation of Effluent Treatment Plant - I on 25th April 2019 are presented in figures 4.2, 4.3 and 4.4. The effluents from different sections of the ETP collected by CES team on 25th April 2019 were characterised for the various parameters and they are presented in Table 6.3 and Table 6.4.

The samples such as raw Effluent (S1), HRT outlet (S2), Bio Feed Inlet (S3), BIO-A (S4), BIO-B (S5), BIO-C (S6), BIO-D (S7), BIO-E (S8), BIO-F (S9), Secondary Clarifier Overflow (S10) & Secondary clarifier Underflow (S11) were collected.

In the cycle I of Performance Characteristics of Effluents Treatment plant -I, The raw Effluent is characterized by high TDS (32,700 mg/L) and high COD (3010 mg/L) and BOD (1316 mg/L). The biological treatment showed only about 91.98% efficiency for the removal of biodegradable organics (BOD) and COD was reduced by 92.22%. The MLVSS of the biological system in the BIO-A was 16,228 mg/L, BIO-B was 16,211 mg/L, BIO-C was 16,202 mg/L, BIO-D was 16,203 mg/L, BIO-E was 16,109 mg/L and in BIO-F was 16,136 mg/L,.

In the cycle II of Performance Characteristics of Effluents Treatment plant -I, The raw Effluent was characterized by high TDS (31,940 mg/L) and high COD (3002 mg/L) and BOD (1,268 mg/L). The biological treatment showed only about 95% efficiency for the removal of biodegradable organics (BOD) and COD was reduced by 92%. The MLVSS of the biological system in the BIO-A was 14,867 mg/L, BIO-B was 15,038 mg/L, BIO-C was 14,896

E/S

mg/L, BIO-D was 14,791 mg/L, BIO-E was 14,923 mg/L and in BIO-F was 14,744 mg/L.

The quantity of the Treated Effluent disposed to sea and Treated Effluent characteristics from M/s Manali Petrochemicals Limited Plant – 1 for the month of February 2019 is furnished in Table 6.5. The average Treated Effluent disposal quantity to sea from plant -I for the month of February 2019 was 2322 KLD. The average characteristics of Treated Effluent was COD 217 mg/L and Suspended solids (90 mg/L).

The Flow meter reading in April 2019 (Table 6.1) indicated that the Effluent Treatment Plant -I was operated at the rate of 105 m³/hour. The flow rate reading indicated that the meters were operated in PO plant Saponifier Bottom to High rate Thickener, ETP Cooling tower sump to Bio Reactor (ETP Inlet), Treated Effluent discharge to sea and Secondary clarifier to Bio Reactor MLSS Recycle location.

Table 6.1 Flow meter reading

SNO	DESCRIPRION	CAPACITY
1	PO plant Saponifier Bottom to High rate Thickener	105 m ³ /hour
2	ETP Cooling tower sump to Bio Reactor (ETP Inlet)	95 to 105 m ³ /hour
3	Treated Effluent discharge to sea	95 m ³ /hour
4	Secondary clarifier to Bio Reactor MLSS Recycle	40 m ³ /hour

The Oxygen used from the storage for Bioreactor A is 240 Nm³/shift (hrs) and for Bioreactor B is 240 Nm³/shift. Bioreactor C, Bioreactor D,

Bioreactor E and Bioreactor F were injected with air, 36,440 m³/hour, from air blower . .

The Chemical consumption for the operation of the Effluent Treatment Plant -I is summarized in table 6.2 . indicates that chemicals added increase the TDS of the effluent. The Monthly power consumption for ETP-I for the month of April 2019 was 3,61,759 units. The Monthly expenditure data based on Effluent generation quantity was Rs 55 to 57 /m³ of Effluent treatment. The Monthly sludge generation from ETP was from 75 to 150 kg / day on Dry basis. (It is purely based on SV 30 in the secondary clarifier and Bio Reactors.

Table 6.2 Monthly Chemical consumption

SNO	DESCRIPRION	CAPACITY
1	Urea	20 kg/Shift
2	Ferric Sulphate,7H ₂ O	5 kg/shift
3	Phosphoric acid (85% w/v)	6 kg/shift
4	BIO-NIL culture	25kg
5	Cow dung	25kg
6	Molasses /sugar	10 Litres /kg The treated wastewater discharged from SOC meets the discharging standards prescribed by pollution control board board. However, the treated wastewater has refractory organics such as di substituted Benzene, unsaturated long chain ether compounds, substituted long chain hydroxyl compounds , polyol derivatives Hence, MPL may include a tertiary treatment consisting of activated carbon powder injection and followed by filtration or activated carbon filter for the removal of refractory organics from the treated wastewater. . The life cycle of refractory organic compounds in the disposal site is required to be monitored by MPL .
7	Flocculent for High Rate Thickener	5 Kg / day
8	Coagulant for Secondary clarifier	280 litres / day

Table 6.3 Results for Cycle-I of Performance Characteristics of Effluents Treatment plant -I

S.NO	PARAMETERS	UNITS	RAW EFFLUENT (S1)	HRT OUTLET (S2)	BIO-FEED INLET (S3)	BIO-A (S4)	BIO-B (S5)	BIO-C (S6)	BIO-D (S7)	BIO-E (S8)	BIO-F (S9)	S.C.O (\$10)	S.C.U (\$11)
1	pH		12.58	12.44	12.38	6.49	6.30	6.40	6.60	6.50	6.53	6.95	6.34
2	EC	µS/cm	51.10	53.00	53.10	51.60	53.40	52.40	53.00	52.90	52.20	53.00	50.00
3	TOTAL SOLIDS	mg/L	34,128	34,240	35,418	57,608	58,742	58,088	58,470	58,268	57,858	33,992	60,000
4	TDS	mg/L	32,700	33,920	35,200	33,020	34,180	33,540	33,920	33,860	33,410	33,920	32,000
5	TSS	mg/L	1428	320	218	24,588	24,562	24,548	24,550	24,408	24,448	72	28,000
6	MLVSS	mg/L	N.D	N.D	N.D	16,228	16,211	16,202	16,203	16,109	16,136	N.D	N.D
7	BOD	mg/L	1316	800	778	214	N.D	N.D	N.D	N.D	202	38	116
8	COD	mg/L	3010	2300	2010	602	595	582	568	572	593	162	234
9	Ca ²⁺	mg/L	15,400	15,388	15,402	15,392	15,352	15,344	15,345	15,340	15,340	15,330	15,325

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Table 6.4 Result for Cycle-II of Performance Characteristics of Effluents Treatment plant -I

SNO	PARAMETERS	UNITS	RAW EFFLUENT (S1)	HRT OUTLET (S2)	BIO-FEED INLET (S3)	BIO-A (S4)	BIO-B (S5)	BIO-C (S6)	BIO-D (S7)	BIO-E (S8)	BIO-F (S9)	S.C.O (S10)	S.C.U (S11)
1	pH		12.52	12.43	12.36	6.38	6.32	6.42	6.5	6.51	6.51	6.95	6.38
2	EC	µS/cm	49.90	53.00	55.00	50.10	47.80	50.60	50.20	50.00	50.20	51.00	47.70
3	TOTAL SOLIDS	mg/L	33,268	34,292	35,400	56,040	54,460	56,215	55,949	55,802	55,950	32,700	58,208
4	TDS	mg/L	31,940	33,980	35,200	32,060	30,590	32,380	32,130	32,000	32,130	32,640	30,530
5	TSS	mg/L	1328	312	200	23,980	23,870	23,835	23,819	23,802	23,820	60	27678
6	MLVSS	mg/L	N.D	N.D	N.D	14,867	15,038	14,896	14,791	14,923	14,744.6	N.D	N.D
7	BOD	mg/L	1268	798	750	205	N.D	N.D	N.D	N.D	192	30	121
8	COD	mg/L	3002	2108	2000	595	592	585	583	579	580	159	228
9	Ca ²⁺	mg/L	15,300	15,298	15,286	15,608	15,593	15,586	15,573	15,580	15,578	15,500	15,480

Table 6.5 MPL ETP-I Data sheet for quantity of Effluent disposal to sea and Characteristics of Treated Effluent (February 2019)

DATE	EFFLUENT DISPOSAL TO SEA QTY (KLD)	TREATED EFFLUENT RESULTS		
		pH	COD (mg/L)	SS (mg/L)
2/1/2019	2452	6.0	248	88
2/2/2019	2565	6.4	234	88
2/3/2019	2452	6.5	240	94
2/4/2019	2400	6.4	219	90
2/5/2019	2302	6.2	219	90
2/6/2019	2348	6.2	210	94
2/7/2019	1842	6.2	218	92
2/8/2019	2276	6.1	220	92
2/9/2019	1607	6.3	205	86
2/10/2019	2312	6.0	210	84
2/11/2019	2394	6.0	205	82
2/12/2019	2699	6.2	215	86
2/13/2019	2530	6.2	210	92
2/14/2019	2421	6.1	212	90
2/15/2019	2233	6.3	214	86
2/16/2019	2405	6.1	218	85
2/17/2019	2304	6.1	210	93
2/18/2019	2490	6.3	216	90
2/19/2019	2308	6.2	226	90
2/20/2019	2520	6.7	215	95
2/21/2019	2255	6.6	225	95
2/22/2019	2572	6.6	220	95
2/23/2019	2139	6.2	214	95
2/24/2019	2191	6.2	218	94
2/25/2019	2222	6.2	220	88
2/26/2019	2094	6.2	205	90
2/27/2019	2414	6.6	205	90
2/28/2019	2265	6.3	210	90
AVERAGE	2322	6.3	217	90

CHAPTER 7

CONCLUSIONS

Based on the process design furnished by M/s Manali Petrochemicals Limited for their 3.6 MLD Effluent Treatment Plant -I is expected to meet the discharge/reuse standards for the inlet characteristics mentioned by the proponent. The following observations/suggestions are to be considered to ensure sustainability of effective treatment of the existing ETP.

1. The Analysis of samples at various units should be done at regular intervals in order to study the performance of the each operation and process.
2. Solid waste generated from the sludge dewatering unit should be disposed safely.
3. As per the characteristics of feed to the bioreactor is concerned, it should be free from free chlorine. The analytical results suggests that the system withstood the free Chlorine. Need not be a guideline.
4. Operation of biological units of ETP for 24 hours feed should be ensured for stabilization of bacterial culture.
5. The effluent collection tank is to be cleaned periodically to avoid accumulation of solids.
6. In order to maintain mean cell residence time in the range of 25 to 48 days in aeration tank, suitable quantity of underflow from the secondary settler should be re-circulated.
7. Proper handling and drying of sludge from Filter press must be ensured.
8. Adequate storage area should be allocated for storing dewatered sludge generated from filter press.
9. Safe storage and handling of chemicals in the ETP should be ensured.

10. Adequate standby units/spare parts should be provided for various mechanical operations such as pumping, aeration, dewatering, back washing etc.
11. Wide access should be provided for each and every unit in the ETP for easy entry and exit.
12. The ETP should be operated by qualified personnel and records should be maintained to establish sustained performance.
13. All workers should undergo periodic examinations by occupational physician to reveal early symptoms of possible chronic effects or allergies.
14. Proper Protective Equipment should be given to the personnel involved in cleaning collection tank, aeration tank and sludge holding tank.
15. Personnel should be given training on Standard Operating Procedures (SOPs) for Health & Safety applicable for ETP.

The treatment process report with calculations for arriving at the sizing of treatment units was reviewed in terms of the above. It has been observed that the design norms followed for sizing of units are in line with CPHEEO norms and adequate for achieving the discharge standards laid down by MoEF & CC for disposal/reuse. However, the efficiency of performance depends on the operation and maintenance of the plant as to maintain the design parameters used in the calculation for sizing of units.


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RECOMMENDATION

The treated wastewater discharged from Secondary Clarifier Overflow meets the discharging standards prescribed by pollution control board board. However, the treated wastewater has refractory organics such as disubstituted Benzene, unsaturated long chain ether compounds, substituted long chain hydroxyl compounds, polyol derivatives. Hence, MPL may include a tertiary treatment consisting of activated carbon powder injection and followed by filtration or activated carbon filter for the removal of refractory organics from the treated wastewater in future. The life cycle of refractory organic compounds in the disposal site could be monitored by MPL .

Annexure-1**DESIGN REPORT****Design Calculations for Aeration tank (Bio-reactor)****Data**

Flow rate	3600	m ³ / day
Volume	6000	m ³
BOD IN	600	mg/L
BOD Out	20	mg/L
BOD net	580	mg/L
BOD net	2088	Kg/ day

A. LIQUID OXYGEN SECTION

The power consumption (kgO₂/kWh) in MIXFLO is in the range of 2 to 2.5 kg of O₂/KWh while with conventional aeration this is from 0.6 to 1 Kg of O₂ / KWh.

Power consumption per hour – 110 kWh

Number of Aeration tanks - 2 Nos

Aeration tank capacity - 1000 m³ per tank (15 m X 15 m X 4.42 m Ht.)

Total treatment tank capacity - 2000 m³

B. BIOLOGICAL TREATMENT SECTION

Air blower capacity - 4000 Nm³ per hour @ 0.7 bar

Number of Blowers - 2 (working) & 1 Standby

Aeration tank inlet flow rate - 130 m³ per hour

Treatment plant capacity - 3600 m³ per day

No of OHR aerators - 120 Nos

Air flow rate per OHR aerator - 55 m³ per hour per OHR aerator

Aeration tank capacity - 1000 m³ per tank

Number of aeration tank - 4 Nos

Total aeration tank capacity - 4000 m³

Hydraulic retention Time - 48 hours
(including Liquid Oxygen Aeration tank)

Annexure-2

STANDARD OPERATING PROCEDURES

HIGH RATE THICKENER

START UP

- Ensure that the maintenance jobs have been completed in all respects.
- Confirm with electrical the availability of power supply.
- Ensure HRT is clean.
- Ensure the raker-arm and bottom pumps are energised.
- Ensure the normal rotation of raker-arm including free vertical movement.
- Ensure the feed inlet isolation valves are open.
- Ensure the HRT overflow line is through to cooling tower.
- Flocculant dosing is given to hot well at the centre of HRT.
- Soda ash dosing is given to the bottom RC line which in-turn is routed to feed inlet from P103.
- Coagulant dosing is given to hot well at the centre of HRT.
- Record the bottom concentration periodically.
- Ensure the HRT bottom pump isolation valves are routed to RVDF.
- Bottom pump should be started once the concentration reaches 80%.
- Record the QA lab analysis reports of HRT overflow samples for pH, TSS, TDS, and COD.

FLOCCULANT DOSING SYSTEM

START UP

- Ensure that the maintenance jobs have been completed in all respects.
- Confirm the availability of electrical power supply.
- Ensure the Raw water makeup line is through the flocculant preparation tank.

- After filling the preparation tank with water, flocculant of desired quantity (250g) shall be added and mixed thoroughly.
- Ensure the isolation valves of flocculant dosing pump is open and routed to HRT hot well.
- Flocculation dosing quantity and rate shall be adjusted as required.

CLARIFLOCULATOR:

START UP:

- Check whether the drive mechanism is properly installed and thoroughly lubricated.
- Clarifier is to be used in line when HRT is in maintenance.
- Check whether all parts are in proper alignment and the bolts are tightened.
- Check whether the bottom sludge pipe is clear without any choking.
- Check whether the mechanical tools used during installation are completely removed from the tank.
- Ensure proper clearance between the blades and the tank bottom at all points throughout the complete revolution of the mechanism.
- Check the proper operation of the overload alarm.
- Fill the tank with raw water up to 25- 30%.
- Run the raker mechanism in the tank filled with water and ensure raker movement is normal.
- Open the valve located on the 6"effluent header(line carrying the effluent from PO, PG and POLYOL plants) and start admitting the effluent into the clarifloculator.
- Take samples at the inlet to the clarifloculator and analyze for suspended solids content.
- Take sample at the over flow launder and analyze for suspended solids content.

- Take samples from the sampling point located at the bottom slurry line and analyze for suspended solids.

NORMAL OPERATION:

- During normal operation the following activities are carried out.
- Analyze the suspended solids in the samples taken at the inlet
- Check the pH of the samples taken from the inlet.
- Analyze the solid content in the sample taken from the bottom slurry line.
- Also take samples at the overflow launder and analyze the same.
- If the solid content at the overflow launder is more than 100 mg/L, increase the thickener feed rate from clarifloculator bottom.
- Take samples at the overflow launder and ensure that it always contains less than 100mg/L before admitting into the cooling water.

SHUT DOWN

- Stop the feed.
- Drain the entire tank if any maintenance job is to be carried out either in the RCC tank or in the raker mechanism.
- Once the tank is empty stop the raker arm and the bottom pump.
- Stop the clarifloculator bottom pump suction lines and clean them.
- Clean clarifloculator with water.

SETTLING CHAMBER: EFFLUENT HOLDING TANK

- HRT overflow comes to be settling tank.
- Purpose of settling tank is to attain uniform pH.
- Effluent from settling tank routed to cooling tower by P3127A/B.
- Record the pH in settling tank.

5/7/17

COOLING TOWER:

START UP

- Start up the fan and check its vibration.
- Open the valves located on the distribution header and admit the effluent to both the cells.
- Take samples at the distribution point and check the temperature.
- Take samples at various points from the cooling water sump and measure the temperature and the pH.
- Start the pump P 3103 A/B and feed the effluent into the bio-reactor if the temperature of the effluent in the sump is less than 45°C.

NORMAL OPERATION & OPERATING PARAMETERS:

During Normal Operation

- Check for the fan vibration.
- Measure the effluent temperature in the sump and record the same. Normal temperature is less than 45°C.
- Check the pH and COD at the cooling tower sump and record the same. (Normal value of pH and COD are 10-11.5 and 1500-2000 mg/L respectively).

SHUT DOWN:

- Close the valves and stop feeding the effluent into the tower stop the fan.
- Keep the tower wet if the shut down is prolonged for a long period. (More than 8 hours).
- Put the CT pumps P 3103 A/B under re-circulation. Stop the pump if the shutdown is for along period.

BIO SYSTEM

TAKING EFFLUENT INTO THE BIOREACTOR SECTION:

- Make sure that the temperature of the effluent at the exit of cooling tower is less than 45°C.
- Take samples at the exit of the cooling tower and analyze pH, SS, TDS, and COD.
- Start the bio-reactor feed pump P 3103 A/B and fill up the effluent in the Bioreactor A.
- Start the mix flow pump (P3104A), when the suction line of mix flow pump A is fully immersed and ensure proper circulation.
- Ensure the liquid oxygen quantity and PRV set pressure maintained at 6kg/cm² and route the liquid oxygen to the ejector system.
- Liquid oxygen SOV can be operated in manual/auto mode. Maintain dissolved oxygen in Bio A 1-3 mg/L.
- Allow the Bio-reactor A to over flow and fill up Bio-reactor B and follow the same procedure for bio B mix flow pump B (P 3104 B) operation and maintain the dissolved oxygen level 1-3 mg/L.
- Allow the bioreactor B to overflow to subsequent bioreactors C,D,E & F.
- Dissolved oxygen level in bioreactor C,D,E & F is maintained by blower.
- Bioreactor F overflow is routed to secondary clarifier.
- Monitor the dissolved oxygen level in Bio A,B,D & F in online DO meter.
- Record the QA lab analysis reports of Bio A, D& F for pH, TSS, TDS, COD, and SV30.

BIO FLOCCULANT DOSING SYSTEM

- Ensure that the maintenance jobs have been completed in all respects.

- Confirm with electrical the availability of power supply.
- Ensure the Raw water makeup line is through to the flocculant preparation tank.
- After filling the preparation tank with water, flocculant of desired quantity (1L/100 L of water) shall be added and mixed thoroughly. Flocculant dosing concentration will be varied depending upon the secondary clarifier overflow TSS level.
- Ensure the isolation valves of flocculant dosing pump is open and routed to Bio F overflow line to secondary clarifier.
- Flocculant dosing quantity and rate shall be adjusted as required.

SECONDARY CLARIFIER

- Check whether the raker arm mechanism is properly installed and thoroughly lubricated.
- Check whether all parts are in proper alignment and the bolts are tightened.
- Check whether the bottom activated sludge line to wet well is clear without any choking.
- Check whether the mechanical tools used during installation are completely removed from the tank.
- Ensure proper clearance between the blades and the tank bottom at all points throughout the complete revolution of the mechanism.
- Fill the tank with raw water up to 25- 30%.
- Run the raker mechanism in the tank filled with water and ensure raker movement is normal and check the raker arm amps.
- Open the bottom valve to wet well.
- Take secondary clarifier overflow samples and check TSS, COD, pH and record.
- Return Activated sludge from wet well can be routed either to Bio A or Bio B by submergible pumps (P 3123 A/B).

- Monitor SV30 at periodic intervals while RAS pump in operation.

BLOWER OPERATION

- Ensure all mechanical jobs have been completed.
- Confirm the direction of rotation is proper.
- Confirm lube oil level.
- Ensure all the butterfly isolation valves in Bioreactor C, D, E & F in open condition and level is same in bioreactors. If level is not same adjust the butterfly valves.
- Start the blower and increase the frequency slowly as per requirement.
- Monitor the pressure and flow of air to the bioreactors

THICKENER:

START UP:

- Check whether the drive mechanism is properly installed and thoroughly lubricated.
- Check whether all parts are in proper alignments and the bolts are tightened.
- Check the drive mechanism for the direction of rotation.
- Check whether the bottom sludge pipe is clear without any choking.
- Check whether mechanical tools used during installation are completely removed from the tank.
- Ensure proper clearance between the blades and the tank bottom at all points throughout the complete evolution of the mechanism.
- Check the proper operation of the overload alarm.
- Fill up the thickener upto 50% with water. Switch on the agitator.
- Start thickener bottom pump and run it under re-circulation.
- Start admitting the slurry from the clarifloculator.
- Take a sample at the inlet of the thickener and analyze for the suspended.

- Start admitting the slurry into the rotary vacuum drum filter.

NORMAL OPERATION:

During normal operation carry out the following activities analyze for the suspended solids content in the samples taken from

1. Inlet to the thickener.
2. Bottom slurry line.
3. Over-flow launder.

SHUT DOWN

- Stop the feed if any maintenance, which is likely to take a few hours (less than 2 hours) has to be carried out.
- Drain the entire tank if any maintenance job (which is likely to take more than 2 hours) is to be carried out either in the RCC or in the raker mechanism.

ROTARY VACUUM DRUM FILTER (RVDF):

START UP:

- Ensure all the equipment and machineries are ready for startup.
- Close the valve in the filter tank drain line.
- Close the valve in the top vacuum line leading from the filter valve to the receiver.
- Open the filtered inlet isolation valve and fill the filter tank up to the over flow line and close the valve.
- Start the agitator, always operate the agitator when slurry is in the tank.
- Start the filter drive and set at about medium speed.

LAGOON OPERATION

- If any maintenance job is required or any solid bed noticed in clarifloculator or thickener, bleeding will be given to lagoon 1 /2. After problem is attended it will be normalized. Lagoon water will be pumped to thickener overflow pit for further processing. After solar drying solids will be used for Brick manufacturing / land filling.

PLATE AND FRAME PRESS FILTRATION

Secondary clarifier Bio sludge concentration is maintained and recycled back (MLSS) to Bioreactor A, B, C and further accumulation is removed by Plate and Frame press. Filtered bio sludge is used as manure.

Annexure- 3

SAFETY MEASURES

1. Safety and health policy committed by top management.
2. Every year safety department objectives committed.
3. Safety audit every year conducted through CIF approved auditors.
4. Once in three months internal audit conducted.
5. Once in six months Certifying body (DNV) audit conducted.
6. Director of Industrial safety and Health Approved onsite emergency Plan.
7. Once in six months Mock drill conducted to check the preparedness to face any emergency.
8. Offsite Mock drill conducted two times with valuable guidance from District collector and MIA.
9. Safety induction to all the new comers.
10. Safety instruction slip issuing at Gate to visitors & truck drivers.
11. Work permit system e.g. hot work, cold work, confined space entry, working at height, Earth excavation.
12. Electrical clearance (EC for Elect equipment's).
13. Electrical Lockout Tag out system followed.
14. LEL report details in the permit.
15. Safety training to employees and contractors.
16. First Aid training from St John ambulance given every year.
17. Daily report safety dept.
18. Plant inspection daily and detailed safety inspection monthly one plant.

19. Daily checklist activities.
20. Accident, Near miss, First aid case analysis.
21. Safety committee meeting every month conducted.
22. Safety Beacon issue every month.
23. Safety week, Safety day celebration, Competition to employees and contractors.
24. Quarterly Safety performance review at MRC.
25. Safety equipment's calibration from third party (OEM).
26. Fire extinguisher, SCBA, testing and refilling.
27. Housekeeping inspection.
28. Fire drill.
29. Environment day celebration and Tree plantation.
30. Lifting tools and tackles testing by competent person.
31. PPE s issued as per requirement to employees and contractors.
32. MPL is ISO 9001 QMS and 14001 EMS certified company.
33. MSDS available for the using chemicals.
34. Ensuring TREM card for Hazardous material transportation.
35. Plant operation by advanced DCS system (Centum VP).
36. UPS power supply for DCS.
37. Emergency DG 1500 KVA two sets for emergency power.
38. Dedicated Fire water storage with three pumps. Jockey pump - Motor driven, P1, P2 diesel driven.

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39. All critical storage's with sprinkler system. CA with automatic sprinkler system.
40. Smoke detectors at critical area.
41. LEL Gas detectors at critical locations and connected to control room.
42. Digital scrolling display at safety dept. and control room.
43. Repeater panel at Control room with auto / manual action switch for siren.
44. Fire call point located all over the plant and non-plant area. Call point once in six month checked from each point.
45. Siren three numbers placed at strategic location and every day morning tested.
46. CFT with three fireman available in the shift.
47. Paging system provided in the Plant areas.
48. Wind socks provided at seven locations.
49. Medical checkup carried out before recruitment and periodically once in two years for all employees and six months once for Plant persons.
50. Fire license renewed every year.
51. All the contractors trained in safety aspects.
52. Safety day, Environment day awareness, and competition conducted to employees & contractors
53. Safety & Environment awareness program, competition conducted to nearby schools.
54. Infrastructure facility provided to nearby health centers.
55. Contractor safety committee conducted once in a year.

56. Risk committee meeting conducted. / Near miss/ Fire report prepared and communicated.

58. Fire license renewed every year.

59. All the contractors trained in safety aspects.

60. Hazop conducted for new projects and modifications.

Environment Related

- More than 2500 trees planted inside & outside the premises.
- Metro water consumption reduced from 0.5 MGD to 0.12 MGD by adopting recovery, reuse, recycle and utilizing RO rejects water from MFL and CMWSSB Kodungaiyur.
- First Industry in Tamil Nadu for Online data monitoring installed and connected to TNPCB, (Stack, ambient).
- New Treated effluent disposal line erected and taken line for marine disposal.
- MOL plant dust recovery system installed.
- Reduced Solid waste generation by using imported lime to replace Low purity Indigenous lime.
- Sludge reused for Brick manufacturing and cement plant and filling low lying area for Green belt development Sludge reused for Brick manufacturing and cement plant and filling low lying area for Green belt development.
- Solar water heater provided for canteen water usage.
- Power saving light post installed to replace old conventional type.
- Infrastructure facility provided for nearby public health centers.

- Environmental awareness program conducted for nearby school children. Competition conducted and prizes given.
- Boiler Fuel conversion from Furnace oil to LNG work is in progress.

**PERFORMANCE EVALUATION OF
MANALI PETROCHEMICALS LIMITED (MPL)
EFFLUENT TREATMENT PLANT-II
MANALI CHENNAI**



Prepared by



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JUNE 2020**

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LIST OF SYMBOLS AND ABBREVIATIONS

BOD	-	Biological Oxygen Demand
CPCB	-	Central Pollution Control Board
CF	-	Cost Function
°C	-	Degree Celsius
CPCL	-	Chennai Petroleum Corporation Ltd
ETP	-	Effluent Treatment Plant
HRT	-	High Rate Thickener
MLR	-	Multiple Linear Regression
MLSS	-	Mixed Liquor Suspended Solids
MPL	-	Manali Petrochemicals Limited
M/s	-	Meter per second
O&M	-	Operation and Maintenance
PG	-	Propylene Glycol
PO	-	Propylene Oxide
PPM	-	Parts Per Million
SCE	-	Secondary Clarifier Effluent
SCU	-	Secondary Clarifier Underflow
SPIC	-	Southern Petrochemical Industries Corporation
TNPCB	-	Tamil Nadu Pollution Control Board
TDS	-	Total Dissolved Solids
TSS	-	Total Suspended Solids
$\mu\text{g}/\text{m}^3$	-	Microgram per meter cube

CHAPTER 1

INTRODUCTION

1.1 GENERAL

M/s Manali Petrochemicals 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 is located at Sathangadu Village, Chennai (adjacent to Balmer Lawrie Ltd) and is capable of manufacturing 18,000 MT of PO, 10,000 MT of PG and 25,000 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 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 reacted with Isocyanates of different grades to produce several grades 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.

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 Propylene Oxide and Propylene Glycol. The Polyol technology was provided

by Press Industria (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.

The unit has renewed the consent orders and it's valid till 31st March 2020. The company has applied for renewal of Consent and renewal is applied and the renewal is in progress for the year 2020-2021.

1.2. NEED FOR STUDY

To monitor the performance evaluation of Manali Petrochemicals Limited (MPL) Effluent Treatment Plant-II.

CHAPTER 2

MANUFACTURING PROCESS DESCRIPTION

2.1 PROPYLENE OXIDE MANUFACTURING UNIT

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.



The solution is then saponified with milk of lime to generate Propylene oxide



The vapor Propylene Oxide is stripped with steam and distilled to get the final product. The final product is sent to propylene oxide storage.

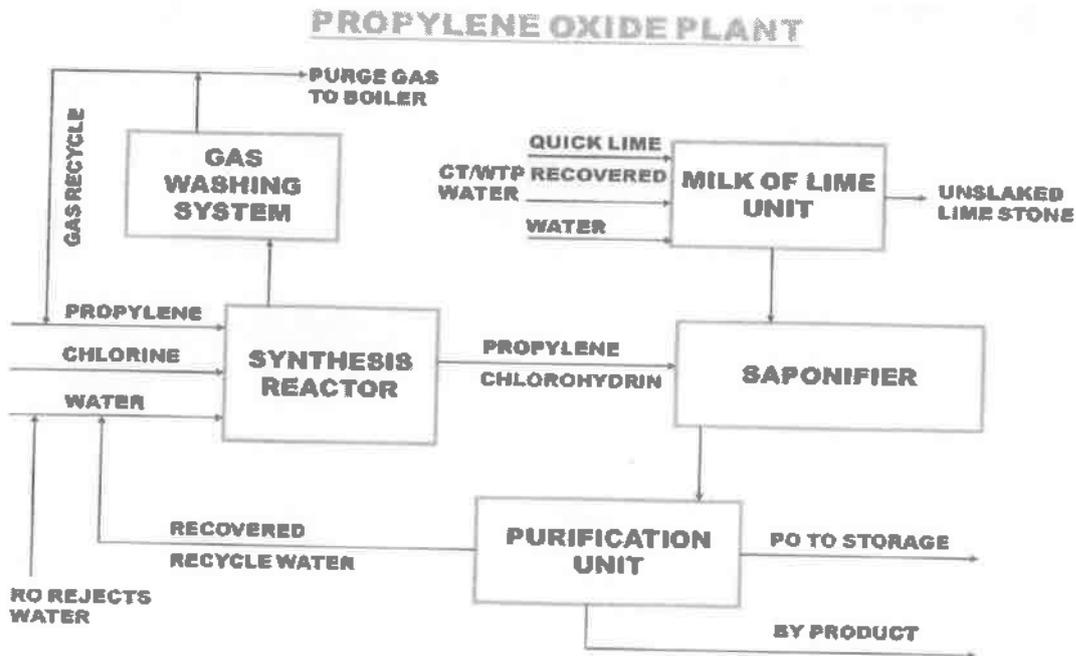


Fig 2.1 Process of Propylene Oxide plant

2.3 POLYETHER POLYOLS MANUFACTURING UNIT

Polyether polyols are manufactured through Propoxylation/Ethoxylation of polyhydric alcohol using liquid catalyst. Glycerin, Di-Propylene Glycol, Tri Ethyl Amine (TEA), are used as starters with 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.

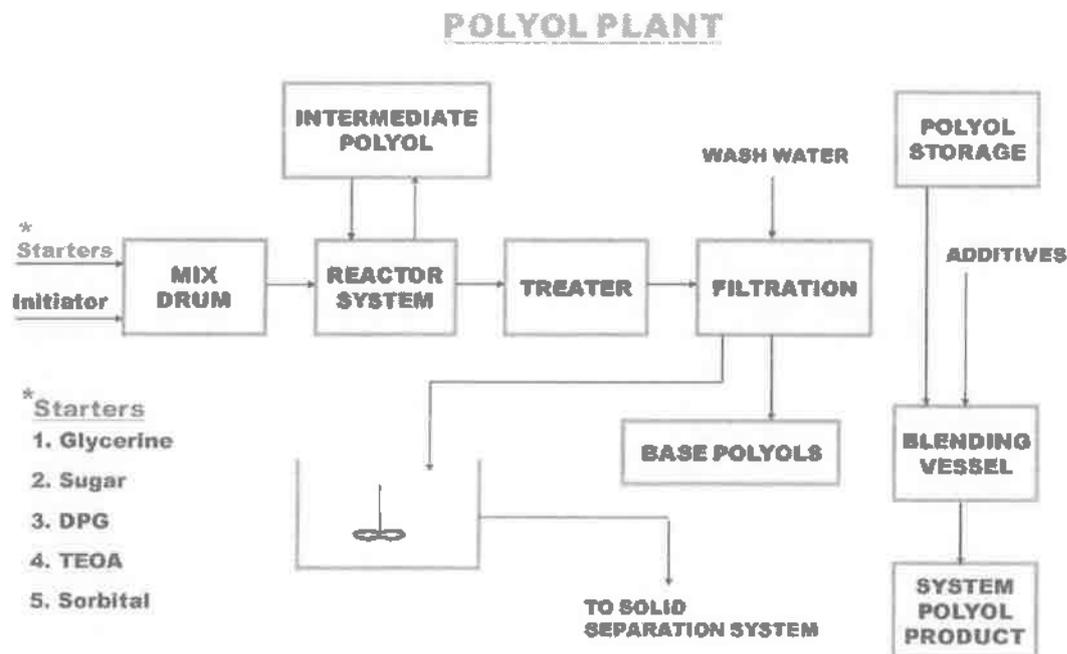


Fig 2.3 Process of Polyol plant

CHAPTER 3

WATER CONSUMPTION & WASTEWATER GENERATION

3.1 WATER BALANCE SHEET

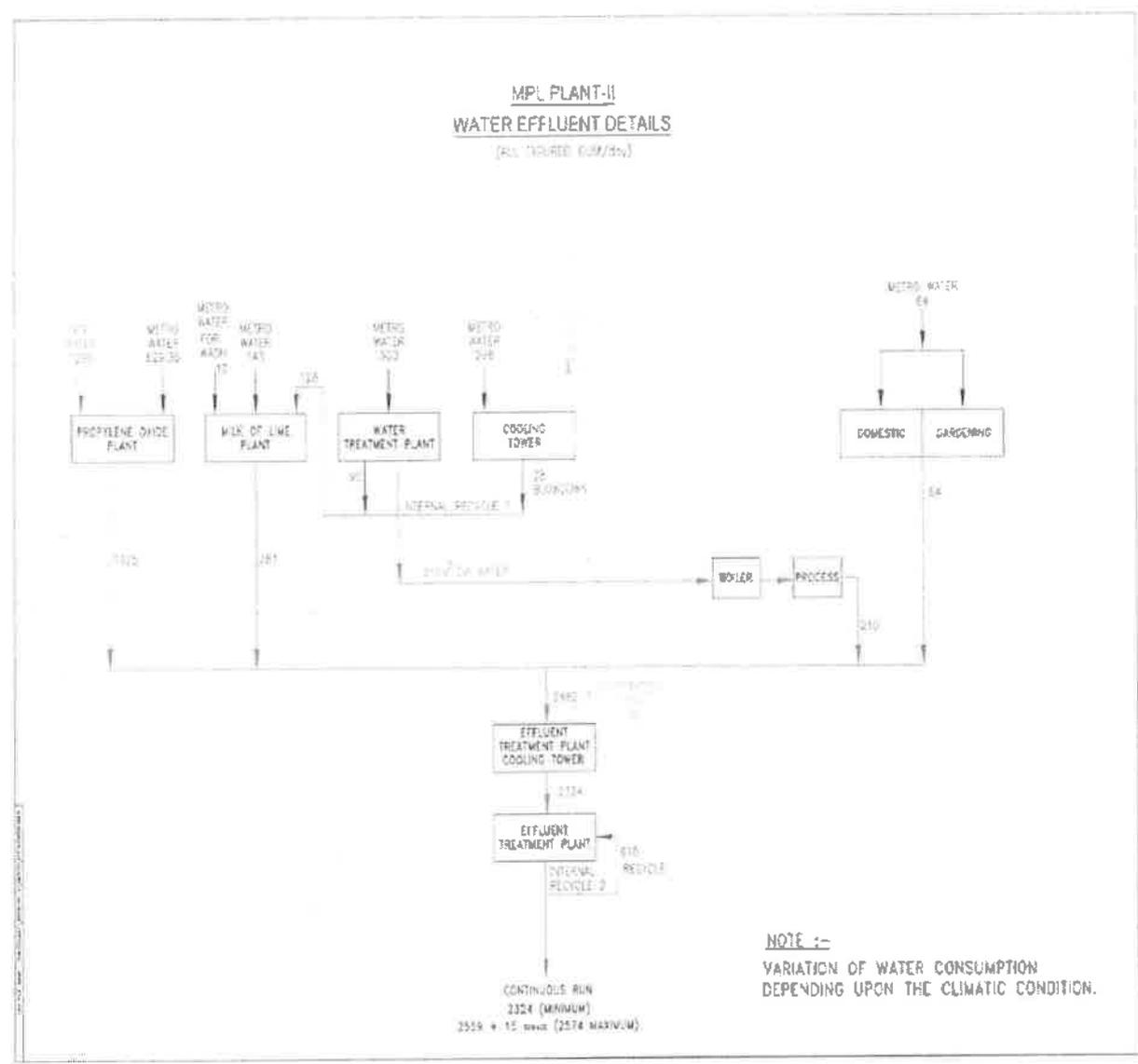


Fig 3.1 Water balance

3.2 WATER REQUIREMENT

Current consumption of water is 2740 KLD which is supplied by Metro water and CMWSSB Secondary treated Sewage water. Whereas MPL will be using the fresh water around 1444 KLD and about 1296 KLD of Secondary treated Sewage water. The details are furnished in table 3.1.

Table 3.1 Water Requirement

SNO	DESCRIPTION	REQUIREMENT IN KLD *
1	Propylene Oxide plant	1925
2	Milk of Lime Plant	143
3	Water Treatment plant	300
4	Cooling Tower	298
5	Domestic & Gardening	64

*Reused water quantity excluded

3.3 WASTEWATER GENERATION DETAILS

The wastewater generated from Propylene Oxide plant, Milk of Lime plant, Water Treatment plant and Domestic & Gardening details is presented in the table 3.2.

Table 3.2 Details of Effluent Generation

SNO	DESCRIPTION	GENERATION IN KLD
1	Propylene Oxide plant	1925
2	Milk of Lime plant	281
3	Water Treatment plant	210
4	Domestic & Gardening	64

3.4 WASTEWATER CHARACTERISTICS

Characteristics of Raw Effluent generated is presented in table 3.3 shows 40,000 mg/L of Total Dissolved Solids, 400 mg/L of BOD, 1800 to 2300 mg/L of COD.

Table 3.3 Characteristics of Raw Effluent

Parameters	Raw Effluent
(A) GENERAL PARAMETERS :	
(i) pH :	10 -11
(ii) Color Units	N/A
(iii) Temperature °C	40 °C
(iv) Suspended solids	
(a) Total mg/L	200
(b) Fixed mg/L	-
(c) Volatile mg/L	-
(v) Dissolved solids	
(a) Total mg/L	40,000
(b) Fixed mg/L	-
(c) Volatile mg/L	-
(vi) Total volatile solids mg/L	-
(vii) Dissolved Oxygen mg/L	<1
(viii) BOD (5 days) @ 20 °C mg/L	400
(ix) C O D , mg/L	1800 - 2300
(x) Oil & Grease mg/L	BDL
(B) CHEMICAL PARAMETERS :in PPM	
(i) Ammonical Nitrogen, mg/L (as N)	BDL
(ii) Nitrates, mg/L (as N)	BDL
(iii) Chlorides, mg/L (as Cl)	26,000- 30,000
(iv) Phosphates, mg/L (as P)	BDL -50 PPM
(v) Phenolic Compounds, mg/L (as phenol)	BDL
(vi) Cyandies ,mg/L (as CN)	BDL
(vii) Sulphides, mg/L (as S)	BDL

(viii) Sulphates,mg/L (as SO ₄)	100 -400 PPM
(ix) Insecticides mg/L	BDL
(x) Total residual Chlorine mg/L (as Cl ₂)	BDL
(xi) Fluorides mg/L (as F)	BDL
(xii) Percent Sodium	0.01
(xiii) Pesticides mg/L	BDL

*BDL- Below Detectable Limit

3.5 WASTEWATER CHARACTERISTICS - SECONDARY DATA

Table 3.4 WasteWater Characteristics - Secondary Data

Characteristics	plant-1
Date of Sampling	22.02.2019
BOD (5 days) @ 20 ° C	310
Calcium	15,390.72
Chloride	27,591.44
COD	1840
Fluoride	0.71
Hexavalent Chromium	BDL
Oil and Grease	7
pH	10.71
Phenolic compounds	BDL
Phosphate	8.79
Sulphate	549.28
Sulphide	1.6
Total chromium	0.062
TDS	46,670
TRC	BDL
TSS	86

All parameters are in mg/L except pH

CHAPTER 4

METHODOLOGY FOR PERFORMANCE EVALUATION OF EFFLUENT TREATMENT PLANT

4.1 EFFLUENT TREATMENT PLANT PROCESS DESCRIPTION

Effluent generated by Propylene Oxide plant at saponifier bottom is pumped to High rate thickener at 75 ° C 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 are withdrawn at 10 T/H. 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. The HRT overflow is a gravity flow to Primary Clarifier. From Primary clarifier overflow goes to collection sump and this effluent is pumped to the top of cooling tower reducing the temperature of the effluent from 65 to 35 ° C. The outlet of cooling tower goes to a sump from where it is pumped to series of aeration tanks from which it is pumped to effluent holding tank (ET1) from there to bioreactor.

In bioreactor, at first, bioculture is developed using biomass, 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. Bioreactors 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 added timely to provide nitrogen and phosphorus as macro nutrients for the growth of bacteria.

The outlet of bioreactor-flows to secondary clarifier which clarifies the activated sludge from the treated effluent. Secondary clarifier bottom sludge is

pumped back to the bioreactor to maintain MLSS. If Excess Bio sludge is formed from secondary clarifier is pumped and routed to Plate and frame filter press in order to remove the excess Bio sludge.

Clarified effluent 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.

4.2 EFFLUENT TREATMENT PLANT SCHEME

ETP Flow chart attached in the Annexure

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4.3 LIST OF EQUIPMENTS

1) HIGH RATE THICKENER

Type	:	Cylindrical Tank
Diameter of the tank	:	13 m
Side wall Depth	:	3.5 m
Material of Construction	:	Reinforced Cement Concrete

2) HRT RACKER ARM UNIT

Equipment Tag No.	:	X 9402
Motor rated power	:	3.7 kW
Material of Construction	:	MILD STEEL

3) HIGH RATE THICKNER BOTTOM PUMP

Equipment Tag No.	:	PC 9402A/B
Motor rated power	:	5.5 kW/7.5 kW
Volumetric flow rate	:	14 m ³ /hr.
Material of Construction	:	CAST IRON

4) NEW HRT FLOCCULANT AGITATOR

Equipment Tag No.	:	AG 9402
Motor rated power	:	0.37 kW
Material of Construction	:	STAINLESS STEEL

5) 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.	:	PD 9402A
Motor rated power	:	0.75 kW
Volumetric flow rate	:	50 LPM
Material of Construction	:	STAINLESS STEEL

6) NEW HRT FLOCCULANT DOSING PUMP

Equipment Tag No.	:	PD 9402B
Motor rated power	:	0.18 kW
Material of Construction	:	PP

7) NEW HRT FLOCCULANT SCREW FEEDER

Equipment Tag No.	:	S 9402
Motor rated power	:	0.18 kW
Material of Construction	:	STAINLESS STEEL

8) RVDF DRUM – I & II

Equipment Tag No.	:	X 9501A/B
Motor rated power	:	1.5 kW

Diameter	:	2440 m
9) RVDF AGITATOR -I		
Equipment Tag No.	:	X 9502A
Motor rated Power	:	2.2 kW
Material of Construction	:	MILD STEEL
10) VACCUM PUMP		
Equipment Tag No.	:	PC 9501A/B
Pressure	:	200 mm Hg
Motor rated power	:	75 / 90 kW
Material of Construction	:	CAST IRON
11) RVDF AGITATOR-2		
Equipment Tag No.	:	X 9502B
Motor rated power	:	2.2 kW
Material of Construction	:	MILD STEEL
12) ET1 SMALL PIT PUMP (N)		
Equipment Tag No.	:	PC 9503A
Volumetric flow rate	:	100 m ³ /hr.
Motor rated power	:	3.7 kW
Speed	:	1450 rpm
Material of Construction	:	CAST IRON
13) ET1 SMALL PIT AGITATOR		
Equipment Tag No.	:	AG 9503
Motor rated power	:	4 kW
Material of Construction	:	MILD STEEL
14) COLLECTION CHAMBER		
Type	:	Cylindrical Tank
Diameter of the tank	:	12 m
Side wall Depth	:	3.5 m
Material of Construction	:	Reinforced Cement Concrete
15) COLLECTION CHAMBER UNDERFLOW PUMP		
Equipment Tag No.	:	PC 9404
Make & Model	:	Johnson 14/8
Flow rate	:	14 m ³ /h
Motor rated power	:	5.5 kW
Material of Construction	:	CAST IRON
16) 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

17) NEW COOLING TOWER PUMP

Equipment Tag No. : PC 9506A/B
 Model : CN 80 – 200
 Flow rate : 100 m³/h
 Motor rated power : 5.5 kW
 Material of Construction : CAST IRON

18) NEW COOLING TOWER FAN

Equipment Tag No. : E 9506-C & D
 Motor rated power : 7.5 kW
 Diameter : 1829 mm
Material of Construction:
 Blade : Aluminum alloy
 Hub : Aluminum

19) 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

20) COOLING TOWER TO AT3 TRANSFER PUMP

Equipment Tag No. : PC 9703-A/B
 Make & Model : MEGA – G100 - 315
 Flow rate : 200 m³/h
 Head : 35 m
 Motor rated power : 18.5 kW
 Material of Construction : CAST IRON

21) 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

22) AERATION TANK CIRCULATION PUMPS

Equipment Tag No. : PC 9356-A/B/C/D
 Head : 35 m
 Motor rated power : 7.5 kW
 Volumetric flow rate : 40 m³/hr.

Rated Speed : 2913 rpm
 Material of Construction : CAST IRON

23) 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

24) AT1 TO EFFLUENT HOLDING TANK TRANSFER PUMP

Equipment Tag No. : PC 9357-A/B
 Head : 45 m
 Volumetric flow rate : 200 m³/h
 Rated Speed : 1450 rpm
 Material of Construction : STAINLESS STEEL

25) 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

26) EFFLUENT HOLDING TANK TO BIOREACTOR 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

27) EFFLUENT HOLDING TANK TO BIOREACTOR TRANSFER PUMP

Equipment Tag No. : PC 9353-A/B
 Head : 30 m
 Motor rated power : 16.34 kW
 Volumetric flow rate : 150 m³/hr.
 Rated Speed : 2900 rpm
 Material of Construction : STAINLESS STEEL316

28) 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

29) TRITON JET AERATOR

Equipment Tag No. : JA 9351-A/B/C/D/E
 Power : 70 HP
 Material of Construction : STAINLESS STEEL

30) TRITON BLOWER

Equipment Tag No. : X 9352-A/B/C/D/E
 Rated Speed : 2900 rpm
 Power : 10 HP
 Material of Construction : UPVC

31) SECONDARY CLARIFIER CHAMBER

Type : Cylindrical Tank
 Diameter of the tank : 14 m
 Side wall Depth : 3.5 m
 Material of Construction : Reinforced Cement Concrete

32) SECONDARY CLARIFIER RACKER ARM

Equipment Tag No. : X 9405
 Motor rated power : 1.5 kW
 Material of Construction : Carbon steel epoxy painted

33) SECONDARY CLARIFIER UNDERFLOW PUMP

Equipment Tag No. : PD 9354-A/B
 Head : 30 m
 Motor rated power : 30 kW
 Volumetric flow rate : 150 m³/hr.
 Rated Speed : 194 rpm
 Material of Construction : CAST IRON

34) COAGULANT DOSING PUMP

Head : 5 kg/cm²
 Volumetric flow rate : 25 LPH
 Rated Speed : 1440 rpm
 Material of Construction : CAST IRON

35) 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

36) TES TRANSFER PUMP

Equipment Tag No. : PC 9301-A

Motor rated power : 45 kW
 Head : 45 m
 Volumetric flow rate : 55.5 LPS
 Material of Construction : STAINLESS STEEL

37) TES TRANSFER PUMP

Equipment Tag No. : PC 9301-B
 Motor rated power : 37 kW
 Head : 67.5 m
 Volumetric flow rate : 160 m³/hr.
 Material of Construction : STAINLESS STEEL

38) TES TRANSFER PUMP

Equipment Tag No. : PC 9301-C
 Motor rated power : 37 kW
 Head : 55 m
 Volumetric flow rate : 254 m³/hr.
 Material of Construction : CAST IRON

39) TES TRANSFER PUMP

Equipment Tag No. : PC 9301-D
 Motor rated power : 18.5 kW
 Head : 58 m
 Volumetric flow rate : 70 m³/hr.

40) 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

41) CULTURE PREPARATION BLOWER

Volumetric flow rate : 3.67 m³/min
 Differential pressure : 14.92 psi

42) CULTURE PREPARATION PUMP

Volumetric flow rate : 14 m³/hr.
 Material of Construction : CAST IRON

43) 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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44) 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	:	Poly propylene

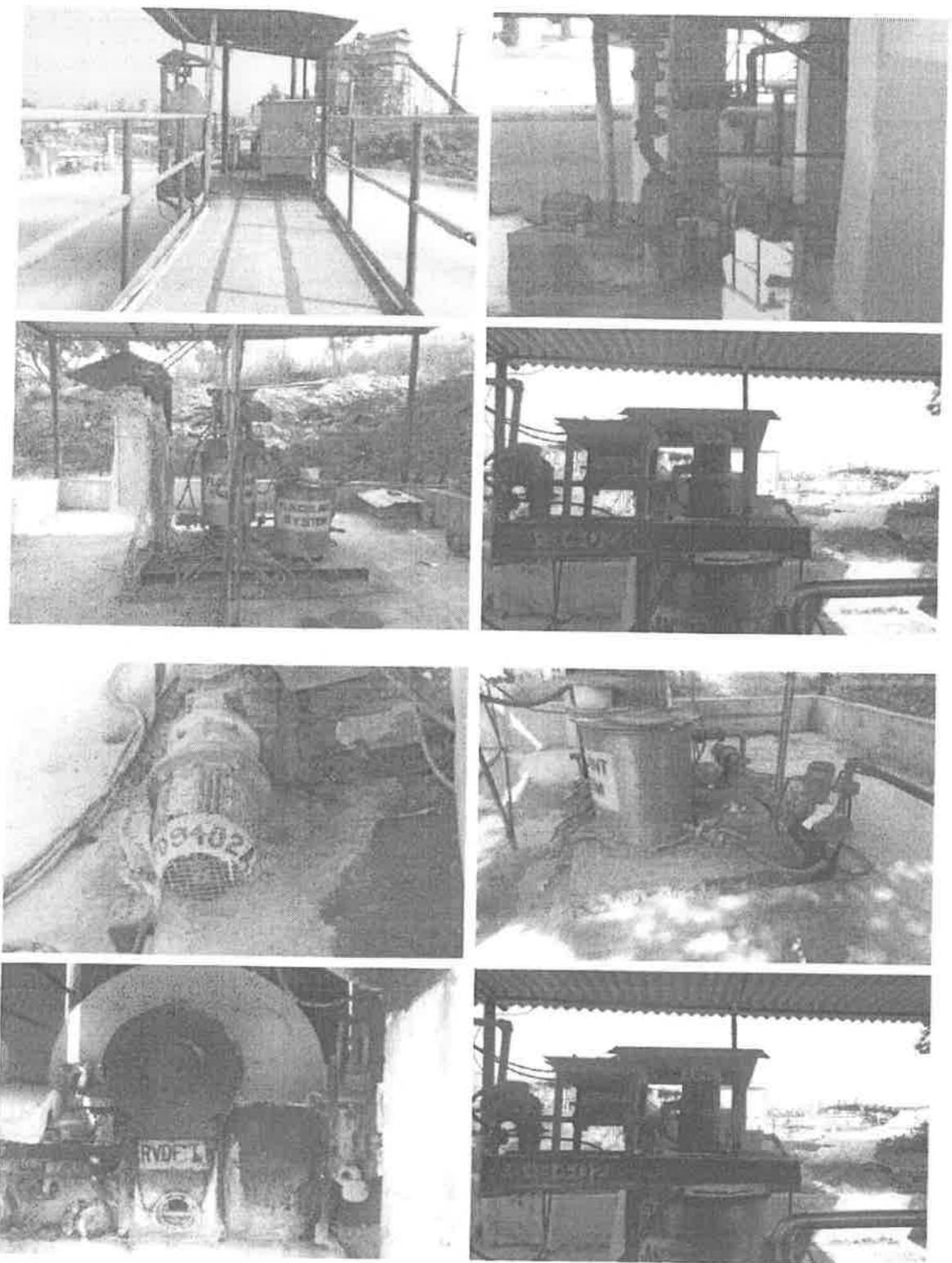


Fig 4.2 Set- I picture from ETP-II

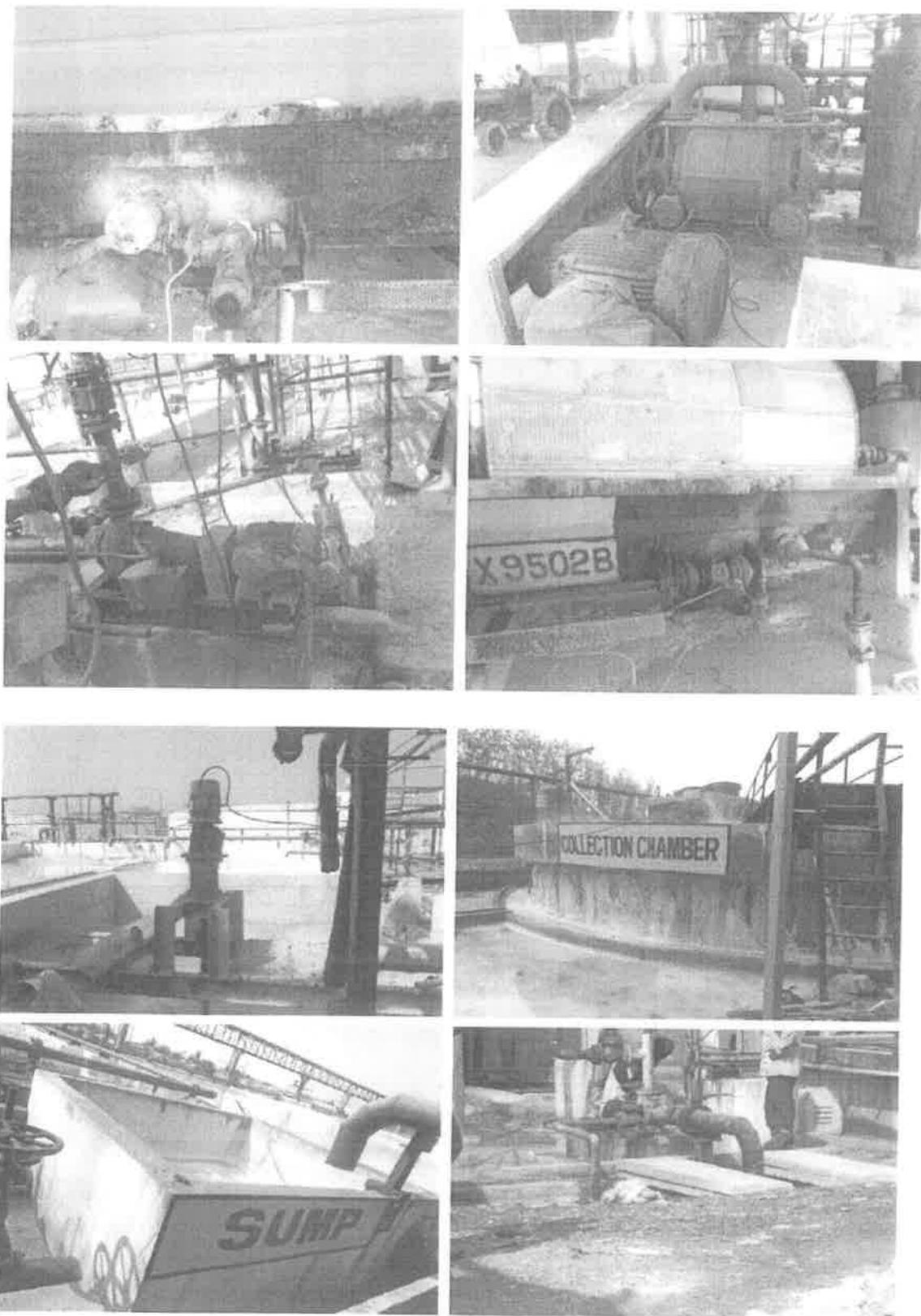


Fig 4.3 Set-2 picture from ETP-II

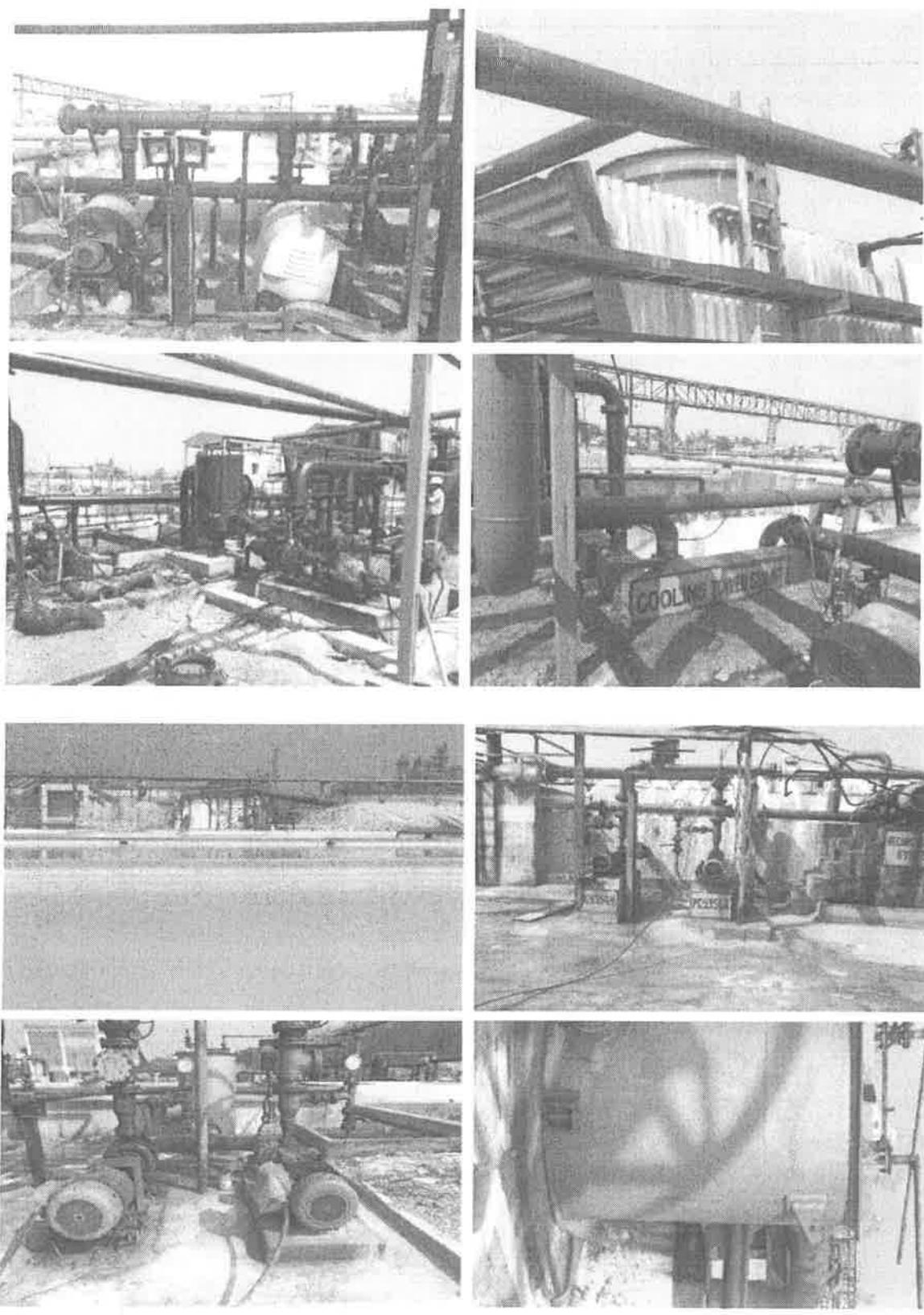


Fig 4.4 Set-3 picture from ETP-II

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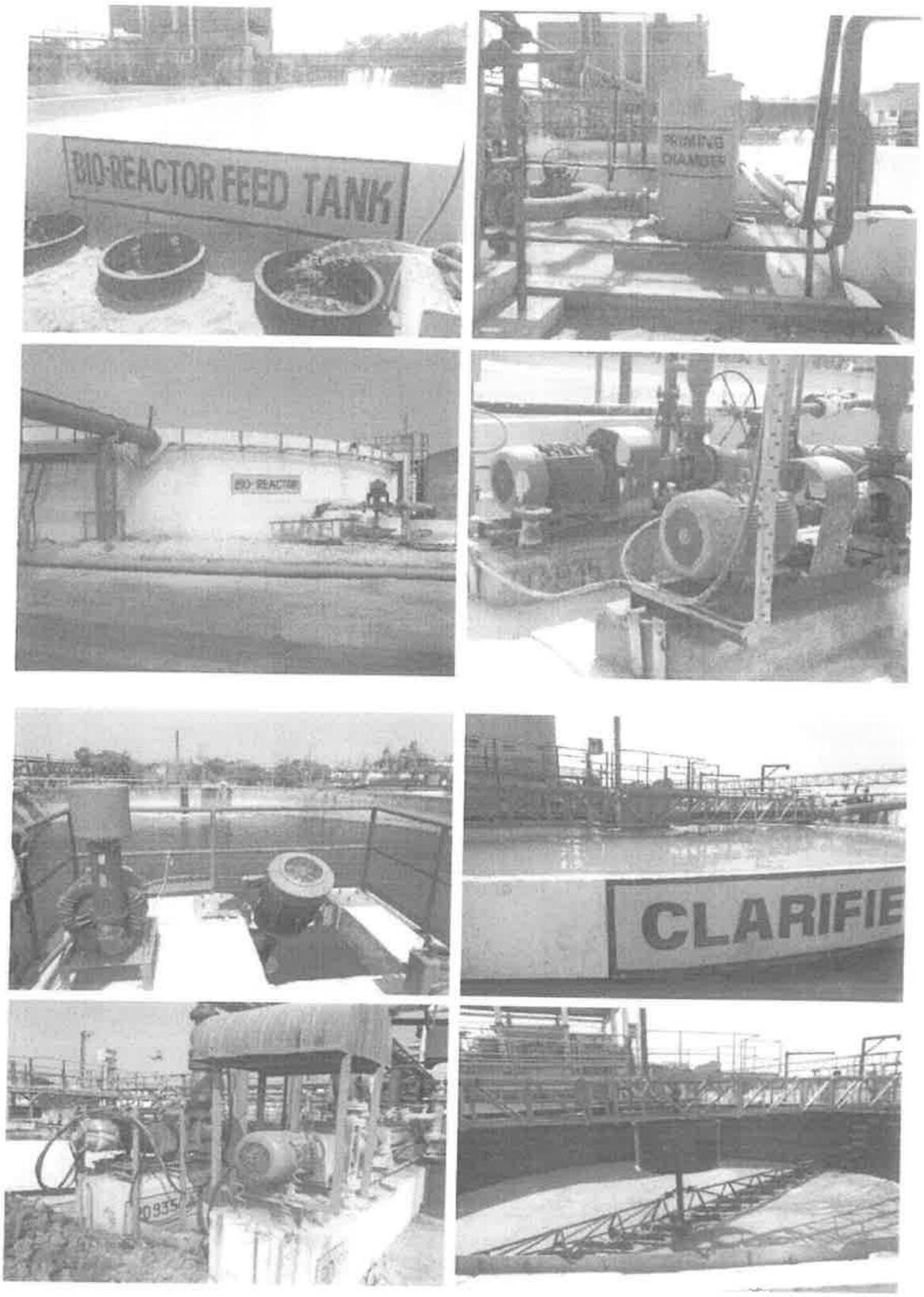


Fig 4.5 Set-4 picture from ETP-II

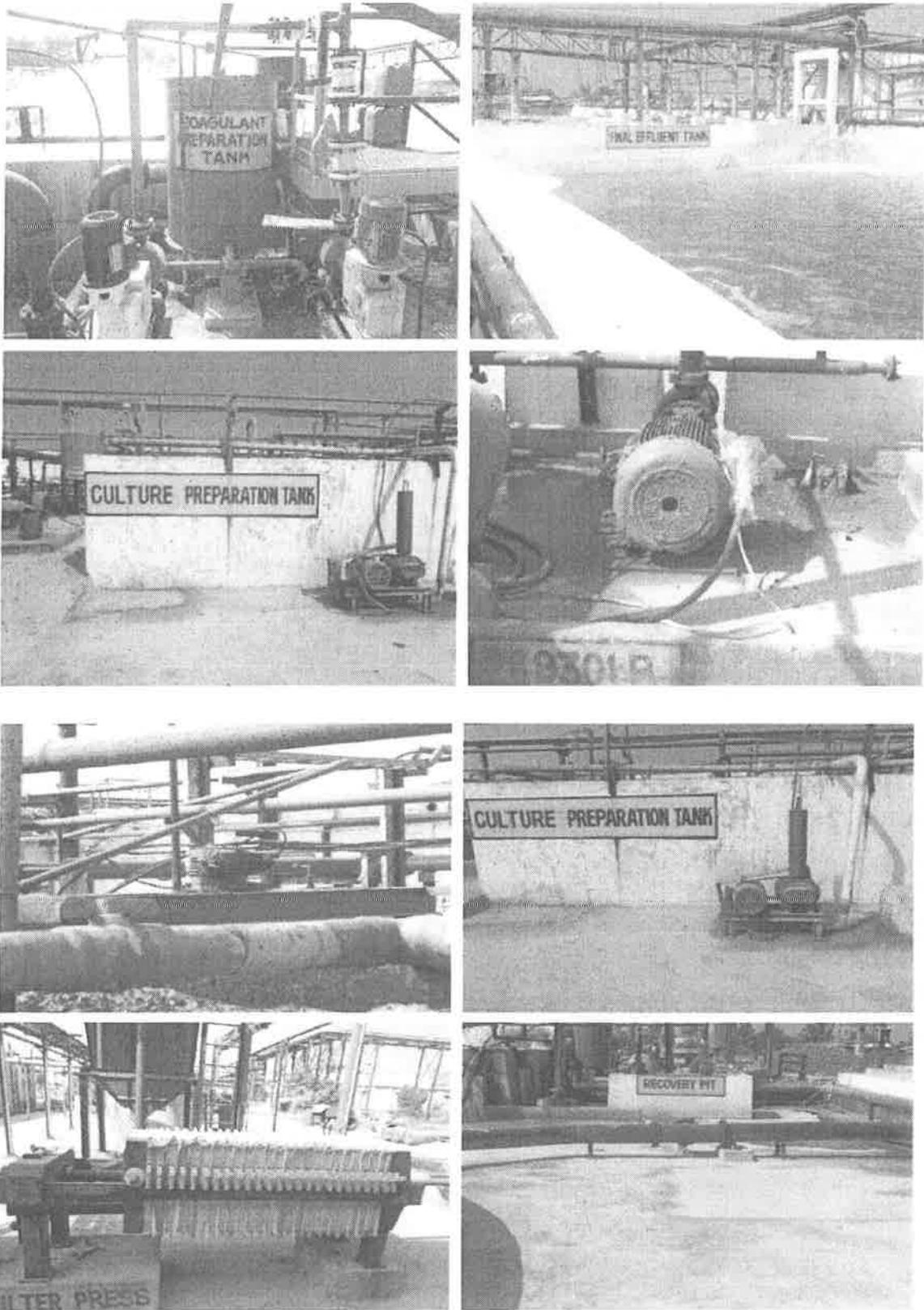


Fig 4.6 Set-5 picture from ETP-II

CHAPTER 5

STUDY REPORT OF ENVIROKRAFT

5.1 COMPOSITION OF MICROBIAL CULTURE

BIONIL RS-1 contains selected bacterial strains to biodegrade a broad Spectrum of organic compounds like cresols, phenols, benzene; toluene; other aromatic hydrocarbons with hydroxylated, nitrogenated groups; ethane; other short-chain alkyl hydrocarbons and related aromatic Compounds including catechol, cumene, ketones, recalcitrant organics and other organic acids present in the chemical industry effluent.

The effective environmental control in biological waste water treatment is based on an understanding of basic principles governing growth of micro-organisms.

Bacteria can reproduce by binary fission that is by dividing; the original cell becomes two new organism the time required for each fission, which is termed as generation time, can vary from days to less than 20 minutes .For example if generation time is 30 minutes, one bacteria would yield 16,777,216 Bacteria after 12 hours. This is hypothetical figure, for bacterial would not continue to divide indefinitely because of various environmental limitations, such as substrate concentration, nutrient concentration or even system size.

The general growth pattern of bacteria in a batch culture is as shown below. Initially, a small number of bacteria of organism are inoculated in to a fixed volume of culture medium and a number of viable organism is recorded as a function of time. The growth pattern based on number of cells has four more or less distinct phases.

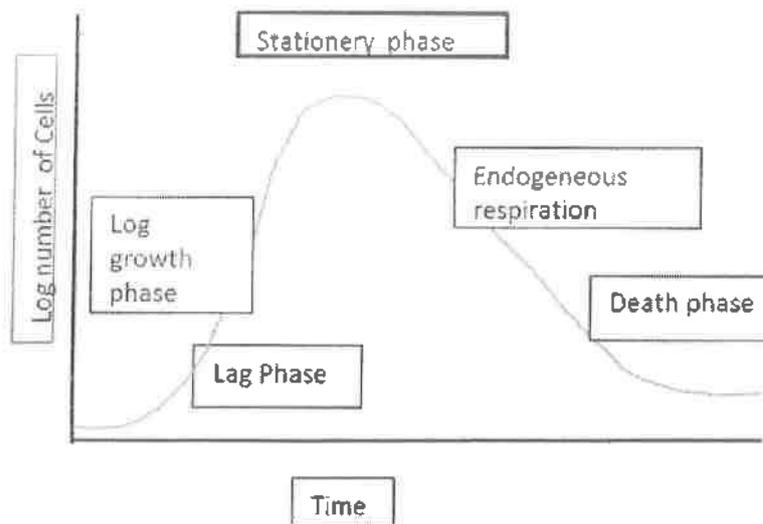


Fig 5.1 Typical Bacterial Population Growth

The lag phase - upon addition of an inoculation to a culture medium, the lag phase represents the time required for the organism to acclimate to their new environment. The log growth phase - during this period, the cells divide at a rate determined by their generation time and their ability to process food (Constant percentage growth phase)

The stationery phase - Here the population remains stationary. Reasons advanced for this phenomenon are

- (a) - that the cells are exhausted the substrate or nutrients necessary for growth and
- (b) - that the growth of new cells offset by the death of old cells.

The log death phase- During this phase, the bacteria death rate exceeds the production of new cells. The death rate is usually a function of viable population and environmental characteristics. In some cases, the log death phase is the inverse of the log growth phase .

The growth pattern can be described in terms of variation in mass of active bacteria and time, below as per phases shown below.

1. The log growth phase - There is always an excess amount of food surrounding the micro-organism and the rate of metabolism and the

growth is only a function of the ability of micro-organism to process the substrate.

2. Declining growth phase - the rate of growth, hence the mass of bacteria decrease because of limitations in food supply.
3. Endogenous phase - The micro-organism are forced to metabolize their own protoplasm without replacement, since concentration of food available is at minimum. During this phase, a phenomenon known as lysis can occur in which the nutrients remaining in the dead cells diffuse out to furnish the remaining cells with food (known as cryptic growth)

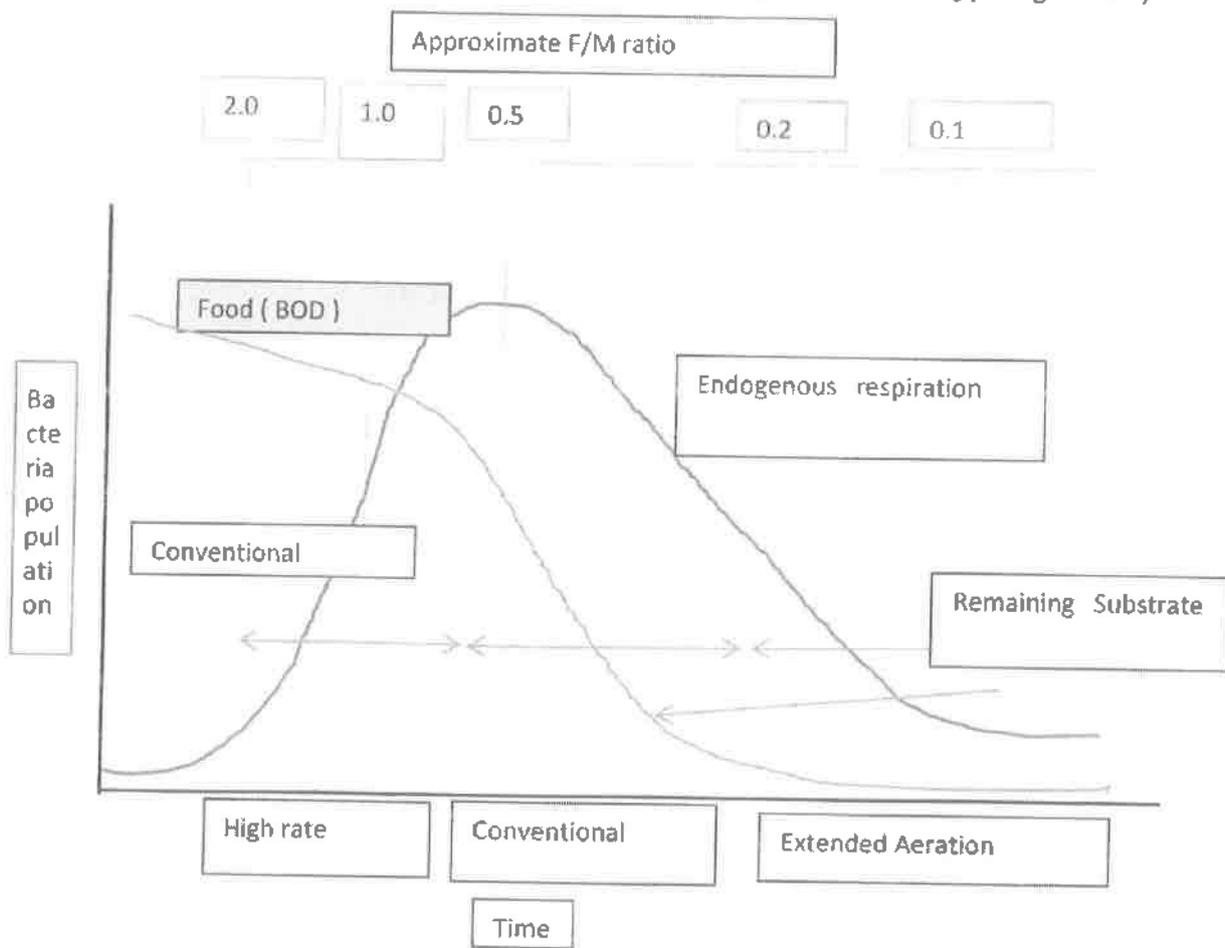


Fig 5.2 Relationship of Bacterial growth phase to food supply in an aerated system

The conversion of organic matter to gaseous end products and cell tissues can be accomplished aerobically. As per sketch shown below.

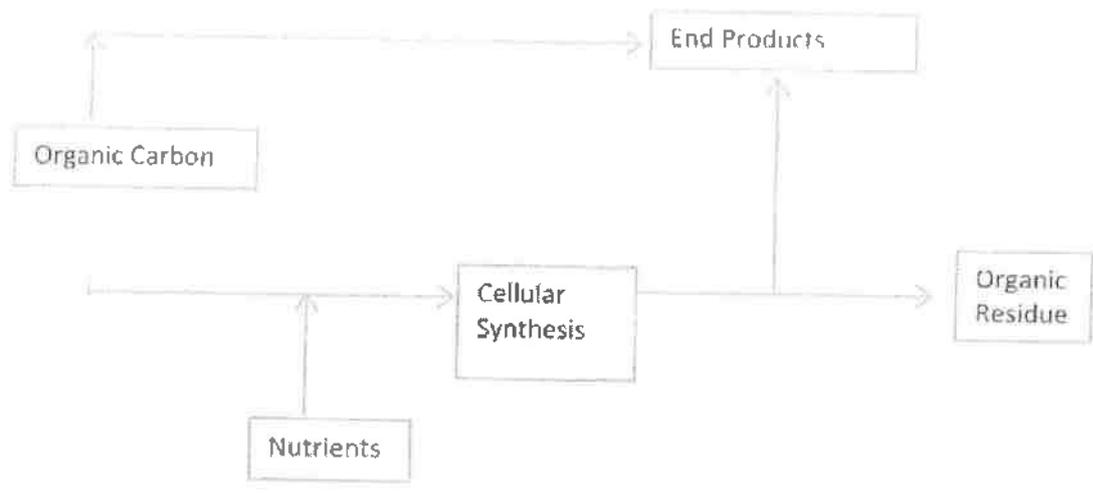
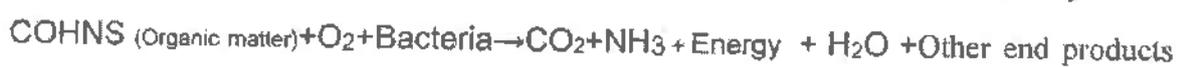


Fig 5.3 Schematic Re-Presentation of Bacterial Oxidation.

As shown, a portion of organic matter is oxidised to end products. This process is carried out to obtain the energy for synthesis of new cells. In the absence of organic matter, the cell tissue will be endogenously respired to gaseous end products and a residual to obtain energy for maintenance in most biological treatment system, these processes occur simultaneously.



Endogenous respiration - Auto oxidation



In these equations, COHNS represents the Organic matter in wastewater. The formula $C_5H_7NO_2$, which represents cell is a generalized value obtained from experimental studies and was first suggested by Hoover and Porges in 1952. Although the endogenous respiration reaction is shown as resulting in relatively simple end products and energy, actually stable organic end products are also formed.

5.2 LAB SCALE TREATABILITY STUDY BY ENVIROCRRAFT

Table 5.1 Lab Scale Treatability Study by Envirokraft

Day	DATE	PARAMETER										REMARKS
		COD (mg/L)	TDS (mg/L) on meter	pH	SV30 (mL/L)	DO (mg/L)	MLSS (mg/L)					
	28.04.2017	1824	20,300	11.5								pH neutralize with sulphuric acid, in 11 litre effluent added 1.5 Litre Biomass & 2 gm. bio culture. Airing continue.
				5.3								While adding Sulphuric acid the pH reduces to 5.3.
	29.04.2017	1824	20,300	8.15								Added 200 ml lime solution to maintain pH at alkaline range.
Day 0	30.04.2017	1728	19,800	7.51	120	4.0	3280					300 ml biomass & 100 ml lime solution is added.
Day 1	01.05.2017	1030	20,500	7.25								
Day 2	02.05.2017	528	21,100	7.35	160	3.8						2 Litre of effluent is added to avoid substrate limitation.
Day 3	03.05.2017	1008	21,100	7.26								Why an inc
Day 4	04.05.2017	464	21,400	7.27	160		3800					1.5 Litre effluent added to reactor by fed batch mode. Feeding continue 10:00 a.m. From 5:00 p.m. onwards the reactor is operated in continuous mode by feeding 2.5 litre of effluent per day.

Day 5	05.05.2017	480	21,800	7.24		2.8		
Day 6	06.05.2017	416	22,500	7.28	150		3630	
		448	23,200	7.06				
Day 7	07.05.2017	464	23,300	6.98		2.7	3845	
Day 8	08.05.2017	448	23,700	7.11				
Day 9	09.05.2017	420	24,700	7.14	160		3995	12 Litre per day of effluent is added to aeration tank.
Day 10	10.05.2017	389	24,700	6.65	160	2.3		No effluent addition. To neutralize acid Lime is added for pH.
Day 11	11.05.2017	443	24,500	6.90				12 Litre per day effluent is added to aeration tank.
Day 12	12.05.2017	415	24,600	7.10	165	1.9		24 Litre per day effluent is added to aeration tank. Feeding continue 24 hrs. Lime is added for to keep pH within the range.
Day 13	13.05.2017	390	24,700	7.05	165	1.2	3920	24 Litre per day effluent is added to aeration tank.
Day 14	14.05.2017	330	24,600	7.02		0.50		No effluent addition.
Day 15	15.05.2017	212	26,000	7.45				R & D stop.

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Details of study :-

1. Envirokraft collected effluent samples from industry and conducted in house tests to gauge its treatability through technologies available at their laboratories. like conventional primary treatment, chemical oxidation, Fenton treatment ,biological treatability, distillation, tertiary treatment whatever is possible & feasible.
2. Experiment's had been conducted at Envirokraft laboratories, Ankleshwar, Gujarat for biological COD-BOD removal on 28.04.2017, for initial set-up of 12 litre of bioreactor having fish tank aerators for mixing & oxygen supply with initially on batch mode & after achieved maximum COD-BOD removal then start it on continual feed base to check the efficiency of biomass, required retention time etc. data generation.
3. During treatability study they observed that effluent pH reduced drastically from 12 to below 6, after some studies done on primary treated effluent with plain aeration of effluent & observed same phenomenon of pH reduction. During testing of probable cause free chlorine is detected, hence its needed to elimination of free chlorine for survival of biomass in bioreactor. with only plain aeration for 40 hour time total free chlorine reduce up to BDL level & pH reduced up to 6. hence during study also pH correction was required & maintain pH with lime solution as shown in table 5.1.
4. From 4th Day onwards no change in COD even after adding 7 L of fresh wastewater having COD 1824. It means COD getting reduced from 1824 to 450 mg/L approx. with available bio mass culture.
5. Fresh waste water feeding rate 7 litres in 24 hours at a rate of 5 drops / min average from feed source.
6. COD stable at Aeration tank outlet approx. 450 mg/L.
7. Fresh wastewater feed rate being increased slowly to see COD variation at overflow of aeration tank

- 8. Aeration tank outlet over flow being tested for BOD, to identify whether any biodegradable organic matter present or not? If present to what extent?
- 9. Aeration tank over flow having COD approx. 450 mg/L will be further put to experiment till COD reduction to 250 mg/L or below. The distillation of Biological treated water having COD value of 450 mg/L- distillate COD is 35 mg/L & TDS 70 mg/L.

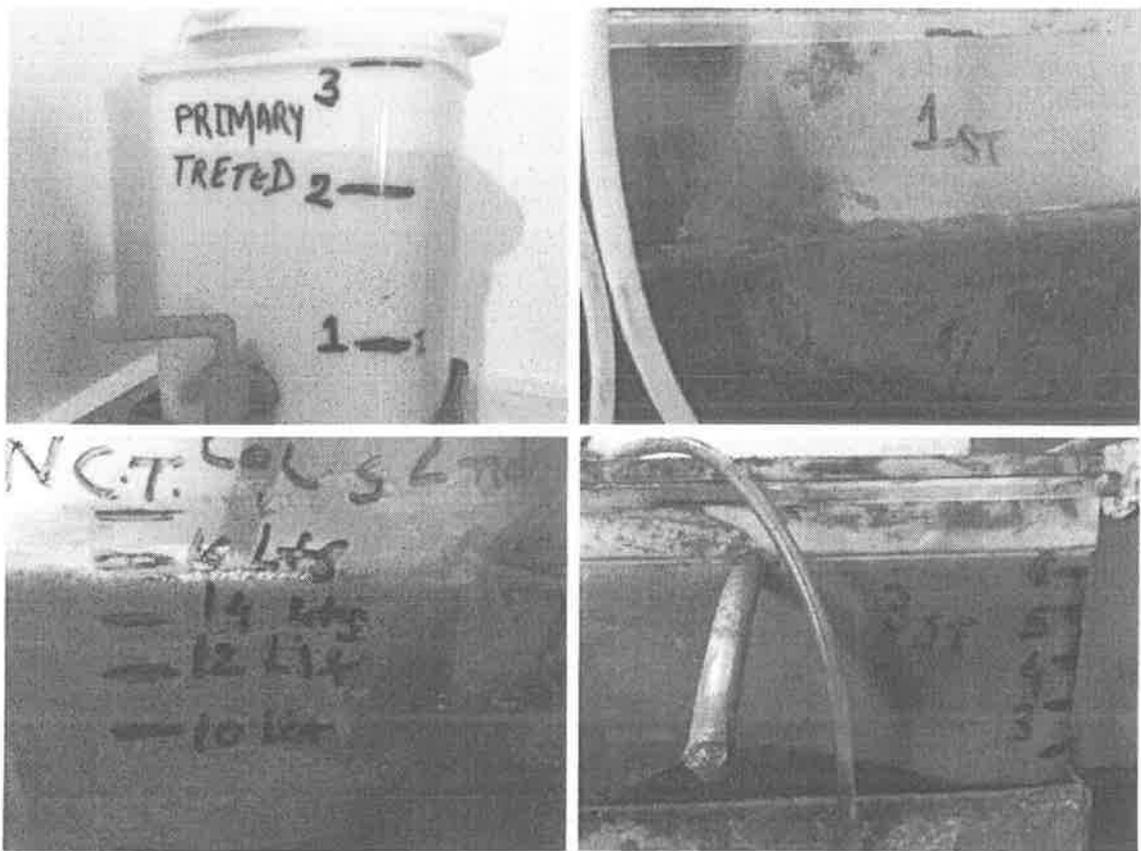


Fig 5.4 Laboratory scale setup used for treatability study by Envirokraft

CHAPTER 6

PERFORMANCE MONITORING

The photographs of the sample collected for Performance evaluation of Effluent Treatment Plant - I on 25th April 2019 are presented in figure 4.2, 4.3, 4.4, 4.5 and 4.6. The monitoring data of the ETP-II for the quality of the effluents from different sections of the ETP-II for the various parameters of the different effluent samples collected by CES team on 25th April 2019 is presented in Table 6.3 and Table 6.4.

The samples were collected in Raw Effluent (S1), HRT outlet (S2), Bio Feed (S3), Bioreactor (S4), Secondary Clarifier Overflow (S5) & Secondary clarifier underflow (S6).

In the cycle I of Performance Characteristics of Effluents Treatment plant -II, The Raw Effluent is having high TDS (30,000 mg/L) and high organic load COD (2380 mg/L) and BOD (1028 mg/L). The biological treatment showed only about 93% efficiency in the removal of biodegradable organics (BOD) and COD reduction percentage is about 93.6%. The MLVSS of the biological system in the Bioreactor is 12,530 mg/L, in terms of Biomass required for a well operating biological treatment system.

In the cycle II of Performance Characteristics of Effluents Treatment plant -II, The raw Effluent is having high TDS (30,400 mg/L) and high organic load COD (2200 mg/L) and BOD (1078mg/L). The biological treatment showed only about 94% efficiency in the removal of biodegradable organics (BOD) and COD reduction percentage is about 93.5%. The MLVSS of the biological system in the Bioreactor is 12,285 mg/L, in terms of Biomass required for a well operating biological treatment system.

The Treated Effluent disposal quantity to sea and Treated Effluent characteristics from Plant – II for the month of February 2019 by M/s Manali Petrochemicals Limited is furnished in table 6.5. The average Treated Effluent disposal quantity to sea from plant -II for the month of February 2019 is 2512 KLD. The average Treated Effluent is having low organic load COD (218 mg/L) and Suspended Solids (90 mg/L).

The Flow meter reading on April 2019 (Table 6.1) indicated that the Effluent Treatment Plant -II was operated at the rate of 110 m³/hour. The flow reading indicated that the meters were operated in PO plant Saponifier Bottom to High rate Thickener, ETP Cooling tower sump to Bio Reactor (ETP Inlet), Treated Effluent discharge to sea and Secondary clarifier to Bio Reactor MLSS Recycle location.

Table 6.1 Flow meter reading

SNO	DESCRIPRION	CAPACITY
1	PO plant Saponifier Bottom to High rate Thickener	110 m ³ /hour
2	ETP Cooling tower sump to Bio Reactor (ETP Inlet)	110 to 115 m ³ /hour
3	Treated Effluent discharge to sea	98 to 102 m ³ /hour
4	Secondary clarifier to Bio Reactor MLSS Recycle	50 m ³ /hour

The Chemical consumption for the operation of the Effluent Treatment Plant -II summarized in table 6.2 indicates that chemicals are added which will be further adding to TDS of the effluent. The Monthly power consumption ETP-II for the month of April 2019 is 3,79,685 units. The Monthly

expenditure data based on Effluent generation quantity is Rs 55 to 57 /m³ of Effluent treatment. The Monthly sludge generation from ETP is from 75 to 150 kg / day Dry basis. (It is purely based on SV 30 in the secondary clarifier and Bio Reactors).

Table 6.2 Monthly Chemical consumption

SNO	DESCRIPRION	CAPACITY
1	Urea	20 kg/Shift
2	Ferric Sulphate	5 kg/shift
3	Phosphoric acid	10 kg/shift
4	BIO-NIL culture	25kg
5	Cow dung	25kg
6	Molasses	10 Litres /kg
7	Flocculent for High Rate Thickener	3.5 to 5 Kg / day
8	Coagulant for Secondary clarifier	160 litres / shift

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Table 6.3 Results for Cycle-I of Performance Characteristics of Effluents Treatment plant -II

S.NO	PARAMETERS	UNITS	RAW EFFLUENT (S1)	HRT OUTLET (S2)	BIO-REACTOR FEED (S3)	BIO-REACTOR (S4)	S.C.O (S5)	S.C.U (S6)
1	pH		12.5	12.32	11.8	6.35	6.62	5.96
2	EC	Micro Siemen/cm	46.4	46.9	48.3	47.2	47.8	44.3
3	TOTAL SOLIDS	mg/L	32,380	31,913	32,682	30,690	30,742	28,536
4	TOTAL DISSOLVED SOLIDS	mg/L	30,000	30,020	30,910	30,210	30,590	28,350
5	TOTAL SUSPENDED SOLIDS	mg/L	1048	300	226	23205	59	27278
6	MLVSS	mg/L	N.D	N.D	N.D	12,530.7	N.D	N.D
7	BOD	mg/L	1028	998	855	ND	72	89
8	COD	mg/L	2380	1893	1772	480	152	186
9	Ca ²⁺ HARDNESS	mg/L	13,900	13,882	13,874	13,860	13,854	13,842

Table 6.4 Results for Cycle-II of Performance Characteristics of Effluents Treatment plant -II

S.NO	PARAMETERS	UNITS	RAW EFFLUENT (S1)	HRT OUTLET (S2)	BIO-REACTOR FEED (S3)	BIO-REACTOR (S4)	S.C.O (S5)	S.C.U (S6)
1	pH		12.45	12.27	11.88	6.22	6.7	5.92
2	EC	Micro Siemen /cm	47.5	48.3	48.7	47.6	49.2	48.8
3	TOTAL SOLIDS	mg/L	32,600	32,890	33,040	30,942	31,633	29,500
4	TOTAL DISSOLVED SOLIDS	mg/L	30,400	30,910	31,170	30,460	31,490	29,310
5	TOTAL SUSPENDED SOLIDS	mg/L	1108	280	230	22,750	52	26,461
6	MLVSS	mg/L				12,285		
7	BOD	mg/L	1078	923	828	N.D	58	108
8	COD	mg/L	2200	1980	1870	482	143	190
9	Ca ²⁺ HARDNESS	mg/L	13,680	13,664	13,652	13,633	13,624	13,618

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Table 6.5 MPL ETP- II Data sheet for quantity of Effluent disposal to sea and Characteristics of Treated Effluent (February 2019)

DATE	EFFLUENT DISPOSAL TO SEA QTY (KLD)	TREATED EFFLUENT RESULTS		
		pH	COD (mg/L)	SS (mg/L)
2/1/2019	2539	6.5	240	88
2/2/2019	2664	6.6	228	90
2/3/2019	2592	6.3	242	85
2/4/2019	2632	6.4	211	89
2/5/2019	2266	6.2	224	90
2/6/2019	2525	6.2	218	94
2/7/2019	2452	6.2	211	90
2/8/2019	2085	6.1	210	96
2/9/2019	1759	6.2	240	90
2/10/2019	1882	6.2	245	86
2/11/2019	2048	6.1	218	80
2/12/2019	2072	6.3	219	92
2/13/2019	2687	6.2	204	89
2/14/2019	2347	6.1	197	94
2/15/2019	2437	6.4	217	88
2/16/2019	2393	6.3	220	86
2/17/2019	2782	6.1	230	90
2/18/2019	2829	6.2	228	90
2/19/2019	2714	6.1	218	84
2/20/2019	2786	6.1	210	90
2/21/2019	2746	5.8	234	90
2/22/2019	2776	6.6	215	90
2/23/2019	2672	6.1	202	96
2/24/2019	2833	6.1	196	90
2/25/2019	2771	6.1	205	86
2/26/2019	2752	6.3	210	91
2/27/2019	2723	6.5	210	95
2/28/2019	2578	6.2	212	90
AVERAGE	2512	6.2	218	90

CHAPTER 7

CONCLUSIONS

Based on the process design furnished by M/s Manali Petrochemicals Limited, for their 3.6 MLD Effluent Treatment Plant -II is expected to meet the discharge/reuse standards for the inlet characteristics mentioned by the proponent. The following observations/suggestions are to be considered to ensure sustainability of effective treatment of the existing ETP.

1. The Analysis of samples at various units should be done at regular intervals in order to study the performance of the each operation and process.
2. Solid waste generated from the sludge dewatering unit should be disposed safely.
3. As per the characteristics of feed to the bioreactor is concerned, it should be free from free chlorine. Need not be a guideline.
4. Operation of biological units of ETP for 24 hours feed should be ensured for stabilization of bacterial culture.
5. The effluent collection tank is to be cleaned periodically to avoid accumulation of solids.
6. In order to maintain mean cell residence time in the range of 25 to 48 days in aeration tank, suitable quantity of underflow from the secondary settler should be re-circulated.
7. Proper handling and drying of sludge from Filter press must be ensured.
8. Adequate storage area should be allocated for storing dewatered sludge generated from filter press.
9. Safe storage and handling of chemicals in the ETP should be ensured.
10. Adequate standby units/spare parts should be provided for various mechanical operations such as pumping, aeration, dewatering, backwashing etc.

11. Wide access should be provided for each and every unit in the ETP for easy entry and exit.
12. The ETP should be operated by qualified personnel and records should be maintained to establish sustained performance.
13. All workers should undergo periodic examinations by occupational physician to reveal early symptoms of possible chronic effects or allergies.
14. Proper Protective Equipment should be given to the personnel involved in cleaning collection tank, aeration tank and sludge holding tank.
15. Personnel should be given training on Standard Operating Procedures (SOPs) for Health & Safety applicable for ETP.

The treatment process report with calculations for arriving at the sizing of treatment units was reviewed in terms of the above. It is observed that the design norms followed for sizing of units are in line with CPHEEO norms and adequate for achieving the discharge standards laid down by MoEF & CC for disposal/reuse. However, the efficiency of performance depends on the operation maintenance of the plant as to maintain the design parameters used in the calculation for sizing of units.


Mr. S. K. ...
Director
Centre for ...
Department of ...
Andhra Pradesh
Chennai

RECOMMENDATION

The treated wastewater discharged from Secondary Clarifier Overflow meets the discharging standards prescribed by pollution control board board. However, the treated wastewater has refractory organics such as disubstituted Benzene, unsaturated long chain ether compounds, substituted long chain hydroxyl compounds, polyol derivatives. Hence, MPL may include a tertiary treatment consisting of activated carbon powder injection and followed by filtration or activated carbon filter for the removal of refractory organics from the treated wastewater in future. The life cycle of refractory organic compounds in the disposal site could be monitored by MPL.

Annexure-1**DESIGN REPORT****Design Calculations for Aeration tank (Bio -reactor)****Data**

Flow rate	3600	m ³ / day
Volume	4845	m ³
BOD IN	600	mg/L
BOD Out	20	mg/L
BOD net	580	mg/L
BOD net	2088	kg/ day

Assumption

O ₂ :BOD	2 kg	O ₂ /kg BOD
---------------------	------	------------------------

O₂ requirement under field condition (AOR)

O ₂ for BOD	3480	kg O ₂ / day
AOR	3480	kg O ₂ / day
AOR	145	kgO ₂ / Hr.

Correction factors to determine Oxygen requirement under Standard Conditions(SOR)

Air temperature	45	Deg.C
Basin temperature	38	Deg.C
Elevation	50	
C _w	2.2	Operating O ₂ concentration in waste water
Alpha	0.6	Correction factor for type of waste
Beta	0.8	Correction factor for Salinity /TDS
C _{s 20}	9	Oxygen concentration at 20 deg. C
Theta	0.73	Temperature Correction factor
Sigma	0.99	Altitude correction factor
C _s	6.6	Oxygen concentration at field condition
Standardized SOR	467.3	Kg Oxygen / hr.

HP requirement

Oxygen transfer rate		
Triton	1.8	kg O ₂ / KWH
Triton power requirement	259.6	kW
	350	H.P.
Hydraulic retention time	1.6	days (Volume/ Flow)

Annexure-2

WASTE WATER TREATMENT PLANT: - OPERATION

HIGH RATE THICKENER

START UP

- Ensure that the maintenance jobs have been completed in all respects.
- Confirm with electrical the availability of power supply.
- Ensure HRT is clean.
- Ensure the raker-arm and bottom pumps are energised.
- Ensure the normal rotation of raker-arm including free vertical movement.
- Ensure the feed inlet isolation valves are open.
- Ensure the HRT overflow line is through to cooling tower.
- Flocculant dosing is given to feed well at the centre of HRT.
- Coagulant dosing is given to hot well at the centre of HRT.
- Record the bottom concentration periodically.
- Ensure the HRT bottom pump isolation valves are routed to RVDF.
- Bottom pump should be started once the concentration reaches 80%.
- Record the QA lab analysis reports of HRT overflow samples for pH, TSS, TDS, and COD.

FLOCCULANT DOSING SYSTEM

START UP

- Ensure that the maintenance jobs have been completed in all respects.
- Confirm with electrical the availability of power supply.
- Ensure the Raw water makeup line is through to the Flocculant preparation tank.
- After filling the preparation tank with water, Flocculant of desired quantity shall be added and mixed thoroughly.
- Ensure the isolation valves of Flocculant dosing pump is open and routed to HRT feed well.

- Flocculator dosing quantity and rate shall be adjusted as required.

OLD HRT:**START UP:**

- Check whether the drive mechanism is properly installed and thoroughly lubricated.
- OLD HRT is taken in line when HRT is in maintenance.
- Check whether all parts are in proper alignment and the bolts are tightened.
- Check whether the bottom sludge pipe is clear without any choking.
- Check whether the mechanical tools used during installation are completely removed from the tank.
- Ensure proper clearance between the blades and the tank bottom at all points throughout the complete evolution of the mechanism.
- Check the proper operation of the overload alarm.
- Fill the tank with raw water up to 25- 30%.
- Run the raker mechanism in the tank filled with water and ensure raker movement is normal.
- Open the valve located on the 6" effluent header (line carrying the effluent from PO, PG and POLYOL plants) and start admitting the effluent into the old HRT.
- Take samples at the inlet to the old HRT and Analyze for suspended solids content.
- Take sample at the over view launder and Analyze for suspended solids content.
- Take samples from the sampling point located at the bottom slurry line and analyzed for suspended solids.

NORMAL OPERATION:

- During normal operation carry out the following activities.

- Analyze for the suspended solids in the samples taken at the inlet.
- Check the pH of the samples taken from the inlet.
- Analyze the solid content in the sample taken from the bottom slurry line.
- Also take samples at the over flow launder and analyze the same.
- If the solid content at the overflow launder is more than 100 ppm, decrease feed rate to old HRT.
- Take samples at the over flow launder and ensure that it always contains less than 100 ppm before admitting into the cooling water.

SHUT DOWN

- Stop the feed.
- Drain the entire tank if any maintenance job is to be carried out either in the RCC tank or in the raker mechanism.
- Once the tank is empty stop the ranker arm and the bottom pump.
- Drop the old HRT bottom pump suction lines and clean them.
- Clean old HRT with water.

PRIMARY CLARIFIER

- HRT overflow after acid correction (if needed) comes to Primary Clarifier.
- Purpose of Primary clarifier is to attain uniform pH and to do initial cooling.
- Effluent from Primary Clarifier tank is routed to cooling tower by PC 9506 A/B.
- Record the pH.

COOLING TOWER:

START UP

- Start up the fans and check its vibration.
- Open the valves located on the distribution header and admit the effluent to both the cells.
- Take samples at the distribution point and check the temperature.
- Take samples at various points from the cold water sump and measure the temperature and the pH.
- Start the pump PC 9353 A/B and feed the effluent into the bio-reactor if the temperature of the effluent in the sump is less than 45 °C.

NORMAL OPERATION & OPERATING PARAMETERS:

During Normal Operation

- Check for the fan vibration.
- Measure the effluent temperature in the sump and record the same.

Normal temperature is less than 45 °C.

- Check the pH and COD at the cooling tower sump and record the same. (Normal value of pH and COD are 10- 11.5 and 1500 -2000 mg/L respectively).

SHUT DOWN:

- Close the valves and stop feeding the effluent into the tower stop the fan.
- Keep the tower wet if the shutdown is prolonged for a long period. (More than 8 hours).
- Put the CT pumps PC 9703 A/B under re-circulation. Stop the pump if the shutdown is for a long period.

BIOREACTOR

TAKING EFFLUENT INTO THE BIOREACTOR SECTION:

- Make sure that the temperature of the effluent at the exit of cooling tower is less than 45°C.
- Take samples at the exit of the cooling tower and Analyze pH, SS, TDS, and COD.
- Start the bio-reactor feed pump PC 9353 A/B and fill up the effluent in the Bioreactor.
- Dissolved oxygen level in bioreactor is maintained by 5 no of Jet Aerators with blowers.
- Bioreactor overflow is routed to secondary clarifier.
- Monitor the dissolved oxygen level in Bioreactor in online using DO meter.
- Record the QA lab analysis reports of Bioreactor for pH, TSS, TDS, COD, and SV30.

BIO FLOCCULANT/COAGULANT DOSING SYSTEM

- Ensure that the maintenance jobs have been completed in all respects.
- Confirm with electrical the availability of power supply.
- Ensure the Raw water makeup line is through to the flocculant preparation tank.
- After filling the preparation tank with water, flocculant of desired quantity shall be added and mixed thoroughly. Flocculant dosing concentration will be varied depending upon the secondary clarifier overflow TSS level.
- Ensure the isolation valves of flocculant dosing pump is open and routed to Bioreactor overflow line to secondary clarifier.
- Flocculant dosing quantity and rate shall be adjusted as required.

SECONDARY CLARIFIER

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- Check whether the raker arm mechanism is properly installed and thoroughly lubricated.
- Check whether all parts are in proper alignment and the bolts are tightened.
- Check whether the bottom activated sludge line is clear without any choking.
- Check whether the mechanical tools used during installation are completely removed from the tank.
- Ensure proper clearance between the blades and the tank bottom at all points throughout the complete evolution of the mechanism.
- Fill the tank with raw water up to 25- 30%.
- Run the raker mechanism in the tank filled with water and ensure raker movement is normal and check the raker arm amps.
- Open the bottom valve to the pump.
- Take secondary clarifier overflow samples and check TSS, COD, pH and record.
- Return Activated sludge from secondary clarifier bottom can be routed back to Bioreactor by pumps (PD 9354 A/B).
- Monitor SV30 at periodic intervals while RAS pump in operation.

JET AERATORS AND BLOWERS OPERATION

- Ensure all mechanical jobs has been completed.
- Confirm direction of rotation is proper.
- Confirm lube oil level.
- Start the Jet Aerators and blowers one by one and as per requirement.
- Monitor the pressure and flow of air to the bioreactor.

ROTARY VACUUM DRUM FILTER (RVDF):

START UP:

- Ensure all the equipment and machineries are ready for startup.
- Close the valve in the filter tank drain line.
- Close the valve in the top vacuum line leading from the filter valve to the receiver.
- Open the filtered inlet isolative valve and fill the filter tank up to the over flow line and close the valve.
- Start the agitator, always operate the agitator when slurry is in the tank.
- Start the filter drive and set that about medium speed.

PLATE AND FRAME PRESS FILTRATION

Secondary clarifier Bio sludge concentration is maintained and recycled back (MLSS) to Bioreactor and further accumulation is removed by Plate and Frame filter press. Filtered bio sludge is used as manure.

Annexure- 3

SAFETY PRACTICES FOLLOWED IN MPL

1. Safety and health policy committed by top management.
2. Every year safety department objectives committed.
3. Safety audit every year conducted through CIF approved auditors.
4. Once in three months internal audit conducted.
5. Once in six months Certifying body (DNV) audit conducted.
6. Director of Industrial safety and Health Approved onsite emergency Plan.
7. Once in six months Mock drill conducted to check the preparedness to face any emergency.
8. Offsite Mock drill conducted two times with valuable guidance from District collector and MIA.
9. Safety induction to all the new comers.
10. Safety instruction slip issuing at Gate to visitors & truck drivers.
11. Work permit system e.g. hot work, cold work, confined space entry, working at height, Earth excavation.
12. Electrical clearance (EC for Elect equipment's).
13. Electrical Lockout & Tag out system followed.
14. LEL report details in the permit.
15. Safety training to employees and contractors.
16. First Aid training from St John ambulance given every year.
17. Daily report safety dept.
18. Plant inspection daily and detailed safety inspection monthly one plant.

19. Daily checklist activities.
20. Accident, Near miss, First aid case analysis
21. Safety committee meeting every month conducted.
22. Safety Beacon issue every month.
23. Safety week, Safety day celebration, Competition to employees and contractors.
24. Quarterly Safety performance review at MRC.
25. Safety equipment's calibration from third party(OEM).
26. Fire extinguisher, SCBA, testing and refilling.
27. Housekeeping inspection
28. Fire drill.
29. Environment day celebration and Tree plantation.
30. Lifting tools and tackles testing by competent person.
31. PPE s issued as per requirement to employees and contractors.
32. MPL is ISO 9001 QMS and 14001 EMS certified company.
33. MSDS available for the using chemicals.
34. Ensuring TREM card for Hazardous material transportation.
35. Plant operation by advanced DCS system (Centum VP)
36. UPS power supply for DCS.
37. Emergency DG 1500 KVA two sets for emergency power.
38. Dedicated Fire water storage with three pumps. Jockey pump - Motor driven, P1, P2 diesel driven.

39. All critical storage's with sprinkler system. HCA with automatic sprinkler system.
40. Smoke detectors at critical area.
41. LEL Gas detectors at critical locations and connected to control room.
42. Digital scrolling display at safety dept. and control room.
43. Repeater panel at Control room with auto / manual action switch for siren.
44. Fire call point located all over the plant and non-plant area. Call point once in six month checked from each point.
45. Siren three numbers placed at strategic location and every day morning tested.
46. CFT with three fireman available in the shift.
47. Paging system provided in the Plant areas.
48. Wind socks provided at seven locations.
49. Medical checkup carried out before recruitment and periodically once in two years for all employees and six months once for Plant persons.
50. Fire license renewed every year.
51. All the contractors trained in safety aspects.
52. Safety day, Environment day awareness, and competition conducted to employees & contractors.
53. Safety & Environment awareness program, competition conducted to nearby schools.
54. Infrastructure facility provided to nearby health centers.
55. Contractor safety committee conducted once in a year

56. Risk committee meeting conducted. Near miss/ Fire report prepared and communicated.

58. Fire license renewed every year.

59. All the contractors trained in safety aspects.

60. Hazop conducted for new projects and modifications.

Environment Related

- More than 2500 trees planted inside & outside the premises.
- Metro water consumption reduced from 0.5 MGD to 0.12 MGD by adopting recovery, reuse, recycle and utilizing RO rejects water from MFL and CMWSSB Kodungaiyur.
- First Industry in Tamil Nadu for Online data monitoring installed and connected to TNPCB, (Stack, ambient).
- New Treated effluent disposal line erected and taken line for marine disposal.
- MOL plant dust recovery system installed.
- Reduced Solid waste generation by using imported lime to replace Low purity Indigenous lime.
- Sludge reused for Brick manufacturing and filling low lying area for Green belt development.
- Solar water heater provided for canteen water usage.
- Power saving light post installed to replace old conventional type.
- Infrastructure facility provided for nearby public health centers.
- Environmental awareness program conducted for nearby school children. Competition conducted and prizes given.

**BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI**

IN THE MATTER OF:

Original Application No. 19 of 2013 (SZ)

Meenavargal Membattu Sangam ... Applicant

vs

The Chief Secretary, Government of Tamil Nadu, Chennai and Others. ...Respondent(s)

Original Application No. 248/2016 (SZ)

Meenava Thanthai K.R. Selvaraj Kumar, Meenavar Nala Sangam. ... Applicant

vs

The State of Tamil Nadu, Rep.by its Secretary to Government, Chennai and Others
...Respondent(s)

Original Application No. 224 of 2016 (SZ)

Meenava Thanthai K.R. Selvaraj Kumar ... Applicant

vs

The Chief Secretary, Government of Tamil Nadu, Secretariat, Chennai and Others.
... Respondent(s)

Appeal No. 51/2017 (SZ)

M/s. Manali Petrochemicals Limited ... Appellant

vs

The Central Pollution Control Board, New Delhi and Others ... Respondent(s)

Appeal No.52 of 2017 (SZ)

M/s. Manali Petrochemicals Limited ... Appellant

vs

The Central Pollution Control Board, New Delhi and Others. ... Respondent(s)

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**Place : Bengaluru
Date : 28.10.2020**



S. Suresh
DEPONENT

S. SURESH
REGIONAL DIRECTOR
CENTRAL POLLUTION CONTROL BOARD
REGIONAL DIRECTORATE (SOUTH)
MIN. OF ENV. FORESTS & CC. GOVT. OF INDIA
BENGALURU - 560 075. MOB: 9480672128

Report of the Joint Committee

(as per Hon'ble Tribunal, Southern Zone, Chennai order dated 08.02.2020, 11.06.2020 & 07.09.2020 in OA nos. 19/2013, 224/2016, 248/2016 and Appeal nos. 51/2017 & 52/2017)

1. Background:

The Honourable National Green Tribunal, Southern Zone, Chennai, in the matter of OA nos. 19/2013, 224/2016, 248/2016 and appeal nos. 51/2017 & 52/2017 directed on 08.02.2020 as;

"..... we feel it appropriate to appoint a joint committee comprising of Central Pollution Control Board, State Pollution Control Board, a senior scientist from National Institute of Ocean Technology (NIOT) and senior scientist dealing with environment engineering (Chemical) from Anna University to inspect the units in question and find out the present status of the functioning of the units namely M/s. Manali Petrochemical Limited and M/s. Tamilnadu Petrochemical limited and ascertain as to whether they are maintaining and managing all pollution control mechanism and whether the discharge of effluent from these industries to sea conforms with the specified norms prescribed by the PCB and the impact of effluents in the sea water and if there is any deficiency found and the sea water quality has not improved, then suggest the remedial measures by which the quality of sea water can be improved and who has to carry out these remedial measures and also assess the environmental compensation against the defaulting units who are responsible for polluting sea water by applying "Polluters Pay" principle and submit a report to this Tribunal within a period of three months.

The remedial measure should contain the short term as well as long term measures to be adopted by the units. They may also consider as to whether the units have complied with the recommendations made by the earlier committee for improvement of the quality of the sea water and if so to what extent that has been complied with and the impact of that compliance in the quality of sea water and if it is not sufficient to suggest more recommendations as a remedial measures to remedy the situation and make the quality of the sea water in conformity with the norms and the time required for completing the remedial measures. They may also conduct a detailed study regarding the effect of contamination caused on the flora and fauna of the aquatic and marine life".

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In compliance to the Hon'ble tribunal order, the committee carried out inspection & monitoring of Source Emission, ETP & Marian outfall during March 04 to 06, 2020 and submitted interim report on 11.06.2020 seeking further time to file final report.

Further Hon'ble tribunal in its order dated 11.06.2020, directed as follows;

"5. Under these circumstances, we feel it appropriate to grant two months time to the committee to submit the report along with the remediation measures if any, required on the basis of the Analysis Report and also suggest alternate methods if any, required for noncompliance of certain suggestions and recommendation given for efficient management of pollution control mechanism which they have mentioned in the 'remarks' column of the compliance of recommendation in the interim report.

The committee is directed to submit the report to this Tribunal on or before 7.9.2020"

NIOT requested further time for submission of marine study report, accordingly, CPCB has submitted request seeking further four weeks time for filing the report. Upon the request Hon'ble Tribunal has grant time till 02.11.2020 to the committee to submit the report as directed.

2. Analysis results of the sample collected in individual units:

In the committee meeting held on 4.3.2020, it was decided to collect samples at the inlet and outlet of ETPs of all the four units and requested all units to discharge the treated wastewater at same time. Accordingly, on 6.3.2020 samples were collected at the inlet & outlet of ETP and also instant readings of the flow were noted. The analytical results are given below.

M/s. Manali Petrochemicals Limited, Unit I:

Parameter	Inlet	Outlet	Marine disposal standards
pH	11.5	6.3	5.5-9.0
TSS mg/L	109	60	100
COD mg/L	1053	165	250
BOD mg/L	254	05	100
Fluoride mg/L	1.36	0.82	15
O&G mg/L	--	12.5	20
Hexavalent chromium mg/L	BDL	BDL	1.0
Sulphate mg/L	202	254	1000
Free ammonia (as NH ₃) mg/L	1.32	NIL	05
Ammonia as N mg/L	1.1	BDL	--
Phenols mg/L	BDL	BDL	5.0
Petroleum hydrocarbons mg/L	--	10.8	--

From the above analysis results, it shows that all the parameters are meeting the prescribed standards. Percent reduction of treatment efficiency in terms of BOD and COD is 98% and 84% respectively.

During the time of sample collection, flow was found to be 88.1 cubic meter/ hour. Hence, total amount of treated effluent discharged in to the sea will be 2114 cubic meter/ day. Based on flow, overall BOD load discharged in to the sea will be 10.6 kg/day.

M/s. Manali Petrochemicals Limited, Unit II:

Parameter	Inlet	Outlet	Marine disposal standards
pH	11.4	6.4	5.5-9.0
TSS mg/L	160	66	100
COD mg/L	1324	139	250
BOD mg/L	285	3.8	100
Fluoride mg/L	1.79	0.88	15
O&G mg/L	--	16	20
Hexavalent chromium mg/L	BDL	BDL	1.0
Sulphate mg/L	173	160	1000
Free ammonia (as NH ₃) mg/L	1.32	NIL	05
Ammonia as N mg/L	1.1	BDL	--
Phenols mg/L	BDL	0.03	5.0
Petroleum hydrocarbons mg/L	--	12.3	--

From the above analysis results, it shows that all the parameters are meeting the prescribed standards. Percent reduction of treatment efficiency in terms of BOD and COD is 98.5% and 89% respectively.

During the time of sample collection, flow was found to be 95 cubic meter/ hour. Hence, total amount of treated effluent discharged in to the sea will be 2280 cubic meter/ day. Based on flow, overall BOD load discharged in to the sea will be 8.7 kg/day.

M/s. Tamilnadu Petrochemicals Limited:

M/s. Tamilnadu Petrochemicals Limited has three units Epichlorohydrin Plant (ECH), Heavy Chemicals Division (HCD) & Linear Alkyl Benzene Plant (LAB). Earlier M/s TPL was discharging treated effluent from all the plants to marine. At present the treated effluent from HCD & LAB plant is used in the ECH plant process. The treated effluent from ECH is discharged to marine.

Parameter	Inlet	Outlet	Marine disposal standards
pH	11.8	6.8	5.5-9.0
TSS mg/L	91	63	100
COD mg/L	626	92	250
BOD mg/L	29	4.7	100
Fluoride mg/L	1.4	1.02	15
O&G mg/L	--	2.7	20
Hexavalent chromium mg/L	BDL	BDL	1.0
Sulphate mg/L	46.7	41.5	1000
Free ammonia (as NH ₃) mg/L	2.4	NIL	05

Ammonia as N mg/L	2.0	1.1	--
Phenols mg/L	BDL	BDL	5.0
Petroleum hydrocarbons mg/L	--	2.3	--

From the above analysis results, it shows that all the parameters are meeting the prescribed standards. Percent reduction of treatment efficiency in terms of BOD and COD is 84% and 85% respectively.

During the time of sample collection, flow was found to be 43.2 cubic meter/ hour. Hence, total amount of treated effluent discharged in to the sea will be 1037 cubic meter/ day. Based on flow, overall BOD load discharged in to the sea will be 4.9 kg/day.

M/s. Kothari Petrochemicals Limited:

Parameter	Inlet	Outlet	Marine disposal standards
pH	8.0	7.2	5.5-9.0
TSS mg/L	09	47	100
COD mg/L	36	150	250
BOD mg/L	03	9.4	100
Fluoride mg/L	0.65	1.05	15
O&G mg/L	--	BDL	20
Hexavalent chromium mg/L	BDL	BDL	1.0
Sulphate mg/L	179	1739	1000
Free ammonia (as NH ₃) mg/L	1.6	1.1	05
Ammonia as N mg/L	21.9	91.1	50
Phenols mg/L	0.02	BDL	5.0
Petroleum hydrocarbons mg/L	--	BDL	--

From the above analysis results, it shows that except sulphate and ammonical nitrogen, remaining parameters are meeting the prescribed standards. But the sulphate and ammonical nitrogen is found within the limit after confluence of treated effluent from all other industry. Since the unit is discharging RO reject, percent reduction could not be evaluated.

During the time of sample collection, flow was found to be 3.6 cubic meter/ hour. Hence, total amount of treated effluent discharged in to the sea will be 86.4 cubic meter/ day. Based on flow, overall BOD load dumped in to the sea will be 0.8 kg/day.

2.1 Analysis results of the sample collected in pipeline:

All the four units have laid common pipeline of overall length 10.6 km and discharge their treated effluent in to sea. Treated effluent from M/s. Kothari petrochemicals, is mixed with treated effluent of M/s. Manali petrochemicals limited unit II and joins the main pipeline near Sathyamurthynagar. Treated effluent of M/s. Tamilnadu petrochemicals limited is mixed with treated effluent of M/s. Manali petrochemicals limited unit I and treated effluent from all the four units is carried to sea

through dedicated pipeline. The units have made arrangements for sample collection at mixing point of MPL II and KPL and MPL I and TPL and near shore (near to Junction road) before the pipeline enters the sea. In all the junctions, flow meters have been installed to measure the instant flow and cumulative flow.

On 6.3.2020, samples were collected simultaneously from the two junctions and also near to the shore before sea disposal. The results are given below.

Parameter	After confluence of MPL II and KPL	After confluence of MPL I and TPL	After confluence of all four units	Marine disposal standards
pH	6.2	6.4	6.4	5.5-9.0
SS mg/L	46	76	71	100
COD mg/L	93	110	125	250
BOD mg/L	3.7	2.3	5.6	100
Fluoride mg/L	--	--	0.84	15
O&G mg/L	--	--	3.5	20
Hexavalent chromium mg/L	--	--	BDL	1.0
Sulphate mg/L	--	--	153	1000
Free ammonia (as NH ₃) mg/L	--	--	NIL	05
Ammonia as N mg/L	--	--	6.1	--
Phenols mg/L	--	--	BDL	5.0
Petroleum hydrocarbons mg/L	--	--	BDL	--

After confluence of all the four units, cumulative flow was found to be 260 cubic meter/ hour or 6240 cubic meter/day. Based on flow, overall BOD load discharged in to the sea by all the units will be 35 kg/day. From the above analysis results, it shows that, overall the treated effluent from all the four units are meeting the tolerance limit prescribed by TNPCB.

3. Analysis results of Source emission:

Monitoring of source emission in the boilers installed at all the industries were also carried out, the analysis results are shown below with oxygen correction factor.

Parameter	MPL I Boiler	Standard (Gas)	MPL II Boiler	Standard (Oil)	KPL CPP Boiler	Standard (Rice Husk)
PM mg/Nm ³	9.1	10	76.3	100	51.8	50
Sulphur dioxide mg/Nm ³	19.2	50	111.7	1700	53.4	
Oxides of nitrogen mg/Nm ³	94.2	350	262.5	450	188.6	

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Parameter	TPL HCD Boiler	TPL PO Boiler	TPL LAB heater stack	HCl plant	Standard
PM mg/Nm ³	6.7	7.85	9.8	--	10
Sulphur dioxide mg/Nm ³	25.3	36.9	27.5	--	50
Oxides of nitrogen mg/Nm ³	160	70.7	114.8	--	350
Acid mist mg/Nm ³	--	--	--	BDL(DL:04)	35

The analysis results show that the emissions are within the standard norms except PM of M/s KPL CPP Boiler stack.

4. Summary of Marine Water Quality:

The marine water quality study was carried out through NIOT, Chennai. The report submitted by NIOT is attached as Annexure A. 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. The common treated effluent discharge outfall of M/s. MPL, M/s TPL & M/s KPL is located in Ennore coast, East coast of India. The sampling stations were located at 500 m and 1000 m distances along three transects to the north, east and south of outfall.



The results of selected parameters and comparison with previous study records reveal that there are spatial and temporal variations within the study area. Increase in nutrient parameters like nitrate recorded maximum value of 20.4 $\mu\text{mol./l}$ is comparable to values recorded in samples collected during low tide at the Ennore creek during the study (Annexure I: Table 2). The BOD values were also relative to quantities recorded in Ennore creek samples (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 be the 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, Royapuram sewage 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 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. The effect 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 as at 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.

5. Environmental Compensation Calculation:

M/s Kothari Petro Chemicals Ltd., exceeded the norms of discharge for the parameter sulphate and Ammonical nitrogen which is 1739 mg/l & 91.1 mg/l against the standard norms 1000 mg/l & 50 mg/l respectively. After mixing with other industrial treated effluent, it reaches the standard norms before discharge into sea.

Moreover, the Particulate Emission (PM) of CPP boiler is measured as 51.8 mg/Nm³ against the standard 50 mg/Nm³.

Considering the above, environmental compensation is calculated using Pollution Index Formula ($EC = PI * N * R * S * LF$)

PI = Pollution Index, RED category industry (PI = 80)

R = Rupees Factor (R = 250)

S = Scale of Operation, Large Scale (S = 1.5)

LF = Location Factor, CEPI Area (LF = 2)

N = Number of days, (N = 40 days) date of committee sampling 06.03.2020 to date of TNPCB sampling 15.05.2020 (compliance). The industry was not in operation during 24.03.2020 to 23.04.2020 due to COVID19 pandemic situation, so this period was not considered for calculation.

$EC = 80 * 40 * 250 * 1.5 * 2 = \text{Rs. } 24,00,000 = \text{Rs } 24 \text{ lakhs.}$

The interim compensation calculated for the period of 40 days is Rs24 Lakhs.

6. Compliance of Recommendation submitted by Previous Committees/Reports:

Recommendation of the two member expert committee was constituted with Dr. Palanivelu, Anna University, Chennai and Dr. N. Vedharaman, CLRI, Chennai as per order dated 22.7.2014 in O.A. No. 19/2013	Present Committee View/ Suggestions
<p>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.</p>	<p>It is informed that: As per Expert committee advice MPL carried out the study to identify the suitable catalytic process. For this small capacity plant catalytic process technology is not viable. Only available for very high capacity plant (minimum 600 TPD). New The investment for the change of process (large capacity plant) is Rs 4000 Cr and no market scope in India. In the catalytic process pollutant load is higher than present chlorohydrin route. Industry may keep exploring possibilities as suggested by previous committee.</p>
<p>2. M/s MPL I & II and other industries should look in to 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.</p>	<p>i) MPL I & II and TPL (ECH – PO): A pilot scale study shall be carried out with DISC membrane or any other suitable technology for reducing the discharge of treated effluent in to the sea. ii) Possibilities shall also be explored for achieving complete or Partial ZLD. iii) Possibility of using treated effluent generated from M/s KPL shall be explored by M/s MPL or M/s TPL. So M/s KPL shall take necessary steps in collaboration with M/s MPL or M/s TPL.</p>

<p>3. Necessary arrangements may be made well in advance to replace the pipe according to its life time to ensure environmental safety.</p>	<p>The effluent line was originally laid and commissioned in the year 1990 and replaced the line in 2011.</p> <p>Pressure & Leak test was carried out through M/s Aquatic Diving, whereas, the life of the pipeline for replacement is not mentioned.</p>
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<p>Summary of NIOT Report (August 2015)</p>	<p>Present Committee View/ Suggestions</p>
<p>The results of selected parameters reveal that there is no spatial or temporal variation in the study area. The concentration of metals shows lower values in the offshore location MPL 10, when compared to the other locations. The background concentrations of the study area are significantly high possibly due to the influence of Royapuram fishers harbour, Chennai Port, Royapuram outfall and several other industries discharging in this area. From these results it can be concluded that the study area was moderately polluted, which may be attributed to the several sources.</p> <p>The studies on biological characteristics reveal the following:</p> <ul style="list-style-type: none"> ➤ The near shore coastal belt shows minor variation in biological characteristics ➤ Various discharges along Ennore coast may induce synergistic effect of toxicant on the benthic population in certain station and in depth studies are warranted. <p>The MPL EIA report does not contain the biological data for comparison. The scope of present short term study is too limited to conclude any discernible trends on the possible impact on environment</p>	<p>It is suggested to carry out continuous study for a period of five years (twice in a year), in which the impact & sources of pollution shall be identified. Accordingly, remedial measures shall be suggested.</p>

Recommendation of Joint Committee Report (CPCB & TNPCB) submitted on May 02, 2016 & September, 2016			
	M/s MPL (Plant I & II)	M/s TPL	M/s KPL
All units 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 same to be made available to TNPCB/CPCB during inspection.	Complied	Installed flow meters. But yet to connect inlet flow meter.	Installed flow meters. Presently connected discharge flow meter only. But yet to connect all other flow meters.
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 from the units and quantity of effluent discharged. This also helps to quick identification of any leaks in the pipeline. These flow meters shall connect to TNPCB/CPCB monitoring centre.	Flow meters installed in the common sea discharge pipeline are yet to be connected.		
To take up detailed marine study by considering the actual quality and quantity of effluent discharged to verify the availability of dilution in the sea and its impact on marine species.	It is suggested to carry out continuous study for a period of five years (twice in a year). Accordingly, remedial measures shall be suggested.		
All units are required to conduct toxicity studies for their effluent and also for combined effluents. The results shall be submitted to TNPCB including species used for the study.			

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7. Conclusion/ Suggestions:

The analysis results of the samples collected during the committee inspection confirms to the discharge norms of the treated effluent into the sea as prescribed by TNPCB. But, Sulphate & Ammonical Nitrogen of M/s Kothari Petrochemical Limited found to be higher than prescribed norms. However, after mixing with other industries treated effluent, sulphate & Ammonical nitrogen value reduces and confirms to norms before discharge into sea.

TNPCB shall direct the industries to submit the compliance report on the following and to take appropriate action as per suggestions made by the committee.

1. M/s Kothari Petrochemicals Ltd., shall be directed to remit the interim compensation of Rs. 24 Lakhs for non-compliance.

2. Short Term:

- a) At present, M/s KPL is discharging the RO reject into the Marine, in order to reduce the quantum of marine discharge as well as for use of raw water, possibilities shall be explored by M/s MPL or M/s TPL for utilizing RO reject generated from M/s. KPL in their process.

(Target: One Month)

- b) If the RO Reject found suitable for utilization, then the discharge of M/s KPL shall be stopped and sent to M/s MPL or M/s TPL.

(Target: Two Month)

- c) Action plan on phase wise revamping of treatment units of the ETP in M/s MPL Unit I and M/s TPL (all three plants HCD, LAB & ECH – PO) shall be submitted, since physical damages found during the visit. Action plan shall be submitted within a month.

(Target: Two Year)

- d) Since M/s TPL is reusing the treated effluent generated from HCD & LAB plant in the ECH – PO plant, online flow meters shall be installed at HCD & LAB plant to quantify the utilization of treated effluent. Moreover, the online effluent monitoring system

installed for the parameters pH, TSS, COD, BOD etc. at HCD/LAB plant shall be relocated to the common discharge pipeline after confluence of all treated effluent and installation of display board showing effluent quality to the general public.

(Target: Three Month)

- e) In order to assess the sea water quality, Continuous Marine Water Quality Monitoring system shall be installed at discharge point for the parameters Temperature, Conductivity, Salinity, Turbidity and Total Dissolved Solids (TDS), Dissolved Oxygen (DO), pH, Chlorophyll, fluorescent Dissolved Organic Matter (fDOM) and phycoerythrin-a pigment of blue-green algae etc. The recorded data shall be shared to NIOT & TNPCB for assessing the marine quality.

(Target: Six Month)

- f) M/s MPL plant I & II and M/s TPL: A pilot scale study shall be carried out with DISC membrane or any other suitable technology for reducing the discharge of treated effluent in to the sea. Possibilities shall also be explored for achieving complete or partial ZLD. Action plan shall be submitted within a month.

(Target: One Year)

- g) Calibration of the flow meters installed in the discharge pipeline shall be carried out periodically and ensure no difference in each of the flow meters.

3. Long Term:

NIOT has suggested long term study in both the report (2015 & 2020) to assess the marine water quality and flora & fauna marine life as well as indicated the pollution from other sources also.

So, it is suggested to have a comprehensive impact assessment study to assess the quality of water and biological impacts in the receiving waters which shall cover larger extents (spatial) along the coast and two seasons (pre monsoon / post monsoon). The study area shall cover Ennore Creek, North Chennai Coastal waters from Pulicat to Muthukadu in the South to cover pollution signals during all seasons as there is northerly drift for 8

months and southerly drift for 4 months in a year. Therefore, representative samples shall be analysed to map the variation in space and time.

In order to have a detail study, it is suggested to carry out continuous study for a period of five years (twice in a year), in which the impact & sources of pollution shall be identified. Accordingly, remedial measures shall be suggested.

TNPCB shall provide list of marine outfall units & other source of pollution including source point data of industrial outfalls (including Ennore creek) and others such as municipal discharges, data from Kamarajar port, Chennai port, Fishing harbour etc. TNPCB shall utilise the Environmental Compensation fund for this study and same may be recovered after the polluter identification. The studies can be conducted by national institutes such as NIOT or any other reputed institutes.

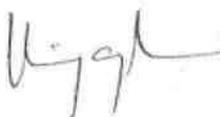
NIOT has observed the marine life quality improvement, after dredging activity carried out during Ennore Port development. Therefore, possible means to improve the marine water / life quality shall be suggested based on data.



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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	North of 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	Northeast of 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 80°17'42"E	Downstream of Ammulvoyal junction

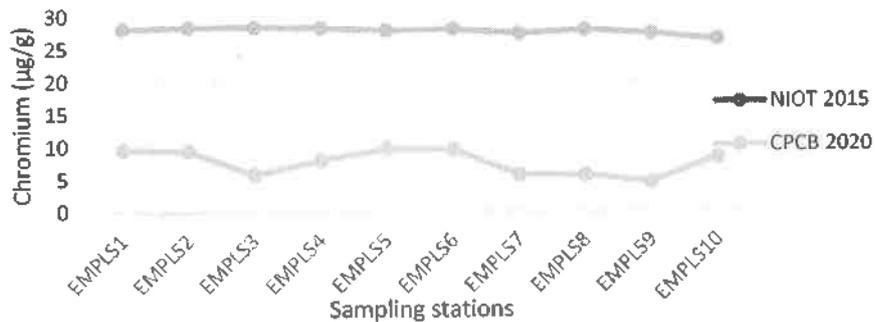


Fig. 17 Chromium variation in the seafloor sediments around MPL offshore discharge

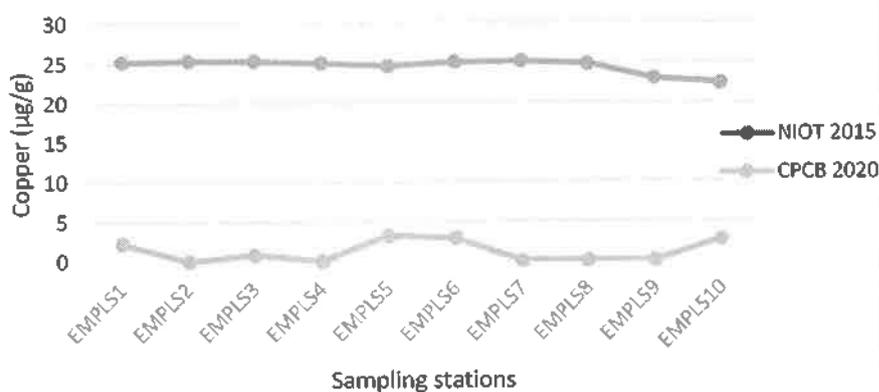


Fig. 18 Copper variation in the seafloor sediments around MPL offshore discharge

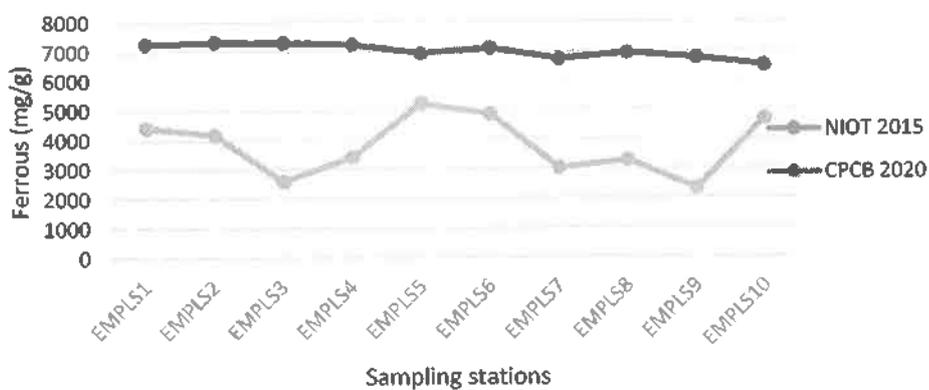


Fig. 19 Ferrous variation in the seafloor sediments around MPL offshore discharge

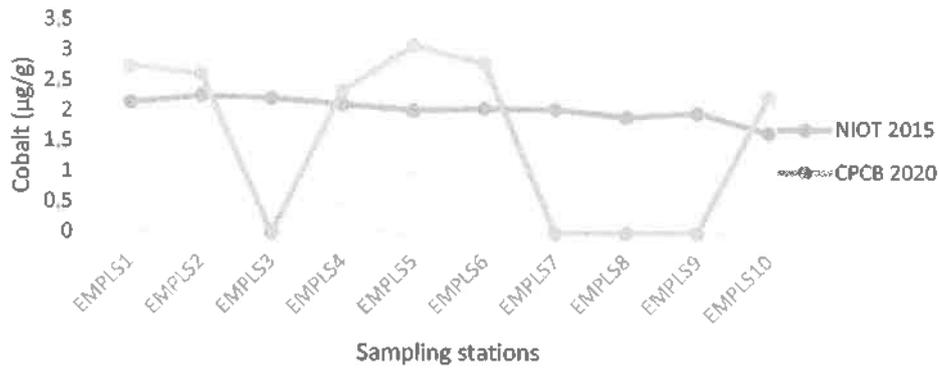


Fig. 14 Cobalt variation in the seafloor sediments around MPL offshore

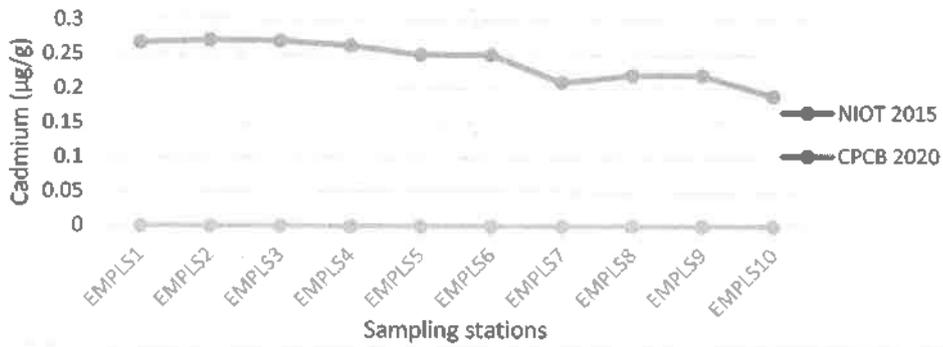


Fig. 15 Cadmium variation in the seafloor sediments around MPL offshore

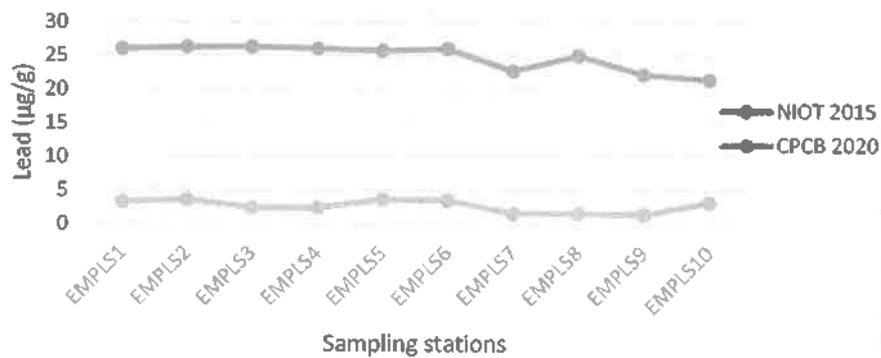


Fig. 16 Lead variation in the seafloor sediments around MPL offshore discharge

(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 of the 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 3.81 µg/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 (2332.74 to 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. The higher concentration of Ni, Co, Cu, Cd, Cr, Fe at EMPL 5 and Mn at EMPL 9 and Hg at EMPL 10 are recorded respectively.

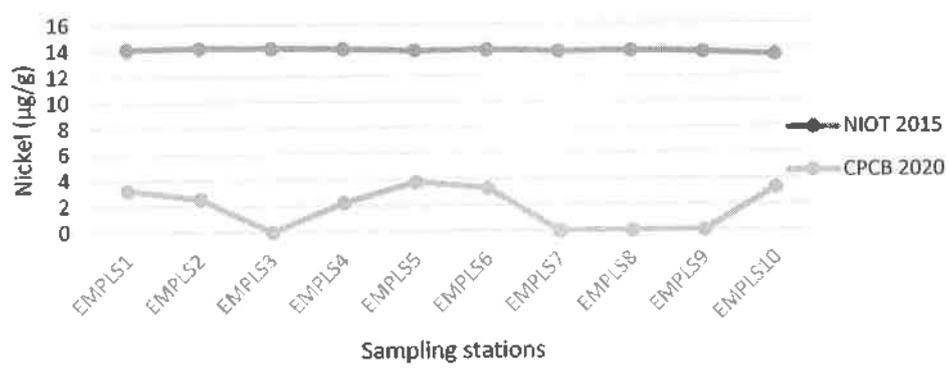


Fig. 13 Nickel variation in the seafloor sediments around MPL offshore discharge

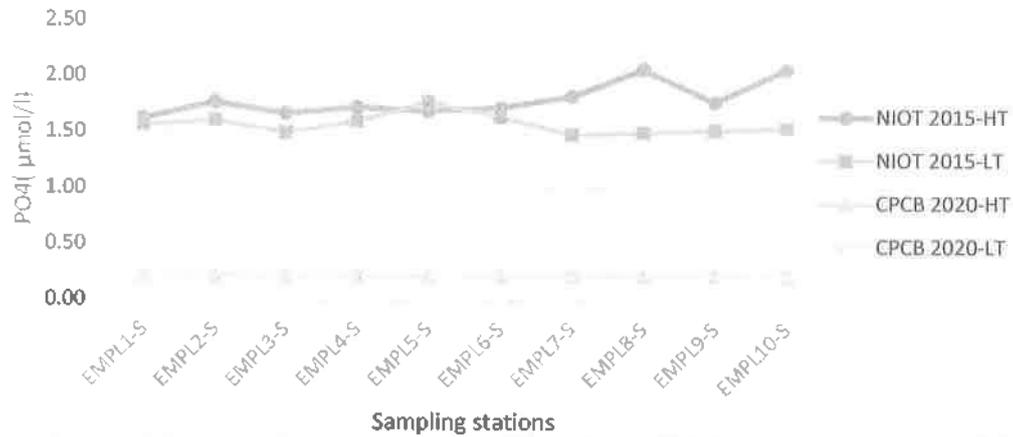


Fig.11 Phosphate variation in the surface waters around MPL offshore discharge

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.

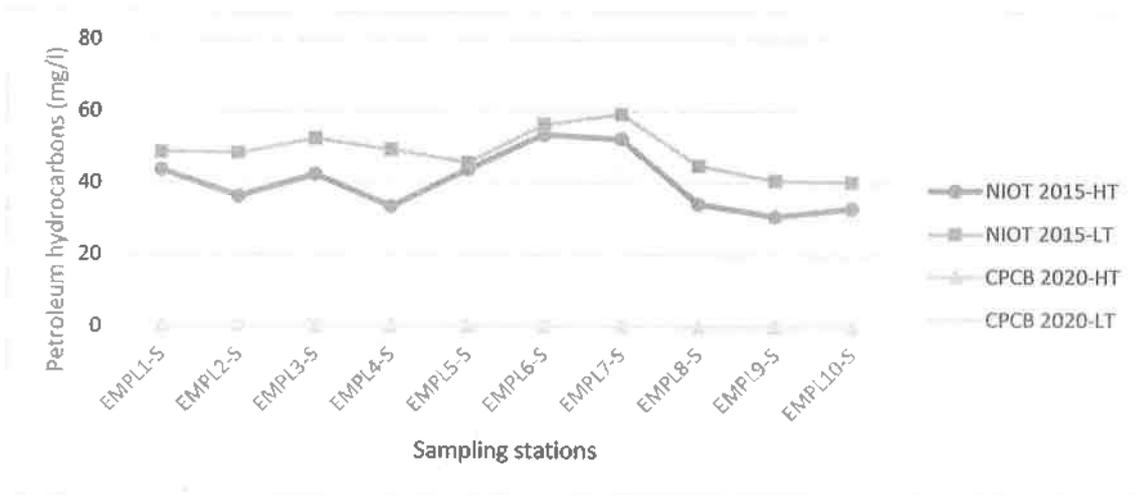


Fig.12 PHC variation in the surface waters around MPL offshore discharge

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 of metal 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

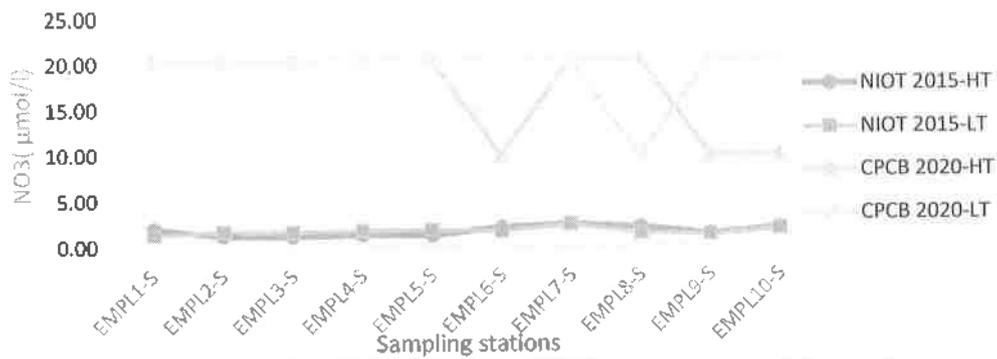


Fig.9 Nitrate nitrogen variation in the surface waters around MPL offshore discharge

c. Nitrite Nitrogen

The transitional Nitrogen product Nitrite varied between 0.04 to 0.67 $\mu\text{mol/l}$ 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 compared with 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.

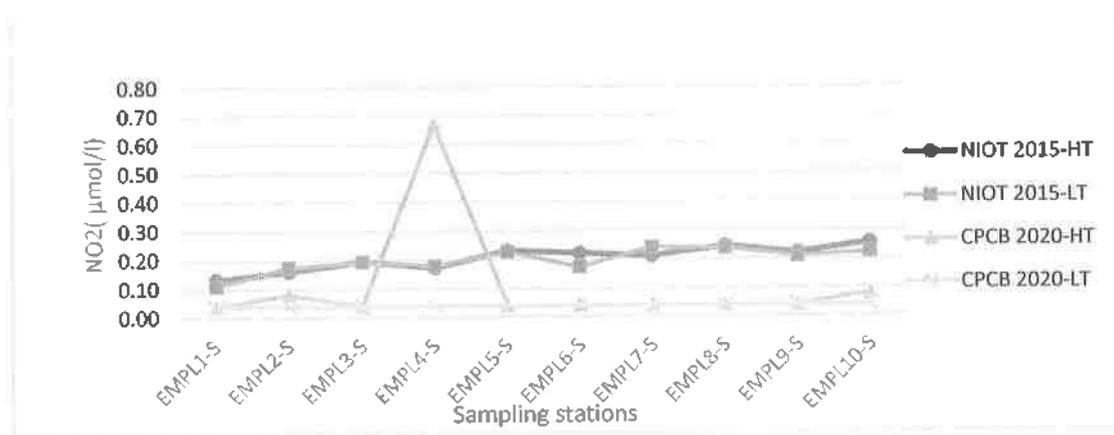


Fig.10 Nitrite nitrogen variation in the surface waters around MPL offshore discharge

d. Phosphate Phosphorous

In general, the Phosphate phosphorous concentrations recorded a constant concentration of 0.21 $\mu\text{mol/l}$ at all the station despite the tidal and depth variation. A manifold decrease in phosphate concentration is observed when compared to 2015 condition.

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 $\mu\text{mol./l}$ at 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 $\mu\text{mol./l}$ despite the values of below detectable quantity in surface waters during this period. The unusual increase in ammoniacal nitrogen values requires detailed studies.

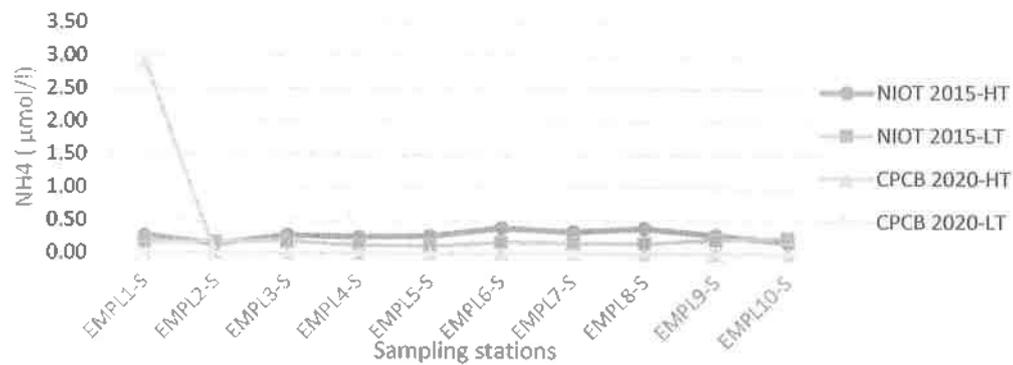


Fig.8 Ammoniacal nitrogen variation in the surface waters around MPL offshore discharge

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 from 10.0 to 20.4 $\mu\text{mol./l}$ recorded 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 $\mu\text{mol./l}$ in both the tides. The nitrate values recorded a significant increase when compared to 2015 studies.

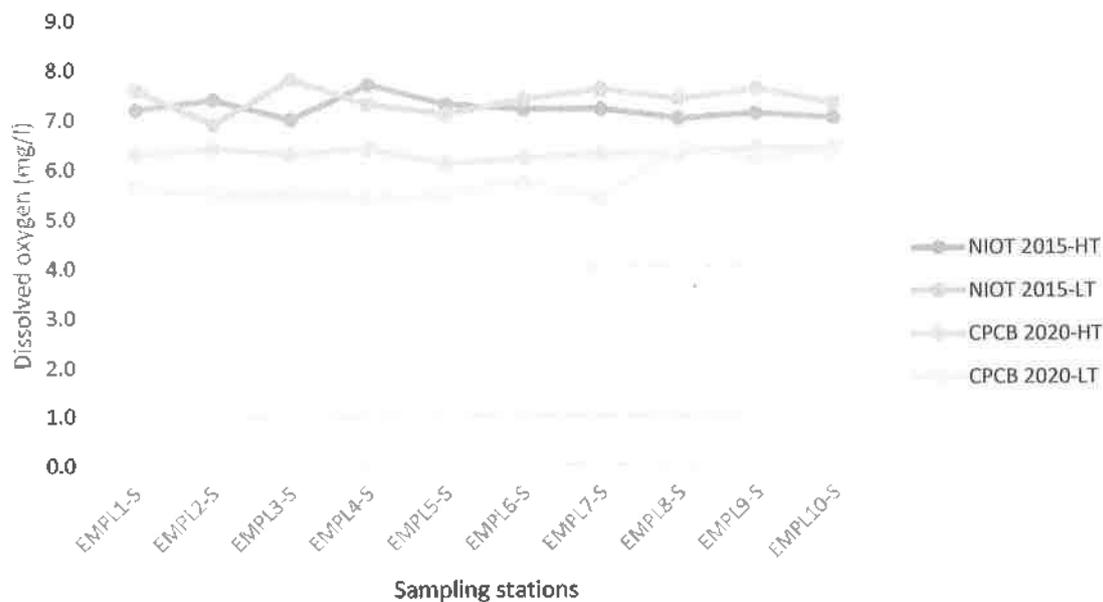


Fig.6 Dissolved oxygen variation in the surface waters around MPL offshore discharge

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.

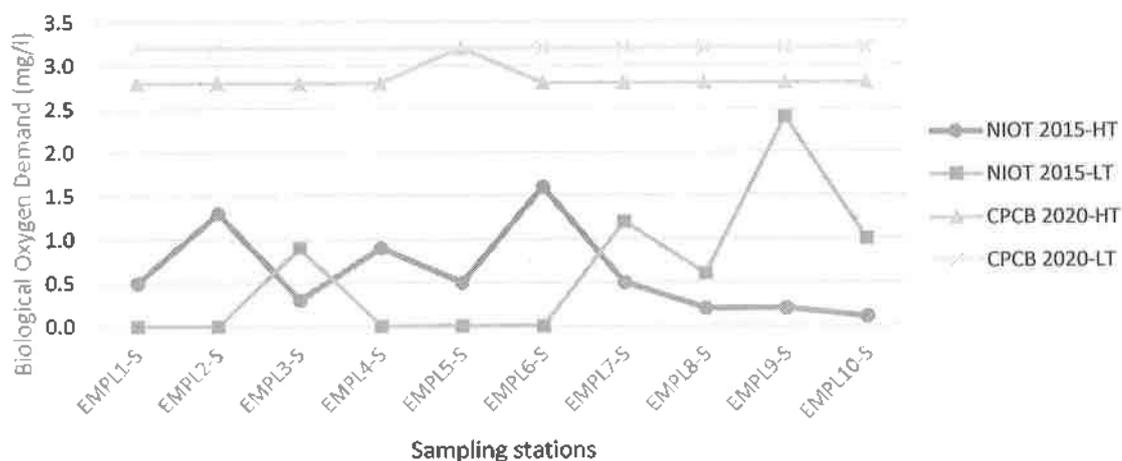


Fig.7 BOD variation in the surface waters around MPL offshore discharge

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

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.

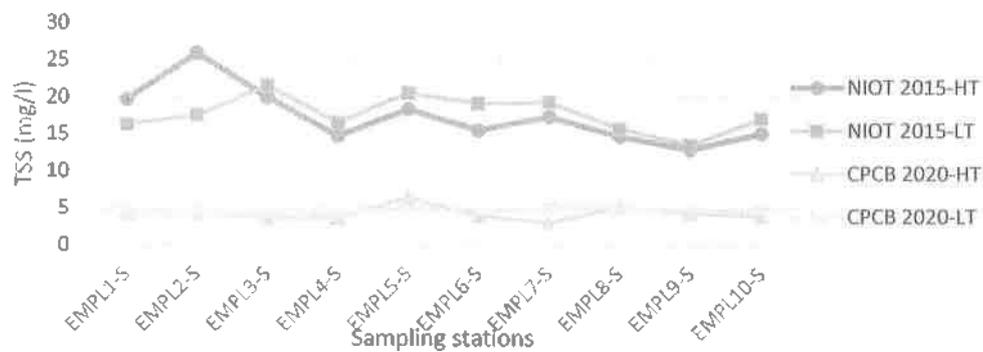


Fig.5 Total suspended solid variation in the surface waters around MPL offshore discharge

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.

PSU may be a spike of analytical abnormality (outlier value). Further, it needs multiple samples of in-depth studies to confirm the same.

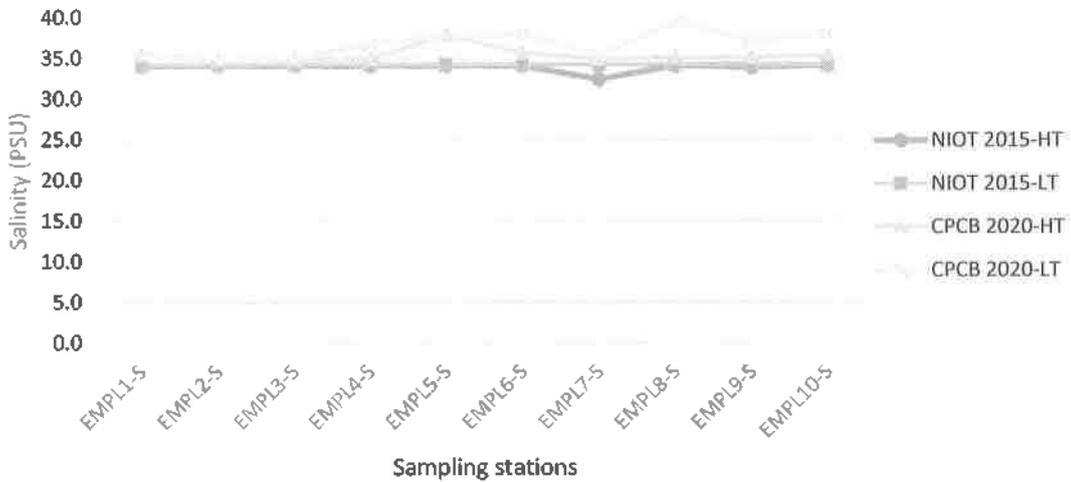


Fig.3 Salinity variation in the surface waters around MPL offshore discharge

pH

The variation of observed pH in the samples ranged between 7.50 and 7.90 in the surface waters of the study area. The Observed pH values are within the range of normal coastal waters.

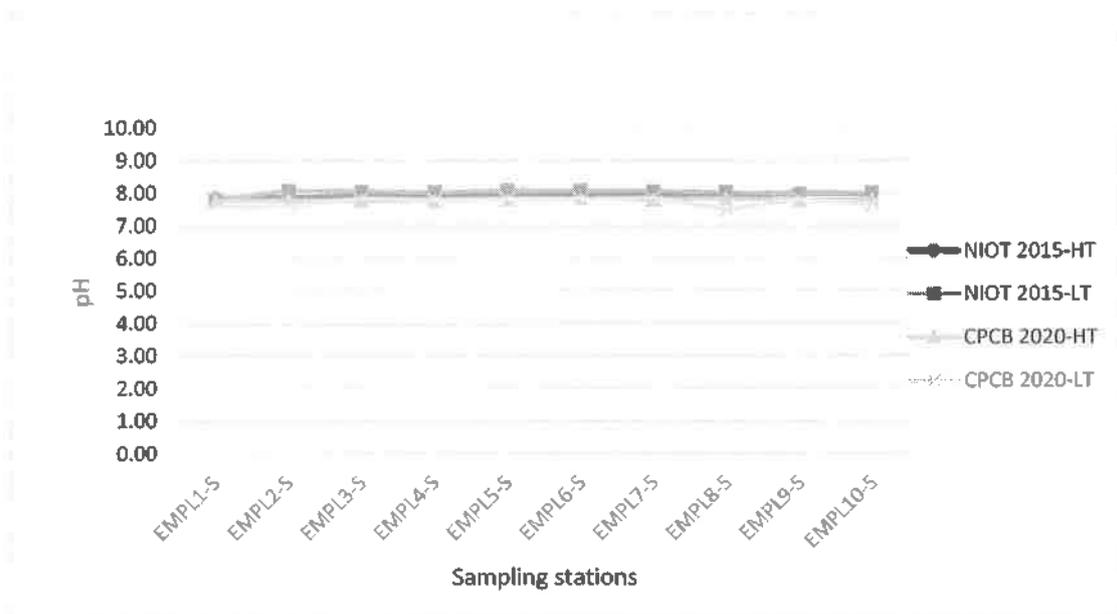


Fig.4 pH variation in the surface waters around MPL offshore discharge

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 2015 intending 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°C 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.

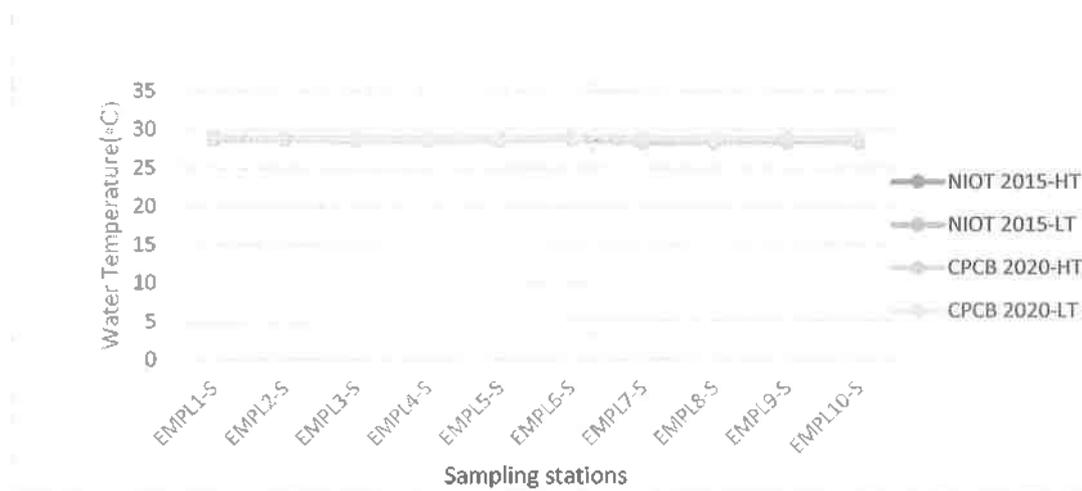


Fig.2 Water temperature variation in the surface waters around MPL offshore discharge

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

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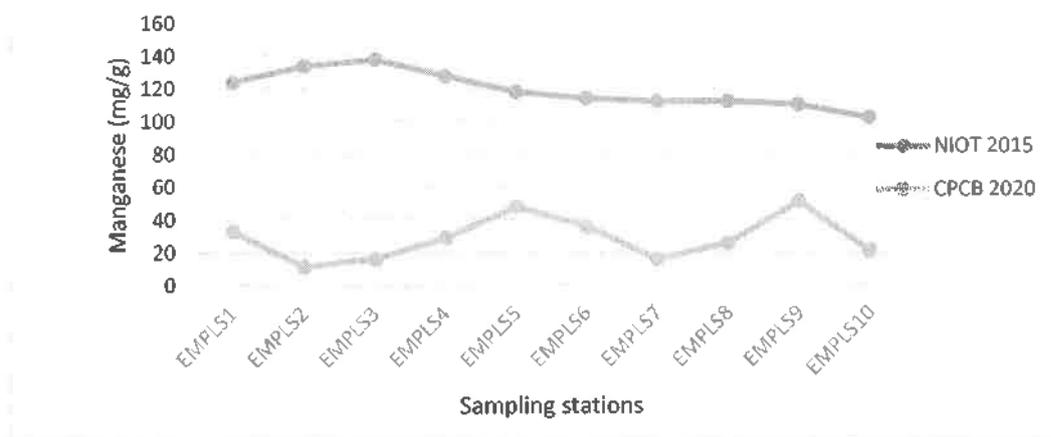


Fig.20 Manganese variation in the seafloor sediments around MPL offshore

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).

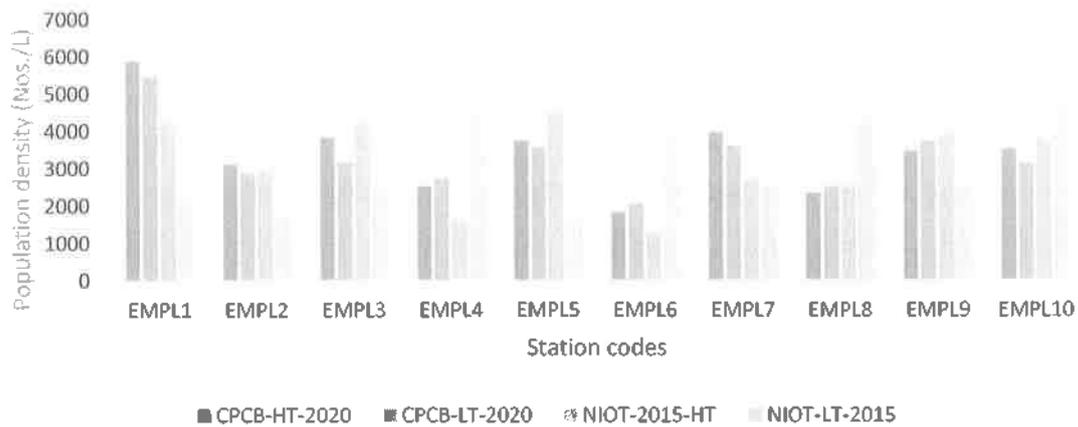


Fig. 21 Phytoplankton population density variation in the surface waters around MPL offshore discharge location during the study period

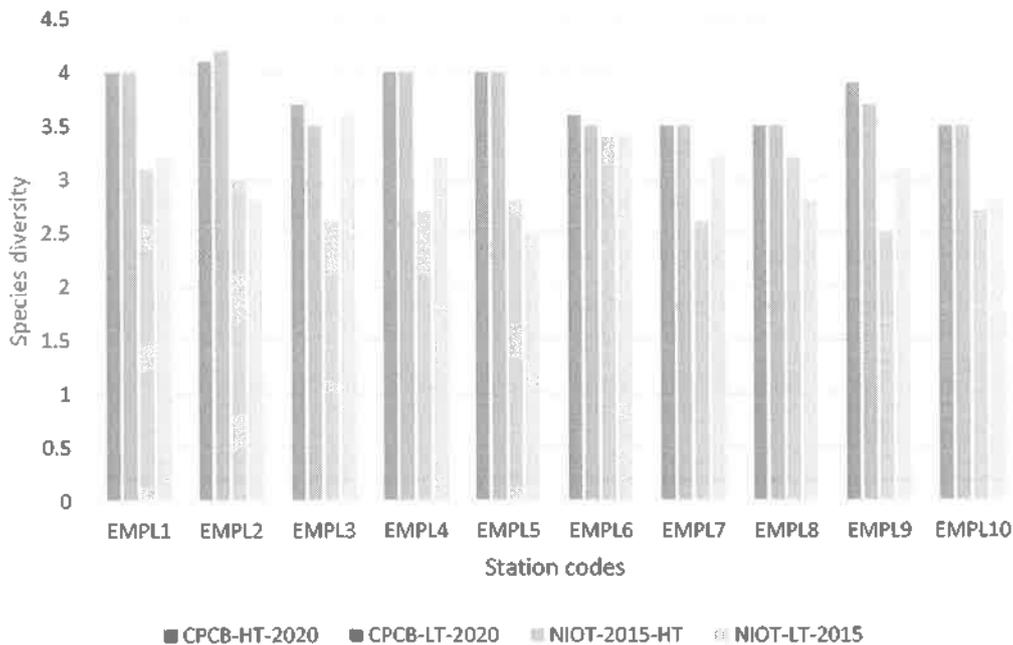


Fig. 22 Phytoplankton species diversity variation in the surface waters around MPL offshore discharge location during the study period

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./ m³ 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.

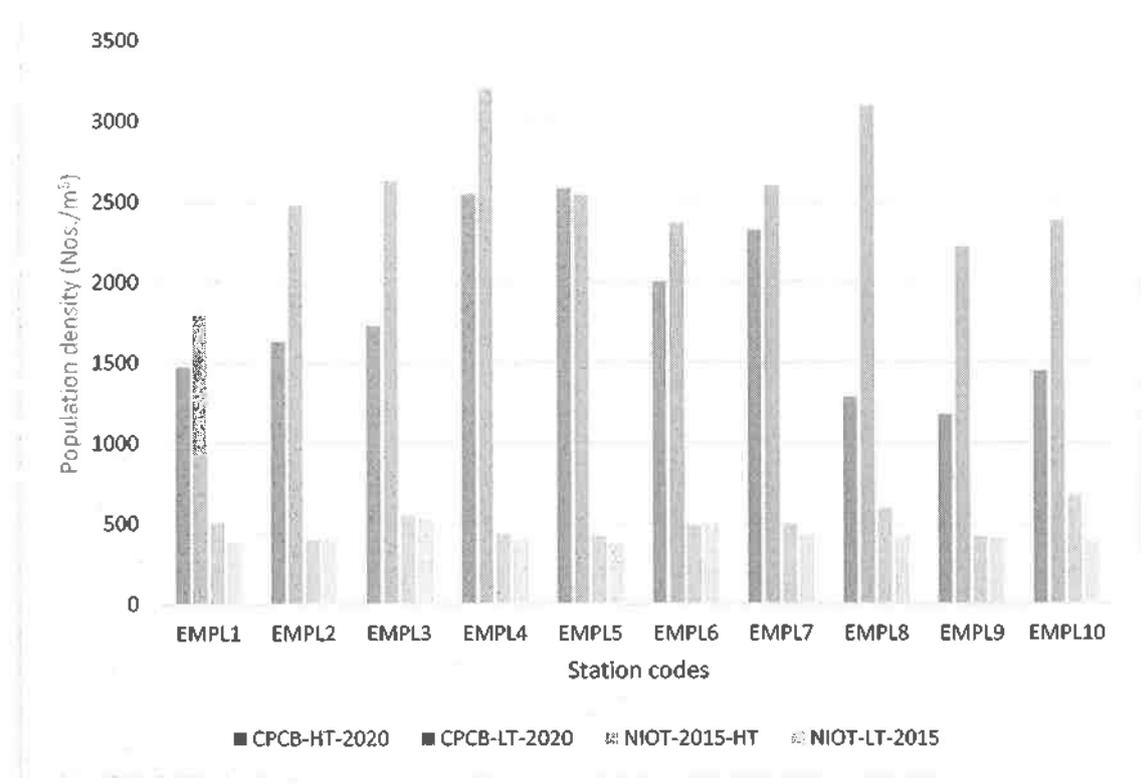


Fig. 23 Zooplankton population density variation in the surface waters around MPL offshore discharge location during the study period

BENTHOS

The subtidal benthic organisms recorded moderate fluctuation of standing stock and diversity. In terms of population, macrobenthos varied between 91 and 329 Nos./m². 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.

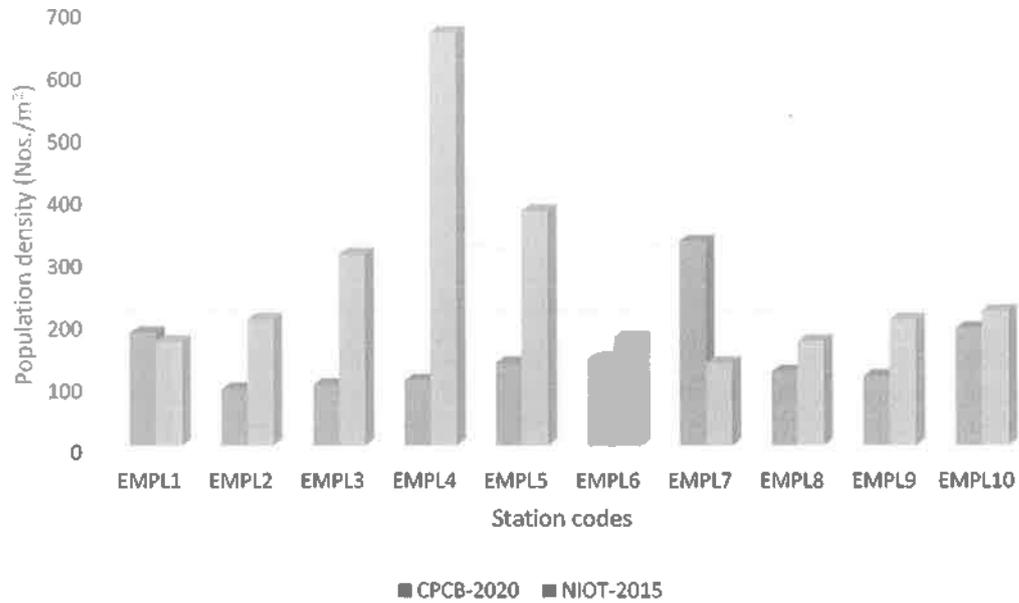


Fig. 24 Benthos population density variation in the sea bottom sediments around MPL offshore discharge location during the study period

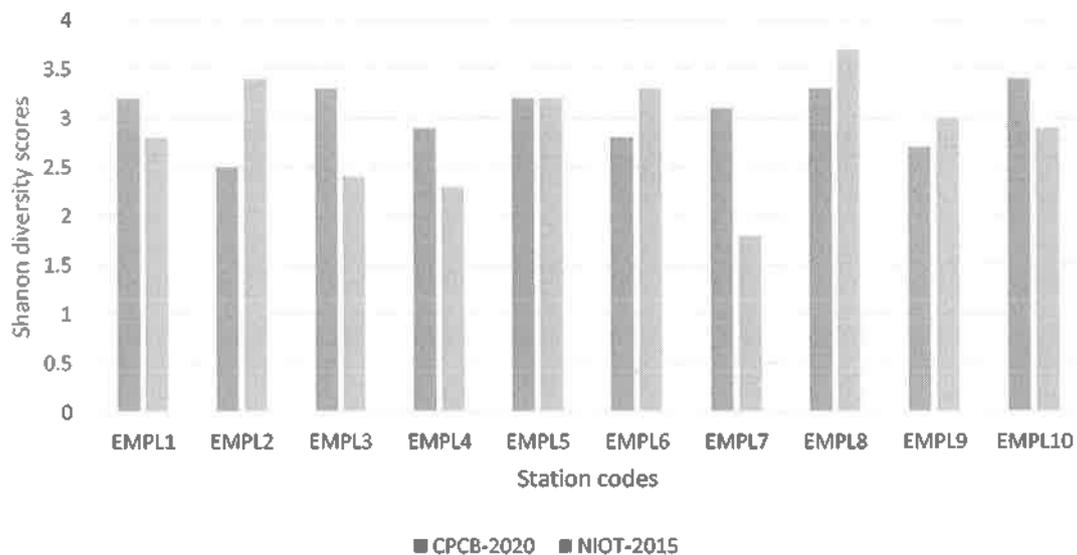


Fig. 25 Benthos population diversity variation in the sea bottom sediments around MPL offshore discharge location during the study period

SUMMARY

The results of selected parameters and comparison with previous study records reveal that there are spatial and temporal variations within the study area. Increase in nutrient parameters like nitrate recorded maximum value of 20.4 $\mu\text{mol./lis}$ comparable to values recorded in samples collected during low tide at the Ennore creek during the study (Annexure I: Table 2). The BOD values were also relative to quantities recorded in Ennore creek samples (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 be the 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, Royapuram sewage 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. The effect 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 as at 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

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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

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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

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Sample ID as per Glens Innovation Lab record	Report ID	Depth (m)	Tide	Ammonia ($\mu\text{mol/L}$)	Nitrate ($\mu\text{mol/L}$)	PO4 ($\mu\text{mol/L}$)	NO2 ($\mu\text{mol/L}$)
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 ($\mu\text{mol/L}$)	Nitrate ($\mu\text{mol/L}$)	PO4 ($\mu\text{mol/L}$)	NO2 ($\mu\text{mol/L}$)
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

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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

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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

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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

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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

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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	<i>Biddulphia regia</i> (7.14), <i>Biddulphia sinensis</i> (4.29), <i>Biddulphia mobiliensis</i> (2.86), <i>Rhizosolenia imbricata</i> (11.43), <i>Rhizosolenia stolterfothii</i> (1.43), <i>Rhizosolenia alata</i> (2.86), <i>Coscinodiscus radiatus</i> (1.43), <i>Ceratium tripos</i> (4.29), <i>Ceratium fusus</i> (7.14), <i>Thalassionema frauenfeldii</i> (4.29), <i>Guinardia flaccida</i> (10.00), <i>Guinardia striata</i> (4.29), <i>Skeletonema costatum</i> (7.14), <i>Leptocylindrus sp</i> (4.29), <i>Asterionella japonica</i> (7.14), <i>Streptotheca thamensis</i> (2.86), <i>Chaetoceros decipiens</i> (5.71), <i>Chaetoceros coarctatus</i> (10.00), & <i>Grammatophora marina</i> (1.43).
EMPL 2	3108	20	<i>Biddulphia regia</i> (4.05), <i>Biddulphia sinensis</i> (2.70), <i>Rhizosolenia imbricata</i> (4.05), <i>Rhizosolenia stolterfothii</i> (8.11), <i>Rhizosolenia robusta</i> (5.41), <i>Rhizosolenia bergonii</i> (2.70), <i>Coscinodiscus radiatus</i> (6.76), <i>Ceratium tripos</i> (4.05), <i>Ceratium fusus</i> (9.46), <i>Thalassionema frauenfeldii</i> (5.41), <i>Guinardia flaccida</i> (8.11), <i>Guinardia striata</i> (2.70), <i>Skeletonema costatum</i> (12.16), <i>Asterionella japonica</i> (5.41), <i>Streptotheca thamensis</i> (2.70), <i>Bellerochea malleus</i> (1.35), <i>Chaetoceros decipiens</i> (1.35), <i>Chaetoceros coarctatus</i> (6.76), <i>Grammatophora marina</i> (4.05) & <i>Trichodesmium sp.</i> (2.70).
EMPL 3	3831	15	<i>Biddulphia regia</i> (13.89), <i>Rhizosolenia imbricata</i> (3.97), <i>Rhizosolenia stolterfothii</i> (7.94), <i>Rhizosolenia calcar-avis</i> (9.92), <i>Coscinodiscus radiatus</i> (11.90), <i>Coscinodiscus granii</i> (1.98), <i>Ceratium fusus</i> (7.94), <i>Ceratium furca</i> (3.97), <i>Dinophysis caudata</i> (5.30), <i>Thalassionema frauenfeldii</i> (5.95), <i>Guinardia flaccida</i> (3.97), <i>Asterionella japonica</i> (0.48), <i>Streptotheca thamensis</i> (3.97), <i>Skeletonema costatum</i> (3.97), <i>Nitzschia sp</i> (1.78) & <i>Chaetoceros decipiens</i> (9.92).
EMPL 4	2196	19	<i>Biddulphia regia</i> (1.64), <i>Biddulphia mobiliensis</i> (8.74), <i>Rhizosolenia imbricata</i> (4.37), <i>Rhizosolenia stolterfothii</i> (3.28), <i>Rhizosolenia alata</i> (7.65), <i>Rhizosolenia robusta</i> (5.46), <i>Rhizosolenia calcar-avis</i> (8.74), <i>Rhizosolenia bergonii</i> (3.28), <i>Coscinodiscus radiates</i> (9.84), <i>Coscinodiscus granii</i> (2.19), <i>Coscinodiscus centralis</i> (4.37), <i>Ceratium tripos</i> (3.28), <i>Ceratium furca</i> (6.56), <i>Ceratium fusus</i> (5.46), <i>Thalassionema frauenfeldii</i> (6.56), <i>Guinardia flaccida</i> (12.02), <i>Skeletonema costatum</i> (2.19), <i>Streptotheca thamensis</i> (1.09), & <i>Chaetoceros decipiens</i> (3.28).

Station code	Population (No/l)	Faunal Groups	Percentage of species contribution
EMPL 5	3740	20	<i>Biddulphia regia</i> (14.12), <i>Rhizosolenia imbricata</i> (5.88), <i>Rhizosolenia alata</i> (4.71), <i>Rhizosolenia robusta</i> (8.24), <i>Coscinodiscus centralis</i> (4.71), <i>Coscinodiscus radiatus</i> (7.06), <i>Ceratium fusus</i> (3.53), <i>Thalassionema frauenfeldii</i> (7.06), <i>Guinardia flaccida</i> (4.71), <i>Skeletonema costatum</i> (3.53), <i>Leptocylindrus sp</i> (1.18), <i>Asterionella japonica</i> (2.35), <i>Anabaena sp</i> (1.18), <i>Streptotheca thamensis</i> (2.35), <i>Bellerochea malleus</i> (4.71), <i>Pleurosigma sp</i> (3.53), <i>Nitzschia sp</i> (1.18), <i>Chaetoceros decipiens</i> (7.06), <i>Chaetoceros coarctatus</i> (9.41) & <i>Chaetoceros gracilis</i> (3.53).
EMPL 6	1826	13	<i>Biddulphia regia</i> (8.43), <i>Biddulphia sinensis</i> (4.82), <i>Rhizosolenia imbricata</i> (9.64), <i>Coscinodiscus radiatus</i> (12.05), <i>Ceratium tripos</i> (4.82), <i>Ceratium furca</i> (9.64), <i>Thalassionema frauenfeldii</i> (4.82), <i>Guinardia flaccid</i> (9.64), <i>Skeletonema costatum</i> (7.23), <i>Streptotheca thamensis</i> (9.64), <i>Bellerochea malleus</i> (2.41), <i>Chaetoceros decipiens</i> (12.05) & <i>Chaetoceros coarctatus</i> (4.82).
EMPL 7	3963	13	<i>Biddulphia mobiliensis</i> (13.12), <i>Rhizosolenia imbricata</i> (9.84), <i>Coscinodiscus granii</i> (6.56), <i>Ceratium tripos</i> (9.84), <i>Ceratium fusus</i> (16.40), <i>Ceratium longiceps</i> (3.23), <i>Thalassionema frauenfeldii</i> (4.92), <i>Guinardia flaccid</i> (3.28), <i>Skeletonema costatum</i> (11.48), <i>Streptotheca thamensis</i> (1.64), <i>Chaetoceros decipiens</i> (4.92), <i>Chaetoceros coarctatus</i> (9.84) & <i>Trichodesmium sp.</i> (4.92).
EMPL 8	2340	13	<i>Biddulphia regia</i> (15.56), <i>Biddulphia sinensis</i> (4.44), <i>Rhizosolenia imbricata</i> (8.89), <i>Coscinodiscus radiatus</i> (1.11) <i>Ceratium tripos</i> (4.44), <i>Ceratium furca</i> (8.89), <i>Thalassionema frauenfeldii</i> (4.44), <i>Guinardia flaccida</i> (8.89), <i>Skeletonema costatum</i> (6.67), <i>Streptotheca thamensis</i> (8.89), <i>Nitzschia sp</i> (2.22), <i>Chaetoceros decipiens</i> (11.11), & <i>Chaetoceros coarctatus</i> (4.44).
EMPL 9	3472	16	<i>Biddulphia regia</i> (14.52), <i>Biddulphia sinensis</i> (3.23), <i>Rhizosolenia imbricata</i> (6.45), <i>Rhizosolenia calcar-avis</i> (8.06), <i>Coscinodiscus centralis</i> (6.45), <i>Ceratium arcticum</i> (3.23), <i>Ceratium fusus</i> (6.45), <i>Dinophysis caudata</i> (4.84), <i>Dictyocha spp.</i> (3.23), <i>Guinardia flaccida</i> (4.84), <i>Guinardia striata</i> (8.06), <i>Leptocylindrus sp</i> (6.45), <i>Bellerochea malleus</i> (4.84), <i>Pleurosigma sp.</i> (6.45), <i>Nitzschia sp.</i> (4.84) & <i>Chaetoceros decipiens</i> (8.06).
EMPL 10	3510	13	<i>Biddulphia regia</i> (1.53), <i>Biddulphia sinensis</i> (9.26), <i>Rhizosolenia imbricata</i> (14.81), <i>Rhizosolenia stolterfothii</i> (5.56), <i>Rhizosolenia alata</i> (3.70), <i>Rhizosolenia calcar-avis</i> (5.56), <i>Dinophysis caudate</i> (3.70), <i>Thalassionema frauenfeldii</i> (3.70), <i>Guinardia flaccida</i> (12.96), <i>Streptotheca thamensis</i> (12.96), <i>Pleurosigma sp</i> (5.56), <i>Chaetoceros decipiens</i> (14.81) & <i>Chaetoceros coarctatus</i> (5.56).

Station code	Population (No/l)	Faunal Groups	Percentage of species contribution
ENC 1	2736	20	<i>Biddulphia regia</i> (7.02), <i>Rhizosolenia imbricata</i> (5.26), <i>Rhizosolenia stolterfothii</i> (3.51), <i>Rhizosolenia bergonii</i> (1.75), <i>Coscinodiscus radiatus</i> (5.26), <i>Ceratium fusus</i> (5.26), <i>Dinophysis caudata</i> (3.51), <i>Dictyocha spp.</i> (7.02), <i>Guinardia striata</i> (3.51), <i>Skeletonema costatum</i> (8.77), <i>Leptocylindrus sp</i> (7.02), <i>Asterionella japonica</i> (5.26), <i>Anabaena sp</i> (3.51), <i>Streptotheca thamensis</i> (7.02), <i>Bellerochea malleus</i> (3.51), <i>Pleurosigma sp</i> (5.26), <i>Nitzschia sp</i> (7.02), <i>Chaetoceros decipiens</i> (5.26), <i>Chaetoceros gracilis</i> (1.75) & <i>Grammatophora marina</i> (3.51).
ENC 2	1110	4	<i>Anabaena sp</i> (24.32), <i>Spirulina sp.</i> (35.14), <i>Scenedesmus dimorphis</i> (21.62) & <i>Pediastrum duplex</i> (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	<i>Biddulphia regia</i> (8.70), <i>Biddulphia sinensis</i> (2.90), <i>Rhizosolenia imbricata</i> (14.49), <i>Rhizosolenia stolterfothii</i> (4.35), <i>Rhizosolenia alata</i> (7.25), <i>Coscinodiscus radiatus</i> (4.35), <i>Ceratium tripos</i> (5.80), <i>Ceratium fusus</i> (4.35), <i>Thalassionema frauenfeldii</i> (1.45), <i>Guinardia flaccida</i> (5.80), <i>Guinardia striata</i> (2.90), <i>Skeletonema costatum</i> (5.80), <i>Leptocylindrus sp</i> (7.25), <i>Asterionella japonica</i> (4.35), <i>Streptotheca thamensis</i> (5.80), <i>Chaetoceros decipiens</i> (4.35), <i>Chaetoceros coarctatus</i> (5.80), & <i>Grammatophora marina</i> (4.35).
EMPL 1	3002	18	<i>Biddulphia mobiliensis</i> (5.06), <i>Rhizosolenia imbricata</i> (2.53), <i>Rhizosolenia stolterfothii</i> (6.33), <i>Rhizosolenia robusta</i> (5.06), <i>Rhizosolenia bergonii</i> (7.59), <i>Coscinodiscus radiatus</i> (6.33), <i>Ceratium tripos</i> (3.80), <i>Ceratium fusus</i> (5.06), <i>Thalassionema frauenfeldii</i> (6.33), <i>Guinardia flaccida</i> (7.59), <i>Guinardia striata</i> (5.06), <i>Skeletonema costatum</i> (1.27), <i>Asterionella japonica</i> (8.86), <i>Streptotheca thamensis</i> (7.59), <i>Chaetoceros decipiens</i> (3.80), <i>Chaetoceros coarctatus</i> (2.53), <i>Grammatophora marina</i> (5.06) & <i>Trichodesmium sp.</i> (6.33).

Station code	Population (No/l)	Faunal Groups	Percentage of species contribution
EMPL 2	3920	18	<i>Biddulphia regia</i> (8.93), <i>Biddulphia mobiliensis</i> (5.36), <i>Rhizosolenia imbricata</i> (7.14), <i>Rhizosolenia alata</i> (3.57), <i>Rhizosolenia calcar-avis</i> (7.14), <i>Rhizosolenia bergonii</i> (1.79), <i>Coscinodiscus radiatus</i> (8.93), <i>Coscinodiscus granii</i> (5.36), <i>Ceratium tripos</i> (5.36), <i>Ceratium furca</i> (7.14), <i>Ceratium fusus</i> (3.57), <i>Thalassionema frauenfeldii</i> (3.57), <i>Guinardia flaccida</i> (1.79), <i>Guinardia striata</i> (3.57), <i>Streptotheca thamensis</i> (8.93), <i>Skeletonema costatum</i> (7.14), <i>Chaetoceros coarctatus</i> (3.57), <i>Chaetoceros decipiens</i> (5.36) & <i>Grammatophora marina</i> (1.79).
EMPL 3	2704	17	<i>Biddulphia regia</i> (12.50), <i>Biddulphia mobiliensis</i> (8.65), <i>Rhizosolenia imbricata</i> (4.81), <i>Rhizosolenia stolterfothii</i> (1.92), <i>Rhizosolenia robusta</i> (2.88), <i>Rhizosolenia calcar-avis</i> (5.77), <i>Coscinodiscus radiatus</i> (9.62), <i>Coscinodiscus granii</i> (2.88), <i>Coscinodiscus centralis</i> (4.81), <i>Ceratium tripos</i> (4.81), <i>Ceratium furca</i> (6.73), <i>Ceratium fusus</i> (5.77), <i>Thalassionema frauenfeldii</i> (3.85), <i>Guinardia flaccida</i> (13.46), <i>Skeletonema costatum</i> (4.81), <i>Streptotheca thamensis</i> (2.88), & <i>Chaetoceros decipiens</i> (3.85).
EMPL 4	3570	18	<i>Biddulphia regia</i> (12.94), <i>Rhizosolenia imbricata</i> (7.06), <i>Rhizosolenia alata</i> (3.53), <i>Rhizosolenia robusta</i> (5.88), <i>Coscinodiscus radiatus</i> (10.59), <i>Ceratium fusus</i> (4.71), <i>Thalassionema frauenfeldii</i> (9.41), <i>Guinardia flaccida</i> (2.53), <i>Skeletonema costatum</i> (3.53), <i>Leptocylindrus sp</i> (2.53), <i>Asterionella japonica</i> (4.71), <i>Streptotheca thamensis</i> (3.53), <i>Bellerochea malleus</i> (2.35), <i>Pleurosigma sp</i> (8.24), <i>Nitzschia sp</i> (3.53), <i>Chaetoceros decipiens</i> (4.71), <i>Chaetoceros coarctatus</i> (7.06) & <i>Chaetoceros gracilis</i> (3.53).
EMPL 5	2116	13	<i>Biddulphia regia</i> (13.04), <i>Biddulphia sinensis</i> (8.70), <i>Rhizosolenia imbricata</i> (6.52), <i>Coscinodiscus radiatus</i> (8.70), <i>Coscinodiscus centralis</i> (2.17), <i>Ceratium tripos</i> (6.52), <i>Ceratium furca</i> (8.70), <i>Thalassionema frauenfeldii</i> (2.17), <i>Guinardia flaccid</i> (6.52), <i>Skeletonema costatum</i> (4.35), <i>Bellerochea malleus</i> (10.87), <i>Chaetoceros decipiens</i> (13.04) & <i>Chaetoceros coarctatus</i> (8.70).
EMPL 6	3886	12	<i>Biddulphia mobiliensis</i> (14.93), <i>Rhizosolenia imbricata</i> (11.94), <i>Coscinodiscus radiatus</i> (5.97), <i>Ceratium tripos</i> (10.45), <i>Ceratium fusus</i> (8.96), <i>Thalassionema frauenfeldii</i> (5.97), <i>Guinardia flaccid</i> (1.49), <i>Skeletonema costatum</i> (7.46), <i>Streptotheca thamensis</i> (5.97), <i>Chaetoceros decipiens</i> (7.46), <i>Chaetoceros coarctatus</i> (11.94) & <i>Trichodesmium sp.</i> (7.46).
EMPL 7	2464	12	<i>Biddulphia regia</i> (18.18), <i>Biddulphia sinensis</i> (2.27), <i>Rhizosolenia imbricata</i> (6.82), <i>Coscinodiscus radiatus</i> (7.95), <i>Ceratium furca</i> (13.64), <i>Thalassionema frauenfeldii</i> (6.82), <i>Guinardia flaccida</i> (5.68), <i>Skeletonema costatum</i> (5.68), <i>Streptotheca thamensis</i> (11.36), <i>Nitzschia sp</i> (4.55), <i>Chaetoceros decipiens</i> (10.23), & <i>Chaetoceros coarctatus</i> (6.82).

Station code	Population (No/l)	Faunal Groups	Percentage of species contribution
EMPL 8	3456	15	<i>Biddulphia regia</i> (10.94), <i>Biddulphia sinensis</i> (6.25), <i>Rhizosolenia imbricata</i> (7.81), <i>Coscinodiscus centralis</i> (14.06), <i>Ceratium arcticum</i> (6.25), <i>Ceratium fusus</i> (4.69), <i>Thalassionema frauenfeldii</i> (7.81), <i>Guinardia flaccida</i> (1.56), <i>Guinardia striata</i> (3.13), <i>Skeletonema costatum</i> (6.25), <i>Asterionella japonica</i> (4.69), <i>Pleurosigma sp.</i> (7.81), <i>Nitzschia sp.</i> (3.13), <i>Chaetoceros decipiens</i> (6.25) & <i>Chaetoceros coarctatus</i> (9.38).
EMPL 9	3480	13	<i>Biddulphia regia</i> (5.00), <i>Rhizosolenia imbricata</i> (16.67), <i>Rhizosolenia stolterfothii</i> (6.67), <i>Rhizosolenia calcar-avis</i> (8.33), <i>Ceratium longiceps</i> (5.00), <i>Dinophysis caudate</i> (6.67), <i>Thalassionema frauenfeldii</i> (1.67), <i>Guinardia flaccida</i> (15.00), <i>Streptotheca thamensis</i> (10.00), <i>Pleurosigma sp.</i> (3.33), <i>Chaetoceros decipiens</i> (15.00), <i>Chaetoceros coarctatus</i> (3.33) & <i>Trichodesmium sp.</i> (3.33).
EMPL 10	2756	15	<i>Biddulphia regia</i> (5.66), <i>Rhizosolenia imbricata</i> (9.43), <i>Rhizosolenia stolterfothii</i> (5.66), <i>Coscinodiscus radiatus</i> (9.43), <i>Ceratium fusus</i> (9.43), <i>Thalassionema frauenfeldii</i> (1.89), <i>Guinardia flaccida</i> (5.66), <i>Skeletonema costatum</i> (1.89), <i>Asterionella japonica</i> (11.32), <i>Anabaena sp.</i> (5.66), <i>Streptotheca thamensis</i> (9.43), <i>Bellerochea malleus</i> (5.66), <i>Pleurosigma sp.</i> (1.89), <i>Chaetoceros decipiens</i> (7.55) & <i>Trichodesmium sp.</i> (9.43).
ENC 2	1064	4	<i>Anabaena sp.</i> (21.05), <i>Spirulina sp.</i> (39.47), <i>Scenedesmus dimorphis</i> (15.79) & <i>Pediastrum duplex</i> (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	<i>Calanoid copepods</i> (10.16), <i>Cyclopoid copepods</i> (5.42), <i>Sagitta</i> (3.93), <i>Medusa</i> (1.02), <i>Siphonophores</i> (5.08), <i>Cladocerans</i> (35.57), <i>Mysids</i> (6.78), <i>Brachyuran larvae</i> (2.03), <i>Fish eggs and larvae</i> (3.25), <i>Lucifer</i> (22.02), <i>Polychaete larvae</i> (3.93) & <i>Nauplius</i> (0.81)
EMPL 2	1638	11	<i>Calanoid copepods</i> (13.80), <i>Cyclopoid copepods</i> (0.61), <i>Sagitta</i> (2.81), <i>Siphonophores</i> (1.28), <i>Cladocerans</i> (48.35), <i>Appendicularians</i> (1.95), <i>Mysids</i> (8.79), <i>Fish eggs and larvae</i> (0.92), <i>Lucifer</i> (19.54), <i>Polychaete larvae</i> (0.98) & <i>Nauplius</i> (0.98)

EMPL 3	1731	13	<i>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)</i>
EMPL 4	2546	12	<i>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)</i>
EMPL 5	2586	11	<i>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)</i>
EMPL 6	2003	12	<i>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)</i>
EMPL 7	2325	12	<i>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)</i>
EMPL 8	1287	13	<i>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)</i>
EMPL 9	1180	12	<i>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)</i>
EMPL 10	1450	11	<i>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)</i>
ENC 1	630	11	<i>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)</i>
ENC 2	497	10	<i>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)</i>

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	<i>Calanoid copepods</i> (8.03), <i>Cyclopoid copepods</i> (0.89), <i>Medusa</i> (0.89), <i>Siphonophores</i> (3.01), <i>Cladocerans</i> (38.35), <i>Appendicularians</i> (1.78), <i>Mysids</i> (12.19), <i>Fish eggs and larvae</i> (1.74), <i>Lucifer</i> (27.87), <i>Polychaete larvae</i> (1.74) & <i>Nauplius</i> (3.48)
EMPL 2	2480	12	<i>Calanoid copepods</i> (8.63), <i>Cyclopoid copepods</i> (0.20), <i>Sagitta</i> (1.39), <i>Medusa</i> (2.78), <i>Siphonophores</i> (1.39), <i>Cladocerans</i> (37.38), <i>Appendicularians</i> (0.48), <i>Mysids</i> (9.73), <i>Fish eggs and larvae</i> (4.17), <i>Lucifer</i> (31.98), <i>Polychaete larvae</i> (1.39) & <i>Nauplius</i> (0.48)
EMPL 3	2631	10	<i>Calanoid copepods</i> (3.76), <i>Cyclopoid copepods</i> (2.62), <i>Sagitta</i> (2.20), <i>Cladocerans</i> (47.78), <i>Appendicularians</i> (2.27), <i>Mysids</i> (11.35), <i>Fish eggs and larvae</i> (2.27), <i>Lucifer</i> (24.90), <i>Polychaete larvae</i> (2.27) & <i>Nauplius</i> (0.57)
EMPL 4	3199	11	<i>Calanoid copepods</i> (6.31), <i>Cyclopoid copepods</i> (2.56), <i>Sagitta</i> (1.59), <i>Siphonophores</i> (4.78), <i>Cladocerans</i> (61.39), <i>Appendicularians</i> (1.47), <i>Mysids</i> (5.10), <i>Fish eggs and larvae</i> (1.28), <i>Lucifer</i> (13.91), <i>Polychaete larvae</i> (1.03) & <i>Nauplius</i> (0.56)
EMPL 5	2543	12	<i>Calanoid copepods</i> (11.84), <i>Cyclopoid copepods</i> (0.98), <i>Harapacticoid</i> (2.91), <i>Medusa</i> (3.97), <i>Siphonophores</i> (5.70), <i>Cladocerans</i> (50.29), <i>Appendicularians</i> (1.30), <i>Mysids</i> (5.27), <i>Fish eggs and larvae</i> (0.71), <i>Lucifer</i> (15.81), <i>Polychaete larvae</i> (0.47) & <i>Nauplius</i> (0.75)
EMPL 6	2367	12	<i>Calanoid copepods</i> (6.34), <i>Cyclopoid copepods</i> (3.13), <i>Sagitta</i> (1.35), <i>Medusa</i> (1.31), <i>Siphonophores</i> (3.72), <i>Cladocerans</i> (56.61), <i>Appendicularians</i> (1.86), <i>Mysids</i> (4.06), <i>Fish eggs and larvae</i> (1.31), <i>Lucifer</i> (17.11), <i>Polychaete larvae</i> (2.70) & <i>Nauplius</i> (0.51)
EMPL 7	2599	11	<i>Calanoid copepods</i> (20.62), <i>Cyclopoid copepods</i> (0.69), <i>Sagitta</i> (2.46), <i>Siphonophores</i> (3.23), <i>Cladocerans</i> (47.98), <i>Mysids</i> (7.08), <i>Brachyuran larvae</i> (1.61), <i>Fish eggs and larvae</i> (1.73), <i>Lucifer</i> (12.50), <i>Polychaete larvae</i> (1.23) & <i>Nauplius</i> (0.85)
EMPL 8	3093	12	<i>Calanoid copepods</i> (15.06), <i>Cyclopoid copepods</i> (2.29), <i>Sagitta</i> (1.33), <i>Medusa</i> (2.29), <i>Siphonophores</i> (2.29), <i>Cladocerans</i> (47.69), <i>Appendicularians</i> (2.29), <i>Mysids</i> (7.25), <i>Fish eggs and larvae</i> (2.29), <i>Lucifer</i> (15.06), <i>Polychaete larvae</i> (1.78) & <i>Nauplius</i> (0.39)
EMPL 9	2219	12	<i>Calanoid copepods</i> (13.50), <i>Cyclopoid copepods</i> (1.58), <i>Harapacticoid</i> (0.99), <i>Sagitta</i> (1.44), <i>Medusa</i> (2.43), <i>Siphonophores</i> (0.72), <i>Cladocerans</i> (43.88), <i>Mysids</i> (16.88), <i>Fish eggs and larvae</i> (5.06), <i>Lucifer</i> (8.44), <i>Polychaete larvae</i> (1.69) & <i>Nauplius</i> (3.38)

EMPL 10	2378	8	<i>Calanoid copepods</i> (7.69), <i>Cyclopoid copepods</i> (2.56), <i>Medusa</i> (5.13), <i>Siphonophores</i> (2.56), <i>Cladocerans</i> (48.72), <i>Mysids</i> (10.26), <i>Lucifer</i> (20.51) & <i>Nauplius</i> (2.56)
ENC 1	802	12	<i>Calanoid copepods</i> (19.45), <i>Cyclopoid copepods</i> (1.50), <i>Harapacticoid</i> (0.50) <i>Sagitta</i> (2.0), <i>Medusa</i> (1.25), <i>Cladocerans</i> (39.40), <i>Appendicularians</i> (1.75), <i>Mysids</i> (2.49), <i>Fish eggs and larvae</i> (7.23), <i>Lucifer</i> (5.49), <i>Polychaete larvae</i> (10.72) & <i>Nauplius</i> (8.23)
ENC 2	615	11	<i>Calanoid copepods</i> (17.56), <i>Cyclopoid copepods</i> (0.65), <i>Sagitta</i> (0.81), <i>Medusa</i> (0.81), <i>Cladocerans</i> (46.83), <i>Appendicularians</i> (1.30), <i>Mysids</i> (4.07), <i>Fish eggs and larvae</i> (5.69), <i>Lucifer</i> (7.32), <i>Polychaete larvae</i> (8.46) & <i>Nauplius</i> (6.50)

Table 5: Benthos population variation along MPL offshore discharge sites and adjoining Ennore creek system during HT

Station code	Total (Nos./m ²)	Percentage of species contribution
EMPL 1	182	<i>Tube worm</i> (3.855), <i>Arca sp.</i> (15.38), <i>Anadara granosa</i> (11.54), <i>Meretrix casta</i> (7.69), <i>Donax sp.</i> (23.08), <i>Astarte elliptica</i> (3.85), <i>Meretrix meretrix</i> (15.38), <i>Cerethedia sp.</i> (3.85) & <i>Clithon oualaniense</i> (15.38).
EMPL 2	91	<i>Tube worm</i> (7.69), <i>Terebellides sp.</i> (7.69), <i>Angulus tenuis</i> (7.69), <i>Arca sp.</i> (7.69), <i>Anadara granosa</i> (7.69), <i>Meretrix casta</i> (7.69), <i>Donax sp.</i> (15.38), <i>Cerethedia sp.</i> (23.08), <i>Parvanachis obesa</i> (7.69) & <i>Cellena radiata</i> (7.69).
EMPL 3	98	<i>Goniada sp.</i> (4.5), <i>Terebellides sp.</i> (2.3), <i>Arca sp.</i> (9.1), <i>Pecten sp.</i> (40.9), <i>Donax sp.</i> (6.8), <i>Meretrix meretrix</i> (2.3), <i>Umbonium vestiarium</i> (27.3), <i>Balanus sp.</i> (2.3), <i>Oliva sp.</i> (4.5).
EMPL 4	105	<i>Tube worm</i> (20.00), <i>Terebellides sp.</i> (6.67), <i>Arca sp.</i> (6.67), <i>Anadara granosa</i> (13.33), <i>Donax sp.</i> (13.33), <i>Meretrix meretrix</i> (13.33), <i>Cerethedia sp.</i> (20.00) & <i>Umbonium vestiarium</i> (6.67).
EMPL 5	133	<i>Cirratulus cirratus</i> (15.79), <i>Ancistrosyllis sp.</i> (10.53), <i>Tube worm</i> (5.26), <i>Arca sp.</i> (10.53), <i>Anadara granosa</i> (5.26), <i>Donax sp.</i> (10.53), <i>Meretrix meretrix</i> (15.79), <i>Cerethedia sp.</i> (10.53), <i>Umbonium vestiarium</i> (10.53) & <i>Sand Dollar</i> (5.26).
EMPL 6	140	<i>Prionospio sp.</i> (5.00), <i>Tube worm</i> (15.00), <i>Angulus tenuis</i> (5.00), <i>Arca sp.</i> (5.00), <i>Anadara granosa</i> (10.00), <i>Donax sp.</i> (15.00), <i>Meretrix meretrix</i> (20.00), <i>Cerethedia sp.</i> (5.00), <i>Umbonium vestiarium</i> (10.00) & <i>Turtella sp.</i> (10.00).
EMPL 7	329	<i>Tube worm</i> (6.38), <i>Terebellides sp</i> (4.26), <i>Arca sp.</i> (10.64), <i>Anadara granosa</i> (14.89), <i>Meretrix casta</i> (8.51), <i>Pecten sp.</i> (2.13), <i>Astarte elliptica</i> (4.26), <i>Donax sp.</i> (23.40), <i>Meretrix meretrix</i> (19.15), <i>Cerethedia sp.</i> (2.13) & <i>Umbonium vestiarium</i> (4.26).
EMPL 8	119	<i>Tube worm</i> (11.76), <i>Terebellides sp.</i> (5.86), <i>Angulus tenuis</i> (5.88), <i>Arca sp.</i> (5.88), <i>Meretrix casta</i> (11.76), <i>Pecten sp.</i> (5.88), <i>Donax sp.</i> (17.65), <i>Meretrix meretrix</i> (11.76), <i>Cerethedia sp.</i> (11.76), <i>Umbonium vestiarium</i> (5.88) & <i>Oliva sp.</i> (5.88).

Station code	Total (Nos./m²)	Percentage of species contribution
EMPL 9	112	<i>Terebellides sp.</i> (6.25), <i>Arca sp.</i> (12.50), <i>Anadara granosa</i> (12.50), <i>Meretrix casta</i> (18.75), <i>Donax sp.</i> (31.25), <i>Meretrix meretrix</i> (6.25), <i>Cerethedia sp.</i> (6.25) & <i>Umbonium vestiarius</i> (6.25).
EMPL 10	189	<i>Prionospio sp.</i> (3.70), <i>Cirratulus cirratus</i> (3.70), <i>Para heteromastus temis</i> (3.70), <i>Tube worm</i> (18.52), <i>Terebellides sp.</i> (7.41), <i>Angulus temis</i> (7.41), <i>Arca sp.</i> (7.41), <i>Anadara granosa</i> (11.11), <i>Meretrix casta</i> (14.81), <i>Donax sp.</i> (7.41), <i>Meretrix meretrix</i> (11.11) & <i>Cerethedia sp.</i> (3.70).
ENC 1	98	<i>Prionospio sp.</i> (14.29), <i>Angulus temis</i> (14.29), <i>Donax sp.</i> (14.29), <i>Meretrix meretrix</i> (14.29), <i>Cerethedia sp.</i> (14.29) & <i>Clithon oualaniense</i> (28.57).

Item Nos.7 to 11

BEFORE THE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI

Original Application No. 19 of 2013 (SZ) (THC)

& M.A.No. 173/2015 (SZ)

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

IN THE MATTER OF:

Meenavargal Membattu Sangam

... Applicant(s)

vs

The Chief Secretary,
Government of Tamil Nadu,
Chennai and Others.

...Respondent(s)

Original Application No. 248/2016 (SZ)

Meenava Thanthai

K.R. Selvaraj Kumar,

Meenavar Nala Sangam.

.. Applicant(s)

vs

The State of Tamil Nadu,
Rep.by its Secretary to Government,
Chennai and Others

...Respondent(s)

Appeal No. 51/2017 (SZ)

M/s. Manali Petrochemicals Limited

... Appellant(s)

vs

The Central Pollution Control Board,
Ministry of Environment, Forest and Climate Change,
Government of India,
New Delhi and Others

... Respondent(s)

Appeal No.52 of 2017 (SZ)

M/s. Manali Petrochemicals Limited ... Appellant(s)

vs

The Central Pollution Control Board,
Ministry of Environment, Forest and Climate Change
Government of India
New Delhi and Others.

... Respondent(s)

Original Application No. 224 of 2016 (SZ)

Meenava Thanthai

K.R. Selvaraj Kumar.

.. Applicant(s)

vs

The Chief Secretary,
Government of Tamil Nadu,
Secretariat, Chennai and Others.

... Respondent(s)

Date of hearing: 11.6.2020

CORAM:

HON'BLE MR. JUSTICE K. RAMAKRISHNAN, JUDICIAL MEMBER

HON'BLE MR. SAIBAL DASGUPTA, EXPERT MEMBER

Original Application No. 19 of 2013 (SZ) (THC)

& M.A.No. 173/2015 (SZ)

For Applicant(s): None.

For Respondent(s): Mr. M. Mani Gopi for R1 to R3.

M/s. Abdul Saleem & S. Saravanan for R4.

Original Application No. 248/2016 (SZ)

For Applicant(s): Mr. Stanley Hebzon Singh

For Respondent(s): Mr. M. Mani Gopi for R1 to R3 & R5.
M/s. Abdul Saleem &
S. Saravanan for R4 & R6

Appeal No. 51/2017 and 52/2017 (SZ)

For Appellant(s): Mrs. AL. Gandhimathi

For Respondent(s): Mr. D.S. Ekambaram &
Mrs. Jayalakshmi for R1 & R2
Mr. Abdul Saleem & S. Saravanan for R3

Mr. S. Saravanan for R4.

Mr. Stanley Hebzon Singh for R5

O.A.No.224 of 2016

For applicant .. Mr. Stanley Hebzon Singh

For respondents .. Mr. Mani Gopi for R2 to R4 & R6

Mr. Abdul Saleem &

Mr. S. Saravanan for R5 & R7

ORDER

In the order dated 8.2.2020, we have considered the previous orders and passed the following order:

“Before disposing the matter, we feel it appropriate to appoint a Joint Committee comprising of Central Pollution Control Board (CPCB), State Pollution Control Board (SPCB), a senior scientist from National Institute of Ocean Technology (NIOT) and senior scientist dealing with environment engineering (Chemical) from Anna University to inspect the units in question and find out the present status of the functioning of the units namely M/s. Manali Petrochemical Limited and M/s. Tamil

Nadu Petrochemical Limited and ascertain as to whether they are maintaining and managing all pollution control mechanism and whether the discharge of effluent from these industries to sea confirms with the specified norms prescribed by the PCB and the impact of effluents in the sea water and if there is any deficiency found and the sea water quality has not improved, then suggest the remedial measures by which the quality of sea water can be improved and who has to carry out these remedial measures and also assess the environmental compensation against the defaulting units who are responsible for polluting sea water by applying "Polluters Pay" principle and submit a report to this Tribunal within a period of three months.

The remedial measure should contain the short term as well as long term measures to be adopted by the units. They may also consider as to whether the units have complied with the recommendations made by the earlier committee for improvement of the quality of the sea water and if so to what extent that has been complied with and the impact of that compliance in the quality of sea water and if it is not sufficient to suggest more recommendations as a remedial measures to remedy the situation and make the quality of the sea water in conformity with the norms and the time required for completing the remedial measures. They may also conduct a detailed study regarding the effect of contamination caused on the flora and fauna of the aquatic and marine life.

Any one of the representative of the petitioner association is permitted to participate in the inspection along with the committee and the committee can consider his suggestion and make necessary observation regarding the same also in the report.

Central Pollution Control Board (CPCB) will be nodal agency for co-ordinating and for providing necessary logistics for this purpose"

and posted the case to 19.5.2020 for consideration of report. Tamil Nadu State Pollution Control Board was also directed to file their report regarding further action if any taken against these units and if there was any subsequent violations found then what was the result. On 19.5.2020, it was adjourned to today by notification. We have received the report submitted by the committee through e-mail.

2. When the matter was taken up today through Video Conference, learned counsel Mr. Stanley Hebzon Singh represented applicants in O.A.Nos.248 of 2016 and 224 of 2016 and fifth respondent in Appeal Nos.51 and 52 of 2017, learned counsel Mr. Abdul Saleem, through Mr. S. Saravanan represented fourth respondent in O.A.No.19 of 2013 and respondents 4 and 6 in O.A.No.248 of 2016, third respondent in Appeal Nos.51 and 52 of 2017 and respondents 5 and 7 in O.A.No.224 of 2016, learned Government Advocate Mr. Mani Gopi represented respondents 1 to 3 in O.A.19 of 2013, respondents 1 to 3 and 5 in O.A.248 of 2016 and respondents 2 to 4 and 6 in O.A.No.224 of 2016, Mrs. AL. Gandhimathi represented appellant in Appeal Nos.51 and 52 of 2017, Mr. D.S. Ekambaram through Mrs. Jayalakshmi represented

respondents 1 and 2 in Appeal Nos.51 and 52 of 2017 and Mr. Vijaya Mehanath represented fourth respondent in Appeal Nos.51 and 52 of 2017.

3. Learned counsel appearing for Central Pollution Control Board submitted that they have filed an interim report. We have received the interim report through e-mail dated 18.5.2020 which reads as follows:

**Interim Status Report of the Joint Committee
(as per Hon'ble Tribunal, Southern Zone, Chennai order dated
08.02.2020 in OA nos. 19/2013, 224/2016, 248/2016 and Appeal nos.
51/2017 & 52/2017)**

1. Background:

The Honourable National Green Tribunal, Southern Zone, Chennai, in the matter of OA nos. 19/2013, 224/2016, 248/2016 and appeal nos. 51/2017 & 52/2017 directed on 08.02.2020 as;

"..... we feel it appropriate to appoint a joint committee comprising of Central Pollution Control Board, State Pollution Control Board, a senior scientist from National Institute of Ocean Technology (NIOT) and senior scientist dealing with environment engineering (Chemical) from Anna University to inspect the units in question and find out the present status of the functioning of the units namely M/s. Manali Petrochemical Limited and M/s. Tamilnadu Petrochemical limited and ascertain as to whether they are maintaining and managing all pollution control mechanism and whether the discharge of effluent from these industries to sea confirms with the specified norms prescribed by the PCB and the impact of effluents in the sea water and if there is any deficiency found and the sea water quality has not improved, then suggest the remedial measures by which the quality of sea water can be improved and who has to carry out these remedial measures and also assess the environmental compensation against the defaulting units who are responsible for polluting sea water by applying "Polluters Pay" principle and submit a report to this Tribunal within a period of three months.

The remedial measure should contain the short term as well as long term measures to be adopted by the units. They may also consider as to whether the units have complied with the recommendations made by the earlier committee for improvement of the quality of the sea water and if so to what extent that has been complied with and the impact of that compliance in the quality of sea water and if it is not sufficient to suggest more recommendations as a remedial measures to remedy the situation and make the quality of the sea water in conformity with the norms and the time required for completing the remedial measures. They may also conduct a detailed study regarding the effect of contamination caused on the flora and fauna of the aquatic and marine life”.

2. About Committee:

In accordance to Hon'ble tribunal direction, CPCB, RD(S), Bengaluru communicated the order and requested for nomination from respective departments vide letter no. Tech/39/NGT(SZ)/RDS/2019-20 dated 13.02.2020. Consequent upon the nominations received from respective department and monitoring was planned during March 04 to 06, 2020 with concurrence of committee members. The committee constituted with following members:

1. Dr. VijayaRavichandran, Scientist'G', NIOT, Chennai
2. Sh. M. Malaiyandi, JCEE, TNPCB, Arumbakkam, Chennai
3. Dr. V.T. Perarasu, Associate Professor, Dept. of Chemical Engg., AU, Chennai
4. Sh. R. Rajkumar, Scientist 'D', CPCB, RD (S), Bengaluru
5. Sh. A. Gnanavelu, Scientist 'C', CPCB, RD (S), Bengaluru

3. Scope of the committee as per order:

- i) To inspect the units in question and find out the present status of the functioning of the units and ascertain as to whether they are maintaining and managing all pollution control mechanism and whether the discharge of effluent from these industries to sea confirms with the specified norms prescribed by the PCB.

- ii) To assess the impact of effluents discharged in the sea water and if there is any deficiency found and the sea water quality has not improved, then suggest the remedial measures by which the quality of sea water can be improved and who has to carry out these remedial measures. The remedial measure should contain the short term as well as long term measures to be adopted by the units. Also to conduct a detailed study regarding the effect of contamination caused on the flora and fauna of the aquatic and marine life.
- iii) To assess the environmental compensation against the defaulting units who are responsible for polluting sea water by applying "Polluters Pay" principle.
- iv) To consider, whether the units have complied with the recommendations made by the earlier committee for improvement of the quality of the sea water and if it is not sufficient to suggest more recommendations as a remedial measures to remedy the situation

4. Committee Meeting & Field Visit:

A preliminary meeting was held on 04.03.2020 with the committee members and discussed about the scope of committee as per order and trailed by the presentation of the following industries about their products, waste water generation, treatment facilities, and air pollution control devices installed:

- i) M/s Manali Petrochemical Ltd., (Plant I & II)
- ii) M/s Tamilnadu Petrochemical Ltd., (LAB, PO & Alkali Plant)
- iii) M/s Kothari Petrochemical Ltd.,

After the detailed discussions, the committee has made following decisions as per infrastructure and manpower.

- To carry out visit of all industries during 4-5.03.2020 and to conduct simultaneous monitoring/sampling of industrial ETPs, Marine (outfall of treated effluent) and Ennore creek (mouth of sea) on 06.02.2020 & sources emission during this period.
- To carry out sources emission monitoring utilizing the manpower of NABL accredited lab M/s Glens, Chennai in supervision of CPCB official Sh. Sudhagarh, JSA. The materials required for monitoring

such as chemicals, thimbles etc. and analysis from CPCB, RD(S) Lab, Bengaluru.

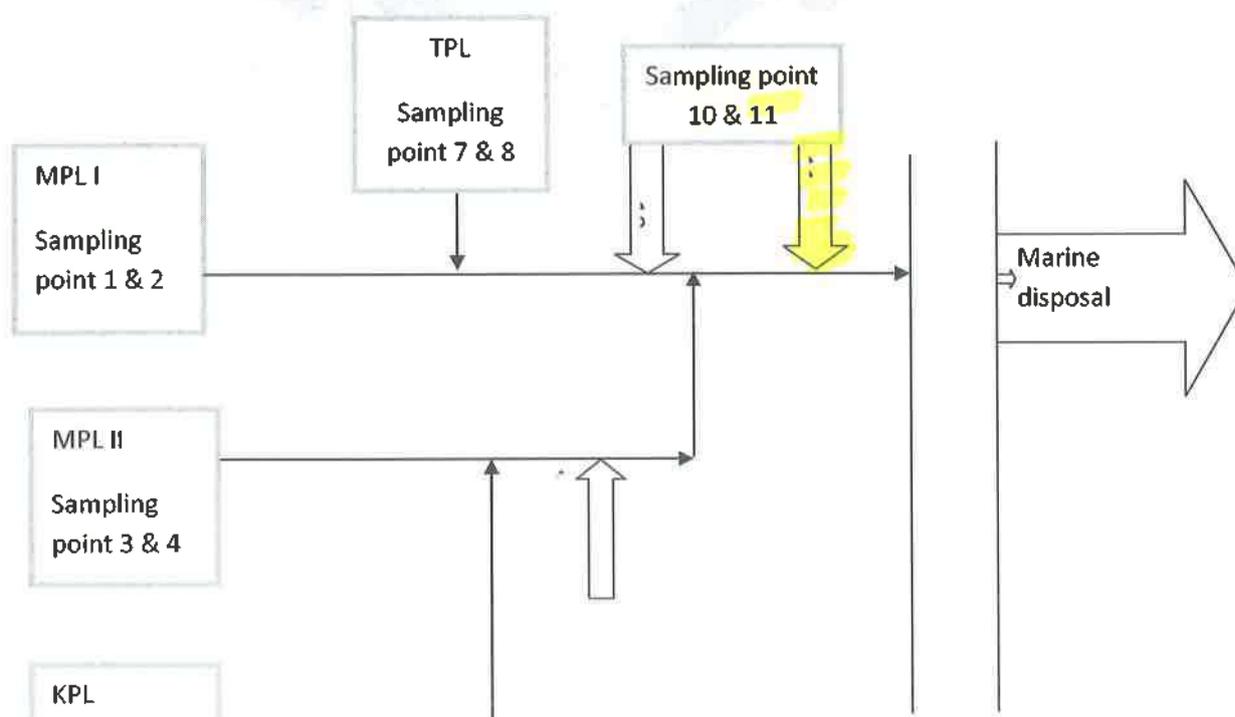
- Sampling & Analysis of the samples collected from industrial treatment plants & discharge pipelines will be carried out by CPCB, RD(S) Lab, Bengaluru.
- Sampling and Analysis (biological parameter) of Marine & Ennore creek will be carried out by NIOT, Chennai
- Analysis of the samples collected from marine & Ennore creek for physio-chemical parameters, heavy metals will be done through NABL accredited lab M/s Glens, Chennai
- The cost for sampling and analysis carried out by NIOT, Chennai and M/s Glens, Chennai will be borne by the industries under polluter pay principal.

After meeting, committee continued with field visit/inspection and as per Hon'ble NGT direction representative of applicant Mr.M.R.Thiyagarajan (President MeenavarNalaSangam) was present on 04.03.2020.

5. Details of Sampling & Analysis Result:

5.1 Sampling at Industries & Discharge Pipeline:

The samples were collected at inlet and outlet of treatment plants installed in the individual industries and also in pipeline carrying treated effluent of all four units leading to marine outfall. Total 11 nos. of samples were collected.



Sampling point 9



5.2 Source Emission Sampling:

The details of the source emission monitoring carried out at seven stacks during committee inspection are given below:

Name of Industries	Monitoring Locations	Fuel Used	Parameters Monitored
M/s MPL (Plant – I)	18 TPH Boiler	LNG	PM, SO ₂ , NO _x
M/s MPL (Plant – II)	10, 10 & 21 TPH Boilers	HO	PM, SO ₂ , NO _x
M/s KPL	12 TPH Boiler	Rice Husk	PM, SO ₂ , NO _x
M/s TPL (LAB)	8 TPH Boiler	LNG	PM, SO ₂ , NO _x
M/s TPL (PO Plant)	12 TPH Boiler	LNG	PM, SO ₂ , NO _x
M/s TPL (HCD)	5 TPH Boiler	LNG	PM, SO ₂ , NO _x
	HCL Plant Scrubber	Process Stack	Acid Mist & Vapour

5.3 Sampling at Marine & Ennore Creek:

Sea samples were collected by NIOT team along with committee during industries sampling, covering 1 km wide and 2 km long stretch along the Ennore coast to include the near field and far field area of outfall. Sampling locations were located at 500 m and 1000 m distances along three transects to the north, south and east of outfall. Samples were collected at surface and mid depth covering both low tide and high tide. Additionally samples were collected at the mouth of ennore creek, to know any pollution impact on sea through this creek. Total 48 nos. of samples were collected and also 14 nos. of sediment samples were collected from the bottom of sea to know the impact due to discharge.

5.4 Analysis results:

Due to COVID 19 lock down analysis report from the laboratories of M/s Glens, Chennai and NIOT yet to receive.

6. Compliance of Recommendation submitted by Previous Committees/Reports:

6.1	Recommendation of the two member expert committee was constituted with Dr.Palanivelu, Anna University, Chennai and Dr. N. Vedharaman, CLRI, Chennai as per order dated 22.7.2014 in O.A. No. 19 of 2013	
6.1.1 Specific Recommendations for environment safety		
i	The units shall have leak detection system and necessary arrangements for immediate repair of pipeline to avoid soil and ground water contamination.	Complied
ii	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.	Partially Complied. Study was carried out only once through NIOT during August 2015. Then the unit approached NIOT during December 2016, but NIOT has not carried out the study due to other commitments. Thereafter the unit trying to findout/engage other organisation to carry out Marian impact assessment study.
iii	Toxicity studies to be conducted for the combined effluent before discharge into sea once in six months	Complied. Study was conducted through M/s SGS during November 2016.
iv	The MPL Units in their process are not using any toxic metals. However TNPCB	Complied

	may ensure this by analysing for presence of heavy metals. In the treated effluent of units.	
6.1.2 General Recommendations for environment safety		
i	As the Metro water pipeline and treated effluent pipe line runs closely 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 pipe lines to avoid problem foresee wherever necessary	It was informed that: The respective lines have been laid at different levels. Further MPL has used heavy thick HDPE pipes. MPL pipe line pressure is less if compared with Metro water line pressure. As stated earlier MPL's Team is carrying out regular inspection of the entire stretch of the pipeline. Also, co-ordinates with agencies such as Highways, TWAD, CMWSSB etc. to ensure that the line is not affected/ tampered whenever they undertake any digging or other work near the effluent line.
ii	Pipeline routes may be marked/identified by suitable means for easy identification and follow-up	Complied. Pipeline route marker provided in 75 places.
iii	Necessary arrangements may be made well in advance to replace the pipe according to its life time to ensure environmental safety.	Complied. The effluent line was originally laid and commissioned in the year 1990 and replaced the line in 2011. <i>However industry shall carry out third party verification in regard to</i>

		<i>the pipeline strength and accordingly pipeline shall be replaced.</i>
iv	Open area lines (Canals) may be closed with suitable materials to prevent damage.	Complied
6.1.3 Specific Recommendations:		
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 treatment process to achieve marine discharge standards.	Complied
2.	The industry should make necessary provisions for the collection of samples from the pipe line 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.	Complied
Long Term		

1.	<p>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.</p>	<p>It is informed that: As per Expert committee advice MPL carried out the study to identify the suitable catalytic process. For this small capacity plant catalytic process technology is not viable. Only available for very high capacity plant(minimum 600 TPD). New The investment for the change of process (large capacity plant) is Rs 4000 Cr and no market scope in India. In the catalytic process pollutant load is higher than present chlorohydrin route.</p>
2.	<p>M/s MPL I & II and other industries should look in to 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.</p>	<p>It is informed that: ZLD is not viable method for these industries, due to effluent characteristics (containing CaCl₂), RO membrane may not work properly and moreover issue will be on disposing of solid waste generation. All units adopting various methods on water conservation and also using treated sewage effluent. M/s MPL is using RO reject from M/s MFL for the process. Treated wastewater from M/s TPL (LAB & Alkali plant) is being utilised by PO plant.</p>

		<i>Feasibility of using treated wastewater from M/s KPL shall be explored by M/s MPL</i>
6.1.4 General Short term Recommendations (within Six Months)		
1.	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.	Complied

6.2	Summary of NIOT Report (August 2015)
<p>The results of selected parameters reveal that there is no spatial or temporal variation in the study area. The concentration of metals show lower values in the offshore location MPL 10, when compared to the other locations. The background concentrations of the study area is significantly high possibly due to the influence of Royapuram fishers harbour, Chennai Port, Royapuram outfall and several other industries discharging in this area.</p> <p>From these results it can be concluded that the study area was moderately polluted, which may be attributed to the several sources.</p> <p>The studies on biological characteristics reveal the following:</p> <ul style="list-style-type: none"> ➤ The near shore coastal belt shows minor variation in biological characteristics ➤ Various discharges along Ennore coast may induce synergistic effect of toxicant on the benthic population in certain station and in depth studies are warranted. <p>The MPL EIA report does not contain the biological data for comparison. The scope of present short term study is too limited to</p>	

conclude any discernible trends on the possible impact on environment

6.3 Recommendation of Joint Committee Report (CPCB & TNPCB) submitted on May 02, 2016 & September, 2016				
		M/s MPL (Plant I & II)	M/s TPL	M/s KPL
i	All units 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 same to be made available to TNPCB/CPCB during inspection.	Complied	Partially Complied	Partially Complied
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.	Complied	NA	NA
iii	All units to prepare planned schedule of pumping of treated effluent	Complied MPL Plant-1 - 24 Hours MPL Plant-2 - 24 hours	Complied TPL - 24 Hours	Complied Kothari- 6.30 hrs to 9.30hrs 16.30 to

	into marine disposal system and to ensure the quality of effluent before discharging into sea.			19.30hrs, 1.30 to 4.30 hours
iv	All the units 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. Also to maintain proper daily records /logbook for effluent generated, treated and quantity of treated effluent sent to marine disposal system.	Complied	Complied	Complied
v	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 from the units and quantity of effluent discharged. This also helps to	Partially Complied. Flow meters installed in the industry are connected to online expect the flow meters installed in sea discharge pipeline outside industry	Partially Complied Flow meters installed in the industry are connected to online expect the flow meters installed in sea discharge pipeline outside industry	Partially Complied Flow meters installed in the industry are connected to online expect the flow meters installed in sea discharge pipeline outside industry

	quick identification of any leaks in the pipeline. These flow meters shall connect to TNPCB/CPCB monitoring center.			
vi	All sampling points are found access to public; these sampling locations are kept in lock and key arrangements, one set of key as well as valve operating devices shall be made available to TNPCB to access at any point of time in these points.	Complied	Complied	Complied
vii	To install online BOD, COD analyzer in the marine disposal line and same shall be connected to TNPCB/ CPCB monitoring center	Complied	Complied	Complied
viii	The industry shall have advanced leak detection system along with manual verification for quick identification of leak and arrangements for immediate repair of the same to	Complied <i>However flow meters shall be connected to DCS system as well as in CPCB & TNPCB server</i>	NA	NA

	prevent the soil and ground water contamination in the surrounding area.			
ix	To take up detailed marine study by considering the actual quality and quantity of effluent discharged to verify the availability of dilution in the sea and its impact on marine species.	Partially Complied. Study was carried out only once through NIOT during August 2015. Then the unit approached NIOT during December 2016, but NIOT has not carried out the study due to other commitments. Thereafter the unit trying to find out/engage other organisation to carry out Marian impact assessment study	Partially Complied.	Partially Complied.
x	To install proper floaters to trace the pipe line passing in the sea as well as the point of diffuser. Without any identification it is very difficult to locate exact point of diffuser while collecting samples from sea disposal	Complied	NA	NA

	points by TNPCB/CPCB and the same may not be true representative samples.			
xi	All units are required to conduct toxicity studies for their effluent and also for combined effluents. The results shall be submitted to TNPCB including species used for the study.	Not Complied Industry has carried out only heavy metal study not with species	Not Complied.	Not Complied.

7. Submission for extension of time:

Sl No.	Scope of the committee as per order	Status
i)	To inspect the units in question and find out the present status of the functioning of the units and ascertain as to whether they are maintaining and managing all pollution control mechanism and whether the discharge of effluent from these industries to sea confirms with the specified norms prescribed by the PCB.	Samples were collected to assess the performance of the pollution control system installed at the units and confirm the discharge norms of treated effluent. Wastewater samples collected - 11 nos. Source emission samples - 07 nos. <i>(Shall be justified/commented after obtaining the analysis report)</i>
ii)	To assess the impact of effluents discharged in the sea water and if there is any deficiency found and the sea water quality has not improved, then suggest the remedial measures by which the quality of sea water can be improved and who has to carry out these remedial measures. The remedial measure should contain the short term as well as long term measures to be adopted by the units.	Totally 48 samples were collected in marine around discharge point and at mouth of Ennore creek. 14 nos. of sediment samples were collected from the bottom of sea <i>(Shall be justified/commented after obtaining the analysis report)</i>

	Also to conduct a detailed study regarding the effect of contamination caused on the flora and fauna of the aquatic and marine life.	
iii)	To assess the environmental compensation against the defaulting units who are responsible for polluting sea water by applying "Polluters Pay" principle.	<i>Environmental compensation shall be assessed and imposed after obtaining the analysis report (if any violation/damage noticed)</i>
iv)	To consider, whether the units have complied with the recommendations made by the earlier committee for improvement of the quality of the sea water and if it is not sufficient to suggest more recommendations as a remedial measures to remedy the situation	Compliance statuses of the earlier committees are detailed in section 6. <i>(After obtaining analysis report, suggestions shall be recommended as a remedial measures)</i>

Due to lockdown, the laboratories are not in a position to submit the final analysis report.

In view of the above fact, the committee requests Honourable Tribunal further two month time to submit the final report considering the present pandemic situation."

4. In the conclusion portion, the committee has sought for two more months time to file the report, as they could not collect the Analysis Report from the laboratory due to lock down declared on account of Corona infection in the State.

5. Under these circumstances, we feel it appropriate to grant two months time to the committee to submit the report along with the remediation measures if any, required on the basis of the Analysis Report and also suggest alternate methods if any, required for non compliance of certain suggestions and recommendation given for efficient management of pollution control

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mechanism which they have mentioned in the 'remarks' column of the compliance of recommendation in the interim report.

The committee is directed to submit the report to this Tribunal on or before 7.9.2020 by e-mail or e-filing at ngtszfilling@gmail.com.

Registry is directed to communicate this order to the members of the committee immediately by e-mail so as to enable them to comply with the direction

For consideration of report post on 7.9.2020

.....J.M.
(Justice K. Ramakrishnan)

.....E.M.
(Shri. Saibal Dasgupta)

O.A. No.19/2013 batch
11.6. 2020
Kkr

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**LICENSE PROPOSAL
OF
PROPYLENE OXIDE UNIT
FOR
Manali Petrochemicals Limited**

January, 2017

SUMITOMO CHEMICAL CO., LTD.

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CONFIDENTIAL**1. Executive Summary**

This license proposal is prepared by Sumitomo Chemical to provide Manali Petrochemicals Limited ("Manali") with the preliminary information of the Sumitomo POC (Propylene Oxide Cumene Process) technology which includes a list of equipment, technical & process requirements, investment costs estimation and other relevant information for Manali to evaluate the possibility of the license of technology.

2. Approximate Estimation of CAPEX**2.1 Design Capacity and Estimation of Capital Investment**

Design Capacity: 200 KTA (Kilo Ton per Annum)

Operating Time: 8,000 Hours per Annum

The unit shall produce 200 KTA of propylene oxide (PO).

Turndown ratio of the unit: 50%

Estimated ISBL cost; US\$318,000,000- for the capacity of 200KTA.

(Year: 2014, Location basis: India, Accuracy: $\pm 30\%$)

(Rs. 2500 cr)
only ISBL
(2014 - Rs. 1500 cr)

Please refer to the diagram in Section 2.4 (page 6) for the scope of ISBL.

2.2 Equipment List and Material of Construction

Major equipment list is tabulated in the Attachment 1, together with the material of construction.

2.3 Laboratory Equipment List

Purpose	Equipment
Shipment Inspection for Product PO	Gas Chromatography
	Titration Equipment
	Water Analysis Equipment (Karl Fischer titration method)
Quality Check for Product PO	Gas Chromatography
	Titration Equipment
	Water Analysis Equipment (Karl Fischer titration method)
Plant Support for Process Liquid	Gas Chromatography
	Titration Equipment
	Water Analysis Equipment (Karl Fischer titration method)
	Inductivity-Coupled Plasma Spectrometry
	Ion Chromatography
	pH Meter

2.4 Off-site Facilities

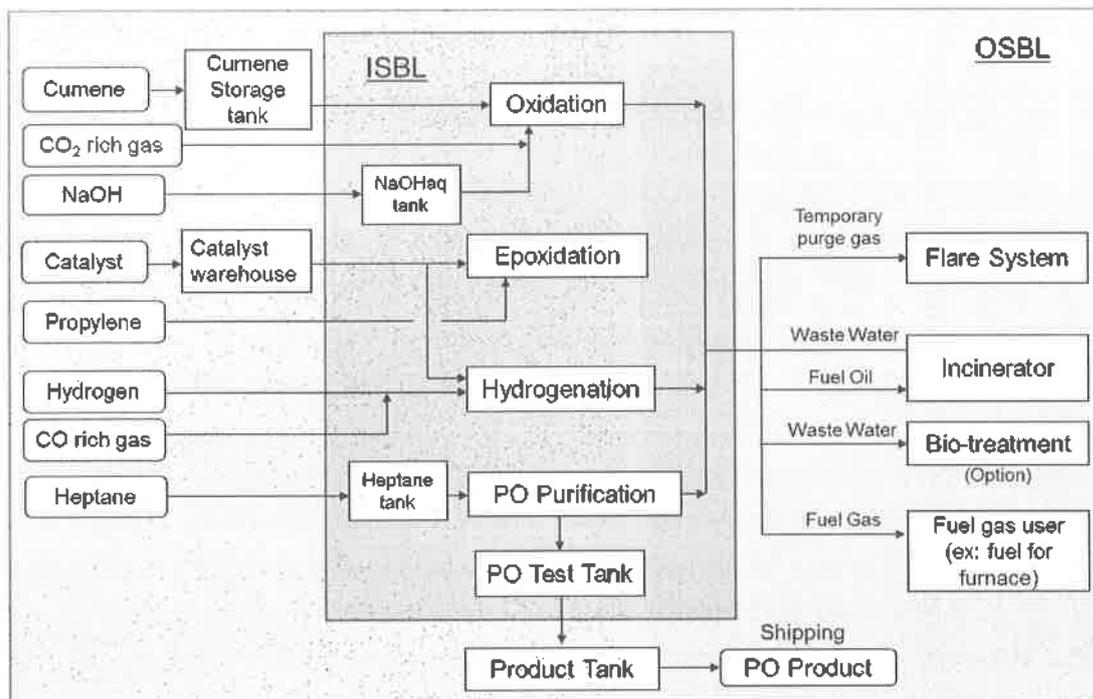
OSBL facilities required include, but are not limited to, the following:

- Logistic Control System and Facilities
- Product Storage including Loading Equipment.
- Catalyst Warehouse
- Raw Material (Monomer, Solvent, etc.) Storage including Unloading, Purifier and Feeding Equipment
- Waste Water Treatment System
- Incinerator
- Flare System

OSBL facilities are outside the scope of our license and need to be designed by and procured from other sources.

Typical configuration of offsite facilities is shown on next page.

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2.5 Utility Facilities

The utilities that need to be supplied from OSBL facilities include, but are not limited to, the following:

- Steam
- Process Water
- Recirculation Cooling Water
- Utility Water
- Instrument Air (Dried Air)
- Utility Air
- Nitrogen
- Electricity
- Drinking Water

Please refer to the Section 3.1.6 for the conditions required at the battery limit.

CONFIDENTIAL**3. Description of Technology****3.1.1 Features of Technology and Process Description**Features of Technology

Conventional processes –the chlorohydrin PO-only process and the organic hydroperoxide processes– have, for PO producers, the large disadvantage of generating environmentally unfriendly waste or exposing the product price to the fluctuating market of co-products that are generated in huge amount.

With the development of a high performance titanium epoxidation catalyst by our researchers, we have succeeded in establishing a novel PO-only manufacturing process where cumene(CUM) acts as the oxygen carrier. The POC is considered a “green process” since it gives higher product yield than conventional processes while only producing small amount of by-products.

Process Description

The Process includes and consists of the following process sections.

(1) Raw material receiving and supply

Propylene and CUM are received and fed into the plant.

(2) Oxidization

CUM is oxidized by air to cumenehydroperoxide (CMHP) without using catalyst in vertical reactors under the alkaline solution emulsion condition. CMHP and unreacted CUM are sent to the epoxidation section after separation of alkaline solution.

(3) Epoxidation

Propylene and CMHP are reacted to produce PO and cumyl alcohol (CMA) in down-flow reactors under liquid phase condition by use of the Epoxidation Catalyst. Reaction mixture of propylene oxide, cumyl alcohol, unreacted propylene and CUM are sent to the propylene and PO separation section.

CONFIDENTIAL**(4) Propylene and PO separation**

Propylene is recovered from the reaction mixture and recycled to the epoxidation section. Crude PO is separated from the mixture of CUM and CMA and sent to the PO purification section. The mixture of CUM and CMA is sent to the hydrogenation section.

(5) Hydrogenation

CMA is first dehydrated and then hydrogenated to be converted to CUM (water is also generated) in up flow reactors under gas/liquid phase condition by use of the dehydration and hydrogenation catalysts. CUM is recovered from such reaction mixture and recycled to the oxidation section. Outlet gas (hydrogen) of the reactors is recycled for reuse.

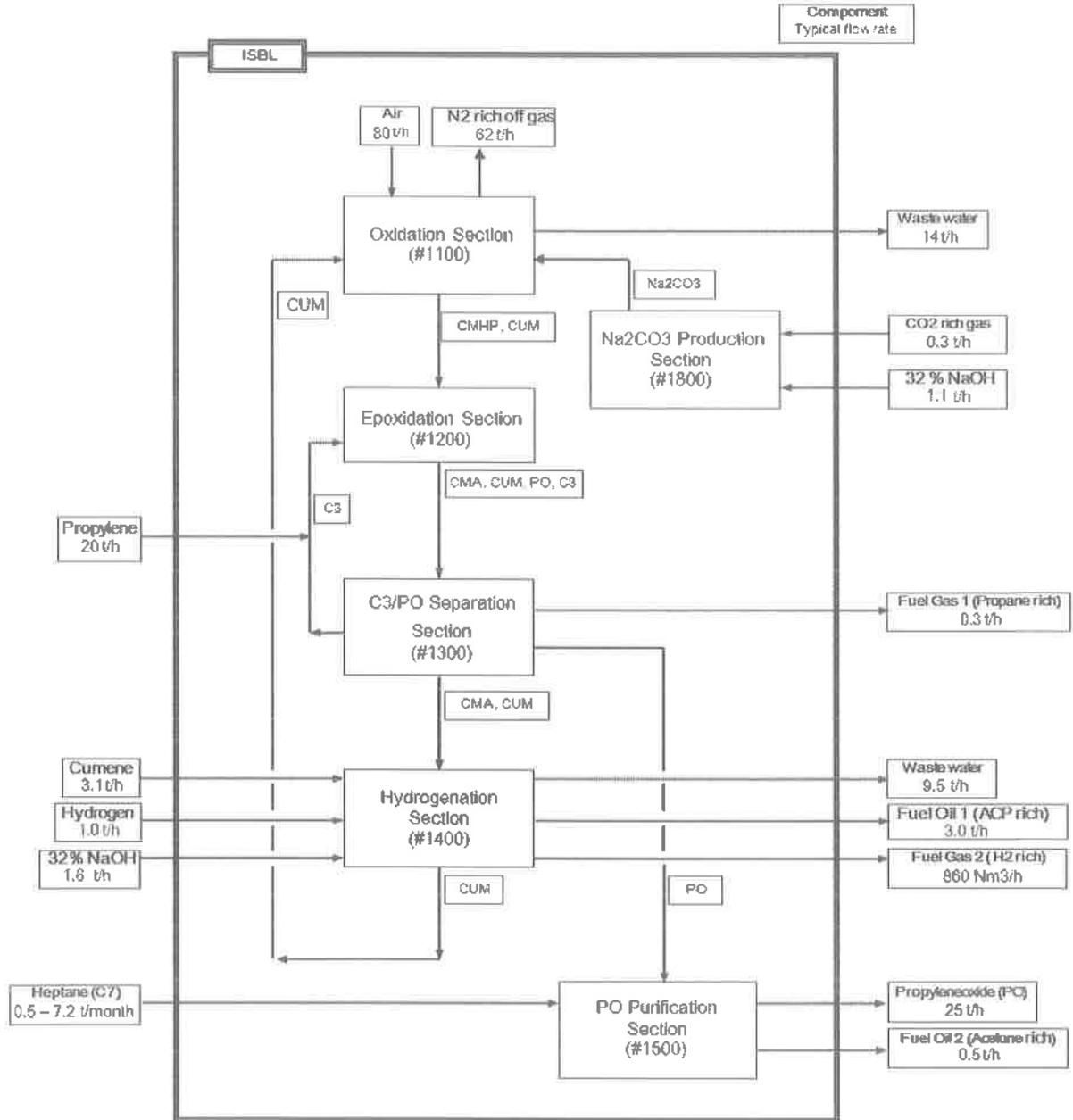
(6) PO purification

Crude PO is purified to produce PO product by several step distillations, including extractive distillation with n-heptane, and sent to the storage tank.

If off-spec PO is produced, it is sent to off-spec tank and recycled to the inlet of purification section for re-purification.

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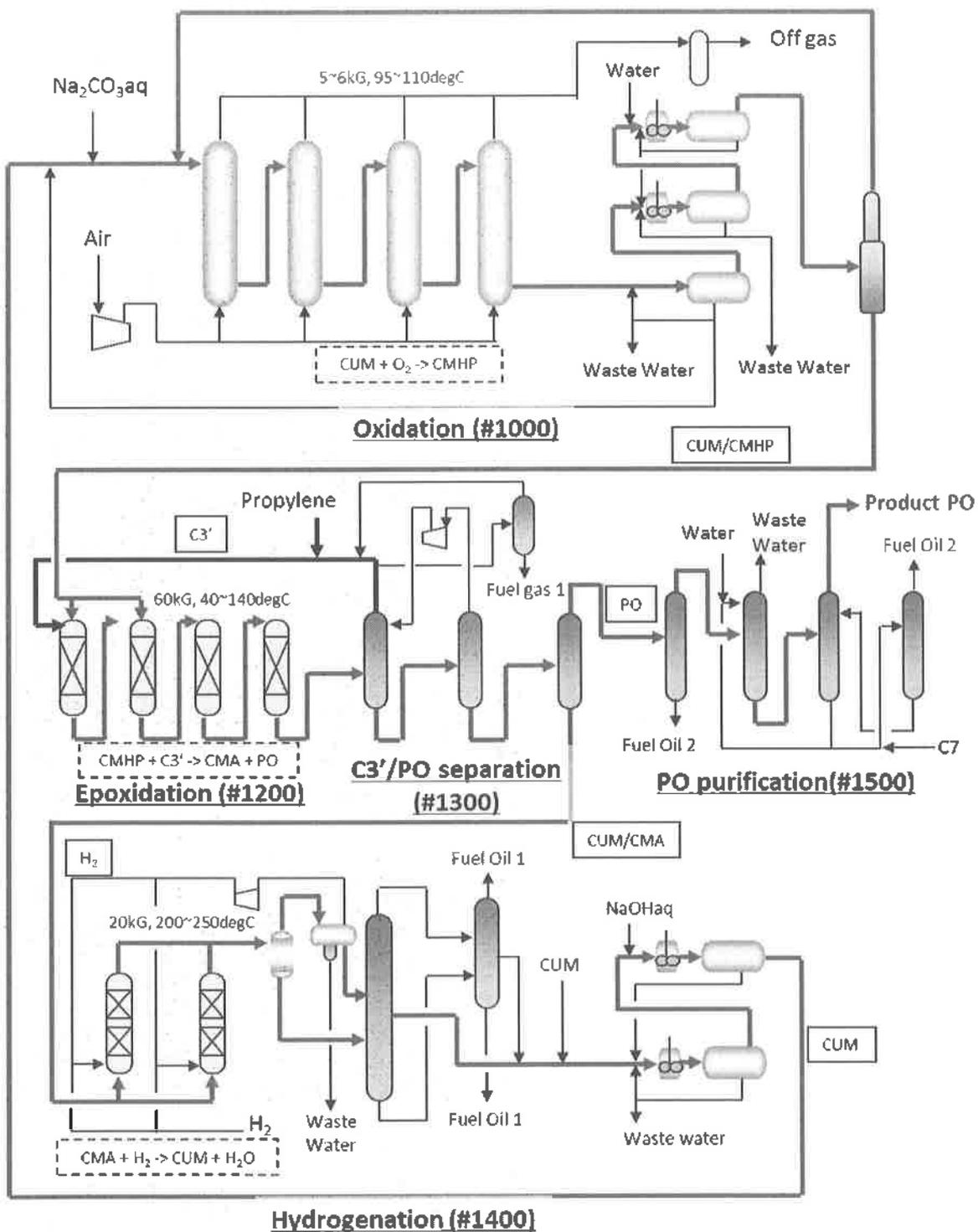
3.1.2 Material Balance



C3: Propylene
 PO: Propylene oxide
 ACP: Acetophenone
 CUM: Cumene
 CMA: Cumyl alcohol
 CMHP: Cumene hydroperoxide

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3.1.3 Process Flow Diagram



CONFIDENTIAL**3.1.4 Product Specification**

			Specification
Purity		wt%	≥99.9
Appearance			Transparent and free of any suspended matter
Color: APHA			≤5
Specific gravity (20°C /20°C)			0.829~0.831
Aldehyde as propionaldehyde		wt%	≤0.005
Moisture		wt%	≤0.005
Acid value as KOH		mg/g	≤0.005
Non-volatile matter		wt%	≤0.0005
Distillation test	5vol%	°C	≥33
	95vol%	°C	≤37

3.1.5 Licensing Record

Sumitomo started the operation of POC plant in Japan in February 2003. We first licensed the technology to Petro Rabigh and the two commercial plants have been under stable operation since their start-ups. Our second license was to S-Oil in South Korea. The plant is under EPC phase with the start-up scheduled in 2018.

Plant	Location	Capacity (KTA)	Start-up
Sumitomo Chemical	Japan	200	February 2003
Petro Rabigh	Saudi Arabia	200	September 2009
S-OIL	South Korea	300	Planned in 2018 (Under EPC)

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3.1.6 Specification of Feedstock and Utilities

Feedstock

(1) Propylene

Test item	Value	Unit
Propylene	99.5	mol% min
Propane	0.5	mol% max
Ethylene	10	molppm max
Ethane	500	molppm max
MAPD	1	molppm max
Hydrogen	10	molppm max
Oxygen	5	molppm max
Carbon monoxide	0.3	molppm max
Carbon dioxide	5	molppm max
H ₂ S	2	molppm max
COS	0.03	molppm max
Water	1	wtppm max
Sulphur	3	wtppm max
Arsine	0.03	wtppm max
Methanol	4	wtppm max

(2) CUM

Test item	Value	Unit
Purity	99.8	wt% min
Benzene	35	wtppm max
n-Propylbenzene	300	wtppm max
Total Butylbenzenes	200	wtppm max
Diisopropylbenzenes	15	wtppm max
Ethylbenzene	200	wtppm max
Phenol	5	wtppm max
Br index	100	mg/100g max
Total Sulphur	2	wtppm max
Specific gravity (15/4 °C)	0.864-0.867	
Acidity	100	wtppm max

(3) Hydrogen

Test item	Value	Unit
Purity	99.99	mol% min
CO	1	molppm max
CO ₂	1	molppm max
Total Sulphur	0.5	wtppm max

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(4) Caustic soda

Test item	Value	Unit
NaOH	32	wt%
NaCl	150	wtppm max

(5) n-Heptane

Test item	Value	Unit
Purity	97	wt% min
Density	0.687~0.690	g/ml (@15 °C)
Distillation test	96	°C min (Initial boiling point)
	100	°C max (Dry point)
	1.5	°C min (ΔT between 5% and 95%)
Colour (Saybolt)	+30	-
Total Sulphur	1	wtppm max
Br index	10	mg/100g max
Distillation residue	1	mg/100g max
Aromatic hydrocarbon	100	wtppm max

(6) CO₂ rich gas

Test item	Value	Unit
CO ₂	99.9	mol% min
Total sulphur	0.5	wtppm max

(7) CO rich gas

Test item	Value	Unit
CO	99.9	mol% min
H ₂ S	0.1	wtppm max

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Service	Pressure (kgf/cm ² g)	Temperature (°C)	Remarks
High Pressure Steam	41.5	399	
Middle Pressure Steam	12	260	
Low Pressure Steam	3.5	180	
Recirculation Cooling Water	Feed 4.7 Return 2.5	Feed 32 Return 45	
Demineralized Water	6	Ambient	
Utility Water	4	Ambient	
Fire Water	N/A	N/A	
Drinking Water	3	Ambient	
Utility Air	7	Ambient	Saturated
Instrument Air	7	Ambient	Dew point: Less than -40 °C
Nitrogen	7	Ambient	

Catalysts

	Consumption (T/year)	Component	Supplier	Re-generat ion Ability	Catalyst Price(JPY/kg)
Epoxidation Catalyst	99	Silicon Oxide with Ti	Sumitomo Chemical	No	12,000 Note 1
Dehydration Catalyst	40	Aluminium Oxide	Sumitomo Chemical	No	Note 2
Hydrogenation Catalyst	51	Alumina-supported palladium	JGC Catalysts and Chemicals	No	Note 3

Notes on Suppliers:

- Epoxidation catalyst must be purchased from Sumitomo Chemical for the term of the License Agreement.
- For Dehydration and Hydrogenation catalysts, Sumitomo Chemical and JGC Catalysts and Chemicals, respectively, are the strongly recommended suppliers. Process performance can only be guaranteed if using the catalysts supplied from the sources specified above.

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Note 1: FOB Japan basis. Trade term can be discussed, but the price will be amended to include freight and other possible costs.

Note 2: A different sector is responsible for sale of this catalyst, so please contact the following for the price quotation.

Mr. Tomoya Ishii

Inorganic Material Division

Energy and Functional Materials Sector

Sumitomo Chemical Co., LTD.

Tel: +81-3-5543-5321

e-mail: ishiit4@sc.sumitomo-chem.co.jp

Note 3: Please contact the following for the price quotation.

Mr. Takashi Iwami

Petrochemical Catalysts Sales Group

Catalysts Sales Dept.

JGC Catalysts and Chemicals Ltd.

Tel: +81-44-556-9157

e-mail: iwami.takashi@jgccc.com

The Required Conditions at the Battery Limit

Feedstock	Pressure (kgf/cm ² g)	Temperature (°C)
Propylene	30.5	34
Cumene	5.0	ambient
Hydrogen	20.7	40
CO ₂ rich gas ²	20.7	41
CO rich gas ²	20.7	41
Caustic Soda(Note.2)	3.5	45
Heptane	Note 1	ambient

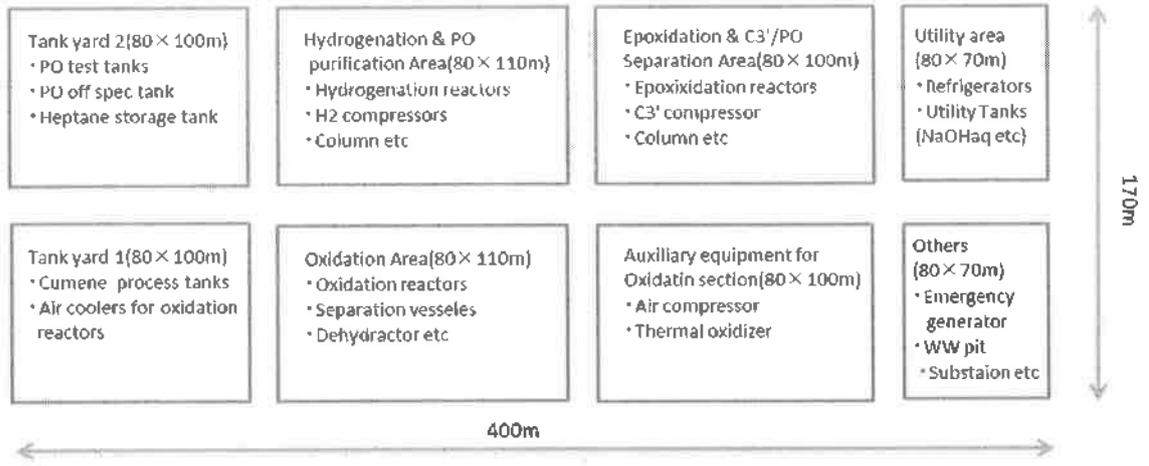
Note 1: These materials are imported in containers and unloaded at ISBL

Note.2: Caustic Soda is received from OSBL to ISBL storage tank.

Catalysts and chemicals shall be delivered to the unit battery limits in appropriate containers.

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3.1.7 Typical Plot Plan



CONFIDENTIAL**3.1.8 Contents of PDP and Operation Manual****Contents of Process Design Package (PDP)**

No.	Item
1	Design Basis
2	Process Description
3	Process Flow Diagrams (PFDs)
4	Material Balance
5	Equipment List
6	Equipment Specifications
7	Piping and Instrument Diagrams (P&IDs)
8	Utility Summary
9	Effluent Summary
10	Catalyst and Chemicals
11	Flare Load Summary
12	Major Process Hazards and Safety System
13	Relief and Depressure Scenarios
14	Instrument List
15	Control Description
16	Cause and Effect
17	Load Schedule
18	Typical Area Classification
19	Piping Specification
20	Typical Plot Plan and Plot Plan Development
21	Basic Design Guideline
22	Recommended Vendors

CONFIDENTIALContents of Operation Manual (OM)

Volume	Chapter	Title
1, OPERATION	I	Process Description
	II	Normal Operation
	III	Preliminary Start-up Activities
	IV	Initial Startup Procedure
	V	Normal Startup Procedures
	VI	Table on Operation Conditions
	VII	Shutdown Procedure
2. ANALYSIS	VIII	Analysis for Quality Control
	IX	Special Requirements for Maintenance

3.2.1 List of Key HSE Issues and RequirementsSafety

Not only Licensor's plant but licensee's plant has been operated with remarkable safety records.

Environment

Only a small amount of effluent is generated (refer to 3.2.2 Process Effluents below).

Excellent monomer efficiency contributes to low effluent emission.

3.2.2 Process Effluents

Process effluents are generated as shown in 3.1.2 Material Balance. Their quantities and components are tabulated below.

Notes:

- The quantities shown are those at the end of the catalyst life.
- All waste streams are generated at all times continuously, except for:
 - i) Fuel Gas 2 (H₂ rich) which is generated only near the end of hydrogenation catalyst life; and
 - ii) Used Catalysts which are replaced and disposed of batch-wise at the end of their life.
- All waste streams are transported to and purged at OSBL.

Classification		Source	Quantities	Handling Treatment	Component Details		
Waste Gas	Fuel Gas 1 (Propane rich)	PO/C3 separation section	0.3 T/H	Reuse as fuel	Propane	25.0	Vol%
					Propylene	33.3	Vol%
					CO	3.8	Vol%
					CO ₂	7.6	Vol%
					CH ₄	26.8	Vol%
	N ₂ rich off gas	Oxidation section	62 T/H	*1	Oxygen	2.1	Vol%
					Nitrogen	Balance	Vol%
					CH ₄	350	Volppm
					Methanol	860	Volppm
					Cumene	500	Volppm
					Acetone	250	Volppm
					Ethylbenzene	40	Volppm
	Fuel Gas 2 (H ₂ rich)	Hydrogenation section	860 Nm ³ /H	Sent to flare	Hydrogen	Balance	Vol%
CH ₄					2.2	Vol%	
CO ₂					2.2	Vol%	
CO					3.3	Vol%	
Waste Liquid	Fuel Oil 1 (ACP rich)	Hydrogenation section	3.0 T/H	Reuse as fuel	Acetophenon	30.1	Wt%
					Cumene	9.5	Wt%
					2-Phenyl-1-Propanol	3.4	Wt%
					Cumene dimer	3.9	Wt%
					Di-propylene glycol	4.6	Wt%
					Tri-propylene glycol	4.1	Wt%
					Ethylbenzene	1.3	Wt%

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					Tar	31.6	Wt%
					Di-cumyl peroxide	5.8	Wt%
Fuel Oil 2 (Acetone rich)	Purification section	0.5 T/H	Reuse as fuel		Propylene oxide	29.2	Wt%
					Water	3.0	Wt%
					Propylene glycol	8.2	Wt%
					Acetone	36.7	Wt%
					n-Propionaldehyde	7.1	Wt%
					2-Methylpentane	2.3	Wt%
					Di-propylene glycol	7.3	Wt%
Water	Oxidation Section	14 T/H	Incineration		Total Oxygen Demand	416,000	mg/L max
					Chemical Oxygen Demand	416,000	mg/L max
					Biochemical Oxygen Demand	258,000	mg/L max
					Total Dissolved Solid	499,000	mg/L max
					Total Suspended Solid	50	mg/L max
					Oil and grease	7,500	mg/L max
					Sodium	14.4	Wt% max
					Phenol	14.9	Wt% max
					Organic acids	7.2	Wt% max
	Hydrogenation section	9.5 T/H	Incineration*2		Total Oxygen Demand	197,000	mg/L max
					Chemical Oxygen Demand	188,000	mg/L max
					Biochemical Oxygen Demand	125,000	mg/L max
					Total Dissolved Solid	100	mg/L max
					Total Suspended Solid	1	mg/L max
					Oil and grease	1	mg/L max
					Phenol	0.11	Wt% max
					Propylene glycol	5.7	Wt% max
	Acetone	0.9	Wt% max				
	Organic acids	1.3	Wt% max				
Waste Solid	Catalyst	Epoxidation, Hydrogenation Section	190T/Y	*1	Catalyst	-	-

*1: Treatment method should be determined in accordance with the local regulation.

*2: Biotreatment is also applicable

CONFIDENTIAL**3.2.3 Handling and Storage of Raw Materials and Products**

Feedstock propylene is received in the receiver drum by pipeline. Hydrogen is supplied to hydrogenation reactor directly. Other liquid material (CUM, heptane, and caustic soda) are shipped to the material tanks. Catalyst is placed in the warehouse.

3.2.4 Waste Treatment and DisposalWaste gas

The off-gas mainly consisting of nitrogen is purged from the top of oxidation reactors. Since the off-gas also contains CUM and other substances with odor, it is cooled and condensed in the condensers in order to recover CUM before being sent to the waste gas treatment.

Waste liquid

Waste water discharged from the process is either incinerated or biologically treated.

3.2.5 Fire Proof System

Fire proof system conforms to the global standard such as NFPA. There is no additional special system.

3.2.6 Flare Stack

Item	Units	Specific Consumption	
		Normal	Maximum
Flare Capacity	T/H	-	1,150

The flare design has large capacity margin as shown in the table above considering the plant emergency event (stop of all condenser cooling).

CONFIDENTIAL**3.3.1 Technology Advantage for Operation and Maintenance****Operation**

As a result of trial and commercial operation in Sumitomo Chemical, we have established easy, stable, and rational operation with minimum man power for POC. Subsequent licensed plant also continues stable operation without major troubles.

Maintenance

POC process has experienced no serious maintenance problem for more than 10 years of its commercial operation. This is mainly due to the following two aspects: i) being free from corrosion caused problem by its process steam as a result of the extensive material science studies and process management, ii) minimizing the maintenance labor on rotating machines by optimizing number of rotating machines and selecting machines with the highest reliability possible.

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3.3.2 Turnaround Shutdown Cycle and Period

Although the turnaround cycle and period depends on the local regulation, 9 weeks shutdown maintenance (including load-up after maintenance and load-down before maintenance (1 week for each)) is required every 2 year for the replacement of dehydration and hydrogenation catalyst. PO plant can keep running except for the above term for the average of 8,000 hours per year if the 9 weeks shutdown is synchronized with the turnaround period.

3.3.3 Specially Required Facilities and Equipment for Maintenance

There is no specially required facilities and equipment for maintenance.

CONFIDENTIAL**4. Operation Cost****4.1 Typical Operation Expenditures**

	Materials	Unit	Specific Consumption
Raw Materials	Propylene	T/T-PO	0.78
	Cumene	T/T-PO	0.125
	Hydrogen	T/T-PO	0.04
Byproduct	Oil	T/T-PO	0.14
Utilities	Condensate	T/T-PO	-2.72
	Electricity	KWh/T-PO	540
	Process Water	T/T-PO	0.15
	Cooling Water	T/T-PO	500
	Middle Pressure Steam	T/T-PO	0.82
	High Pressure Steam	T/T-PO	2.2
	Nitrogen	Nm ³ /T-PO	17

Notes:

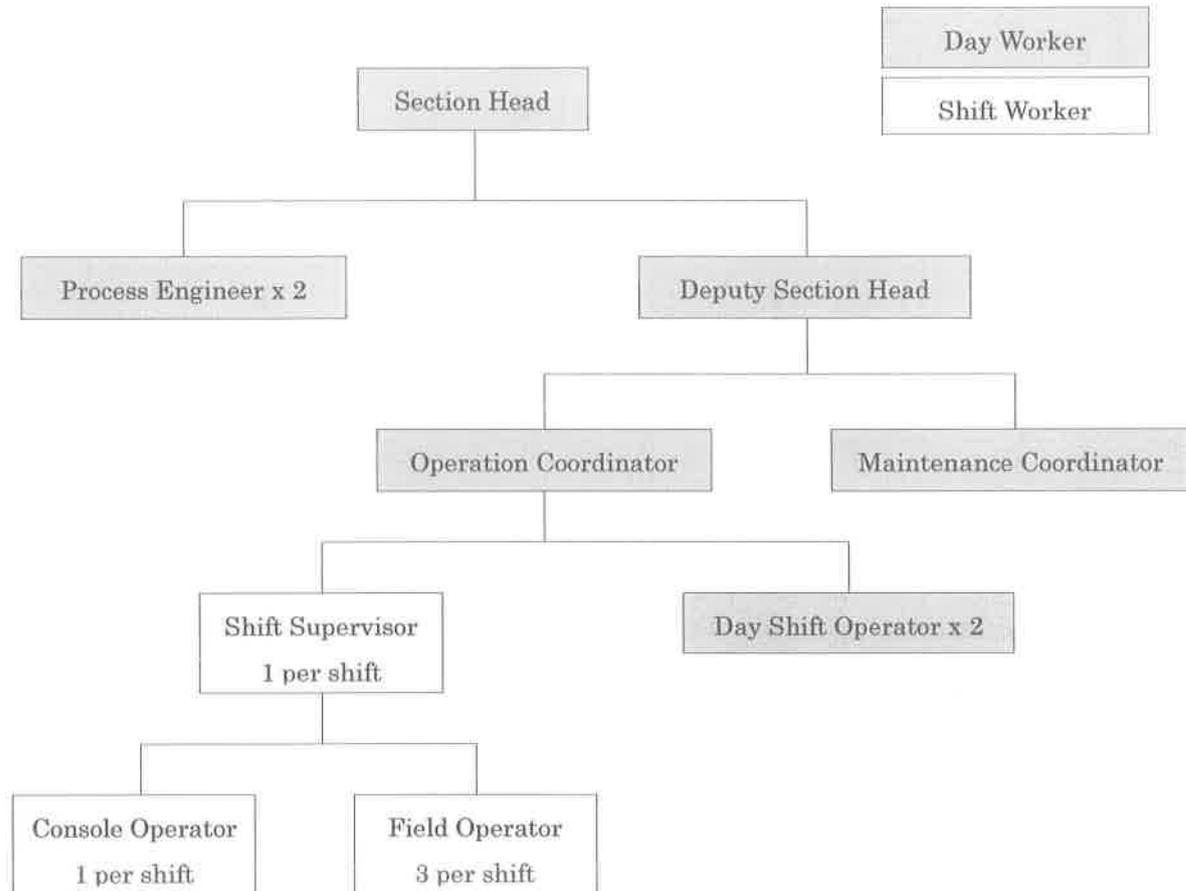
Above values are not guaranteed values.

The feedstock consumption of the unit is dependent on the catalyst life and changes with the catalyst life cycle. It is at its lowest when the new catalyst is introduced and gradually increases with time as the catalyst gets older.

The above are the typical values which are the average of such variable consumption, representing the average plant performance.

CONFIDENTIAL**4.2 Manpower Requirement and Organization**

This organization scheme is one example and for your reference purpose only. Manali can modify it according to Manali's own organization rules or policy.

**4.3 Maintenance Cost**

Maintenance cost is estimated to be 3% of ISBL investment cost.

CONFIDENTIAL**5. Others**

Sumitomo Chemical will provide Manali with the following items as part of PDP after concluding ESA (Engineering Service Agreement). For the contents of PDP, please refer to 3.1.8. Contents of PDP and Operation Manual.

- Process Flow Diagram (detailed version)
- Electrical Distribution (as "Load Schedule" in PDP)
- Instruments requirement (as "Instrument List" in PDP)
- DCS requirement (as "Control Description" in PDP)
- Safety system requirement (as "Major Hazards and Safety System" in PDP)
- Piping requirement (as "P&ID" and "Piping Specifications" in PDP)

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Attachment 1

Main Equipment List for the case of 200KMTA

CONFIDENTIAL

Sumitomo Chemical Co., Ltd.

ITEM No.	QTY	SERVICE	TYPE	MATERIAL	RECOMMENDED VENDOR	Delivery Date
K-1010	1	Air Compressor No.1	Centrifugal	C : S.Steel I : S.Steel	Kobe Steel, Ltd.	15 Months
K-1020	1	Air Compressor No.2	Centrifugal	C : S.Steel I : S.Steel	Kobe Steel, Ltd.	15 Months
K-1330	1	Recycle Propylene Compressor	Centrifugal	C : S.Steel I : S.Steel		15 Months
K-1420A/B	2	Recycle Hydrogen Compressor	Reciprocating	Cylinder : S.Steel Liner & Piston Rod : S.Steel Piston : S.Steel	Kobe Steel, Ltd.	15 Months
RU-1910A/B	2	Brine Unit	Screw Indirect Refrigeration	C : C. Steel	Ebara Corporation	
D-1050	1	Oxidation Sec. Hot Water Drum	Vertical	C. Steel		
D-1111	1	Circulation Water Drum	Vertical	S.Steel		
D-1146	1	Oxidation Neutralization Settler	Horizontal	C.Steel + S.Steel Clad		
D-1150	1	Oxidation Washing 1st Mixer	Vertical	C.Steel + S.Steel Clad		
D-1151	1	Oxidation Washing 1st Settler	Horizontal	C.Steel + S.Steel Clad		
D-1152	1	Oxidation Washing 2nd Mixer	Vertical	C.Steel + S.Steel Clad		
D-1153	1	Oxidation Washing 2nd Settler	Horizontal	C.Steel + S.Steel Clad		
D-1155	1	Degassing Drum for Oxidation	Horizontal	C.Steel + S.Steel Clad		
D-1158	1	D-1155 Vent Gas Drum	Vertical	S.Steel		
D-1165	1	T-1160 Reflux Drum	Horizontal	S.Steel		
D-1170	1	Oxidation Oil Drum	Vertical	S.Steel		
D-1185	1	Oxidation Condensate Drum	Horizontal	C.Steel + S.Steel Clad		
D-1190	1	Off Gas Seal Drum	Vertical	S.Steel		
D-1200	1	Hot Water Drum	Vertical	C. Steel		
D-1315	1	T-1310 Reflux Drum	Horizontal	C.Steel + S.Steel Clad		
D-1318	1	Propylene Drum	Vertical	S.Steel		
D-1325	1	T-1320 Reflux Drum	Horizontal	S.Steel		
D-1330	1	K-1330 1st Suction Drum	Vertical	S.Steel		
D-1335	1	T-1330 Reflux Drum	Horizontal	C.Steel + S.Steel Clad		
D-1345	1	T-1340 Reflux Drum	Horizontal	S.Steel		
D-1350	1	Crude Product Drum	Horizontal	C.Steel		
D-1420	1	Hydrogenation Discharge Vapor Liquid Separation Drum	Vertical	C.Steel + S.Steel Clad		
D-1425	1	K-1420A/B Suction Drum	Vertical	S.Steel		
D-1430	1	T-1430 Feed Oil Separation	Horizontal	C.Steel + S.Steel Clad		
D-1435	1	T-1430 Reflux Drum	Horizontal	S.Steel		
D-1436	1	T-1440 Feed Oil Separation	Horizontal	S.Steel		
D-1445	1	T-1440 Reflux Drum	Horizontal	S.Steel		
D-1455	1	Intermediate Drum	Vertical	C.Steel + S.Steel Clad		
D-1460	1	RCUM Neutralization 1st Mixer	Vertical	S.Steel		
D-1461	1	RCUM Neutralization 1st	Horizontal	S.Steel		
D-1462	1	RCUM Neutralization 2nd	Vertical	S.Steel		
D-1463	1	RCUM Neutralization 2nd	Horizontal	S.Steel		
D-1470	1	Fuel Oil Drum	Horizontal	S.Steel		
D-1508	1	Gas Scrubber	Vertical	S.Steel		
D-1515	1	T-1510 Reflux Drum	Horizontal	C.Steel		
D-1525	1	T-1520 Reflux Drum	Horizontal	S.Steel		
D-1528	1	Settler	Horizontal	S.Steel		
D-1535	1	T-1530 Reflux Drum	Horizontal	S.Steel		
D-1545	1	T-1540 Reflux Drum	Horizontal	C.Steel		
D-1556	1	Seal Drum for Check Tank	Horizontal	S.Steel		
D-1570	1	Fuel Drum	Horizontal	C.Steel + S.Steel Clad		
D-1580	1	Tankyard BD Drum	Horizontal	S.Steel		
D-1682	1	Oxidation Oily Drain Drum	Horizontal	S.Steel		
D-1685	1	T-1680 Reflux Drum	Horizontal	S.Steel		
D-1687	1	Hydrogenation Oily Drain Drum	Horizontal	S.Steel		
D-1689	1	Epoxy section Oily Drain Drum	Horizontal	S.Steel		
D-1710	1	Oxidation BD Drum	Horizontal	S.Steel		
D-1730	1	BD Drum	Horizontal with Jacket	C.Steel + S.Steel Clad		
D-1740	1	Hydrogenation BD Drum	Horizontal	S.Steel		
D-1750	1	Product Refine BD Drum	Horizontal	S.Steel		
D-1760	1	Flare Seal Drum	Horizontal	S.Steel		
D-1790	1	Flare Seal BD Drum	Horizontal	S.Steel		
D-1881	1	Sodium Carbonate Drum	Square	S.Steel		
D-1885	1	T-1880 Vent Gas Knockout	Vertical	S.Steel		
D-1960	1	MP Steam Drum	Vertical	C.Steel		

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Main Equipment List for the case of 200KMTA

CONFIDENTIAL
Sumitomo Chemical Co., Ltd.

ITEM No.	QTY	SERVICE	TYPE	MATERIAL	RECOMMENDED VENDOR	Delivery Date
D-1970	1	LP Steam Drum	Vertical	C.Steel		
D-1980	1	Condensate Drum	Horizontal	C.Steel		
E-1055A	1	Oxidation Sec. Hot Water Trim Cooler A	Plate	S.Steel		
E-1055B	1	Oxidation Sec. Hot Water Trim Cooler B	Plate	S.Steel		
E-1104	1	TK-1100 Vent Cooler	Horizontal BEM	S: S.Steel T: S.Steel		
E-1111	1	1st Oxidation Preheater	Horizontal BEM	S: S.Steel T: S.Steel		
E-1112	1	2nd Oxidation Preheater	Horizontal BEM	S: C.Steel T: S.Steel		
E-1115	1	R-1110 Air Cooler	Air fin Induced Draft	T: S. Steel + AL FIN		
E-1125	1	R-1120 Air Cooler	Air fin Induced Draft	T: S. Steel + AL FIN		
E-1135	1	R-1130 Air Cooler	Air fin Induced Draft	T: S. Steel + AL FIN		
E-1141	1	1st Oxidation Discharge Cooler	Horizontal AFM	S: S.Steel T: S.Steel		
E-1145	1	R-1140 Air Cooler	Air fin Induced Draft	T: S. Steel + AL FIN		
E-1154	1	TK-1150 Vent Cooler	Horizontal BEM	S: S.Steel T: S.Steel		
E-1155	1	1st TK-1150 BD Cooler	Air fin Induced Draft	T: S. Steel + AL FIN		
E-1156	1	TK-1150 BD Cooler	Horizontal AEM	S: S.Steel T: S.Steel		
E-1158	1	D-1155 Vent Cooler	Horizontal BEM	S: S.Steel T: S.Steel		
E-1160 A/B	2	T-1160 Reboiler	Horizontal BEU (Enforced)	S: S.Steel T: S.Steel		
E-1161	1	T-1160 Preheater	Horizontal BEM	S: S.Steel T: S.Steel		
E-1165	1	T-1160 Condenser	Horizontal AXM	S: S.Steel T: S.Steel		
E-1166	1	T-1160 Vent Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1169	1	Z-1167 Vent Cooler	Double Pipe	S: C.Steel T: S.Steel		
E-1175	1	1st D-1170 Feed Cooler	Air fin Induced Draft	T: S. Steel + AL FIN		
E-1176	1	2nd D-1170 Feed Cooler	Horizontal AEM	S: S.Steel T: S.Steel		
E-1180	1	1st Oxidation Off Gas Condenser	Horizontal BEM	S: S.Steel T: S.Steel		
E-1185	1	2nd Oxidation Off Gas Condenser	Horizontal BEM	S: S.Steel T: S.Steel		
E-1186	1	Oxidation Off Gas Vent Condenser	Horizontal BEM	S: S.Steel T: S.Steel		
E-1200A	1	Hot Water Trim Cooler A	Plate	P: S.Steel		
E-1200B	1	Hot Water Trim Cooler B	Plate	P: S.Steel		
E-1211	1	1st Propylene Preheater	Horizontal CEU	S: S.Steel T: S.Steel		
E-1212	1	2nd Propylene Preheater	Horizontal CEU	S: C.Steel T: S.Steel		
E-1225	1	R-1220 FEED Cooler	Horizontal CEU	S: C.Steel T: S.Steel		
E-1235	1	R-1230 FEED Cooler	Horizontal CEU	S: C.Steel T: S.Steel		
E-1245	1	R-1240 FEED Cooler	Horizontal CEU	S: C.Steel T: S.Steel		
E-1310	1	T-1310 Reboiler	Vertical BEL	S: C.Steel T: S.Steel		
E-1315	1	T-1310 Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1318	1	T-1318 Condenser	Vertical BEM	S: S.Steel T: S.Steel		
E-1320	1	T-1320 Reboiler	Vertical BEL	S: C.Steel T: S.Steel		

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Main Equipment List for the case of 200KMTA

CONFIDENTIAL
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ITEM No.	QTY	SERVICE	TYPE	MATERIAL	RECOMMENDED VENDOR	Delivery Date
E-1325	1	T-1320 Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1330	1	T-1330 Reboiler	Vertical BEL	S: C.Steel T: S.Steel		
E-1332A/B	2	Propane Vaporizer	Double Pipe Hair Pin	S: C.Steel T: S.Steel		
E-1335	1	T-1330 Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1340	1	T-1340 Reboiler	Vertical BEL	S: C.Steel T: S.Steel		
E-1345	1	T-1340 Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1365	1	TK-1360 BD Cooler	Horizontal AEM	S: S.Steel T: S.Steel		
E-1400	1	F/R Heat Exchanger	Horizontal BEU	S: S.Steel T: S.Steel		
E-1401	1	No.1 Hydrogenation Preheater	Horizontal AEU	S: C.Steel T: S.Steel		
E-1402	1	No.2 Hydrogenation Preheater	Horizontal AEU	S: C.Steel T: S.Steel		
E-1411	1	Hydrogenation Shut Down Heater	Horizontal AEM	S: C.Steel T: S.Steel		
E-1430	1	T-1430 Reboiler	Vertical BEL	S: C.Steel T: S.Steel		
E-1431	1	Hydrogenation Discharge Condenser	Horizontal BKU	S: C.Steel T: S.Steel		
E-1432	1	Hydrogenation Discharge Vent Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1435	1	1st T-1430 Condenser	Horizontal BKU	S: C.Steel T: S.Steel		
E-1436	1	2nd T-1430 Condenser	Horizontal BKU	S: C.Steel T: S.Steel		
E-1437	1	T-1430 Vent Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1440	1	T-1440 Reboiler	Vertical BEM	S: C.Steel T: S.Steel		
E-1441	1	1st T-1430 SC Cooler	Horizontal BKU	S: C.Steel T: S.Steel		
E-1442	1	2nd T-1430 SC Cooler	Horizontal BKU	S: C.Steel T: S.Steel		
E-1443	1	3rd T-1430 Cooler	Air fin Induced Draft	T: S. Steel + AL FIN		
E-1445	1	T-1440 Condenser	Horizontal AXM	S: S.Steel T: S.Steel		
E-1446	1	T-1440 Vent Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1449	1	Z-1447 Vent Cooler	Double Pipe	S: C.Steel T: S.Steel		
E-1465	1	TK-1460 BD Cooler	Horizontal AEM	S: S.Steel T: S.Steel		
E-1475	1	D-1470 BD Cooler	Horizontal AEU	S: S.Steel T: S.Steel		
E-1501	1	T-1510 Preheater	Horizontal BEU	S: S.Steel T: S.Steel		
E-1510	1	1st T-1510 Reboiler	Vertical BEL	S: S.Steel T: S.Steel		
E-1511	1	2nd T-1510 Reboiler	Vertical BEL	S: S.Steel T: S.Steel		
E-1512	1	3rd T-1510 Reboiler	Vertical BEL	S: S.Steel T: S.Steel		
E-1515	1	T-1510 Condenser	Horizontal AEU	S: C.Steel T: C.Steel		
E-1520	1	T-1520 Reboiler	Vertical BEL	S: C.Steel T: C.Steel		
E-1525	1	T-1520 Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1530	1	T-1530 Reboiler	Vertical BEL	S: C.Steel T: C.Steel		
E-1535	1	T-1530 Condenser	Horizontal AEM	S: S.Steel T: S.Steel		

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Main Equipment List for the case of 200KMTA

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ITEM No.	QTY	SERVICE	TYPE	MATERIAL	RECOMMENDED VENDOR	Delivery Date
E-1540	1	T-1540 Reboiler	Vertical BEL	S: C.Steel T: C.Steel		
E-1545	1	T-1540 Condenser	Horizontal AEM	S: C.Steel T: C.Steel		
E-1547	1	1st Solvent Cooler	Horizontal AEU	S: C.Steel T: C.Steel		
E-1548	1	2nd Solvent Cooler	Horizontal AEU	S: C.Steel T: C.Steel		
E-1549	1	3rd Solvent Cooler	Horizontal AEU	S: C.Steel T: C.Steel		
E-1560A/B	2	Check Tank Circulation Cooler	Horizontal BEM	S: S.Steel T: S.Steel		
E-1575	1	D-1570 BD Cooler	Horizontal AEM	S: S.Steel T: S.Steel		
E-1590	1	TK-1590 Circulation Cooler	Horizontal BEM	S: S.Steel T: S.Steel		
E-1660	1	TK-1660 Cooler	Double Pipe	S: C.Steel T: C.Steel		
E-1680	1	T-1680 Reboiler	Vertical BEL	S: C.Steel T: S.Steel		
E-1682	1	D-1682 Vent Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1685	1	T-1680 Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1687	1	D-1687 Vent Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1689	1	D-1689 Vent Condenser	Horizontal AEM	S: S.Steel T: S.Steel		
E-1696	1	TK-1691 Feed Cooler	Horizontal AEM	S: S.Steel T: S.Steel		
E-1730	1	BD Circulation Heater	Double Pipe	S: C.Steel T: S.Steel		
E-1731	1	BD Vent Heater	Double Pipe	S: C.Steel T: S.Steel		
E-1750	1	D-1750 Cooler	Double Pipe	S: C.Steel T: S.Steel		
E-1880	1	Sodium Carbonate Cooler	Plate	S.Steel		
E-1885	1	T-1880 Vent Gas Condenser	Horizontal AEU	S: S.Steel T: S.Steel		
E-1980	1	D-1980 Vent Condenser	Horizontal AEM	S: C.Steel T: C.Steel		
E-1985	1	SC Cooler	Air fin Induced Draft Package Unit for Direct Fired Type including Waste Gas Heat Recovery	T: S. Steel + AL FIN		
F-1190	1	Thermal Oxidizer			Teukishima Kankyo Engineering Ltd.	
M-1150	1	D-1150 Agitator	Vertical Turbine	S. Steel		
M-1152	1	D-1152 Agitator	Vertical Turbine	S. Steel		
M-1210	1	Epoxy Feed Mixer	Static mixer	C: S.Steel E: S.Steel		
M-1220	1	R-1220 Feed Mixer	Static mixer	C: S.Steel E: S.Steel		
M-1230	1	R-1230 Feed Mixer	Static mixer	C: S.Steel E: S.Steel		
M-1240	1	R-1240 Feed Mixer	Static mixer	C: S.Steel E: S.Steel		
M-1460	1	D-1460 Agitator	Vertical turbine	S. Steel		
M-1462	1	D-1462 Agitator	Vertical turbine	S. Steel		
M-1525	1	D-1525 Line Mixer	Static mixer	C: S.Steel E: S.Steel		
M-1528	1	D-1528 Line Mixer	Static mixer	C: S.Steel E: S.Steel		
M-1880	1	T-1880 Line Mixer	Static mixer	S. Steel		
M-1881	1	D-1881 Agitator	Vertical turbine	S. Steel		

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Main Equipment List for the case of 200KMTA

CONFIDENTIAL
Sumitomo Chemical Co., Ltd.

ITEM No.	QTY	SERVICE	TYPE	MATERIAL	RECOMMENDED VENDOR	Delivery Date
P-1050A/B	2	Oxidation Sec. Hot Water Circulation Pump	Horizontal Centrifugal ASME/ISO	C: C.Steel I: S.Steel		
P-1100A/B	2	Cumene Feed Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel		
P-1101	1	TK-1100 Water Transfer Pump	Canned	C: S.Steel I: S.Steel		
P-1105	1	TK-1150 Water Transfer Pump	Canned	C: S.Steel I: S.Steel		
P-1110A/B	2	R-1110 Bottom Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel		
P-1111A/B	2	Circulation Water Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1120A/B	2	R-1120 Bottom Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel		
P-1130A/B	2	R-1130 Bottom Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel		
P-1140A/B	2	R-1140 Bottom Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel		
P-1146A/B	2	D-1146 Circulation Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1150A/B	2	TK-1150 Feed Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel		
P-1151A/B	2	D-1151 Circulation Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1153A/B	2	D-1153 Circulation Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1158A/B	2	D-1158 Pump	Horizontal Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1160A/B	2	T-1160 Bottom Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel		
P-1161A/B	2	T-1160 Reboiler Enforced Circulation Pump	Horizontal Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1165A/B	2	T-1160 Reflux Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1166A/B	2	D-1165 Water Feed Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1167A/B	2	Z-1167 Hot Well Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1170A/B	2	D-1170 Feed Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel	Ebara Corporation	
P-1185A/B	2	D-1185 Cumene Recycle Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1186A/B	2	D-1185 Water Recycle Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1200A/B	2	Hot Water Circulation Pump	Horizontal Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1315A/B	2	T-1310 Reflux Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel		
P-1316A/B/C	3	Propylene Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel	Ebara Corporation	
P-1325A/B	2	T-1320 Reflux Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1335A/B	2	T-1330 Reflux Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel		

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ITEM No.	QTY	SERVICE	TYPE	MATERIAL	RECOMMENDED VENDOR	Delivery Date
P-1340A/B	2	T-1340 Bottom Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel	Ebara Corporation	
P-1345A/B	2	T-1340 Reflux Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1350A/B	2	D-1350 Feed Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1360	1	TK-1360 Feed Pump A	Horizontal Centrifugal API	C: S.Steel I: S.Steel	Ebara Corporation	
P-1361	1	TK-1360 Feed Pump B	Horizontal Centrifugal API	C: S.Steel I: S.Steel		
P-1420	1	Hydrogenation Circulation Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel		
P-1430A/B	2	D-1430 Water Circulation Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1435A/B	2	T-1430 Reflux Pump	Horizontal Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1436	1	D-1436 Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1438A/B	2	T-1430 Side Cut Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel		
P-1440A/B	2	T-1440 Bottom Pump	Canned Jacket	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1441	1	T-1440 Vacuum Pump	Nash	C: S.Steel I: S.Steel		
P-1443A/B	2	EJ-1447 Hot Well Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1445A/B	2	T-1440 Reflux Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1446A/B	2	D-1445 Water Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1447A/B	2	T-1440 Side Cut Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1455	1	D-1455 Feed Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1456A/B	2	TK-1456 Feed Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1458	1	TK-1456 Inlet Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1460	1	TK-1460 Feed Pump	Horizontal Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1461A/B	2	D-1461 Circulation Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1463A/B	2	D-1463 Circulation Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1470A/B	2	Fuel Oil Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1508A/B	2	D-1508 Pump	Horizontal Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1510A/B	2	T-1510 Bottom Pump	Horizontal Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1515A/B	2	T-1510 Reflux Pump	Horizontal Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1520A/B	2	T-1520 Bottom Pump	Horizontal Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1525A/B	2	T-1520 Reflux Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1526A/B	2	D-1525 Water Feed Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	

756

750

Attachment 1
Main Equipment List for the case of 200KMTA

CONFIDENTIAL
Sumitomo Chemical Co., Ltd.

ITEM No.	QTY	SERVICE	TYPE	MATERIAL	RECOMMENDED VENDOR	Delivery Date
P-1528A/B	2	D-1528 Pump	Horizontal Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1530A/B	2	T-1530 Bottom Pump	Horizontal Centrifugal API	C: S.Steel I: S.Steel		
P-1535A/B	2	T-1530 Reflux Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1540A/B	2	T-1540 Bottom Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1545A/B	2	T-1540 Reflux Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1556	1	D-1556 Transfer Pump	Horizontal Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1560A/B	2	TK-1560 Circulation Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1561A/B	2	Product Transfer Pump	Horizontal Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1570A/B	2	D-1570 Feed Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1580	1	D-1580 Transfer Pump	Vertical Submerged Centrifugal ASME/ISO	C: S.Steel I: S.Steel		
P-1590A/B	2	TK-1590 Feed Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1660A/B	2	Na2CO3 Pump	Canned with jacket	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1670A/B	2	Caustic Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1680A/B	2	T-1680 Bottom Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1682A/B	2	D-1682 Water Pump	Vertical Centrifugal	C: S.Steel I: S.Steel		
P-1683A/B	2	D-1682 Oil Pump	Vertical Centrifugal	C: S.Steel I: S.Steel		
P-1685A/B	2	T-1680 Reflux Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1687A/B	2	D-1687 Water Pump	Vertical Centrifugal	C: S.Steel I: S.Steel		
P-1688A/B	2	D-1687 Oil Pump	Vertical Centrifugal	C: S.Steel I: S.Steel		
P-1689A/B	2	D-1689 Water Pump	Vertical Centrifugal	C: S.Steel I: S.Steel		
P-1691A/B	2	TK-1691 Feed Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1692A/B	2	D-1689 Oil Pump	Vertical Centrifugal	C: S.Steel I: S.Steel		
P-1710A/B	2	D-1710 Pump	Vertical Centrifugal	C: S.Steel I: S.Steel		
P-1730A/B	2	D-1730 Pump	Vertical Centrifugal	C: S.Steel I: S.Steel		
P-1740A/B	2	D-1740 Pump	Vertical Centrifugal	C: S.Steel I: S.Steel		
P-1750A/B	2	D-1750 Pump	Vertical Centrifugal	C: S.Steel I: S.Steel		
P-1790A/B	2	D-1790 Oil Pump	Horizontal Centrifugal	C: S.Steel I: S.Steel		
P-1791A/B	2	D-1790 Water Pump	Horizontal Centrifugal	C: S.Steel I: S.Steel		
P-1880A/B	2	Sodium Carbonate Circulation Pump	Canned	C: S.Steel I: S.Steel		
P-1881A/B	2	Sodium Carbonate Feed Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1885A/B	2	Washing Water Circulation Pump	Canned	C: S.Steel I: S.Steel	Teikoku Electric Mfg.	
P-1910A/B	2	Brine Pump	Horizontal Centrifugal	C: C.Steel I: C.Steel		

Attachment 1

CONFIDENTIAL

Main Equipment List for the case of 200KMTA

Sumitomo Chemical Co., Ltd.

ITEM No.	QTY	SERVICE	TYPE	MATERIAL	RECOMMENDED VENDOR	Delivery Date
P-1920A/B	2	DMW Charge Pump	Canned	C: S.Steel I: S.Steel		
P-1970A/B	2	LPSC Pump	Horizontal Centrifugal	C: C.Steel I: S.Steel		
P-1980A/B	2	SC Pump	Horizontal Centrifugal	C: S.Steel I: S.Steel		
P-1991	1	No.1 Aired Pump	Diaphragm (Air Drive)	C: S.Steel Diaphragm: PTFE		
P-1992	1	No.2 Aired Pump	Diaphragm (Air Drive)	C: S.Steel Diaphragm: PTFE		
P-1993	1	No.3 Aired Pump	Diaphragm (Air Drive)	C: S.Steel Diaphragm: PTFE		
P-1994	1	No.4 Aired Pump	Diaphragm (Air Drive)	C: S.Steel Diaphragm: PTFE		
P-1995	1	No.5 Aired Pump	Diaphragm (Air Drive)	C: S.Steel Diaphragm: PTFE		
P-1996	1	No.6 Aired Pump	Diaphragm (Air Drive)	C: S.Steel Diaphragm: PTFE		
R-1110	1	Oxidation Reactor No.1	Vertical	C.Steel + S.Steel Clad		12 Months
E-1110	1	R-1110 Internal Heat Exchanger	Horizontal BU	C: C.Steel T: S.Steel		12 Months
R-1120	1	Oxidation Reactor No.2	Vertical	C.Steel + S.Steel Clad		12 Months
E-1120	1	R-1120 Internal Heat Exchanger	Horizontal BU	C: C.Steel T: S.Steel		12 Months
R-1130	1	Oxidation Reactor No.3	Vertical	C.Steel + S.Steel Clad		12 Months
E-1130	1	R-1130 Internal Heat Exchanger	Horizontal BU	C: C.Steel T: S.Steel		12 Months
R-1140	1	Oxidation Reactor No.4	Vertical	C.Steel + S.Steel Clad		12 Months
E-1140	1	R-1140 Internal Heat Exchanger	Horizontal BU	C: C.Steel T: S.Steel		12 Months
R-1210	1	Epoxidation Reactor No.1	Vertical	C.Steel + S.Steel Clad		12 Months
R-1220	1	Epoxidation Reactor No.2	Vertical	C.Steel + S.Steel Clad		12 Months
R-1230	1	Epoxidation Reactor No.3	Vertical	C.Steel + S.Steel Clad		12 Months
R-1240	1	Epoxidation Reactor No.4	Vertical	C.Steel + S.Steel Clad		12 Months
R-1250	1	Epoxidation Reactor No.5	Vertical	C.Steel + S.Steel Clad		12 Months
R-1401	1	Hydrogenation Reactor No.1	Vertical	C.Steel + S.Steel Clad		12 Months
R-1402	1	Hydrogenation Reactor No.2	Vertical	C.Steel + S.Steel Clad		12 Months
T-1160	1	Dehydrator	Packed/Tray	S.Steel		12 Months
T-1310	1	HP Propylene Column	Tray	S.Steel		12 Months
T-1318	1	Propylene Recovery Column	Packed	S.Steel		12 Months
T-1320	1	LP Propylene Column	Tray	C.Steel + S.Steel Clad		12 Months
T-1330	1	Propane Separation Column	Tray	C.Steel + S.Steel Clad		12 Months
T-1340	1	Crude Product Column	Packed	C.Steel + S.Steel Clad		12 Months
T-1430	1	CUM Purification Column	Tray	C.Steel + S.Steel Clad		12 Months
T-1440	1	Tar Removal Column	Packed/Tray	C.Steel + S.Steel Clad		12 Months
T-1510	1	Heavy Ends Column	Tray	C.Steel + S.Steel Clad		12 Months
T-1520	1	No.1 Extractive Distillation Column	Tray	S.Steel		12 Months
T-1530	1	No.2 Extractive Distillation Column	Tray	C.Steel		12 Months
T-1540	1	Solvent Column	Tray	C.Steel		12 Months
T-1680	1	Waste Water Stripper	Packed	S.Steel		12 Months
T-1880	1	CO2 Absorber	Packed/Tray	S.Steel		12 Months
TK-1100	1	RCUM Tank	Dome roof	S.Steel		
TK-1150	1	Oxidation Oil Tank	Dome roof	S.Steel		
TK-1360	1	CMA Tank	Cone roof (Inner Float)	S.Steel		
TK-1456	1	Solvent Tank	Cone roof	C.Steel		
TK-1460	1	Crude Cumene Tank	Cone roof (Inner Float)	S.Steel		
TK-1560A/B	2	Product Check Tank	Dome roof (Inner Float)	S.Steel		
TK-1590	1	Crude Product Tank	Dome roof (Inner Float)	S.Steel		
TK-1660	1	Na2CO3 Tank	Cone roof	C.Steel		
TK-1670	1	Caustic Tank	Cone roof	S.Steel		

Attachment 1
Main Equipment List for the case of 200KMTA

CONFIDENTIAL
Sumitomo Chemical Co., Ltd.

ITEM No.	QTY	SERVICE	TYPE	MATERIAL	RECOMMENDED VENDOR	Delivery Date
TK-1691	1	Incineration Waste Water Tank	Cone roof with Coil	S.Steel		
TK-1910	1	Brine Tank	Cone roof	C.Steel		
Z-1110	1	R-1110 Off Gas Sample Cooler	Drum with Coil	S.Steel		
Z-1120	1	R-1120 Off Gas Sample Cooler	Drum with Coil	S.Steel		
Z-1130	1	R-1130 Off Gas Sample Cooler	Drum with Coil	S.Steel		
Z-1140	1	R-1140 Off Gas Sample Cooler	Drum with Coil	S.Steel		
Z-1147A/B	2	D-1146 Discharge Prefilter	Cartridge Filter	S: S.Steel		
Z-1148	1	D-1146 Discharge Coalescer	Horizontal with filter separator	S: S.Steel E: ECTFE	Pall Corporation	
Z-1150	1	Pot for Pump drain	Horizontal	S.Steel		
Z-1152A/B	2	D-1151 Discharge Prefilter	Cartridge Filter	S: S.Steel		
Z-1153	1	D-1151 Discharge Coalescer	Horizontal with filter separator	S: S.Steel E: ECTFE	Pall Corporation	
Z-1154 A/B	2	D-1153 Prefilter	Cartridge Filter	S: S.Steel E: Polypropylene		
Z-1155	1	D-1153 Coalescer	Horizontal with filter separator	S: S.Steel E: ECTFE	Pall Corporation	
Z-1167	1	T-1160 Hot Well	Vertical	S.Steel		
Z-1332	1	Mist Separator	Vertical	C.Steel		
Z-1447	1	T-1440 Hot Well	Vertical	S.Steel		
Z-1456	1	Pot for Pump drain	Horizontal	S.Steel		
Z-1460	1	Pot for Pump drain	Horizontal	S.Steel		
EJ-1050	1	Oxidation Hot Water Steam Mixer	Steam mixer	C: C.Steel E: S.Steel		
EJ-1167-	2	1st T-1160 Ejector	Ejector	S.Steel		
EJ-1167-	2	2nd T-1160 Ejector	Ejector	S.Steel		
E-1167-1	1	1st T-1160 Ejector Condenser	Horizontal BEM	S: S.Steel T: S.Steel		
E-1167-2	1	2nd T-1160 Ejector Condenser	Horizontal BEM	S: S.Steel T: S.Steel		
EJ-1447-1/2	2	1st 2nd T-1440 Ejector	Ejector	S.Steel		
E-1447-1	1	1st T-1440 Ejector Condenser	Horizontal BEM	S: S.Steel T: S.Steel		
E-1447-2	1	2nd T-1440 Ejector Condenser	Horizontal BEM	S: S.Steel T: S.Steel		

Note: Sumitomo will provide Manali with equipment specification as a part of PDP after ESA conclusion.

C.Steel : Carbon Steel
S.Steel : Stainless Steel
AL : Aluminum Alloy



Date: June 23, 2021

Ref: 2021-3093 ASA

Manali Petrochemicals Limited.,

Ponneri high road, Manali,

Chennai-600 068

Kind Attn: Mr. Nisant (Projects Development Team)

**Sub: Enquiry for Zero Liquid Discharge 100 m³/hr at Manali Petrochemicals Limited –
Technical recommendations reg**

Dear Sir,

After various brainstorming sessions by our technical experts on this subject, the team has come up with the below technical recommendations for this special ZLD project.

1. ZLD in the traditional sense isn't possible with the CaCl₂ salts for two primary reasons.
 - a. First, ZLD crystallizers work by evaporating the water fraction of the stream and controlling the crystal formation of the remaining mixed-salts that are present. This works very well for NaCl and Na₂SO₄ and other moderately soluble salts. Unfortunately, CaCl₂ is not on the list of "nice to deal with" and the crystals cannot be formed in a crystallizer. Since the crystals don't form, they cannot be dewatered and ZLD cannot be achieved.
 - b. Another major problem with CaCl₂ systems is that the CaCl₂ crystals are deliquescent and cannot be landfilled for disposal. They would absorb moisture from the atmosphere and liquefy themselves. It's difficult to find an off-take.
2. We considered modifying the chemistry here by adding chemicals, enough to make a crystallizer ZLD system feasible. But unfortunately, the flow rate is so high and CaCl₂ concentration also high, that the chemical opex makes this unviable.
3. For a CaCl₂ brine treatment, we can concentrate it to a thick brine (6 ton/h flow @40wt% CaCl₂) and this brine could be either injected into a deep-well for disposal or used for other purposes including drilling mud among others.

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Challenges in Forced circular evaporation:

- 4. The thermal system to achieve this concentration will be forced-circulation evaporator due to precipitation of other salts such as NaCl which will come out of the solution. The size of this system is extremely large and very expensive since it needs to be built with high nickel alloys. The vessels will be as large as we can make them based on a transportation study from the manufacturer to the plant. All of these decisions are complicated and require a lot of due diligence in order to define.

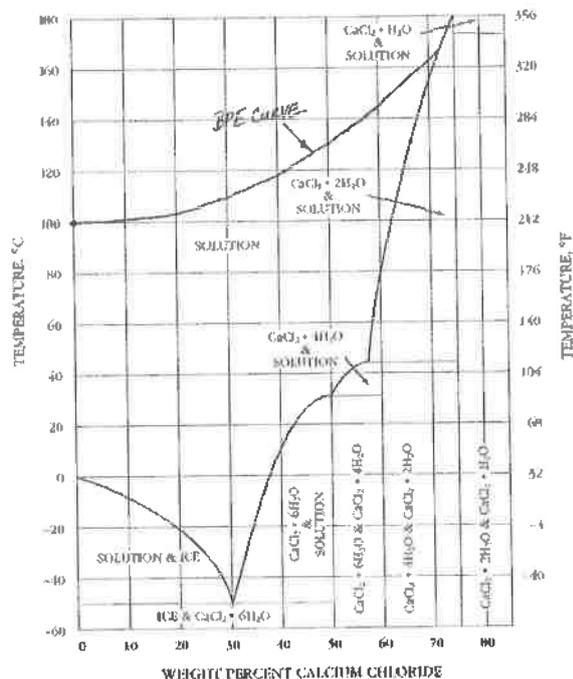
Challenges in operation cost:

- 5. Then the question is how to provide energy to the FC evaporator. This would either be done with ~20-30 ton/h of 10barg steam or with ~6 MW of electrical power in an MVC arrangement.
- 6. After the 40wt% CaCl₂ concentration is achieved, we can do brine take-off immediately (as discussed in Point No.3). The other option would be a fluidized bed dryer or granulator (buy-out package) which will take the 40wt% CaCl₂ brine and convert the CaCl₂ to an anhydrous granule. This would require about 4 ton/h 10barg steam.

Alternate technologies:

- 7. Alternatively, our team also put down their thoughts on vacuum crystallisation / low temperature evaporation technologies where the system is operated at low temperature and favors the formation of many hydrates and double salts which precipitate at low concentrations at lower temperature. Unfortunately, this also is not in favorable condition for CaCl₂ crystals as it does not crystallise. Please refer the below solubility chart for CaCl₂ where you can see that different hydrated species of CaCl₂ are formed at lower temperatures. In fact, our team has experiences with this technology and found that instead of generating crystals (which are suitable

Figure 1 — Phase Diagram for CaCl₂ and Water Solutions



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for ZLD), it actually produces a white kind of slime (mashed potatoes). Even with this technology we would be only able to generate a concentrated brine as highlighted above in point no.3.

To more clearly define this, the project will need to define off-take options and secure tie-ups with a third party. We request your team to consider the above points in terms of capex, opex, etc and do let us know your comments to proceed further.

Awaiting your kind feedback on the above points

Thanking you,

**Yours truly,
For Aquatech Systems (Asia) Pvt. Ltd.**

**J. Ragland
Deputy Manager
Sales & Business Development (South)**



Manali Petrochemicals Limited

Ponneri High Road, Manali, Chennai - 600 068
Phone : 044 - 25941025 Fax : 044 - 25941199

Ref.: MPL/H (TS)/LOI/2020/08/01

August 14, 2020

CSIR-National Environmental Engineering Research Institute
Nagpur – 440 020
Email: s_pal@neeri.res.in

KIND ATTN.: Sukdeb Pal, PhD
Senior Scientist
WWTD

SUB: DEMONSTRATION OF CSIR-NEERI DEVELOPED CA-RID TECHNOLOGY FOR REMOVAL OF CALCIUM FROM PROCESS EFFLUENT OF MANALI PETROCHEMICALS LIMITED
REF.: YOUR CA-RID PROPOSAL MAIL DATED 25.011.2019 NEGOTIATED PRICE DATA BASED ON MAIL CONFIRMATION - MAIL DATED 03.08.2020

With reference to the above we are pleased to release this letter of intent for the demonstration of CSIR-NEERI developed Ca-Rid technology for removal of calcium from process effluent of Manali Petrochemicals Limited

Scope of Proposal

Demonstration of CSIR-NEERI’s CaRid Technology at pilot scale facility at M/s. MPL’s Chennai plant premises and submission of completion report.

Terms of reference (TOR)

- CSIR-NEERI shall provide the technical inputs for the design of the pilot facility for demonstration of CaRid Technology of CSIR-NEERI.
- M/s. MPL will construct the pilot plant based on the design of CSIR-NEERI at their Chennai plant premises.
- M/s. MPL will bear all expenses for the setting up of the pilot plant.
- CSIR-NEERI will charge Rs. 8 lakhs towards the charges for supervision, travel and Institute overheads. (1st. Instalment: 50% of project cost with work order + GST*; 2nd. Instalment: 30% of the project cost + GST* within 15 days after completion of field demonstration and analysis; 3rd. Instalment: 20% of the project cost + GST* within 15 days after submission of the demonstration report)
- M/s. MPL, has to decide on setting-up demonstration facility at site using either the existing facilities available with MPL or if needed new facilities would be created.
- The expenses for the erection, commissioning, operation & maintenance and chemicals & consumables required for demonstration/functioning of pilot plant will be borne by M/s. MPL.
- CSIR-NEERI will carry out on-site quantification of parameters in the influent and treated effluent in terms of major physicochemical parameters such as pH, calcium etc. Purity of the recovered by-product(s) will be determined in laboratory of the CSIR-NEEERI, Nagpur or in the laboratory of M/s. MPL in their Chennai Plant.

Registered Office :

SPIC House, 88, Mount Road, Guindy, Chennai - 600 032.
CIN : L24294TN1986PLC013087 - Website : www.manalipetro.com





MANALI PETROCHEMICALS

Manali Petrochemicals Limited

Ponneri High Road, Manali, Chennai - 600 068

Phone : 044 - 25941025 Fax : 044 - 25941199

- One technical person from M/s. MPL to be associated as coordinator during field work to facilitate interaction/ sampling & data collection/permissions from relevant agencies/departments.
- M/s. MPL shall make available all relevant process details required for the study including water consumption, wastewater generation data and design details with drawings of existing treatment facilities to CSIR-NEERI.
- M/s MPL shall make available skilled workers during field demonstration for operation of the pilot facility and sampling.
- M/s. MPL shall make available laboratory facilities for onsite wastewater analysis.
- CSIR-NEERI shall carry samples as required to CSIR-NEERI, Nagpur for project investigations and carrying out further studies.
- M/s MPL shall provide free lodging and boarding (i.e., breakfast, lunch and dinner) to the visiting CSIR-NEERI team to M/s. MPL, Chennai during field work, meeting, discussion, presentation etc.

Project Duration:

The duration of the project including demonstration and finalization of reports is 3 (three) months with effect from the date of receipt of first instalment of the project cost by CSIR-NEERI.

COMMERCIAL TERMS:

- | | | |
|-----------------------------|---|--|
| 1. Basic Price | : | INR 8,00,000 |
| 2. Basic Price + GST @ 18 % | : | INR 9,44,000 |
| 3. Payment Terms | : | 50% of project cost with work order + GST*
30% of the project cost + GST* within 15 days after completion of field demonstration and analysis
60 % after receipt of material
20% of the project cost + GST* within 15 days after submission of the demonstration report |

* @18% or as applicable on date of disbursement. In addition, the party shall pay all taxes including surcharges of Central Government and State Government as applicable on the date of payment. All such taxes are subject to change as per directive of Government of India/State Government.

Kindly sign the duplicate copy of the LOI as token of acceptance and send to us.

Thanking you,

Yours faithfully,
For **MANALI PETROCHEMICALS LIMITED**



T THANGASAGARAN
DGM (Projects/Technical Services/QA)

Registered Office :

SPIC House, 88, Mount Road, Guindy, Chennai - 600 032.

CIN : L24294TN1986PLC013087 - Website : www.manalipetro.com



Proposal

Performance Assessment of Effluent Treatment Plant Treating Petrochemical Effluent at Manali Petrochemicals Ltd., Chennai and Undertaking Feasibility Studies for Recycle & Reuse of Treated Effluent to Achieve ZLD Status

Submitted to



**CSIR-National Environmental Engineering Research Institute
Nagpur – 440 020**



November, 2019



**CSIR-National Environmental Engineering Research Institute
Nagpur – 440 020**



1.0 Project Title

Performance Assessment of Effluent Treatment Plant Treating Petrochemical Effluent at Manali Petrochemicals Ltd., Chennai and Undertaking the Feasibility Studies for Recycle & Reuse of Treated Effluent to Achieve ZLD Status

2.0 Preamble

Manali Petrochemicals Limited (MPL) located in Chennai, Tamil Nadu, is a chemical manufacturing unit since 1986 manufacturing 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. M/s MPL manufactures Propylene oxide through chlorohydrin route. In the chlorohydrin process, propylene is reacted with chlorine, water and calcium hydroxide to generate PO and chlorinated by-products such as dichloro-propane and CaCl_2 .

3.0 Origin of the proposal

M/s MPL generates around 2400 m³/d of wastewater from the PO manufacturing process. The wastewater is organic in nature with highly alkaline pH and with very high concentration of calcium chloride (4.5-5%, w/v). The wastewater is treated in the existing Effluent Treatment Plant consisting of primary treatment in which the calcium chloride is first separated in high rate thickener followed by rotary vacuum drum filter (RVDF) and then subsequently treated in biological units using special alkaline microbial consortium. The final treated effluent is then discharged into the sea.

The high concentration of calcium chloride of the wastewater generated from PO manufacturing process is the major hurdle that has hindered reuse of the treated wastewater in the process. Presently, ETP of M/s MPL is treating the wastewater for meeting the designated discharge standards. In order to achieve ZLD or reuse of treated water in the process, M/s MPL have come across three potential technologies namely

- Ca-Rid Technology for removal of calcium ions (Pretreatment Technology)
- Electrodialysis Technology for separation of ions (Posttreatment Technology)
- Reverse Osmosis (RO) followed by Waste Heat Evaporator (WHE) (Advanced treatment)

The management of M/s. Manali Petrochemicals Limited (MPL) desires to get a scientific study conducted for

- Evaluating the performance of the existing ETP under the existing operating condition
- Conducting a feasibility study to reuse treated effluent, replace the use of fresh Metro water in the manufacturing process and achieve the 'ZLD' status
- Technology evaluation of technology options either shortlisted by M/s MPL or suggested by CSIR-NEERI and recommend a suitable process package to achieve the 'ZLD' status.

To achieve these objectives the management of M/s. MPL has approached CSIR-NEERI seeking CSIR-NEERI's involvement carry out said study.

4.0 Scope of Research Proposal

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

A. Performance evaluation of existing ETP

- Site reconnaissance for inventorying the unit operations and unit processes of individual treatment plant with respect to the design and capacity of the treatment plant, quantity of effluent being treated, treatment scheme being followed, designated use of treated water or effluent or sewage generated, discharge norms being followed as per the consent to operate given by pollution control board, etc. (information to be provided by M/s MPL)
- Assessment of quantity of wastewater being generated as against the design and additional wastewater likely to be generated in future after expansion, if any

-
- Physicochemical characterization of the wastewater stream(s) for essential parameters like pH, COD, BOD, Calcium, Chloride, TKN, Ammonia, Nitrate, Sulphate, TDS, TSS, etc.
 - Detailed adequacy and efficacy assessment of the existing treatment facilities based on hourly monitoring and flow compositing for 8 to 12 h based on one to two rounds of monitoring.
 - Assessment of treatment methods, operational parameters and problem areas, if any, under existing operating conditions at site
 - Performance evaluation of each unit process and unit operation of the existing ETP.
 - Determining the problem areas and assessing the scope of improvement in the existing ETP
 - Recommendations for improving the operational short falls in the existing ETP
 - Presentation of findings to M/s MPL
 - Submission of Interim Report 1
- B. Conducting a feasibility study to reuse treated effluent, replace the use of fresh Metro water in the manufacturing process and achieve the 'ZLD' status
- Conducting studies to improve calcium removal in the pre-treatment and primary treatment to enhance downstream biological process
 - Microbial characterization (using advanced microscopic and molecular biological tools) of the biomass existing in the biological unit of ETP
 - Development of special microbial consortium capable of surviving and effectively degrading the pretreated wastewater
 - Developing a new process package (consisting of combinations of pretreatment, primary treatment, secondary treatment and tertiary treatment) for treatment of effluent generated at M/s MPL for meeting the proposed RO inlet quality based on treatability studies at CSIR-NEERI
 - Demonstrating the developed process at bench scale to M/s MPL
 - Developing protocol for seed cultivation of developed microbial consortium in bulk scale at M/s MPL premises
 - Training the ETP operators of M/s MPL for maintaining healthy biomass for effective biological treatment of pretreated wastewater
 - Recommendation of new process package for delivering treated effluent having the proposed RO influent quality standards (RO influent quality to be decided on the basis of operational cost of RO, permeate quality and recycling ratio of permeate)
 - Presentation of results achieved at treatability studies, demonstration of bench scale process and discussion
 - Submission of Interim Report II
- C. Technology evaluation of three technology options shortlisted by M/s MPL premises and determining the improvement potential of downstream treatment of Ca-Rid pre-treated effluent
-

- Evaluation of Electro-Dialysis technology at demonstration scale in M/s MPL premises based on actual 2-3 trials for treating the effluent generated from the existing ETP
- Evaluating the potential of Electro-Dialysis technology at demonstration scale in MPL premises based on actual 2-3 trials for treating the effluent generated from the new process developed in the section B
- Evaluation of Reverse Osmosis (RO) followed by Waste Heat Evaporator (WHE) (Advanced treatment) at demonstration scale in M/s MPL premises based on actual 2-3 trials for treating the effluent generated from the existing ETP
- Recommending the scheme for achieving Zero Liquid Discharge with tentative cost estimates (broad basis)
- Submission of Interim report III
- Presentation and discussion of all the components
- Final report submission

5.0 Duration of Project : Part A: 4 months
 Part B: 10 months
 Part C: 4 months
 Total Duration: 18 months

6.0 Payment Schedule

Parts	Project Cost	Installment	Payment Schedule
Part A	₹ 18.50 Lacs + GST*	First	:60% of cost of Part A + GST* with work order
		Second	:40% of the cost of Part A + GST* within 7 days from the date of submission of interim report I
Part B	₹ 30.06 Lacs + GST*	First	:60% of cost of Part B + GST* with work order
		Second	40% of the cost of Part B + GST* within 7 days from the date of submission of interim report II
Part C	₹ 5.00 Lacs + GST*	First	:60% of cost of Part C + GST* with work order
		Second	:40% of the cost of Part C + GST* within 7 days from the date of submission of interim report III
Total	₹ 53.56 Lacs+ GST * (as applicable)		

*As applicable on the date of disbursement. Besides, the party shall pay all taxes including surcharges of Central Government and State Government as applicable on the date of payment. All such taxes are subject to change as per the directive of Government of India/State Government.

- GSTIN: 27AAATC2716R2ZE

- NEERI is exempted from Income-tax under section 35(1) (ii) of the Income Tax Act 1961.

- Date of start of the study will be after receipt of the first instalment of the Institute's Fee for each components A, B and C.

7.0 Disbursement: Through Electronic Transfer to
 State Bank of India,
 NEERI Branch,
 IFS Code: SBIN0004224
 CSIR-NEERI Saving Bank A/c: 30266513766

8.0 Sponsor

M/s. Manali Petrochemicals Limited, Chennai

9.0 Ownership of Intellectual Property

In the event patentable inventions result from the research conducted hereunder, CSIR-NEERI shall file application seeking Intellectual Property Rights (IPR). The ownership of this IPR or any patents arising from this research shall vest in CSIR-NEERI, and it shall be the responsibility of CSIR-NEERI to file, maintain, and protect such patent and bear all associated costs. M/s. MPL shall not file any application for seeking patent protection in its own name or in the name of its associates or any other person on any matter relating to the information disclosed to it by CSIR-NEERI. M/s. MPL shall not oppose or direct cause any person to oppose any application seeking patent.

10.0 Confidentiality

During the tenure of study and thereafter both CSIR-NEERI and M/s. MPL undertake on their behalf and on behalf of their subcontractors/employees/representatives/associates to maintain strict confidentiality and prevent disclosure thereof, of the information/data exchanged/generated. CSIR-NEERI shall hold in confidence all the details of technical evaluation conducted under this study or information learned by experience with M/s. MPL.

11.0 Disclaimer

CSIR-NEERI shall carry out an independent study and submit the report. M/s. MPL shall exercise due diligence for taking appropriate decision to implement the contents of the report.

12.0 Inputs Required from Sponsor

- The sponsor must inform CSIR-NEERI if there are any legal cases pending or subjudice matter pertaining to the proposed study. If the matter is subjudice, CSIR-NEERI shall render the consultancy services under the agreed terms, and shall not be a party to represent on behalf of M/s. MPL in any legal matters or proceedings.

- All relevant technical details required for the study to be made available to CSIR-NEERI.
- At least one technical person to be associated for time to time technical discussions during the entire period of method development.
- Transportation of effluent (wastewater) sample as required to CSIR-NEERI, Nagpur for project investigations and carrying out treatability studies.
- Comments on draft report within 15 days of submission.
- Local logistics to be arranged for the visiting CSIR-NEERI team during site monitorings and discussions

Project Report
on
Reduction of chloride and calcium content in
petrochemical process effluent water by
electrodialysis



Electroorganic Division
CSIR-Central Electrochemical Research Institute
KARAIKUDI - 630 003

MARCH 2020

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CHAPTER - I

INTRODUCTION

CHAPTER - I

INTRODUCTION

1.1. Introduction to industrial waste water

Industrial waste water characteristics vary with type of discharge. Food processing, dairy operations and meat packing all have wastes that are very high BOD[1000 mg/l]. This BOD is high in dissolved sugars, fats & proteins and low in suspended material. It will dramatically increase the loading on the secondary treatment processes. Some food process wastes can also have a high pH, like potato processing and some vegetable canning or a low pH like green chili processing or fruit canning.

Toxins like heavy metals coming from metal plating, battery shops and heavy equipments manufacturing and solvents from industries like body shops, dry cleaner & furniture manufacturing can kill the micro organisms that are needed to treat the waste. Copper, chrome, lead and cyanide are all chemicals that are commonly found in heavy industrial manufacturing discharges. Hospitals and other medical facilities have the potential to discharge wastes that are radioactive or represent a biohazard.

In some cases, pre-treatment of these industrial waste water discharges may be required. Systems that deal with industrial discharges should adopt a pre-treatment ordinance to cover conditions that the system may need to impose on the industrial discharges in order to maintain NPDES requirements on the treatment plant effluent. If local ordinances are different from specific categorical limits imposed in the federal regulations, the most stringent limits of the two must be followed. Pre-treatment ordinances can require actual treatment of the industrial waste prior to discharge to the system, or it may levy a monetary surcharge based on the addition loading that results from the discharge.

1.2 Acceptable water quality standards

Water quality management should ensure that water supplied is free from pathogenic organisms, clear potable, free from undesirable taste and odour, of reasonable temperature neither corrosive nor scale forming and free from minerals which could produce undesirable physiological effect

Table 1.1 Acceptable water quality standards

S.No	Characteristics	Acceptable value	Cause for rejection
1.	Turbidity(units on NTU scale)	2.5	10
2.	Colour(units on platinum-cobalt scale)	5.0	25
3.	Taste and odour	Unobjectionable	Unobjectionable
4.	pH	7.0 to 8.5	6.5 to 9.2
5.	Total dissolved solids (ppm)	500	1500
6.	Total hardness (ppm as CaCO ₃)	200	600
7.	Chlorides (ppm as Cl)	200	1000
8.	Sulphates (as SO ₄ , ppm)	200	1000
9.	Fluorides (as F, ppm)	1.0	1.5
10.	Nitrates (as NO ₃ , ppm)	45	100
11.	Calcium (as Ca, ppm)	75	200
12.	Magnesium(as Mg, ppm)	30	150
13.	Iron(as Fe, ppm)	0.1	1.0
14.	Manganese (as Mn, ppm)	0.05	0.5

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1.3 Drinking Water Standards as per BIS-10500(2004) :

Table 1.2 Drinking Water Standards [BIS-10500(2004)]

S.No	Parameter	Desirable limits (as ppm)	Permissible limit (as ppm)
1.	pH	6.5 to 8.5	6.5 to 8.5
2.	TDS	500	2000
3.	Total Alkalinity	200	600
4.	Total hardness	300	600
5.	Nitrates	25	45
6.	Chlorides	250	1000
7.	Fluoride	1	1.5
8.	Iron	0.3	1
9.	Sulphate	200	400
10.	Calcium	75	200
11.	Magnesium	30	100
12.	E-coli	0	No relaxation

1.4 Chemical methods for the treatment of waste water

Those process used for treatment of waste water in which change is brought about by means of or through chemical reaction are known as chemical unit processes. Chemical treatment process usually includes neutralization, coagulation, flocculation, chemical precipitation, oxidation, reduction, ion-exchange, chemical adsorption, reverse osmosis and electro dialysis.

Table 1.3 Application of chemical unit processes in waste water treatment (WWT)

S. No	Waste water treatment process	Application
1.	Chemicals precipitation	Removal of phosphorus and enhanced of suspended solids removal in primary sedimentation facilities used for physical-chemical treatment
2.	Gas transfer	Addition and removal of gases
3.	Adsorption	Removal of organics not removed by conventional chemical and biological treatment methods also used for de-chlorination of waste water before final discharge of treated effluent
4.	Disinfection	Selective destruction of disease-causing organisms. Chlorine is the most commonly used chemical. Disinfection with ozone.
5.	De-chlorination	Removal of total combined chlorine residual that exist after chlorination.
6.	Other	Various other chemicals for specific objectives in WWT.

1.4.1 Neutralization

This is a unit process where the acid or alkaline waste should be neutralized before being discharged to transported to some additional treatment. The reagents usually used in the neutralization are caustic soda, lime and sodium carbonate. Some other reagents are also employed for specific applications (e.g., ammonia, carbon dioxide, calcium carbonate, sodium carbonate, sulphuric acid, etc.)

1.4.2. Coagulation and flocculation

In these unit process, the waste water is treated with certain chemicals which forms a flock that absorbs and entrains the suspended and colloidal particles present. In coagulation individual particles agglomerate or combine together. When coagulant is used in water, it forms a spongy gelatinous precipitate which absorbs fine size particles in water and bind them together. The whole process result into bigger particles which are easily settable.

Some important factors have to be followed: proper coagulant & flocculent selection, adequate mixing and efficient detention time. In order to determine approximately the dosage of coagulant, the usual test which is performed in the laboratory, is the jar test.

1.4.3 Chemical precipitation

Chemical precipitation in the waste water treatment involves the addition of chemicals to alder the physical state of dissolved & suspended solids and facilitate their removal by sedimentation. They are mainly used for removal of heavy metals, phosphates and certain soluble anionic colour components.

The toxicity of some contaminants can be reduced or destroyed by oxidation. The oxidizing agents used in the process are sodium hypochlorite peroxide, ozone etc. the cyanides are generally treated in the manner.

1.4.5 Reduction

Usually chromium is treated by reduction where the hexavalent from of chromium is converted into trivalent chromium by means of liquid sodium bisulphate or di sodium meta bisulphate, subsequently precipitated as chromium hydroxide, and removed by sedimentation.

1.4.6 Ion-exchange

This method is generally employed for the purification of raw water or for upgrading the treated water on an acceptable level or for removal of undesirable anions and from a waste water. The process involves the exchange of cations by hydrogen ions (H^+) and anions by hydroxyl ions (OH^-). To facilitate these exchange the use of certain resins is made. To generate the used resins some acid or alkali are necessary.

1.4.7 Carbon adsorption

This method is chiefly employed for removal of dissolved organics such as saturated oils, alkenes & alkynes, dyes, phenols etc. certain colours and odours are also removed by this method. This method is based on the principle that charcoal of the charcoal filter where the surface tension on the activated carbon particles causes molecules to adhere on it.

1.4.8 Reverse osmosis

This is the physico-chemical process that separates pure water from its pollutants. This membrane filter operation is also called as hyper filtration or super filtration. The method requires a high pressure to be applied to the waste to force out the liquid (water only) through a semi-permeable membrane, leaving behind dissolved solids.

1.4.9 Electrodialysis

It is a method of separation of dissolved salts from the solution based on the difference in the rates of diffusion. The permeation through the membranes enhanced by the application of electrical energy. The membranes are commonly employed are cellulose nitrate, cellophane and parchment.

1.4.9 Other methods

Some other methods of physico-chemical treatment includes, gas stripping, evaporation, distillation, etc.

1.5 Electrodialysis method for the treatment of industrial waste water:

Electrodialysis is used to transport salt ions from one solution through ion exchange membranes to another solution under the influence of an applied potential difference electrical this is done in an electrodialysis cell. The cell consists of a feed compartment, dilute compartment and electrodes compartments formed by an anion exchange membrane (AEM) and cation exchange membrane (CEM) placed between two electrodes. In practical electrodialysis processes, multiple electrodialysis cells are arranged into a configuration called an electrodialysis stack, with alternating anion and cation exchange membranes forming the multiple electrodialysis cells.

Electrodialysis processes are unique compared to distillation techniques and other membrane based process (such as reverse osmosis) in that dissolved species are moved away from the feed stream rather than the reverse. Because the quantity of dissolved species in the feed stream is far less than that of the fluid, electrodialysis offers the practical advantage of much higher feed recovery in many applications.

1.5.1 Working principle of electro dialysis cell used for water purification:

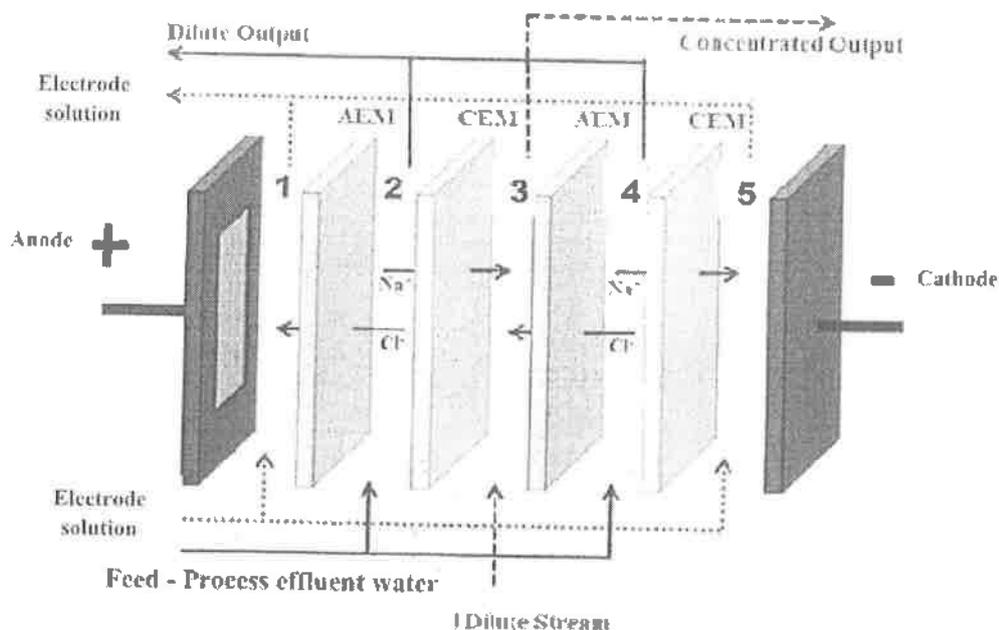


Figure 1.1. Schematic diagram of Electro dialysis cell for the treatment of process effluent water

In an electro dialysis stack, feed streams[2&4](process effluent), electrode stream [1 &5] (anode/cathode electrolyte/solution) and dilute stream[3] (dilute solution) are allowed to flow through the appropriate cell compartments formed by the ion exchange membranes. Under the influence of an electrical potential difference, the negatively charged ions (e.g., chloride) in the feed stream migrate toward the positively charged anode. These ions pass through the positively charged anion exchange membranes(AEM), but are prevented from further migration toward the anode by the negatively charged cation exchange membrane(CEM) and therefore stay in the dilute stream[3], which becomes concentrated with the anions. The positively charged species (e.g., sodium) in the feed stream[2 & 4] migrate toward the negatively charged cathode and pass through the negatively charged cation exchange membrane. These cation also stay in the dilute stream[3], prevented from further migration. Only an equal number of anions and cation charge equivalents are transferred from the feed stream(2 & 4) into the dilute stream(3) and so the charge balance is maintained in each stream.

The result of the electrodialysis process is an ion concentration increase in the dilute stream[3] with a depletion of ions in the feed streams[2 & 4].

Anode and Cathode Reactions

At the cathode



At the anode



1.5.2 Applications of electrodialysis

The major application of electrodialysis is for desalination of brackish water / sea water as an alternative to RO for potable water production & seawater concentration for salt production. In normal potable water production without the requirement of high recoveries, RO is generally believed to be more cost effective when total dissolved solids (TDS) are 3000 ppm or greater, while electrodialysis is more cost effective for TDS feed concentration lesser than 3000 ppm or when high recoveries of the feed are required.

Another important application for electrodialysis is the production of pure water and ultrapure water by electro deionization (EDI). In EDI, the compartments (diluate, concentrate, or both) of the electrodialysis stack are filled with ion exchange resin. When feed with low TDS feed (e.g., feed purified by RO), the diluate can reach very low levels

(e.g., 18Megaohms). The ion exchange resin act to retain the ions , allowing these to be transported across the ion exchange membranes. The main usage of EDI systems are in electronics, pharmaceutical, and cooling tower applications.

Some practical applications of electrodialysis include:

- Large scale brackish & seawater desalination and salt production
- Small and medium scale drinking water production (e.g., town & villages, construction & military camps, nitrate reduction, hotels and hospitals).
- Water reuse (e.g., industrial laundry waste water , produced water from oil /gas production , cooling tower makeup & blow down, metals industry fluids, wash-rack water).
- Pre-demineralization (e.g., boiler makeup and pre treatment, ultrapure water pre treatment, process water desalination, power generation, semiconductor, chemical manufacturing , food and beverage).
- Food processing.
- Agricultural water (e.g., water for green houses, hydroponics, irrigation livestock).
- Glycerene purification.
- Glycol desalting (e.g., antifreeze or engine-coolants, capacitor electrolyte fluids, oil & gas dehydration ,conditioning and processing solutions, industrial heat transfer fluids , secondary coolants from heating , Heating, venting and air conditioning (HVAC).

In application, electrodialysis systems can be operated as continuous production or batch production processes. In a continuous process, feed is passed through a sufficient number of stacks placed in series to produce the final desired product quality. In batch processes, until the final product or concentrate quality is achieved. Electrodialysis is usually applied to deionization of aqueous solutions. However, desalting of sparingly conductive aqueous organic and organic solutions is possible.

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CHAPTER -II

OBJECTIVES AND SCOPE OF THE PROJECT

CHAPTER - II

OBJECTIVES AND SCOPE OF THE PROJECT

i. Objective: Reduction of chloride and calcium content in petrochemical process effluent water by electro dialysis.

ii. Scope:

- i. Removal of chloride/calcium ion from the effluent water of petrochemical process by electro dialysis in 500 ml/2.0 L/10.0 L per batch scale.
- ii. Process parameters study on current density, selection of electrode and membrane, etc., on 500 ml/2.0 L/10.0 L scale study.
- iii. Analysis of chloride and calcium content in petrochemical processes effluent water before and after electro dialysis.
- iv. Demonstration of electro dialysis process on 10.0 litre per batch to the client.
- v. Submission of final project report to the client.

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CHAPTER - III

EXPERIMENTAL DETAILS

CHAPTER - III
EXPERIMENTAL DETAILS

1. Schematic diagram of Electrodialysis

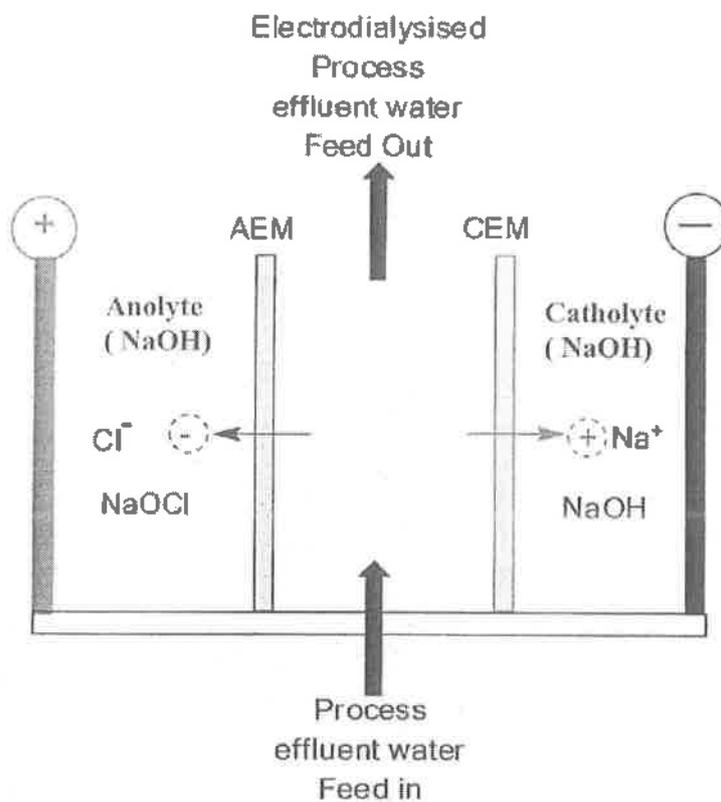


Figure 3.1 Schematic diagram for the electrodesalination of process effluent water

- AEM - Anion Exchange Membrane
- CEM - Cation Exchange Membrane
- Anolyte - NaOH (1.0%)
- Catholyte - NaOH (1.0%)

2. Process flow Sheet

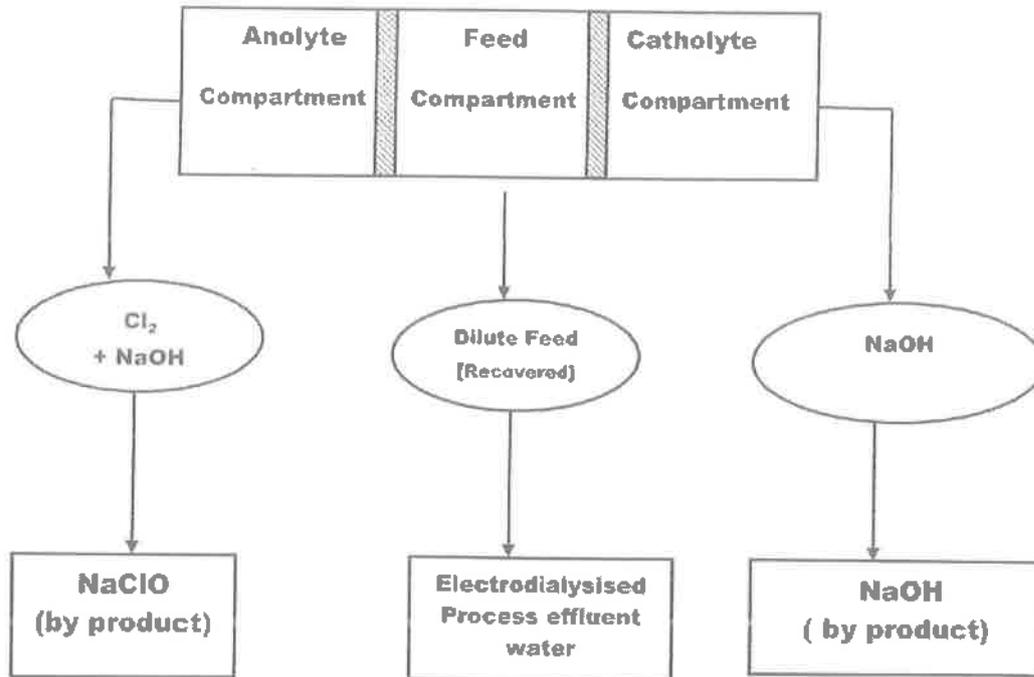


Figure 3.2 Process Flow Sheet for the treatment of process effluent water by electrodiolysis

3. Electrodialysis Process description:

Electrodialysis of process effluent water was carried out in a three compartment ED cell having anion & cation exchange membranes(AEM & CEM). Electrodialysis has been conducted as per the data given in experimental condition Table 1 with dimensionally stable anode (DSA) as anode and stainless steel-316 grade as cathode. Analysis of cations like Na^+ , Ca^{2+} and anions like Cl^- , SO_4^- were carried out before and after electrodialysis and the results are discussed as mentioned below.

i. Feed Chamber:

500 ml of process effluent water was taken as a feed solution in the feed chamber and the electrodialysis was carried out. After the electrodialysis the feed solution was subjected to analysis of anions/cations.

ii. Anolyte Chamber:

A 450 ml solution of 1.0% NaOH (w/v) was taken as anolyte for conductivity and graphite used as anode in the anolyte chamber. After the electrodialysis the anolyte solution was analysed. The formation of NaClO is found in the range of 1-2 gpl.

iii. Catholyte Chamber:

A 450 ml solution of 1.0% NaOH (w/v) in 450 ml of water was taken as catholyte for conductivity and graphite is used as cathode in the catholyte chamber. After electrodialysis the catholyte solution was filtered to remove the solid $\text{Ca}(\text{OH})_2$ and the amount of NaOH was analysed to know its concentration.

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CHAPTER - IV

RESULTS AND DISCUSSION

Chapter - IV

Results and Discussion

1. Laboratory Scale electro dialysis study- 500/2000 ml batch ED cell :

Studies were carried out to remove the anions and cations present in the process effluent water by M/s. Manali Petrochemicals Ltd, Chennai. Before electro dialysis (ED) the feed water(process effluent) was analysed to know the concentration of anions and cations present in the sample. Electro dialysis was carried out in 600 ml capacity 3 compartment electro dialysis batch cell fitted with anion exchange membrane (AEM) and cation exchange membrane (CEM). Graphite plates were used as anode and cathode. In anolyte compartment 1.0 % NaOH was taken as anolyte and maintained the pH 14 to prevent the NaClO decomposition by adding additional NaOH solution during the electro dialysis and in catholyte compartment 1.0 % NaOH was taken as catholyte.

Constant current (Galvanostatic) electro dialysis was carried out at a current density of 1 to 10 mA/cm² at room temperature for 7 hours. Feed, catholyte and anolyte were analysed periodically and the cell voltage developed was noted. Chloride, hypochlorite and calcium contents were estimated by volumetric titration and compared with the authentic samples. Atomic Absorption Spectroscopy (AAS) is used to estimate sodium, magnesium and potassium contents in the feed before and after electro dialysis. The electro dialysis data and specification are given in Table 4.1. Table 4.2 gives the information about the ions present in the feed before and after ED. Effect of current passed and current density were given in Table 4.3 and Table 4.4.

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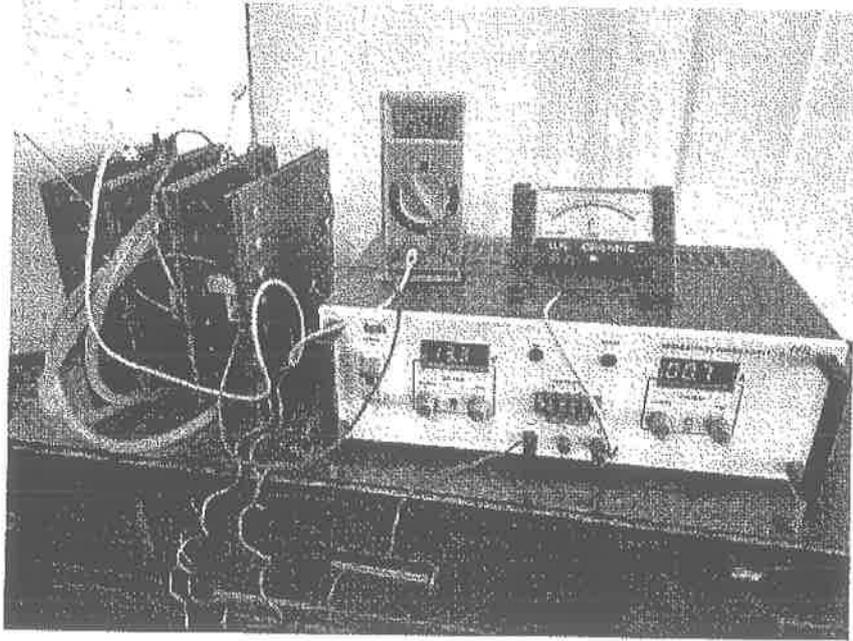


Figure 4.1 Photograph of electrodiolysis set up for process effluent water in batch cell

Table 4.1 Electrodialysis experimental parameters

S No	Parameters	Data
1	Feed - Process effluent water	500 ml in batch cell
2	Anode	DSA, area= 50 cm ²
3	Cathode	Graphite, area= 80 cm ²
4	Anolyte	1.0 % NaOH = 450 ml
5	Catholyte	1.0 % NaOH = 450 ml
6	Current density	30 mA/cm ²
7	Duration - ED	23 hours
8	Current rate	1500 mA
9	Cell voltage	6.8 to 20.0 V
10	Total Charge passed	36,000 mAh
11	Cell Type	3 compartment cell with AEM (Ionac-MA 3475) & CEM (Nafion-324)
12	Cell - Material Of Construction	PVC
13	Cell - Specifications	L X W X H (cm)
	Feed Chamber	11 cm x 5.5 cm x 12.5cm
14	Anolyte Chamber	11 cm x 5.5 cm x 12.5 cm
15	Catholyte Chamber	11 cm x 5.5 cm x 12.5 cm
16	Inter electrode distance	5 cm

Table 4.1 shows the optimised experimental condition for the 600 ml capacity electro dialysis (ED) system. A three compartment ED cell was used with cation exchange membrane (CEM) and anion exchange membrane (AEM) with graphite as anode and cathode. 500 ml of feed (process effluent water) was taken in the feed chamber (middle compartment) and 450 ml of 1.0% NaOH, 450 ml of 1.0% NaOH solutions were used as anolyte and catholyte respectively. Electrodialysis was conducted at a current density of 30 mA/cm² under constant current electrolysis technique. Electrodialysis duration was 24 hours and cell voltage observed was between 6.8 to 20.0 V. The total charge passed for electro dialysis of 600 ml feed solution was 36,000 mAh or 36.0 Ah.

Table 4.2 shows the analysis report of ions present in the solution before and after electro dialysis of process effluent water. The TDS of the solution was reduced to 390 ppm from 48,180 ppm and the conductivity also reduced to 730 $\mu\text{S}/\text{cm}$ from 98,000 $\mu\text{S}/\text{cm}$.

The chloride ion concentration was reduced to 70 ppm from the initial concentration of 28,350 ppm. The calcium ion concentration was 16,400 ppm in the feed solution and reduced to 5 ppm. From the table it reveals that after the electro dialysis of process effluent water, the anions Cl^- concentration is as per the desirable standard limit of water (IS-10500: 2012, BIS-105000: 2009) and the concentration of cations Ca^{2+} was reduced to allowable standard limit of water (IS-10500: 2012, BIS-105000: 2009)

Table 4.2 Electro dialysis of process effluent water - 500 ml capacity batch cell.

S No	Parameters	Effluent water supplied by MPL	Effluent water After electro dialysis (500 ml cell)
1	TDS-ppm	48,180	390
2	Conductivity-($\mu\text{S}/\text{cm}$)	98,000	730
3	pH	7.4	11.9
4	Cl^- ion -ppm	28,350	70
5	Cl^- ion Removal efficiency	--	99.75%
6	Ca^{2+} ion - ppm	16,400	5
7	Ca^{2+} ion Removal efficiency	--	99.96%
8	Feed volume taken - ml (Effluent water)	500 ml	-
9	Recovery of effluent water after electro dialysis	--	200 ml
10	Effluent Water Recovery efficiency after electro dialysis	--	40%
11	Electro dialysis duration	---	23 hours

2. Electrodialysis of process effluent water - 2400 ml batch ED cell :

Table 4.3 shows the analysis report of ions present in the solution before and after electrodialysis of process effluent water carried out in 2400 ml capacity batch ED cell . The TDS of the solution was reduced to 12,350 ppm from 98,900 ppm and the conductivity also reduced to 23,000 $\mu\text{S}/\text{cm}$ from 2,16,000 $\mu\text{S}/\text{cm}$. The chloride ion concentration was reduced to 200 ppm from the initial concentration of 30,100 ppm. The calcium ion concentration was 16,400 ppm in the feed solution and reduced to 40 ppm.

Table 4.3 Electrodialysis of process effluent water - 2400 ml capacity batch cell.

S No	Parameters	*Effluent water supplied by MPL	Effluent water After electrodialysis (2.4 L cell)
1	TDS- (ppm)	98,900	12,350
2	Conductivity-($\mu\text{S}/\text{cm}$)	2,16,000	23,000
3	pH	13.6	12.9
4	Cl ⁻ ion - (ppm)	30,100	200
5	Cl ⁻ ion Removal efficiency		99%
6	Ca ²⁺ ion - (ppm)	80	40
7	Ca ²⁺ ion Removal efficiency (%)		50%
8	Feed volume taken - (Effluent water) (ml)	2400 ml	
9	Recovery of effluent water after electrodialysis (ml)	1580 ml	
10	Recovery of effluent water after electrodialysis (%)	66 %	
11	Electrodialysis duration (hours)	47 hours	

* (Effluent water is pre- treated with NaOH and removed Ca(OH)₂ as precipitate)

3. Electrodialysis of process effluent water in 2.0/4.0 litre capacity flow cell.

Experiments were carried out in 10.0 litre capacity electrodialysis flow cell. In the flow DSA is used as anode and stainless steel as cathode. The membrane working area is 150 cm². Table 4.4 shows the analysis report of ions present in the solution before and after electrodialysis of process effluent water carried out in 2000 ml capacity flow type ED cell. The TDS of the solution was reduced to 518 ppm from 85,500 ppm and the conductivity also reduced to 970 $\mu\text{S}/\text{cm}$ from 2,16,000 $\mu\text{S}/\text{cm}$. The chloride ion concentration was reduced to 210 ppm from the initial concentration of 30,100 ppm. The calcium ion concentration was 16,400 ppm in the feed solution and reduced to 40 ppm.

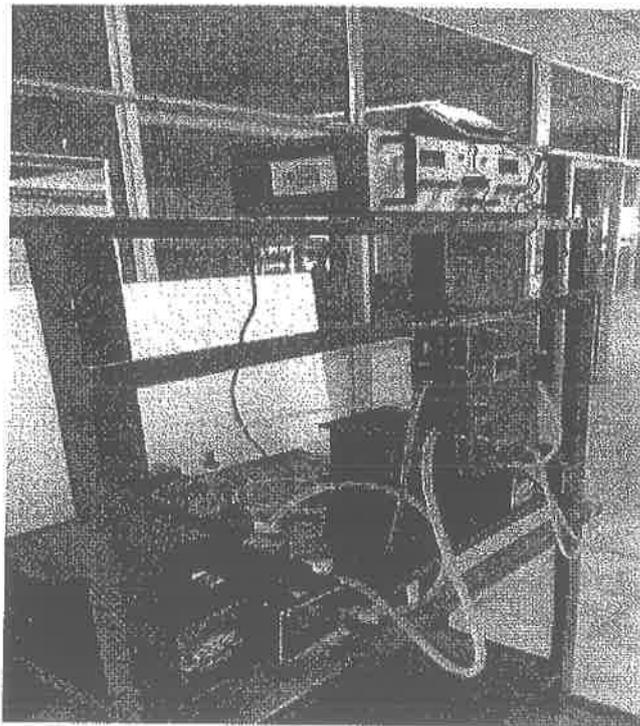


Figure 4.2 Photograph of electrodialysis flow Cell [150 cm² area per stack]

Table 4.4 Electrodialysis of process effluent water - 2000 ml capacity flow cell.

S No	Parameters	*Effluent water supplied by MPL	Effluent water After electrodialysis (2.0 L Flow cell)
1	TDS- (ppm)	85,500	518
2	Conductivity-(μ S/cm)	2,16,000	970
3	pH	13.6	11.0
4	Cl ⁻ ion - (ppm)	30,100	210
5	Cl ⁻ ion Removal efficiency	99%	
6	Ca ²⁺ ion - (ppm) (After pre-treatment of process water)	80	40
7	Ca ²⁺ ion Removal efficiency (%)	50%	
8	Feed volume taken - (ml) (process Effluent water)	2000 ml	
9	Recovery of process effluent water after electrodialysis (ml)	1390 ml	
10	Recovery of process effluent water after electrodialysis (%)	70 %	
11	Electrodialysis duration (hours)	7 hours 15 minutes	

* (Effluent water is pre- treated with NaOH and removed Ca(OH)₂ as salt precipitate)

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Table 4.5 shows the analysis report of ions present in the solution before and after electro dialysis of process effluent water carried out in 4000 ml capacity flow type ED cell. The TDS of the solution was reduced to 1980 ppm from 85,500 ppm and the conductivity also reduced to 3450 $\mu\text{S/cm}$ from 2,16,000 $\mu\text{S/cm}$. The chloride ion concentration was reduced to 210 ppm from the initial concentration of 30,100 ppm. The calcium ion concentration was 16,400 ppm in the feed solution and reduced to 40 ppm.

Table 4.5 Electro dialysis of process effluent water [4.0 litre capacity flow cell]

S No	Parameters	*Effluent water supplied by MPL	Effluent water After electro dialysis (4.0 L Flow cell)
1	TDS- (ppm)	85,500	1980
2	Conductivity-($\mu\text{S/cm}$)	2,16,000	3450
3	pH	13.6	11.9
4	Cl ⁻ ion - (ppm)	30,100	210
5	Cl ⁻ ion Removal efficiency (%)	98%	
6	Ca ²⁺ ion - (ppm) (After pre-treatment of process water)	80	40
7	Ca ²⁺ ion Removal efficiency (%)	50%	
8	Feed volume taken - (ml) (process Effluent water)	4000 ml	
9	Recovery of process effluent water after electro dialysis (ml)	2800 ml	
10	Recovery of process effluent water after electro dialysis (%)	70 %	
11	Electro dialysis duration (hours)	6 hours per litre	
12	Amount of NaOCl formed [anolyte compartment] (%)	1.76% NaOCl (or) 17.6 gpl of free Cl ₂ available in anolyte solution	
13	Amount of NaOH formed [Catholyte compartment] (g)	83 g of NaOH per litre (as a saturated solution)	

* (Effluent water is pre- treated with NaOH and removed the Ca(OH)₂ as precipitate)

4. Electrodialysis of process effluent water in 10.0 litre capacity flow cell.

Experiments were carried out in 10.0 litre capacity electro dialysis flow cell. In the flow DSA is used as anode and stainless steel as cathode. The membrane working area is 650 cm². Table 6 shows the analysis report of ions present in the solution before and after electro dialysis of process effluent water carried out in 4000 ml capacity flow type ED cell. The TDS of the solution was reduced to 375 ppm from 85,500 ppm and the conductivity also reduced to 530 μ S/cm from 1,68,000 μ S/cm. The chloride ion concentration was reduced to 175 ppm from the initial concentration of 30,800 ppm. The calcium ion concentration was 16,400 ppm in the feed solution and reduced to 40 ppm.

Table 4.6 Electrodialysis of process effluent water - 10.0 litre capacity flow cell.

S No	Parameters	*Effluent water supplied by MPL	Effluent water After electro dialysis (10.0 L Flow cell)
1	TDS- (ppm)	88,800	375
2	Conductivity-(μ S/cm)	1,68,000	530
3	pH	13.5	11.7
4	Cl ⁻ ion - (ppm)	30,800	175
5	Cl ⁻ ion Removal efficiency(%)	98%	
6	Ca ²⁺ ion - (ppm) (After pre-treatment of process water)	80	40
7	Ca ²⁺ ion Removal efficiency (%)	50%	
8	Feed volume taken - (litre) (process Effluent water)	10.0 L	
9	Recovery of process effluent water after electro dialysis (litre)	7.0 L	
10	Recovery of process effluent water after electro dialysis (%)	70 %	
11	Electro dialysis duration (hours)	10 hours	
12	Amount of NaOCl formed [anolyte compartment] (%)	1.76% NaOCl (or) 17.6 gpl of free Cl ₂ available in anolyte solution	
13	Amount of NaOH formed(g) [Catholyte compartment]	83 g of NaOH per litre	

* (Effluent water is pre- treated with NaOH and removed the Ca(OH)₂ as precipitate)

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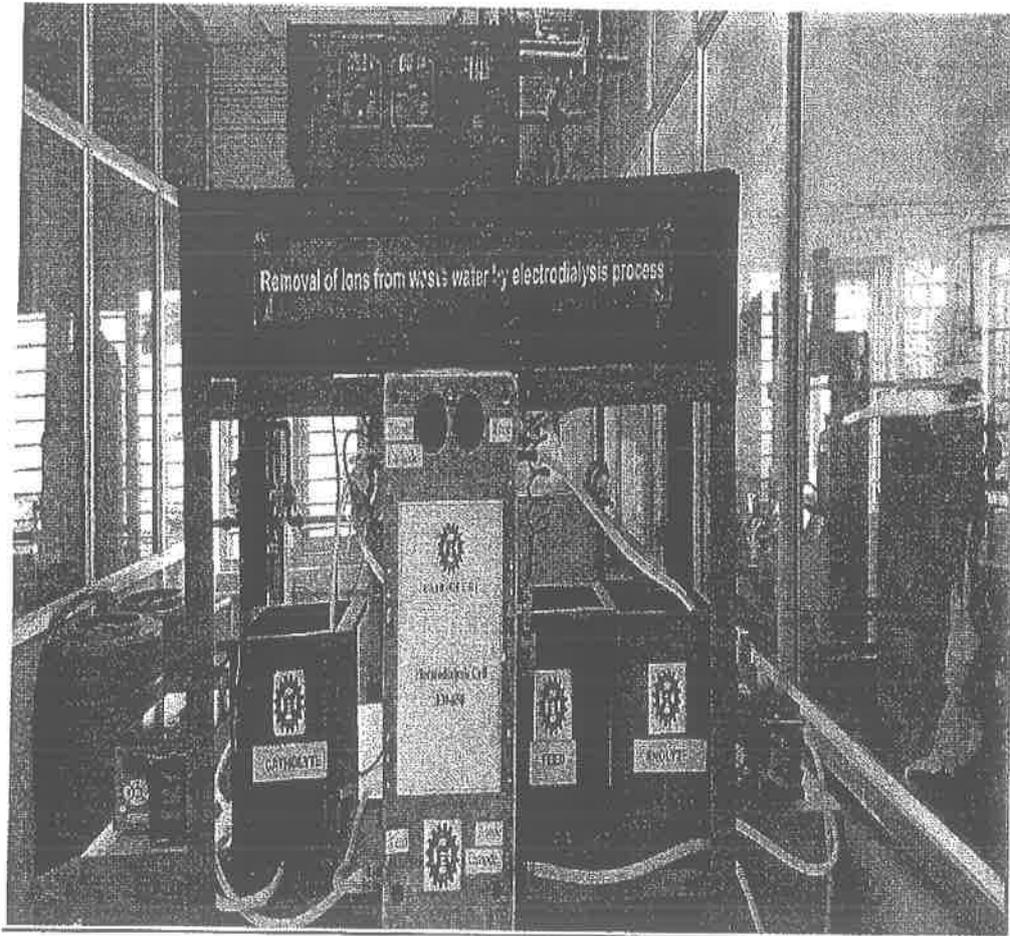


Figure 4.3 Photograph of electrodesalination Cell [650 cm² area per stack]

II. Analysis of Anolyte [For NaClO formation]:**Reaction mechanism in the anolyte chamber:**

After completion of electrolysis the anolyte solution was analysed. NaClO formation was observed in the anolyte solution with available chlorine content in the range of 0.39 to 1.67 gpl. The formed NaClO compound is not stable and the concentration decreased with respect to the time.

III. Analysis of catholyte [for NaOH formation]:

Reaction mechanism in the catholyte chamber:



After completion of electro dialysis the catholyte solution was analysed. NaOH and other related hydroxide formation were observed in the catholyte solution. The catholyte may be mixture of NaOH and $\text{Ca}(\text{OH})_2$ based on the concentration of Na^+ and Ca^{2+} ions present in the feed solution. Since $\text{Ca}(\text{OH})_2$ is less soluble it separates out as white solid during the electro dialysis and it can be removed by simple filtration after completion of electro dialysis.

CHAPTER - V

PRE-DESIGN COST ESTIMATION

CHAPTER - V**Pre-design cost estimation**
Electrodialysis of process effluent water**Basis:** Process effluent water (Supplied by M/s. Manali Petrochemical Ltd. Chennai)

- ED Cell** : Three Compartment ED flow Cell- 10.0 L capacity
Feed : 10.0 L of Process effluent water
Anolyte : 10.0 L of 1.0% NaOH solution
Catholyte : 10.0 L of 1.0% NaOH solution

Requirements for treatment per 1.0 Litre of Process effluent water :

S No	Items	Requirement Units/litre	Cost (Rs. per kg/unit)	Total cost (Rs.)
1	Anolyte - 1.0% NaOH	4.0 g	10.00	0.04
2	Catholyte-1.0% NaOH	4.0 g	10.00	0.04
3	Power for electrodialysis	0.55 kWh or unit	5.00/unit	2.75
4	Other utilities	} 50% of cost of production or Total raw materials & power costs (total of Sl. no. 1 to 3)		0.178
5	Labour and supervision			
6	Maintenance and Repairs			
7	Over heads			
8	Administration expenses			
9	Taxes & etc.			
Cost for electrodialysis per litre				3.008
Cost for electrodialysis per m³				3008.00

CHAPTER - VI

CONCLUSION

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CHAPTER - VI

CONCLUSION

I. CONCLUSIONS:

- i. From the process effluent water, the anion[Cl⁻] present was removed with 99% removal efficiency.
- ii. Cations like Na⁺ and Ca²⁺ present in the process effluent water were removed with 99% removal efficiency.
- iii. By-products like NaClO and Hydroxides of Na⁺ and Ca⁺ were formed in-situ during the electro dialysis process.
- iv. Removal efficiency for ions present in the process effluent water is = 98-99%
- v. Current efficiency for electro dialysis of process effluent water is = 55%
- vi. Energy consumption for electro dialysis is = 0.55 kWh/litre or 550 kWh/m³
- vii. Recovery of treated process effluent water (dilute) after electro dialysis = 65-70%
- viii. Batch and batch re-circulation electrochemical cells were used for the electro dialysis.
- ix. For electro dialysis of process effluent water dimensionally stable anode(DSA) and graphite/stainless steel cathode were used.
- x. Anion exchange membrane [Ionac-MA 3475] and cation exchange membrane [Nafion-324] were used
- xi. Cost for electro dialysis of process effluent water per m³ = Rs. 3000.00

CHAPTER - IX

RECOMMENDATIONS

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CHAPTER - IX
RECOMMENDATIONS

- i. After electro dialysis, the ions present in the treated process effluent water is equivalent to the standard or desirable limit and hence electro dialysis method is a suitable method for the removal of anions and cations from the process effluent water. The treated water can be used for other unit operations.
- ii. The anolyte and catholyte recommended for electro dialysis is 1.0% NaOH.
- iii. Flow cell (Batch re-circulation) electro dialysis cell is recommended for electro dialysis.
- iv. For electro dialysis dimensionally stable anode(DSA) and stainless steel/graphite cathode are recommended.
- v. Anion exchange membrane [Jonac-MA 3475] and cation exchange membrane [Nafion-324] are recommended.
- vi. Chlorine gas can be obtained from the anode chamber or NaClO (free available chlorine of 1.6 gpl) can be prepared by in-situ during electro dialysis.
- vii. NaOH and $\text{Ca}(\text{OH})_2$ can be obtained in the catholyte chamber in-situ during electro dialysis.

(Dr. T. RAJU)
Project co-ordinator
Electroorganic Division
CSIR-CECRI, KARAIKUDI



REPORT

ON

SITE TRIAL STUDIES

USING

ROCHEM'S

PT-RO MODULE SYSTEMS

ON

ETP TREATED EFFLUENT STREAM

OF

**M/S. MANALI PETROCHEMICALS LIMITED,
CHENNAI.**

SUBMITTED BY

**ROCHEM SEPARATION SYSTEMS (INDIA) PVT. LTD.,
MUMBAI**



To,
M/s. Manali Petrochemicals Limited,
Ponneri High Road,
Manali,
Chennai.

Rochem Separation Systems (India) Pvt. Ltd.
101, HDIL Tower, Anant Kanekar Marg,
Bandra (East), Mumbai 400 051.
Tel: 91-22 6704 9000
Fax: 91-22 6704 9010
Email: rochem@rochemindia.com
Website: www.rochemindia.com
CIN- U24100MH1991PTC064068
Date: 11th June, 2019
Ref: RSS/T/0027/2019 Rev 00

Kind Attention : Mr. S. Kamala Bharathy (Assistant Manager-Projects)

Subject : Site Trial Report for ROCHEM PT-RO Membrane System on ETP Treated Effluent Stream.

Dear Sir,

We thank you for the opportunity provided to us for demonstrating the ROCHEM PT-RO membrane system capabilities on the pilot plant at your site.

We are pleased to submit the Pilot Trial Report of PT Module RO system on the ETP Treated Effluent Stream.

As evident from the report, the trials have been highly successful in terms of achieving the results as expected.

We value your patronage and strive to deliver quality services at all times.

Thanking you,

Yours faithfully,

**FOR ROCHEM SEPARATION SYSTEMS
(INDIA) PVT. LTD.**

**HITUL NAIK
(REGIONAL MANAGER)**

(c: Quotation/Petrochemicals/Manali Petrochemicals Limited, Chennai/Site Trial Offer for Manali Petrochemicals Limited, Chennai Rev 00.doc)

SITE TRIAL STUDIES



OBJECTIVES:

- To check and establish the effectiveness of Plate and Tube module PT-RO System on **ETP Treated Effluent Stream.**
- To Recover Reusable Permeate.
- To establish separation and rejection characteristics of the membrane.
- To establish the reduction of Conductivity and COD of the effluent after passing through the PT-RO system
- To establish the robustness of the PT-RO Module over a long period of continuous operation with **ETP Treated Effluent.**

TRIAL METHODOLOGY:

- 1) The sample is checked for Conductivity, COD etc.
- 2) The sample is processed in pilot plant.
- 3) The feed, permeate & reject samples are collected for laboratory analysis.

EXECUTIVE SUMMARY:

To Recover Reusable Permeate from Existing RO reject stream.

Separation and rejection characteristics	Established
Total average recovery	50%
Reduction in COD etc.	Established
Concentration of rejects	Established at least by 2 times
Concentration without pretreatment (only pH correction & Anti-scalant dosing)	SMBS Dosing

SOURCE OF THE STREAMS ON WHICH TRIAL CONDUCTED:

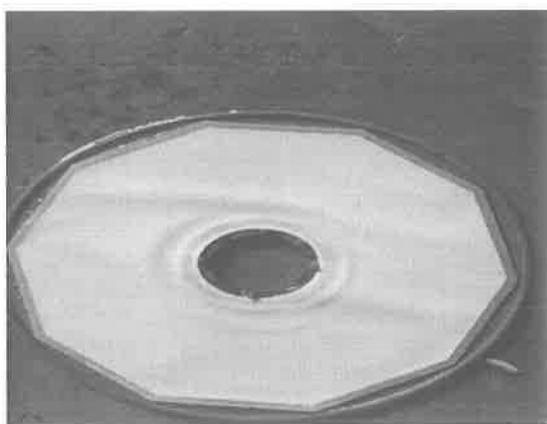

The recommended (Feed) source was **ETP Treated Effluent**

- PT-RO Recovery : 50% volume as permeate
- Conductivity Reduction : > 95% for RO
- Color Reduction : Colorless
- Odour Reduction : Odourless
- Initial PH before correction : 5.3

SUMMARY OF RESULTS:

	Feed	Permeate	% Reduction	Reject
pH	4.8	4.7	---	
Conductivity in $\mu\text{s}/\text{cm}$	106460	5730	> 95%	123360
COD in ppm	1360	< 50	>95%	--
Recovery	100	50%	--	50%

Membrane photo before cleaning :



No fouling observed.

**CONCLUSIONS:**

- 1) The ETP Treated Effluent does not require any pretreatment before feeding into ROCHEM PT RO System.
- 2) Stable Permeate of 50% is obtained on ETP Treated Effluent at Pilot Plant depending on whether dam water or bore well water is fed to existing raw water treatment RO plant.
- 3) We recommend PT-RO Installation for ETP Treated Effluent to recover reusable Permeate.
- 4) In case the outlet permeate parameter required needs to be changed/polished; Please do inform so as to enable us to design System accordingly.

We Trust the above pilot plant trial report shall be in line with your requirement & look forward to hear from you soon.

Thanking you & assuring you of our best services,

Yours faithfully,

**FOR ROCHEM SEPARATION
SYSTEMS (INDIA) PVT. LTD.**

**HITUL NAIK
(REGIONAL MANAGER)**

(e: Quotation/Petrochemicals/Manali Petrochemicals Limited, Chennai/Site Trial Offer for Manali Petrochemicals Limited, Chennai Rev 00.doc)

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REPORT

ON

PILOT TRIAL STUDIES

FOR

MANALI PETROCHEMICALS LTD, CHENNAI

USING

ROCHEM

WASTE HEAT EVAPORATOR

ON

RO REJECT

SUBMITTED BY

**ROCHEM SEPARATION SYSTEM INDIA PRIVATE LIMITED,
MUMBAI.**



To,
M/s Manali Petrochemicals Ltd,
Chennai

ROCHEM SEPARATION SYSTEMS (INDIA)
PVT.LTD.
101, HDIL Tower, Anant Kanekar Marg,
Bandra (East), Mumbai 400 051.

Tel: 91-22 6704 9000
Fax: 91-22 6704 9010

Email: rochem@rochemindia.com
Website: www.rochemindia.com

Date: 10th July, 2019
Ref: WHE/19-20/022

Kind Attention : Ms S Kamala Bharathy (Assistant Manager-Project)

Subject : Pilot Trial Report for ROCHEM Waste Heat Evaporator Membrane (WHE) System on RO reject .

Dear Sir,

We thank you for the opportunity provided to us for demonstrating the ROCHEM WHE membrane system capabilities on the pilot plant at our Vasai facility.

We are pleased to submit the Pilot Trial Report of Waste Heat Evaporator Membrane Module on RO reject generated post RO factory trial on Treated effluent received from your Chennai facility for your kind perusal.

As evident from the report, the trials have been successful in terms of achieving the results as expected.

We value your patronage and strive to deliver quality services at all times.

Thanking you,

Yours faithfully,

FOR ROCHEM SEPARATION SYSTEMS (I) PVT LTD,

NISHCHAL WADEKAR



EXECUTIVE SUMMARY

Feed Sample	RO reject
Feasibility of using WHE System on RO reject of Treated Effluent stream	Established
Total recovery in WHE	61%
Reduction in TDS in distillate	>99%
Concentration of WHE Rejects (TDS)	>3,00,000 ppm



PILOT TRIAL STUDIES

OBJECTIVES:

- To check and establish the effectiveness of WHE module on RO reject
- To achieve maximum concentration of feed without crystallization.
- To recover reusable Distillate.

TRIAL METHODOLOGY:

- 1) WHE feed was generated by running RO pilot plant on feed 340 lit capacity of Treated effluent stream available at our Vasai factory.
- 2) The Treated effluent stream had around 5% CaCl₂ salts in it.
- 3) RO plant was run to yield 50% recovery.
- 4) RO rejects of capacity 150 lit thus generated was treated further on WHE pilot plant.
- 5) The WHE feed effluent was analyzed as follows :

Parameters	Unit	RO reject
Qty	Lit	70
pH	---	5
Salinity	%	12.5

- 6) The effluent was taken for trials on Waste Heat Evaporator pilot plant as given below :

Run hrs	Feed		Distillate		Brine	
	Flow (lph)	Salinity	Flow (lph)	Conductivity (microS/cm)	Flow (lph)	Salinity
1	100	12.5	12.30	174	103.29	13.5
2	100	15	17.36	136	91.04	16
3	100	22	15.88	121	83.81	24.6



Trial Summary :

- 1) We were able to operate plant on feed with recovery of 61%.
- 2) Salinity achieved in reject 24.6 from initial 12.5 in the feed.
- 3) TDS achieved in WHE reject >3,00,000 ppm from initial \approx 1,50,000 ppm.

Sample volume feed : 70 lit
Distillate recovered : 43 lit
Reject volume : 27 lit

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CONCLUSION

- 1) Based on the piloting at Vasai factory, it was established that ROCHEM Waste Heat Evaporator (WHE) can be included in scheme for concentration of RO rejects of Treated effluent stream.
- 2) We recommend ROCHEM WHE Installation for RO reject stream to concentrate feed to maximum.
- 3) High Quality of distillate is obtained such that it can be reused directly.
- 4) The reject of ROCHEM WHE can be further concentrated in Finisher to attain ZLD.

We Trust the above pilot plant trial report shall be in line with your requirement & meets your approval.

Thanking you & assuring you of our best services.

Yours faithfully,

FOR ROCHEM SEPARATION SYSTEMS (I) PVT LTD,

NISHCHAL WADEKAR



**RENTAL OFFER
OF
ROCHEM
WASTE HEAT EVAPORATOR SYSTEM
FOR
M/s MANALI PETROCHEMICALS LTD,
CHENNAI**

Date : 20th December, 2019

Reference: WHE/19/20/133

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Sr.No	Description	Page No
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3.	Application Of Rochem WHE In Concentration Of Nitro effluent Stream	8
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To,
M/s Manali Petrochemicals Limited,
Ponneri high road,
Manali, Chennai:600 068

Rochem Separation Systems (India) Pvt. Ltd.
101, HDIL Tower, Anant Kanekar Marg,
Bandra (East), Mumbai 400 051.
Tel: 91-22 6704 9000
Fax: 91-22 6704 9010
Email: rochem@rochemindia.com
Website: www.rochemindia.com
CIN- U24100MH1991PTC064
Date: 20-12-2019
Ref: WHE/19/20/133

Kind Attention :Ms. S. Kamala Bharathy (Assistant Manager-Projects)

Subject: Rental Offer for the supply of ROCHEM WHE for PT(HP) - RO Reject stream treatment.

Dear Sir,

We thank you for your interest in our technology & solution for Effluent treatment & ZLD.
We refer to your discussion with our Mr Hitul Naik, we are pleased to submit our offer for Waste Heat Evaporator system on rental basis for 6 months for your kind perusal.

Pleased find attached offer of WHE System of designed feed capacity 7.5 m3/day for PT (HP)- RO Reject stream. We hope this meets your approval & expectations.

We look forward to discussing the same with your selves at mutually convenient date & time.

Assuring you of our best services always.

Thanking You,

For ROCHEM SEPARATION SYSTEMS (INDIA) PVT.LTD,

NISHCHAL WADEKAR

Section 1: ROCHEM Waste Heat Evaporator system and underlying Principle

ROCHEM Waste Heat Evaporator (WHE) based on Membrane Distillation is a relatively new process and it is investigated worldwide as a low cost, energy saving alternative to conventional separation processes such as distillation, Multieffect evaporation and in some cases reverse osmosis (RO), where waste heat is available.

The ROCHEM WHE process is less affected by scaling and fouling unlike Reverse Osmosis and has much lower energy consumption than conventional evaporation. Thus yielding the more or equivalent recyclable Water and saving Heat and Energy, thus needed to concentrate in evaporators.

ROCHEM WHE process allows the separation of volatile components from solutions. If the solution contains non-volatile components, it is possible to remove solvent by concentrating the solutions.

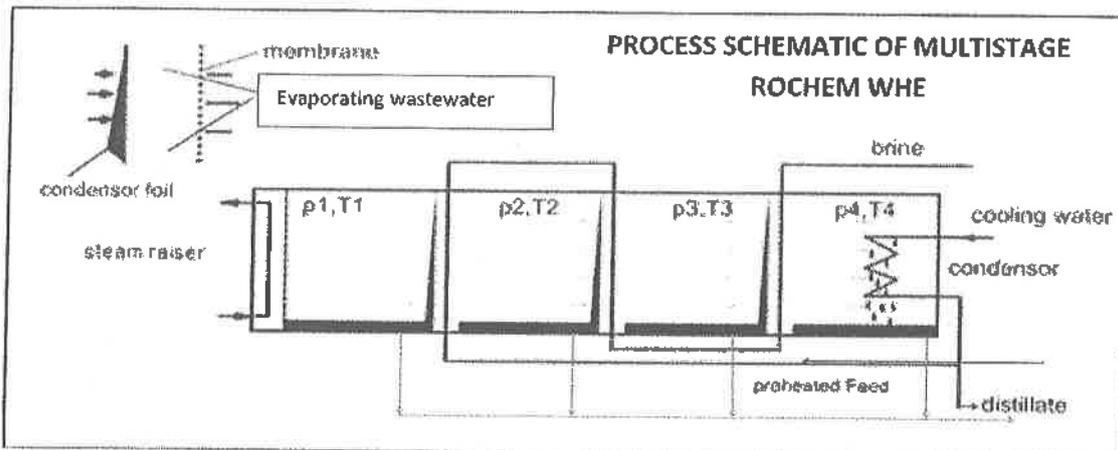
The phenomenon that defines process of ROCHEM WHE is relatively simple, however the mechanism of mass transport through systems is much complicated.

A heated, aqueous feed solution is brought into contact with one side (feed side) of a hydrophobic, micro porous membrane. The hydrophobic nature of the membrane prevents penetration of the aqueous solution into the pores, resulting in a vapour-liquid interface at each pore entrance.

The driving force for the process is linked to both the partial pressure gradient and the thermal gradient between the two membrane sides. ROCHEM WHE can be characterised by the following steps:

Vaporisation of the more volatile compounds at the liquid/vapour interface and diffusion of the vapour through the membrane pores according to a Knudsen mechanism.

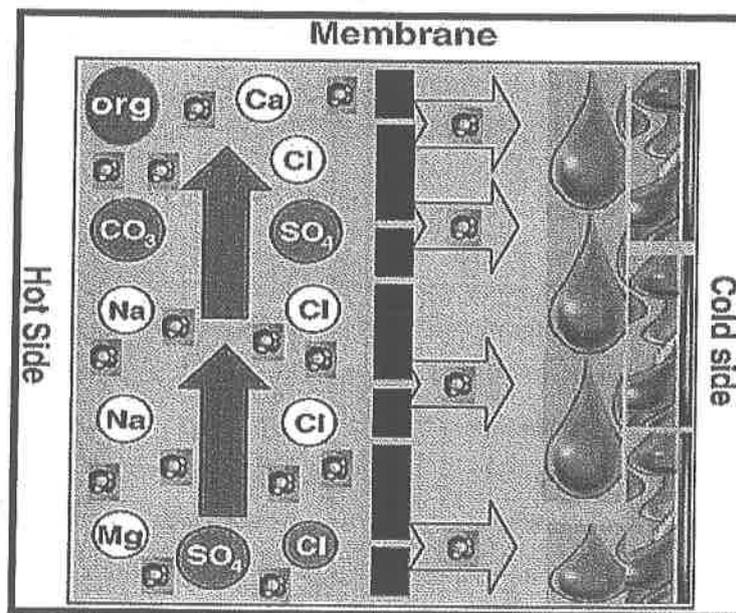
ROCHEM WHE allows concentration of aqueous solution by producing fresh water also from highly concentrated feeds where RO cannot operate. Therefore, it is possible to increase the global recovery factor in a wastewater concentration by treating the brine of a RO process with a ROCHEM WHE unit. Moreover as hydrodynamics poorly influences permeate fluxes for concentration applications, it is possible to design some membrane modules or systems in which low liquid velocities will be maintained which will allow to reduce the energy costs due to water feeding.



Process of concentration in ROCHEM WHE:

Wastewater is Concentrated in the following way:

1. Heat is transported from the bulk fluid to the wastewater surface
2. Wastewater evaporates from the surface
3. Wastewater vapour diffuses through the membrane
4. Wastewater vapour condenses on the other side of the membrane



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In practical terms, water is first passed through a pre-treatment filter in order to remove solid particulate matter. Since all matter at a given temperature is volatile or solid, i.e. volatile or non-volatile has vapour pressure or has not, installed equipment will be able to remove all conceivable contaminants from sea-water, brackish water, municipal sewage, industrial waste water and from any ground- and surface water.

Absolute removal

In distillation technologies, the vapour may carry small droplets of water which contain contaminants - particles, ions, bacteria, virus, pyrogens and the like. This is called "entrainment". This entrainment can be reduced by various devices, but it is theoretically impossible to reach total separation.

In filter technologies, the relatively high pressure may cause small amounts of impurities - particles, ions or pyrogens, even bacteria and virus, to pass the filter.

In ROCHEM WHE, there are no theoretical restraints to total separation. Nothing is entrained with vapour and nothing is pressured through the membrane.

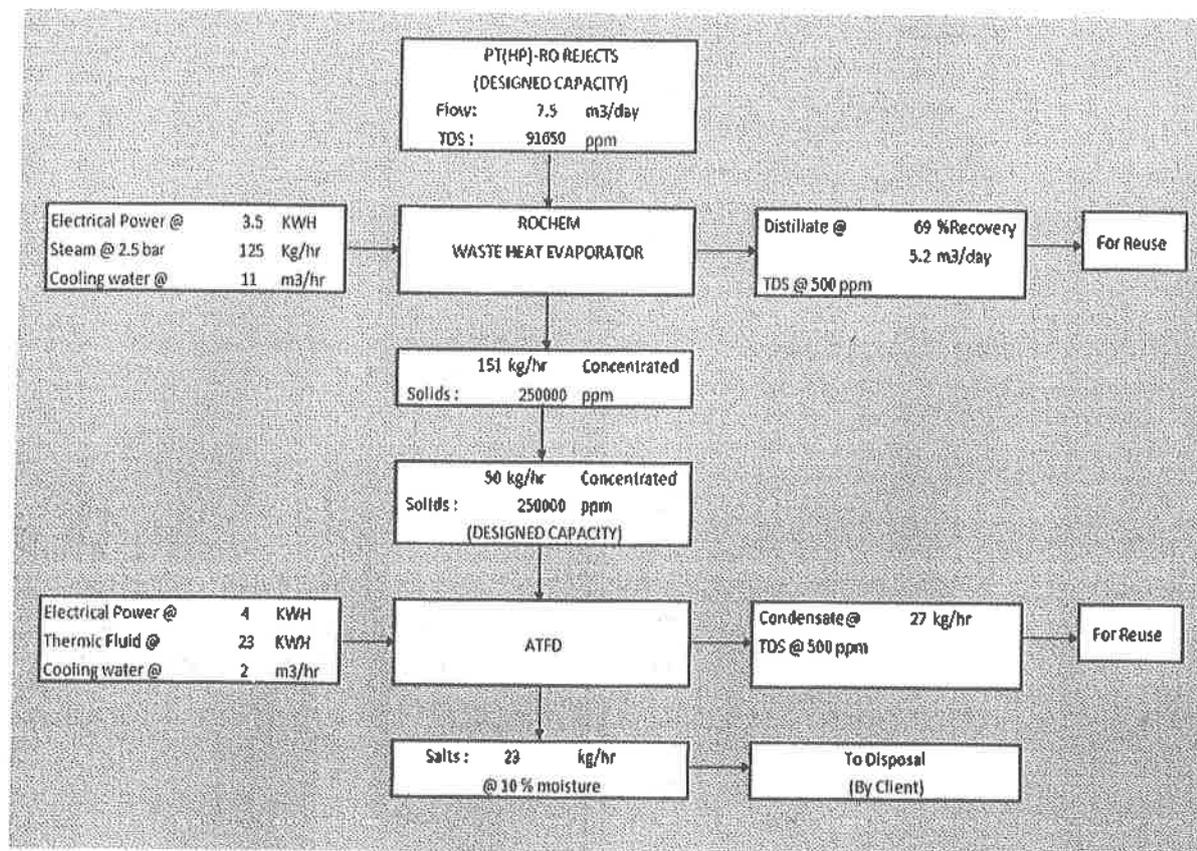
Advantages of ROCHEM WHE process:

1. Compact and low foot print.
2. Low operating temperature compared to conventional evaporator hence steam savings.
3. The waste heat source can be utilised. The fresh steam source not necessary.
4. Low electrical energy requirement.
5. Low operating pressure hence increased process safety.
6. Reduced scaling issues.
7. No corrosion issues.
8. High fluxes per unit area with conventional evaporation.
9. High quality of output.
10. Low operating costs.
11. Reduction in non-condensable species in vapour phase.
12. Low sensitivity to concentration polarisation.

Section 2: PROCESS SCHEME

ROCHEM WASTE HEAT EVAPORATOR SYSTEM for PT(HP)-RO Reject stream

Capacity 7.5 m³/day @ 20 hrs. Operation



*Performance quoted is subject to analysis report.

Section 3: Application Of Rochem WHE In Concentration Of PT(HP)-RO Reject stream

Concentration of rejects by RO systems is limited however using Membrane Distillation system the rejects can be further concentrated to obtain disposable salt concentration post the ATFD thereby achieving Zero Liquid Discharge. Hence we propose ROCHEM WHE in treatment scheme of RO Reject stream as shown in flow sheet in previous section of this offer. The details of units incorporated in manufacturing of ROCHEM WHE are as follows:

Design considerations for WHE system

1) Feed (PT(HP)-RO Reject) to WHE:

Description	Unit	Details
Feed Flow (Designed)	m ³ /day	7.5
TDS *	ppm	91650
COD	ppm	2650

2) WHE Distillate:

Description	Unit	Details
Distillate Flow	m ³ /day	5.2
TDS	ppm	500

3) WHE Concentrate:

Description	Unit	Details
Flow	Kg/hr	151
Solids	ppm	2,50,000

*Detailed analysis of feed to be verified by Rochem

Note: WHE Feed should be free of surfactants, oils & Wetting agents.

Section 4 A: LIST OF UNIT & EQUIPMENT IN ROCHEM WHE UNIT FOR RO REJECTS

1. ROCHEM Waste Heat Evaporator skid system	:	1 Set
a) ROCHEM WHE Membrane Module	:	1 set
Distillate capacity	:	260 lph
No. Of effects	:	4 effects/ 6 effects.
MOC of Membrane and frame	:	Polymer/PP
b) Internal feed tank	:	1 No.
Capacity	:	1 KL
MOC	:	HDPE
c) Heating loop tank	:	1 No.
Capacity	:	1 KL
MOC	:	SS 304 and duly insulated
d) Internal Distillate tank	:	1 No.
Capacity	:	10 lit
MOC	:	PPH
e) Internal Distillate transfer Pump	:	1 No.
Capacity	:	520 lph
MOC	:	PP
Drive	:	0.373 KW
f) CIP tank	:	1 No.
Capacity	:	1 KL
MOC	:	PPH/HDPE
g) Internal Brine tank	:	1 No.
Capacity	:	10 lit
MOC	:	PPH

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- h) Internal Brine transfer Pump : 1 No.
- Capacity : 100 lph
- MOC : PP
- Drive : 0.373 KW
- i) Cooling Loop Heat Exchanger : 1 No.
- MOC : SS 304
- Make : GEA/ Alfa Laval
- j) Vacuum Pump : 1 No.
- Capacity : 13 CFM
- Type : Water ring
- Drive : 1.1 KWH
- k) Vacuum pump cooling system : 1 Set.
- l) Control System & Instrumentation : 1 lot

The system shall have state of art, self diagnostic PLC based safety features built in to make it user friendly and reliable.

Make – Schneider - Telemecanique

- Measuring units : 1 lot
- Level switches (h/l) : 1 lot
- Flow transmitters : 1 lot
- Temperature Transmitters : 1 lot
- Pressure Switch : 1 lot
- pH indicator : 1 no.
- motorized control valve : 1 No.
- Auto valves : 1 lot
- m) External brine tank : 1 No
- Capacity : 5 KL
- MOC : HDPE
- n) External brine transfer pump : 1 no
- Capacity : 100 lph
- MOC : PP
- Drive : 0.373 KWH

o) External distillate tank	:	1 no.
Capacity	:	2 KL
MOC	:	HDPE

2. ATFD Details

Basic details

Feed flow (Designed)	:	50 Kg/hr
Total solids	:	2,50,000 ppm solids
Condensate flow	:	27 Kg/hr
TDS	:	500-1000 ppm
Concentrate details		
Mixed Salt out	:	23 Kg/hr
Total solids	:	90%
Final Moisture in Dry Product	:	10%
Thermic Fluid @ 180 Deg C	:	16000 kcal/hr
Electrical power	:	4 KWH (CLIENT SCOPE)
Cooling water	:	2 m3/hr (CLIENT SCOPE)
Cooling water inlet temperature	:	32 deg. cel.
Cooling water outlet temperature	:	38 deg. cel.

Material of Construction (ATFD)

Inner Shell	:	SS 316 L
Rotor	:	SS 316 L
Outer Shell	:	SS 304

Technical Specifications (Mechanical)

Jacket Temperature	:	250 deg. cel. (Design)
Jacket Pressure	:	10 Kg/cm2 – g (Design)
Surface Area	:	Suitable
Rotor Design	:	High Performance hinged blades (dryer Type)/Suitable
Rotor speed	:	Suitable
Distributor	:	Distribution ring/suitable
Top bearing	:	Taper Roller Type
Bottom Bearing	:	Roller type or Bush bearing

- Skid mounted ATFD
- Electrical based thermic fluid heater for ATFD system
- ATFD insulation/cladding.

Note: List of equipment's is tentative & subject to change, if required, in post detail engineering without altering overall system performance

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Section 4 B: LIST OF UNIT'S/EQUIPMENT'S IN CLIENT SCOPE

- | | | |
|--|---|-----------|
| 1. PT(HP) RO Reject tank | : | 1 no |
| Capacity | : | 10 KL |
| MOC | : | HDPE |
| 2. PT(HP) RO Reject transfer pump | : | 1 no |
| Capacity of Pump | : | 800 lph |
| Power | : | 0.746 KWH |
| MOC | : | SS 316 |
| 3. Steam Control Station (PRDS) comprising of PSV,PRV, Steam control valve, pressure gauges, safety valve, steam trap, strainer etc for WHE system | | |
| 4. Cooling tower with transfer pumps & accessories | : | 1 Set |
| 5. External Distillate transfer pump | : | 1 No. |
| Capacity of Pump | : | 500 lph |
| Power | : | 0.373 KWH |
| MOC | : | SS 304 |
| 6. ATFD condensate storage tank & transfer pump | : | 1 No |
| 7. ATFD mixed salt disposal and handling. | | |

Section 5: BATTERY LIMITS

WHE Feed (PT(HP) -RO Rejects)	At inlet of WHE degasser system & WHE internal feed tank with Suitable piping by Client.
WHE distillate	At outlet of Internal distillate pump by ROCHEM. Storage tank by Rochem, further transfer with suitable piping by client.
WHE brine	At outlet of Internal brine transfer pump by ROCHEM. Further transfer & treatment of WHE reject in Rochem scope.
Steam & Steam condensate for WHE system	<p>Steam at inlet of WHE preheating heat exchanger, heating loop tank system by client.</p> <p>Steam Condensate from outlet of preheating heat exchanger, heating loop tank system to be taken back by Client.</p> <p>Suitable Piping to and from Heat exchanger, heating loop Tank with PRDS to be provided by Client.</p>
Thermic Fluid for ATFD system	<p>Thermic Fluid at inlet of ATFD system by Rochem and further take back to Thermic Fluid heater by Rochem</p> <p>Suitable Piping to and from ATFD system shall be in Rochem Scope.</p>
ATFD condensate	At outlet of ATFD system by Rochem, storage and further transfer by Client.
ATFD salts	At outlet of ATFD system by Rochem, further disposal and handling by Client.
Cooling water	Client to provide cooling water at inlet of cooling loop heat exchanger, WHE vacuum pump & inlet of ATFD system. Further take back cooling water from outlet of cooling loop heat exchanger, WHE vacuum pump & ATFD system to cooling tower by Client.
CIP System	CIP system in ROCHEM scope. CIP effluent drainage and Cleaning chemicals in Client scope
Utilities like raw water and power	Upto treatment site by Client, further transfer by ROCHEM

Utilities Requirements from Client:

- Electrical power connection with suitable isolation.
- Total connected power for all connected system shall be approx. 9 KWH
- Cooling water requirement of 13 m³/hr of 30 deg C.
- Steam requirement for WHE shall be 125 kg/hr @ 2.5 bar with steam control station (PRDS)
- Electrical requirement for Thermic fluid heater @ 23 KW per hour

Area Requirement	:	(L x B x H)
a) ROCHEM WHE	:	4 m x 4 m x 4.5 m
b) ATFD	:	4 m x 6 m x 7 m

Section 6 : SCHEDULE OF EXCLUSIONS

1. Unloading and positioning of Plant at Site.
2. Installation, Erection and commissioning of Plant at Site under Rochem supervision. For installation, erection & commissioning Client shall provide helpers, fitters, electricians etc.
3. Necessary Pre Treatment (If required) for WHE Feed to be taken care by Manali Petrochemicals Limited
4. Chemicals for pre-treatment & Acid for operation of plant to be supplied by client including for testing and commissioning.
5. Steam and steam control station comprising of PRV,PSV, strainer, steam control valve, pressure gauges, safety valve, steam trap etc. for WHE system to be provided by Client.
6. Cooling tower with transfer pumps & accessories to be provided by Client for WHE & ATFD.
7. Supply of feed through suitable piping at plant skid inlet i.e on the feed tank
8. Supply and provision of continuous power supply at local panel near plant skid with suitable isolator, distributor & protection device.
9. Energizing control panel of WHE and ATFD
10. In case of frequent power failure, Client to provide UPS of suitable capacity.
11. Electrical supply for Thermic fluid heater system.
12. Utilities such as operating power, steam, cooling water and other utilities such as fresh water connection for commissioning, plant operation/miscellaneous purpose.
13. CIP effluent drainage, transfer to ETP & handling in client scope.
14. For WHE & ATFD all civil works, structural work, plant foundations, piping & wiring to & from the plant.
15. Transfer of treated effluent for reuse /further application.
16. Facilities for storage/treatment/ disposal of final Salts/Crystals.
17. Earthing pit, Earthing grids/strips
18. Air conditioned control panel room for PLC.
19. Lodging, Boarding & local transportation for our engineers during installation, Erection & Commissioning.
20. ROCHEM WHE, Chemical pre-treatment and ATFD Shed with illumination.
21. Raw water as required for cooling, rinsing, cleaning etc.
22. Transportation from Vasai to your works
23. The removal/dismantling and packing and transportation of old equipment's, wherever necessary.
24. Any other requirements that shall be required and not specifically mentioned in our offer.

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25. You shall reimburse/bear the cost of clearances, unloading, engineer expenses and allowances, maintenance charges for the system and a rental for the period.
26. The System will be the property of ROCHEM at all times during tenure of contract.
27. Additionally, you will provide –
- i) Helpers as on required basis.
 - ii) We request a fully equipped office space for our Site Engineer near the System, separate and lockable.
 - iii) Storage space for spares and consumables, separate and lockable.
 - iv) You will allow free movement of our material in / out of your premises.

Section 7 : Commercial

1.	Treatment Charges	:	<p>Treatment Charge @ Rs.5,80,000/- (Rupees Five Lakh and Eighty Thousand only) plus Taxes & Duties extra as applicable at actuals.</p> <p>In case start-up activities are delayed for reasons not attributable to ROCHEM, then the payment against treatment charges shall be payable after 1 month from the date of receipt of the Plant at your site.</p>
2.	Variable Charges	:	<p>O&M Charges & Manpower charges</p> <p>Inclusive in treatment charges</p>
3.	Electric Power, Steam, Cooling water & other utilities	:	<p>In client scope and to be provided free of cost.</p>
4.	Agreement Conditions	:	<p>Treatment charges to be paid at rate 100% irrespective of the plant utilization by client.</p>
5.	Tenure	:	<p>The agreement shall be for a fixed period of minimum 6 months and cannot be canceled.</p>

Terms & Conditions

1.	PACKING & FORWARDING	:	Extra at actuals to your account.
2.	TAXES & DUTIES	:	GST as applicable.
3.	FREIGHT CHARGES	:	Extra at actuals to Client's account.
4.	TRANSIT INSURANCE	:	To be arranged by Client
5.	UNLOADING	:	Extra at actuals to your account.
6.	DELIVERY TERMS	:	Within 10-12 weeks from the date of receipt of Purchase order and advance payment .
7.	PAYMENT	:	50% advance with order with taxes Balance Payment with taxes prior to dispatch against Proforma Invoice In case Installation/commissioning activities are delayed beyond 1 month from the date of supply for reasons not attributable to ROCHEM, then the payment against installation/commissioning shall be payable against supply of goods at your site.
8.	INSTALLATION	:	Installation to be undertaken by your goodselves under our supervision.
9.	COMMISSIONING	:	We will depute our commissioning engineer at site for supervision of the installation and commissioning of the system. Our charges for the same are as follows : Rs. 5000/- per man day. Lodging, Boarding and Local Transportation, 2 nd AC Train Fare to & fro your works, extra to your account
10.	VALIDITY	:	This offer is valid for 1 month.

NOTE:

- 1) The System will be the property of ROCHEM at all times. Rochem will have exclusive access to the plant at all times.
- 2) The above mentioned offer is fixed price on lump sum basis.
- 3) The above prices/costs are ex-works and are exclusive of taxes & duties which would be extra as applicable, subjected to annual escalation.GST as applicable shall be extra.
- 4) The above charges are exclusive of power, steam & utilities and subject to Force Majeure.
- 5) E Way Bill shall be generated by Rochem and duly acknowledged by MPL

WARRANTY

ROCHEM warrants that this system will produce distillate water within its designed limitations for a period of twelve (12) months from the date of dispatch of the system, provided that the system is operated on the feed water of the minimum standard in accordance to the submitted reference analysis and that the operator adheres exactly to the installation, operating and maintenance instructions and recommendations.

Component of the system supplied by ROCHEM which is found to be defective through poor workmanship or materials, which by its nature may have a shorter life than 12 months, will be repaired or replaced if its performance is proved to be less than normal by industry standards.

This warranty may be voided if the unit is operated with malfunctioning components or controls which results in the system being unable to meet its designed performance.

The warranty shall preclude any claim direct or indirect consequential or liquidated damages arising out of said contract and our liability shall be limited to repair /replace any of the defective components.

ROCHEM will repair or replace the unit or components found to be defective due to bad workmanship or materials on a free of charge ex works basis.

A defective unit or component may be returned, freight prepaid, to ROCHEM for repair or replacement ex-factory, as determined by ROCHEM, should the unit be defective under this warranty.

This warranty does not cover any system or component, which fails due to damage from mishandling, misuse, substandard feed water, improper maintenance or neglect of maintenance, poor or improper installation or incorrect electrical supply. This warranty may also be voided if serial numbers and/or components are found to be mutilated or missing.

The warranty does not cover or apply to consumable items such as filter elements, lubricants, pulsation damper, hp-pump valves and seals, or chemicals used in the operation or maintenance of the system.

The terms of this warranty become effective on dispatch of the equipment from our factory.

There are no warranties expressed or implied which go beyond the foregoing statement.

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101, P1111, Tovan, Anna Kankar Marg,
Bandra (East), Mumbai - 400 051.

info@reserve.co

+ 91 22 6704 9000

+ 91 22 6704 9070

To,
M/s. Manali Petrochemicals Limited,
Ponneri High Road,
Manali,
Chennai.

Date: 09th August, 2019
Ref: ROS/0041/2019 Rev 00

Kind Attention : Mr. S. Kamala Bharathy (Assistant Manager-Projects)

Subject : Rental offer for the supply of ROCHEM PT-RO Membrane System of capacity 20 cum/hr for 6 months.

Dear Sir,

We take this opportunity to introduce ourselves as a technology expert in Waste Water Treatment and specialize in patented **PLATE & TUBE™ (PT™)** Reverse Osmosis membrane system for recovery/reuse of difficult waste water. We undertake projects to provide detail designing and engineering, manufacturing and supply of the Membrane Separation Systems (PT-RO/NF/UF), the Pre-treatment Systems, Effluent Treatment Plants and Zero Liquid Discharge (ZLD) solutions.

ROCHEM'S membrane module system is a superior open channel filtration system which allows for application of membrane based separation systems to high COD, BOD streams without inherent problems as faced by the conventional membrane systems.

Over the past years, ROCHEM has effectively catered to a spectrum of industries like textile, distillery, pharmaceutical, tannery, chemicals, pesticides, agrochemicals, starch, automobile, steel with varied waste water qualities and provided them with sustainable and economical solutions.

- RO/UF plants
- High Pressure RO plants
- Any other ZLD related equipment such as Evaporators & Crystallizers etc;

KEY FEATURES OF ROCHEM PT-RO MEMBRANE SYSTEM

- > No/ Low fouling
- > Able to handle TSS, High COD & BOD

ROCHEM

- No requirement of activated carbon filter
- No requirement of low micron (1 um) fine filtration, only 10 micron used
- No requirement of ultra / nano filtration membrane pre-treatment.
- Skid mounted system with minimal requirement of area.
- PLC based semi-automatic system
- Simple treatment scheme, consistent & reliable operation, excellent product support assured.

This entire set up is due to ROCHEM's endeavor to pass on our confidence in the ROCHEM Membrane Systems to our customers and focus on providing our clients with sustainable solutions at the best value for money.

Few advantages are highlighted below:

- The PT Module has a low membrane replacement costs and resulting in a highly reliable and efficient system.
- The reusable quality of treated water from the system is an additional benefit.
- Minimal pre-treatment of effluent results in lower consumption of chemicals and consequent lower running costs.

With reference to discussion your goodselves had with our undersigned, we are pleased to submit our offer for Rochem PT(HP) RO Membrane system of capacity 20 cum/hr on rental basis for 6 months for your kind perusal.

We hope the above is in line with your requirements and shall be pleased to provide you with any further assistance that you may so desire.

We look forward to discussing the same with yourselves.

Assuring you of our best services always.

Thanking you,
Yours Sincerely,

**FOR ROCHEM SEPARATION SYSTEMS
(INDIA) PVT. LTD.**

**TURBAASHU BHATTACHARYA
(BUSINESS UNIT HEAD)**

(c: Quomion/Petrochemicals/Mansil Petrochemicals Limited, Chennai/Office-Rental_Mansil Petrochemicals Limited, Chennai_20 Mphs PT(HP) RO for 6 months Rev 00.doc)

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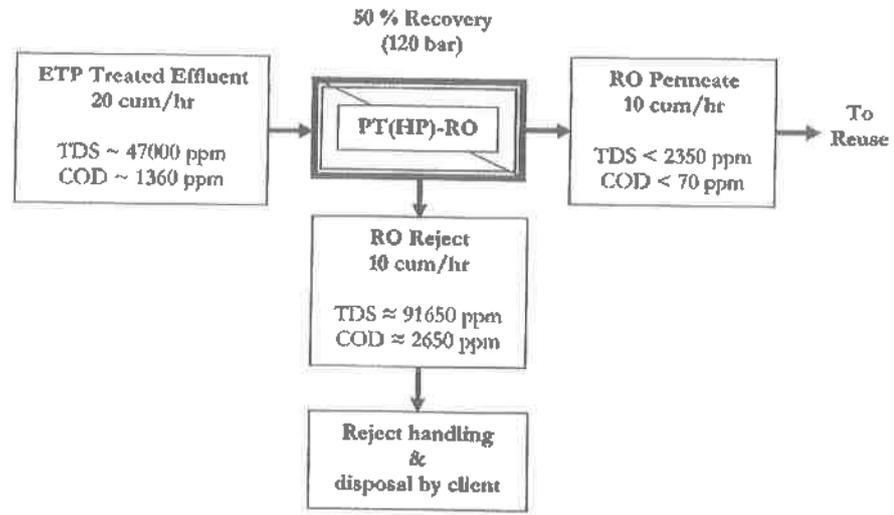


Section 1 : Treatment Scheme

EFFLUENT TREATMENT UNIT WITH REVERSE OSMOSIS FOR RECYCLE

ROCHEM PT(HP) RO Membrane System for ETP Treated Effluent Recycle.

Capacity 20 cum/hr @ 20 hrs. Operation



***Note: Necessary Pre Treatment (If required) to be taken care by Manali Petrochemicals Limited**



Section 2: Techno-commercial Offer

ROCHEM PT(HP) RO MEMBRANE SYSTEM FOR EFFLUENT RECYCLE.

(Micro Processor controlled, semi-automatic, Fully Fail safe and Unattended Operation)

Input Effluent to PT(HP) RO System	:	ETP Treated Effluent @ pH of 6.0 - 6.5 max. (by HCL by client)
Input Effluent Capacity	:	20 cum/hr
RO Input Effluent Quality	:	
TDS		< 47000 ppm
COD		< 1360 ppm
RO Permeate Capacity	:	10 cum/hr
RO Permeate Quality	:	Colourless
TDS*		< 2350 ppm
COD*		< 70 ppm
Recovery of RO Permeate	:	50 %

NOTE:

- System recovery is designed based on feed data provided by client.
- * Permeate quality is subject to change based on pilot trials on actual effluent.
- **Solvents, oxidizing agents assumed to be Nil, other heavy metals like strontium, barium etc. assumed to be absent. Free Chlorine assumed to be NIL.
- You shall provide Power & HCL as required free of cost.
- Presence of alcohol in feed assumed to be nil
- This design is subject to input effluent quality. Any deviation in the effluent feed quality will have a direct effect on the system recovery.
- All the civil units' related work required shall be done by you.

The system shall have state of art, self diagnostic PLC based safety features built in to make it more user friendly and more reliable with minimum downtime.



Treatment Charges:

1. **Mobilization Advance** : Client shall pay **Rs. 30,00,000/-**. As security deposit. This shall be payable as advance with order.
2. **Treatment Charge** : Treatment Charges (guaranteed) based on feed of 20 l/dph is @ **Rs 7,65,000/-** (which amounts to **Rs. 71/- per m3 of feed**) + GST as applicable on actuals based on 27 working days considered in a month.
In case start-up activities are delayed for reasons not attributable to ROCHEM, then the payment against treatment charges shall be payable after 1 month from the date of receipt of the Plant at your site.
3. **Variable Charges** : O&M charges is **Rs. 55/m3 feed and Rs. 5,94,000/month**
Manpower charges will be Rs. 50,000/- month, Supervisor in General shift by Rochem and MPL will provide 1 operator in each shift.
Support to Engineer: Lodging, Boarding and Local Transportation - by client during rental period.
4. **Electric Power** : **In client scope, to be provided free of cost.**
5. **Tenure** : The agreement shall be for a fixed period of minimum 6 months and cannot be cancelled.
6. **Agreement Conditions** : Treatment & Manpower charges to be paid at rate 100% irrespective of the plant utilization by client and Variable O&M Charges shall be paid for minimum 90% the capacity utilised and the fixed O&M charges shall be payable for the full plant capacity.
7. **Total monthly payable by client** **Rs. 14,09,000/-**

Note:

- The above prices/cost are ex-works and are exclusive of taxes & duties which would be extra as applicable, subjected to annual escalation. GST will be extra as applicable. E Way Bill shall be generated by Rochem and duly acknowledged by MPL.
- In the event that either RO Plant is not operational at full capacity, the Rental and Manpower charges shall be payable in full. Variable O&M Charges shall be paid for the capacity utilised and the fixed O&M charges shall be payable for the full plant capacity

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Section 3: Commercial Terms & Conditions

- 1. **PACKING & FORWARDING** : Extra at actuals to your account.
- 2. **TAXES & DUTIES** : GST as applicable will be paid by you.
IGST : 18%
GST No. : 27AABCR1955P1ZV
HSN Code for RO Plant : 84212190
SAC Code for services : 998732
- 3. **FREIGHT CHARGES** : Extra at actuals to your account. (to & fro)
- 4. **TRANSIT INSURANCE** : To be arranged by your good selves.
- 5. **DELIVERY TERMS** : Within 6-8 weeks from the date of receipt of Purchase order and advance payment.
- 6. **PAYMENT** : Payment to be released within 15 days from the date of receipt of invoice
- 7. **INSTALLATION & COMMISSIONING** : Unloading, Installation & positioning of equipment at site to be undertaken by Client. Supervision by ROCHEM engineer.
Client will provide helpers for E&C.
- 8. **VALIDITY** : This offer is valid for 1 month.

NOTE:

- 1. The System will be the property of ROCHEM at all times. Rochem will have exclusive access to the plant at all times.
- 2. You shall execute a standard agreement for short term contracts with Rochem or its affiliate company along with your work order.

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Section 4 : Battery Limits

We shall bring the System to your site. The following shall be in your scope;

- 1) Unloading of the plant at site on receipt in presence of our Engineer.
- 2) Erection of the Plant at site under our supervision.
- 3) All civil work including plant foundations, walkways within RO plant, piping & electrical wiring to and fro the plant.
- 4) Pressurized supply of effluent at plant inlet at a pressure of 2.0-4.0 Kg/cm². (i.e. feed pump, feed tank & piping upto RO plant, etc.)
- 5) Arrange piping for permeate from Plant Skid to your Storage Tank.
- 6) Facility for storage / treatment / disposal of final rejects.
- 7) Acid (HCl) & reducing agent (if required in case of +ve ORP) to be supplied by client i.e. (pump, tanks, piping etc.)
- 8) In case feed TSS and Temperature mention in our offer is not matching with inlet water quality then Settling for TSS correction & Temperature correction of feed to your scope.
- 9) In case permeate quality mention in our offer is not matching with your requirement then pH adjustment of permeate by means of suitable dosing i.e. Dosing System injector/pump, tanks, piping, etc. shall be to your scope.
- 10) RO Shed with illumination & Ventilation.
- 11) Provision of Air conditioner for Control Panel room.
- 12) Supply of uninterrupted electrical power supply at Plant Panel with suitable Isolator, incomer & Protective Devices.
- 13) Pipe supports, clamping / Cable trays & cable tray supports arrangements & Foundation bolts. Earthing grids / strips.
- 14) Preparation of foundation as per Layout provided by us.
- 15) Lodging, Boarding & Local transportation during the commissioning & operating period for our engineers/ staff is in your scope.
- 16) Any other utility such as raw water, cleaning material, etc.

Additionally, you will provide –

- i. Helpers as on required basis.
- ii. We request a fully equipped office space for our Site Engineer near the System, separate and lockable.
- iii. Local transportation at site & food at site should be arrange by EID Parry for Rochem supervisor.
- iv. Storage space for spares and consumables, separate and lockable.
- v. You will allow free movement of our material in / out of your premises.

We trust the above offer is in line with your requirement.
In case you need any further details please feel free to communicate.

Thanking you,
Yours faithfully,

**FOR ROCHEM SEPARATION SYSTEMS
(INDIA) PVT. LTD.**

**TURBAASHU BHATTACHARYA
(BUSINESS UNIT HEAD)**

(*) Question/Chemicals/Manual Petrochemicals Limited, Chennai/Offer-Recs/Masali Petrochemicals Limited, Chennai_Skdh 177(HP) RO for 6 months Rev (R) doc

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Annexure I: Specification Unit Parameters Reference RO Feed Analysis

Sr.	Parameter	Unit	Value
1.	pH	---	6.0 – 6.5 max (by HCl by client)
2.	ORP Value	mV	Negative (by client)
3.	Turbidity	NTU	< 5
4.	Total Suspended Solids	mg/ltr	< 200
5.	Total Dissolved Solids	mg/ltr	< 47000
6.	Conductivity	µS/cm	< 70100
7.	Total Hardness as CaCO ₃	mg/ltr	< 500 (assumed)
8.	Calcium Hardness as CaCO ₃	mg/ltr	< 300
9.	Magnesium Hardness as CaCO ₃	mg/ltr	< 200
10.	M-alkalinity as CaCO ₃	mg/ltr	< 100 (assumed)
11.	P-alkalinity as CaCO ₃	mg/ltr	Nil
12.	Chlorides as Cl	mg/ltr	< 22000 (assumed)
13.	Sulphates as SO ₄	mg/ltr	< 300 (assumed)
14.	Iron as Fe	mg/ltr	< 1
15.	Oil & Grease	mg/ltr	< 10
16.	Free chlorine	mg/ltr	Nil
17.	Phosphates	mg/ltr	< 50 (assumed)
18.	Nitrates as NO ₃	mg/ltr	< 10 (assumed)
19.	Sodium as Na	mg/ltr	< 14200 (assumed)
20.	Potassium as K	mg/ltr	< 50 (assumed)
21.	Total Silica as SiO ₂ *	mg/ltr	< 15 *
22.	Temperature	°C	30-40 °C
23.	COD	mg/ltr	< 1360
24.	BOD	mg/ltr	< 460 (assumed)

Note:

- Pre-treatment if required will be in client scope.
- Above parameters are tentative based on feed parameters provided by client
- Solvents, oxidizing agents assumed to be Nil, other heavy metals like strontium, barium etc. assumed to be absent. Free Chlorine assumed to be NIL.
- *In case Silica level is > 15 ppm, recovery will be affected.
- Derating Temperature – Normal Range 30–40 deg C
Operating Range 30 - 40 deg C
Lower temperature < 30 deg C will lead to higher energy consumption & lower recovery.
Higher temperature > 40 deg C will lead to higher permeate TDS.
- Feed Conditioning By Client (If Required)
Feed pH to be corrected by using HCl by client.
- Feed ORP by Reducing agent SMBS by client
- With every drop in 1 °C from 30 °C, there shall be corresponding reduction in 2% recovery.
- Any change in parameters exceeds the above designed values the recovery of permeate will be affected.

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Annexure II: Specification Unit Parameters Reference RO Permeate Analysis

Sr.	Parameter	Unit	Value PT(HP) RO
1.	Flow	cum/hr	10
2.	pH	---	6.8 ~ 7.2 max. (depending on feed pH)
3.	TSS	mg/ltr	Nil
4.	Total Dissolved Solids	mg/ltr	< 2350
5.	*COD	mg/ltr	< 70

Note: COD reduction will be by 90-95% from feed levels.

* Permeate quality is subject to change based on pilot trials on actual effluent.

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To,
M/s. Manali Petrochemicals Limited,
Ponnneri High Road,
Manali,
Chennai.



161, H101, Towers, Anna's Convent Mat. Bldg.
Baner (East), Mumbai 400 051.

info@roserve.com

+ 91-22 6704 9000

+ 91-22 6704 9010

Date: 09th August, 2019
Ref: ROS/0040/2019 Rev 00

Kind Attention : Mr. S. Kamala Bharathy (Assistant Manager-Projects)

Subject : Rental offer for the supply of ROCHEM PT-RO Membrane System of capacity 5 cum/hr for 6 months.

Dear Sir,

We take this opportunity to introduce ourselves as a technology expert in Waste Water Treatment and specialize in patented **PLATE & TUBE™ (PT™)** Reverse Osmosis membrane system for recovery/reuse of difficult waste water. We undertake projects to provide detail designing and engineering, manufacturing and supply of the Membrane Separation Systems (PT-RO/NF/UF), the Pre-treatment Systems, Effluent Treatment Plants and Zero Liquid Discharge (ZLD) solutions.

ROCHEM'S membrane module system is a superior open channel filtration system which allows for application of membrane based separation systems to high COD, BOD streams without inherent problems as faced by the conventional membrane systems.

Over the past years, ROCHEM has effectively catered to a spectrum of industries like textile, distillery, pharmaceutical, tannery, chemicals, pesticides, agrochemicals, starch, automobile, steel with varied waste water qualities and provided them with sustainable and economical solutions.

- RO/UF plants
- High Pressure RO plants
- Any other ZLD related equipment such as Evaporators & Crystallizers etc;

KEY FEATURES OF ROCHEM PT-RO MEMBRANE SYSTEM

- No/ Low fouling
- Able to handle TSS, High COD & BOD

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- No requirement of activated carbon filter
- No requirement of low micron (1 um) fine filtration, only 10 micron used
- No requirement of ultra / nano filtration membrane pre-treatment.
- Skid mounted system with minimal requirement of area.
- PLC based semi-automatic system
- Simple treatment scheme, consistent & reliable operation, excellent product support assured.

This entire set up is due to ROCHEM's endeavor to pass on our confidence in the ROCHEM Membrane Systems to our customers and focus on providing our clients with sustainable solutions at the best value for money.

Few advantages are highlighted below:

- The PT Module has a low membrane replacement costs and resulting in a highly reliable and efficient system.
- The reusable quality of treated water from the system is an additional benefit.
- Minimal pre-treatment of effluent results in lower consumption of chemicals and consequent lower running costs.

With reference to discussion your goodselves had with our undersigned, we are pleased to submit our offer for Rochem PT(HP) RO Membrane system of capacity 5 cum/hr on rental basis for 6 months for your kind perusal.

We hope the above is in line with your requirements and shall be pleased to provide you with any further assistance that you may so desire.

We look forward to discussing the same with yourselves.

Assuring you of our best services always.

Thanking you,
Yours Sincerely,

**FOR ROCHEM SEPARATION SYSTEMS
(INDIA) PVT. LTD.**

**TURBAASHU BHATTACHARYA
(BUSINESS UNIT HEAD)**

(c: Question/Petrochemicals/Masali Petrochemicals Limited, Chennai/Offer-Rental_Masali Petrochemicals Limited, Chennai_5kph: PT(HP) RO for 6 months Rev 00doc)

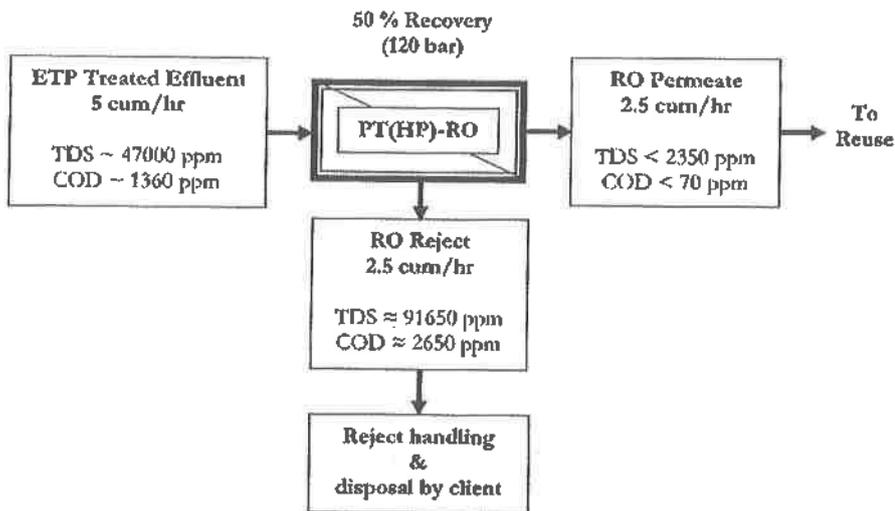
RO/REVERSE

Section 1 : Treatment Scheme

EFFLUENT TREATMENT UNIT WITH REVERSE OSMOSIS FOR RECYCLE

ROCHEM PT(HP) RO Membrane System for ETP Treated Effluent Recycle.

Capacity 5 cum/hr @ 20 hrs. Operation



*Note: Necessary Pre Treatment (If required) to be taken care by Manali Petrochemicals Limited

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Section 2: Techno-commercial Offer

ROCHEM PT(HP) RO MEMBRANE SYSTEM FOR EFFLUENT RECYCLE. (Micro Processor controlled, semi-automatic, Fully Fail safe and Unattended Operation)	
Input Effluent to PT(HP) RO System	: ETP Treated Effluent @ pH of 6.0 – 6.5 max. (by HCL by client)
Input Effluent Capacity	: 5 cum/hr
RO Input Effluent Quality	:
TDS	< 47000 ppm
COD	< 1360 ppm
RO Permeate Capacity	: 2.5 cum/hr
RO Permeate Quality	:
TDS*	< 2350 ppm
COD*	< 70 ppm
Recovery of RO Permeate	: 50 %

NOTE:

- System recovery is designed based on feed data provided by client.
- * Permeate quality is subject to change based on pilot trials on actual effluent.
- **Solvents, oxidizing agents assumed to be Nil, other heavy metals like strontium, barium etc. assumed to be absent. Free Chlorine assumed to be NIL.
- You shall provide Power & HCL as required free of cost.
- Presence of alcohol in feed assumed to be nil
- This design is subject to input effluent quality. Any deviation in the effluent feed quality will have a direct effect on the system recovery.
- All the civil units' related work required shall be done by you.

The system shall have state of art, self diagnostic PLC based safety features built in to make it more user friendly and more reliable with minimum downtime.



Treatment Charges:

1. **Treatment Charge** : Treatment Charges (guaranteed) based on feed of 5 kph is @ Rs 2,25,000/- (which amounts to Rs. 83/- per m3 of feed) + GST as applicable on actuals based on 27 working days considered in a month.
In case start-up activities are delayed for reasons not attributable to ROCHEM, then the payment against treatment charges shall be payable after 1 month from the date of receipt of the Plant at your site.
2. **Variable Charges** : O&M charges is Rs. 55/m3 feed and Rs. 1,48,500/month
Manpower charges will be Rs. 50,000/- month, Supervisor in General shift by Rochem and MPL will provide 1 operator in each shift.
Support to Engineer: Lodging, Boarding and Local Transportation - by client during rental period.
3. **Electric Power** : In client scope, to be provided free of cost.
4. **Tenure** : The agreement shall be for a fixed period of minimum 6 months and cannot be cancelled.
5. **Agreement Conditions** : Treatment & Manpower charges to be paid at rate 100% irrespective of the plant utilization by client and Variable O&M Charges shall be paid for minimum 90% the capacity utilised and the fixed O&M charges shall be payable for the full plant capacity.
6. **Total monthly payable by client** Rs. 4,23,500/-

Note:

- The above prices/cost are ex-works and are exclusive of taxes & duties which would be extra as applicable, subjected to annual escalation. GST will be extra as applicable. E Way Bill shall be generated by Rochem and duly acknowledged by MPL.
- In the event that either RO Plant is not operational at full capacity, the Rental and Manpower charges shall be payable in full. Variable O&M Charges shall be paid for the capacity utilised and the fixed O&M charges shall be payable for the full plant capacity.

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ROSERVE**Section 3: Commercial Terms & Conditions**

1. **PACKING & FORWARDING** : Extra at actuals to your account.
2. **TAXES & DUTIES** : GST as applicable will be paid by you.
IGST : 18%
GST No. : 27AABCR1955P1ZV
HSN Code for RO Plant : 84212190
SAC Code for services : 998732
3. **FREIGHT CHARGES** : Extra at actuals to your account. (to & fro)
4. **TRANSIT INSURANCE** : To be arranged by your good selves.
5. **DELIVERY TERMS** : Within 6-8 weeks from the date of receipt of Purchase order and advance payment.
6. **PAYMENT** : Payment to be released within 15 days from the date of receipt of invoice
7. **INSTALLATION & COMMISSIONING** : Unloading, Installation & positioning of equipment at site to be undertaken by Client. Supervision by ROCHEM engineer.
Client will provide helpers for E&C.
8. **VALIDITY** : This offer is valid for 1 month.

NOTE:

1. The System will be the property of ROCHEM at all times. Rochem will have exclusive access to the plant at all times.
2. You shall execute a standard agreement for short term contracts with Rochem or its affiliate company along with your work order.

Section 4 : Battery Limits

We shall bring the System to your site. The following shall be in your scope;

- 1) Unloading of the plant at site on receipt in presence of our Engineer.
- 2) Erection of the Plant at site under our supervision.
- 3) All civil work including plant foundations, walkways within RO plant, piping & electrical wiring to and fro the plant.
- 4) Pressurized supply of effluent at plant inlet at a pressure of 2.0-4.0 Kg/cm². (i.e. feed pump, feed tank & piping upto RO plant, etc.)
- 5) Arrange piping for permeate from Plant Skid to your Storage Tank.
- 6) Facility for storage / treatment / disposal of final rejects.
- 7) Acid (HCl) & reducing agent (if required in case of +ve ORP) to be supplied by client i.e. (pump, tanks, piping etc.)
- 8) In case feed TSS and Temperature mention in our offer is not matching with inlet water quality then Settling for TSS correction & Temperature correction of feed to your scope.
- 9) In case permeate quality mention in our offer is not matching with your requirement then pH adjustment of permeate by means of suitable dosing i.e. Dosing System injector/pump, tanks, piping, etc. shall be to your scope.
- 10) RO Shed with illumination & Ventilation.
- 11) Provision of Air conditioner for Control Panel room.
- 12) Supply of uninterrupted electrical power supply at Plant Panel with suitable Isolator, incomer & Protective Devices.
- 13) Pipe supports, clamping / Cable trays & cable tray supports arrangements & Foundation bolts. Earthing grids / strips.
- 14) Preparation of foundation as per Layout provided by us.
- 15) Lodging, Boarding & Local transportation during the commissioning & operating period for our engineers/ staff is in your scope.
- 16) Any other utility such as raw water, cleaning material, etc.

Additionally, you will provide –

- i. Helpers as on required basis.
- ii. We request a fully equipped office space for our Site Engineer near the System, separate and lockable.
- iii. Local transportation at site & food at site should be arrange by EID Parry for Rochem supervisor.
- iv. Storage space for spares and consumables, separate and lockable.
- v. You will allow free movement of our material in / out of your premises.

We trust the above offer is in line with your requirement.

In case you need any further details please feel free to communicate.

Thanking you,
Yours faithfully,

**FOR ROCHEM SEPARATION SYSTEMS
(INDIA) PVT. LTD.**

**TURBAASHU BHATTACHARYA
(BUSINESS UNIT HEAD)**

(c: Quotation/Chemicals/Material Petrochemicals Limited, Chennai/Office-Header, Material Petrochemicals Limited, Chennai_Sklph PT (HP) RO for 6 months Rev B1.doc)

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RESERVE

Annexure I: Specification Unit Parameters Reference RO Feed Analysis

Sr.	Parameter	Unit	Value
1.	pH	---	6.0 – 6.5 max (by HCl by client)
2.	ORP Value	mV	Negative (by client)
3.	Turbidity	NTU	< 5
4.	Total Suspended Solids	mg/ltr	< 200
5.	Total Dissolved Solids	mg/ltr	< 47000
6.	Conductivity	μ S/cm	< 70100
7.	Total Hardness as CaCO ₃	mg/ltr	< 500 (assumed)
8.	Calcium Hardness as CaCO ₃	mg/ltr	< 300
9.	Magnesium Hardness as CaCO ₃	mg/ltr	< 200
10.	M-alkalinity as CaCO ₃	mg/ltr	< 100 (assumed)
11.	P-alkalinity as CaCO ₃	mg/ltr	Nil
12.	Chlorides as Cl	mg/ltr	< 22000 (assumed)
13.	Sulphates as SO ₄	mg/ltr	< 300 (assumed)
14.	Iron as Fe	mg/ltr	< 1
15.	Oil & Grease	mg/ltr	< 10
16.	Free chlorine	mg/ltr	Nil
17.	Phosphates	mg/ltr	< 50 (assumed)
18.	Nitrates as NO ₃	mg/ltr	< 10 (assumed)
19.	Sodium as Na	mg/ltr	< 14200 (assumed)
20.	Potassium as K	mg/ltr	< 50 (assumed)
21.	Total Silica as SiO ₂ *	mg/ltr	< 15 *
22.	Temperature	°C	30-40 °C
23.	COD	mg/ltr	< 1360
24.	BOD	mg/ltr	< 460 (assumed)

Note:

- Pre-treatment if required will be in client scope.
- Above parameters are tentative based on feed parameters provided by client
- Solvents, oxidizing agents assumed to be Nil, other heavy metals like strontium, barium etc. assumed to be absent. Free Chlorine assumed to be NIL.
- *In case Silica level is > 15 ppm, recovery will be affected.
- Derating Temperature – Normal Range 30–40 deg C
Operating Range 30 - 40 deg C
Lower temperature < 30 deg C will lead to higher energy consumption & lower recovery.
Higher temperature > 40 deg C will lead to higher permeate TDS.
- Feed Conditioning By Client (If Required)
Feed pH to be corrected by using HCl by client.
- Feed ORP by Reducing agent SMBS by client
- With every drop in 1 °C from 30 °C, there shall be corresponding reduction in 2% recovery.
- Any change in parameters exceeds the above designed values the recovery of permeate will be affected.

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 of 2015

Submitted to
Before the National Green Tribunal
South Zone, Chennai



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

Annexure II: Specification Unit Parameters Reference RO Permeate Analysis

Sr.	Parameter	Unit	Value PT(HP) RO
1.	Flow	cum/hr	2.5
2.	pH	---	6.8 – 7.2 max. (depending on feed pH)
3.	TSS	mg/ltr	Nil
4.	Total Dissolved Solids	mg/ltr	< 2350
5.	*COD	mg/ltr	< 70

Note: COD reduction will be by 90-95% from feed levels.

* Permeate quality is subject to change based on pilot trials on actual effluent.

- (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

H. D. Kumar

D. Kumar

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


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

JOINT COMMITTEE

Inspection Points Compliance Report (MAY - 2016)

April 11-13 -2016		Inspection points compliance report
S.NO	Findings of Joint Monitoring Team	Compliance Status
5.0 (i)	All the 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.	<ul style="list-style-type: none"> ✓ MPL Plant- I & II installed the flow meters in the all the water lines eg. <ul style="list-style-type: none"> ☛ Metro water incoming to plant, ☛ Metro water to the process plants ☛ MFL RO rejects water receipt line, ☛ CMWSSB tertiary treated water line, ☛ TTRO water incoming line, ☛ ETP plant inlet and ☛ sea disposal line ☛ old Cooling water make up line, ☛ New cooling tower makeup line ☛ Drinking water line for domestic use. ☛ Boiler Inlet ✓ Every month all the details prepared and submitted to TNPCB. Strictly followed this requirement. (COMPLIED) ✓
(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.	<ul style="list-style-type: none"> ✓ 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)
(iii)	All four industries have to prepare planned schedule of pumping of treated effluent in to marine disposal system and to ensure the quality of effluent meeting standards before discharging into sea.	<ul style="list-style-type: none"> ✓ Now MPL Plant-1, MPL Plant-2, Kothari, TPL -ECH mutually agreed the pumping time schedule are documented <p>MPL Plant-1:- 24 Hours</p> <p>MPL Plant-2 : - 24 hours</p> <p>TPL-ECH: - 24 Hours</p> <p>Kothari:- 6.30 hrs to 9.30hrs,16.30 to 19.30hrs,1.30 to 4.30 hours</p> <p>(COMPLIED)</p>

(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.	<ul style="list-style-type: none"> ✓ Level Indicator provided in the Treated effluent Tank-photo submitted. ✓ Log book for accountability of effluent generated, treated and quantity of treated effluent disposed is thru online meter. ✓ Flow meters installed in the ETP inlet and Sea disposal line with recording in the DCS, ✓ This flow meter online connectivity given to TNPCB-CAREAIR CENTRE also. ✓ Every month total water received used for process, Industrial cooling, Domestic water and Treated effluent disposed to sea quantity details submitted to TNPCB. ✓ Joint inspection team indicated this flow meter installed is confirmed (COMPLIED)
(v)	All industries 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.	<ul style="list-style-type: none"> ✓ As per the CPCB recommendations, three flow meters installed at the following location. ✓ 1-flow meter at exit of Plant-1 ✓ 2-flow meter at exit of Plant-2 and Kothari. Flow Meter erected working normal. ✓ 3-flow meter at common point closer to sea. Ramakrishnanagar sea entry area ✓ Plant-II and Kothari connection point down stream Flow meter installed. ✓ MPL Plant-1 and TPL connection point down stream Flow meter installed. ✓ All meters working normal. (COMPLIED)
(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.	<ul style="list-style-type: none"> ✓ Sample points provided with grill gate and Lock provided and key handed over to TNPCB on 27.05.2016. TNPCB officials can access at any point of time. (COMPLIED)
(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.	<ul style="list-style-type: none"> ✓ MPL-I &II installed online advanced BOD, COD analyzer in the marine disposal pipeline supplied by M/s HACH INSTRUMENTS and connected to CAC TNPCB. (COMPLIED)

(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.	<ul style="list-style-type: none"> ✓ 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 arisen. ✓ Five flow meters installed in the sea disposal line to identify any leaks. <p style="text-align: center;">(COMPLIED)</p>
(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.	<ul style="list-style-type: none"> ✓ Detailed marine study was already carried out by NIOT Govt of india and its report was submitted before this honorable tribunal. ✓ As per CPCB recommendation, we once again requested the NIOT THE GOVT OF INDIA for marine study. ✓ Correspondence with NIOT is attached for your reference. <p style="text-align: center;">(COMPLIED)</p>
(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.	<ul style="list-style-type: none"> ✓ We have installed the floating indicator above the diffuser. Float and chain for locating the diffuser area (sea inside). We have provided these arrangements with experts, daily it is inspected and recorded in the inspection report. <p style="text-align: center;">(COMPLIED)</p>
(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 TNPCC including species used for the study to assess the actual situation.	<ul style="list-style-type: none"> ✓ MPL already carried out Toxicity study for MPL effluent thru SGS Lab and report submitted. Marine impact study carried out by the following agencies as per standard followed. 1.NIOT.Govt.of India ✓ 2. Hubert Enviro care system. ✓ As per NIOT recommendation now planned to carry out marine impact study thru Centre for Aquatic study, Annamalai University, Chidambaram. <p style="text-align: center;">(COMPLIED)</p>

(Proof for Wrong
Iron Content)

Despite to the above, the Respondent Industries have operated the industries without adhering to the recommendations issued by first and second committee of this Hon'ble Tribunal.

15. With the above non-compliances by the Respondent industries, this Hon'ble Tribunal has once again passed the following order dated 29.07.2016:-

Quote:

"CPCB and TNPCB to effect a fresh joint inspection and find out as to whether the recommendations of the joint committee dated 30.04.2016 have been implemented or not. We make it clear that in the event of joint inspection report reiterating the earlier stand, the Tribunal may take corrective stand against the 5th respondent".

16. The Applicant submits that the joint committee of CPCB and TNPCB has filed a report on September, 2016 before this Hon'ble Tribunal by observing the following:-

REPORT OF ANALYSIS

MANALI PETROCHEMICALS LIMITED - UNIT-I

S.No	Parameters	Inlet	Outlet	Permissible level
3.	BOD	900	783	100
4.	COD	1832	1673	250

REPORT OF ANALYSIS

MANALI PETROCHEMICALS LIMITED - UNIT-II

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S.No	Parameters	Inlet	Outlet	Permissible level
1.	BOD	1900	833	100
2.	COD	2876	1832	250

- With respect to the MPL-II, the Committee observed that iron found slightly exceeding the prescribed standards of Marine disposal

REPORT OF ANALYSIS

TAMIL NADU PETROCHEMICALS LIMITED

S.No	Parameters	Inlet	Outlet	Permissible level
1.	BOD	1.0	193	100
2.	COD	3.0	894	250

Report of the Committee is annexed as Annexure-III

17. The Applicant submits that the above tabular column and observation of the committee has again confirmed that the Respondent Industries ie. MPL-I, MPL-II and TPL have discharging high concentration of Hazardous effluents into the sea without proper treatment. Further, the report of the committee has emphasis that the respondent Industries have failed to adhere with the recommendations issued by the earlier committee for the environmental safety.

BEFORE THE NATIONAL GREEN TRIBUNAL (SOUTHERN ZONE) CHENNAI

APPEAL NOS. 51 & 52 OF 2017

IN THE MATTER OF:

M/s Manali Petrochemicals Ltd., Plant I & II, Chennai

... Applicants

Vs

The Central Pollution Control Board & 3 Ors.

... Respondents

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2	Annexure I : Status Report of M/s Manali Petrochemicals Ltd., Unit - I & II in Compliance of Hon'ble NGT(South) order dated July 07, 2017	04-53

Signed and verified on this 20th day of September, 2017 at Bengaluru

COUNSEL FOR
CPCB

S. Suresh
20/09/2017
DEPONENT
S. SURESH
REGIONAL DIRECTOR
CENTRAL POLLUTION CONTROL BOARD
REGIONAL DIRECTORATE (SOUTH)
MIN. OF ENV. FORESTS & CC, GOVT. OF INDIA
BENGALURU-560075, MOB: 9486672128



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BEFORE THE NATIONAL GREEN TRIBUNAL (SOUTHERN ZONE) CHENNAI
APPEAL NOS. 51 & 52 OF 2017

IN THE MATTER OF:

M/s Manali Petrochemicals Ltd., Plant I & II, Chennai

... Applicants

Vs

The Central Pollution Control Board & 3 Ors.

... Respondents

COUNTER AFFIDAVIT ON BEHALF OF THE RESPONDENT NO. 1 & 2, THE
CENTRAL POLLUTION CONTROL BOARD (CPCB)

I, S. Suresh, Son of S.R. Sathyanarayana, Hindu, aged about 55 years, having office at the Regional Directorate, 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 Regional Director, Regional Directorate (South), Central Pollution Control Board (hereafter called as CPCB), Bengaluru and have been authorized to file the present affidavit. I am fully conversant with the facts of the case and hence, competent and authorized to depose and swear the present affidavit as under:
- 3. That the Hon'ble National Green Tribunal, Southern Zone Bench, Chennai, in the matter of Application No. 19 of 2013(SZ), M.A. No. 173 of 2016 (SZ), Application No. 224 & 248 of 2016 (SZ) and Appeal nos. 51 & 52 of 2017 (SZ), M/s Meenvargal Membattu Sangam Vs. The Chief Secretary Govt. of Tamilnadu & Ors, passed orders on 07/07/2017 directing that CPCB to have one more inspection and file a status report on the next dated of hearing. In compliance to the said orders of the Hon'ble Tribunal, a team of officials from CPCB and TNPCB inspected the M/s Manali Petrochemicals Ltd Plant I & II on September 05, 2017 and verified the status of up gradation of proposed treatment system to achieve prescribed standards and also collected the samples from different points of ETP to verify the present status of operation of ETP to achieve prescribed standards. The Report on status of implementation of proposed ETP by M/s MPL - I & II is given at Annexure R1/1.

Corrn:
Initial:



S. Suresh
20/11/2017
Regional Director
Central Pollution Control Board
1st & 2nd Floors, Nisarga Bhavan
Thimmaiah Main Road, 7th D Cross
Shivanagar, Bengaluru - 560 079

4. That the conclusions and recommendations of this respondent with respect to present status of achievability of standards and implementation of proposed ETP to achieve prescribed standards are submitted as below:

Manali Petrochemicals Ltd., Unit – I

- a) M/s Manali Petrochemical Ltd. Unit – I found complied with 2nd & 6th directions, partially complied with 1st direction and not complied with 3rd, 4th and 5th directions of CPCB. (Refer page nos. 4 to 6 of status report)
- b) The progress made towards up gradation of ETP as per NGT order was not found satisfactory, after passing 2 months of time very less progress made w.r.t construction and erection of civil structure as well as equipment's.
- c) The unit has not made any improvement w.r.t treatment system. The concentration of TDS and Chloride at inlet and outlet of ETP reveals the 5 times of dilution which results in reduction of BOD from 663 mg/L to 90 mg/L and COD from 1696 mg/L to 212 mg/L at outlet of ETP.
- d) During inspection 2 compartments of aeration was under installation of liquid aeration diffusers and not in operation, chemical dosage followed by aeration was carried out in remaining 4 compartments of aeration, achieving BOD to 90 mg/L and COD to 212 mg/L is not possible rather than dilution technique.

Manali Petrochemicals Ltd., Unit – II

- a. M/s Manali Petrochemical Ltd. Unit – I found complied with 5th directions, partially complied with 1st direction and not complied with 2nd, 3rd and 4th directions of CPCB. (Refer page nos. 8 to 9 of status report)
- b. In Plant – II, the proposed treatment system is totally differs from Plant – I, no much equipment and civil works involved in this scheme.
- c. The progress made towards up gradation of ETP as per NGT order was not found satisfactory. In plant – II they proposed to modify the aeration system by providing jet aerators followed by chemical dosage system which requires less construction and erection work, however this small modification also not completed even after passing 2 months' time which confirms the lethargic attitude of the unit.
- d. The unit has not made any improvement w.r.t treatment system. The concentration of TDS and Chloride at inlet and outlet of ETP reveals the more than 2 times of dilution. in spite of dilution the concentration of BOD (350 mg/L) and COD (580 mg/L) is not meeting with prescribed standards.

Comm:
Initial:



S. Suresh
20/01/2011
Regional Director
Central Pollution Control Board
1st & 2nd Floors, Nisarga Bhavan
Thimmaiah Main Road, 7th D Cross
Shivanagar, Bengaluru – 560 079

5 That as per the findings of CPCB & TNPCB inspection, it is humbly submitted that M/s MPL I & II may be directed to comply with the following:

- To submit time bound action plan for upgradation of ETP to meet prescribed standards along with Bank Guarantee.

Or

- To close all operation of both units till completion of erection and commissioning of proposed ETP
- To replace old flow meters with new flow meters having display system of instant flow as well as cumulative flow.
- To take up immediate steps to replace advanced TOC analyzer which can measure BOD & COD at any high TDS concentration in the treated effluent.
- To take up regular maintenance of on line measuring equipment's such as probe sensor to prevent from scale/corrosion

PRAYER

This answering respondent shall abide by any order passed the Hon'ble Tribunal

S. Suresh
20/9/2017
DEPONENT
S. SURESH
REGIONAL DIRECTOR
CENTRAL POLLUTION CONTROL BOARD
REGIONAL DIRECTORATE (SOUTH)
MIN. OF ENV. FORESTS & CC, GOVT. OF INDIA
BENGALURU-560079, MOB: 9480672128

VERIFICATION

It is verified that the content of this Counter Affidavit 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 20th Day of September, 2017 at Bengaluru

**COUNSEL FOR
CPCB**



S. Suresh
20/9/2017
DEPONENT
S. SURESH
REGIONAL DIRECTOR
CENTRAL POLLUTION CONTROL BOARD
REGIONAL DIRECTORATE (SOUTH)
MIN. OF ENV. FORESTS & CC, GOVT. OF INDIA
BENGALURU-560079, MOB: 9480672128

Annexure -R1/1

	Status Report of M/s Manali Petrochemicals Ltd., Unit - I & II in Compliance of Hon'ble NGT(South) order dated July 07, 2017	Regional Directorate, Bengaluru
<p>1.0. Background</p> <p>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 had 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 (TNPCCB) as per the recommendation of the Expert Committee dated 19.09.2014 and file a status report before this Tribunal by the next hearing". In compliance of this order, CPCB, Regional Directorate, Bengaluru inspected and submitted the detailed report on the matter.</p> <p>The matter was heard in NGT, 5th respondent (M/s Manali Petrochemicals Ltd.) filed reports and informed that "the specific observation made by the Joint monitoring team was rectified and BOD, COD levels has come down". Subsequently, the Hon'ble NGT passed an order dated July 29, 2016, directed "CPCB and TNPCCB to effect a fresh joint inspection and find out as to whether the recommendations of the joint inspection report dated 30.04.2016 have been implemented or not. We make it clear that in the event of Joint Inspection Report reiterating the earlier stand, the Tribunal may take a corrective stand against the 5th respondent". In compliance to this order, once again, CPCB, Regional Directorate, Bengaluru inspected the units and submitted the compliance status report on the matter.</p> <p>Meanwhile the president of "Meenava Thanthai K.R. Selvarajkumar Meenava Nala Sangam" complained against the M/s Manali Petrochemicals Ltd., Unit I & II regarding discharge of treated effluent into sea by violating the prescribed standards of TNPCCB which affected the marine life as well as livelihood of fisherman. In this matter, both units were inspected on March 16, 2017. Based on the observations made during inspection, the Chairman, CPCB issued closure directions to both units under Section 5 of E(P)A 1986 vide dated May 17, 2017 and directed to close their operation with immediate effect till the industry complies with the norms.</p> <p>Thereafter, M/s Manali Petrochemicals Ltd., Unit - I & II filed an appeal in Hon'ble NGT, Chennai. The matter was heard in the NGT, Chennai on July 07, 2017 wherein officials of CPCB, TNPCCB, and Consultant from Sashtra University were present, after detailed discussions with all parties, the Hon'ble NGT passed an order dated July 07, 2017 "<i>.... In these circumstances, we are of the considered view that this is not the appropriate time for the purpose of ordering 'closure' of these units, especially in the circumstances that there has been certain improvement.....and directed the CPCB to have one more inspection and file status report on the next dated of hearing i.e. 22.09.2017.</i>"</p> <p>In compliance to above mentioned order, CPCB, Regional Directorate, Bengaluru deputed a team and informed to TNPCCB vide letter dated August 30, 2017 regarding schedule of inspection and also requested to co-ordinate with CPCB team during visit. The team comprised of following officials from CPCB, Regional Directorate, Bengaluru and TNPCCB District Environmental</p>		

Engineer Office, Ambattur carried out joint inspection on September 05, 2017 and the entire inspection work was supervised by Mrs. H. D. Varalaxmi, Sr. Env. Engineer, CPCB, Bengaluru.

Central Pollution Control Board	Tamil Nadu Pollution Control Board
1. Mrs. H.D. Varalaxmi, SEE/Sci. D - Team Leader	1. Mr. D. Vasudevan, DEE
2. Dr. B.S. Anupama, Scientist B	
Representatives from M/s Manali Petrochemicals Ltd., Unit -I & II	
1. Mr. G. Balasubramanian, Director (works), MPL	
2. Mr. Balaguru, Safety Officer, MPL	

2.0. Status report of units

During inspection both units were found in operation, status of operation and compliance of CPCB directions and steps taken to achieve prescribed standards are as follows:

2.1 M/s Manali Petrochemicals Ltd., Unit - I

The validity of consent to operate under Water & Air Act issued by the TNPCB was found expired on 31/03/2017 (*Annexure -1*), and informed that, they applied for renewal. As per the status of online consent management system, it was observed that the documents "returned being incomplete view reason" (*Annexure - 2*). The unit informed that they paid consent fee but renewal was kept pending due to case pending in the Hon'ble NGT. As per the earlier consent, the unit was given permission to manufacturing of following products and by products by using raw materials viz. Propylene, Chlorine, Quick Lime, HCL Furnace Oil, Methanol, Tea and Caustic.

Sl. No.	Products	Consent Capacity (MT/year)
1	Propylene Oxide	18000
2	Propylene Glycol	10000
3	Polyol	25000
4	Propylene Glycol Mono Methyl Ether	2700
By Products		
1.	DCP- Dichloro Propane	3600
2.	Tri Propylene Glycol	120
3	Di-Propylene Glycol Mono Methyl Ether-DPGMME	460
4	Di-Propylene Glycol	1120

During inspection, the unit was found manufacturing Propylene Oxide (49.510 MT/day), Propylene Glycol (25.913 MT/day), PGMME (8.33 MT/day) and Polyol (30.860 MT/day).

The unit receives water from different sources. As per the records the water consumption and effluent generation and treated in the ETP are as follows;

Sl. No.	Details	Water consumption (m ³ /day)	Effluent generation (m ³ /day)
1	Manufacturing process	2651	2334
2	Cooling tower / Utility	297	55
3	Domestic use	68	15

As per the flow record, the effluent discharged into sea was found in the tune of 2389 m³/day which is within the consented quantity of 2399 m³/day and the same is cross verified with flow meter installed at inlet to bio-reactor and out let of ETP

2.1.1. Observations of Joint monitoring team: Following are the steps taken to upgrade the ETP to achieve prescribed limit of TNPCB

The unit has installed one new cooling tower and existing cooling tower being taken up for revamping. The unit propose to operate two cooling tower to reduce temperature in the range of 35-40°C before sending to aeration tank (Photo graph no 1).

- Erected the liquid oxygen storage tank, installed new liquid oxygen diffuser in 2 compartments of Aeration tank (A & B) and its pumping & pipeline network was under progress (Photograph no. 2). In remaining 4 compartments of aeration tank, they proposed to install OHR diffuser, it is informed that equipment's were received from Port, installation of the same is yet to be start.
- Earth work and piling for blower room, secondary clarifier and settling tank was under progress (Photo graph no. 3).
- Earmarked the Ozonè generator room, electrical work was under progress and other related civil work yet to be start (Photo graph no.4).
- Schematic diagram of proposed treatment system for achieving prescribed standards is enclosed at Annexure - 3.

The unit provided the Status of equipment's received and road map for completion of installation, as per the road map, commissioning of equipment's are expected to be completed by end of October 2017 only. copy of the same is enclosed at Annexure -4. Photographs taken during inspection are enclosed at Annexure - A.

2.1.1 Status of compliance w.r.t observations and Directions issued U/S 5 of E(P)A 1986 vide CPCB letter dated May 17, 2017:

S.No	CPCB Observations / Directions	Status of Compliance with respect to CPCB observations as on September 05, 2017
i	The unit has not installed Flow meter to measure the effluent generated from different sections	The unit has installed only one flow meter at inlet of ETP to measure the total effluent taken for treatment. But, not yet installed for different sources like process, utility etc. Hence the observation is partially complied. Apart from above, the unit installed flow meter at following treated effluent discharge line of MPL I & II, the details are :

v	In the analysis report it was observed that industry has exceeded the norms with respect to BOD and COD at ETP outlet.	To meet prescribed limit, the unit has taken steps to upgrade the ETP, however still Potassium per sulphate chemical oxidation process is practiced, as per analysis results of sample taken during inspection reveals the achievement of BOD concentration of 90 mg/L and COD concentration of 212 mg/L by dilution technique <i>Hence the observation / direction is not Complied</i>
Vi	The unit has not received SMS alerts from server or CPCB due to improper configuration.	The unit has taken steps to proper configuration and also verified the connectivity and SMS alert received and action taken by the unit which confirms the functioning of OCEMS. <i>Hence the observation/direction is Complied.</i>

2.1.3 Present status of operation of effluent treatment system

- The effluent from the different section are taken to high rate thickener to allow to settle the sludge, the settled lime sludge being taken to rotary drum filter for dewatering, the over flow from high rate thickener being taken to pressure sand filter to reduce SS and chemical dosage is given (potassium persulphate) @ 450mg/l to reduce BOD & COD. The overflow from clarifier taken to cooling tower to reduce temperature from 70 °C to 45 °C , after reducing temperature the effluent being 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, the treated effluent is stored in the treated water tank and the same is being pumped to marine pipeline to discharge into sea.
- Due to ongoing up gradation of ETP, 2 compartment (A & B) of existing aeration tank being taken up for installation of liquid oxygen diffuser, remaining 4 compartments are used for treating effluent by giving chemical dosage followed by aeration in other two compartments.
- The TSS probe was found shifted from bio -reactor to final treated effluent storage tank.
- During inspection the effluent receiving to ETP was found in the range of 70 - 75 m³/hr and treated effluent pumping to marine disposal system was found in the range of 63-65 m³/hr. The flow meter installed at inlet of ETP found in poor condition which is required to be replace or revamping.
- During inspection the team as collected samples to verify the present status of compliance w.r.t prescribed standards for marine disposal, the analysis results of untreated and treated effluent are depicted below:

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

Sl. No.	Parameters	Sampling Location			Marine disposal standards
		Inlet of ETP (Raw Effluent)	From bio reactor after adding potassium per sulphate	Out let of ETP	
1	pH	11.2	6.4	6.4	5.5 -9.0
2	Conductivity (µs/cm)	57800	35300	14280	-
3	Total Suspended Solids (mg/L)	248	48	39	100

4	Total Dissolved Solids (mg/L)	49736	24276	9758	-
5	BOD ₅ at 27°C 3days (mg/L)	663	383	90	100
6	COD (mg/L)	1696	850	212	250
7	Oil & Grease (mg/L)	-	-	1.05	20
8	Calcium (mg/L)	25791	-	2725	-
9	Chloride (mg/L)	27053	-	5222	-
10	Sulphates (mg/L)	572	-	365	1000
11	Fluoride (mg/L)	1.56	-	0.8	15
12	Sulfide (mg/L)	12.6	-	0.65	5.0
13	Copper (mg/L)	BDL	-	BDL	3.0
14	Cadmium (mg/L)	BDL	-	BDL	2.0
15	Total Chromium (mg/L)	BDL	-	BDL	2.0
16	Iron (mg/L)	1.38	-	0.46	3.0
17	Manganese (mg/L)	0.24	-	0.07	2.0
18	Nickel (mg/L)	BDL	-	BDL	5.0
19	Lead (mg/L)	BDL	-	BDL	2.0
20	Zinc (mg/L)	BDL	-	BDL	15
21	Cobalt (mg/L)	BDL	-	BDL	-

- As per the analysis results of samples taken from the inlet and outlet of ETP, the concentration of TDS at inlet (49736 mg/L) and outlet (9758 mg/L) reveals the dilution of effluent at treated effluent storage tank as well as in the bio reactor, similarly the concentration of Chloride (27053 mg/L at inlet & 5222 mg/L at outlet) and Calcium ((25791 mg/L at inlet & 2725 mg/L at outlet) also confirm the dilution of effluent before discharging.
- The concentration of TDS and Chloride at inlet and outlet of ETP reveals the 5 times of dilution which results in reduction of BOD from 663 mg/L to 90 mg/L and COD from 1696 mg/L to 212 mg/L at outlet of ETP.
- During inspection 2 compartments of aeration were under installation of liquid aeration diffusers and not in operation. chemical dosage followed by aeration was carried out in remaining 4 compartments of aeration, achieving BOD to 90 mg/L and COD to 212 mg/L, is not possible rather than dilution technique.

2.2 M/s Manali Petrochemicals Ltd., Unit - II

The validity of consent to operate under Water & Air Act issued by the TNPCB was found expired on 31.03.2017 (*Annexure -4*), it is informed that, they applied for renewal, as per the status of online consent management system, it was observed that the documents "returned being incomplete view reason" (*Annexure - 5*) The unit informed that they paid consent fee but renewal was kept pending due to case pending in the Hon'ble NGT. As per the earlier consent, the unit was given permission to manufacturing of following products and by products by using raw materials viz. Propylene, Chlorine, Quick Lime, HCL Furnace Oil and Caustic :

Sl. No.	Products	Consent Capacity (MT/ year)
1.	Propylene Oxide	18000
2.	Propylene Glycol	10000
3.	Polyol	25000
By Products		
1.	DCP- Dichloro Propane	3600
2.	Di Propylene Glycol	1320
3.	Tri-Propylene Glycol	168

During inspection, the unit was found manufacturing Propylene Oxide (49.820 MT/day), Propylene Glycol (28.048 MT/day) and Polyol (61.123 MT/day). As per the records of the water received from different sources and effluent generated and taken to ETP are as follows;

Sl. No.	Details	Water consumption (m ³ /day)	Effluent generation (m ³ /day)
1.	Manufacturing process	2810	2496
2.	Cooling tower / Utility	308	48
3.	Domestic use	69	15

As per the flow record the effluent discharged into sea was found in the tune of 2544 m³/day which is within the consented quantity of 2559 m³/day and the same is cross verified with flow meter installed at inlet to bio- reactor and out let of ETP

2.2.1 Observations of Joint monitoring team: Following are the steps taken to upgrade the ETP to achieve prescribed limit of TNPCB

- The unit has installed one new cooling tower and existing cooling tower being taken up for revamping. The unit propose to operate two cooling tower to reduce temperature in the range of 35-40°C before sending to aeration tank (*Photo graph no 5*).
- Modification of existing storage tank to new aeration system by installing jet aerators was found under progress (*Photograph no. 6*).
- Modification of existing stand by clarifier was under progress (*Photograph no. 7*).
- Schematic diagram of proposed treatment system for achieving prescribed standards is enclosed at *Annexure - 6*

The unit provided the Status of equipment's received and road map for completion of installation, as per the road map, commissioning of equipment's are expected to be completed by first week of November 2017 only, copy of the same is enclosed. The unit provided the Status of equipment received and road map for completion of installation of the

same is enclosed at Annexure -7. Photographs taken during inspection are enclosed at Annexure - B.

2.2.2 Status of compliance made w.r.t Observations and Directions u/s 5 of E(P)A 1986 issued vide CPCB letter dated May 17, 2017:

S.No	CPCB Observations / Directions	Status of Compliance as on date of inspection dated September 05, 2017
i	The unit has not installed Flow meter to measure the effluent generated from different sections	<p>The unit has installed only one flow meter at inlet of ETP to measure the total effluent taken for treatment. But, not yet installed for different sources like process, utility etc. Hence the observation is partially complied.</p> <p>Apart from above, the unit installed flow meter at following treated effluent discharge line of MPL I & II, the details are:</p> <ul style="list-style-type: none"> a At out let of ETP – to quantify the treated effluent discharged to sea b After confluence of treated effluent from MPL – I and TPL plant. c After confluence of treated effluent from MPL – II and Kothari Ltd. d To measure combined treated effluent discharged to sea <p><i>Partially Complied</i></p>
ii	The online TOC analyser was not working	<p>The TOC analyser is not yet repaired and rectified and found in as same state. The unit informed that they approached vendors for TOC analyser, only one vendor (M/s HACH Instrument) accepted and supplied & commissioned the TOC, due to high TDS and Scale formation in the diaphragm causing non functioning of analyser, the issue was discussed with instrument supplier and suggested for advanced model, procurement of new model is under process.</p> <p><i>Hence the observation / direction is not Complied</i></p>
iii	The ETP system was not adequate to meet the prescribed standards of marine disposal	<p>To meet the prescribed discharge standards, the unit proposed to upgrade the ETP comprises of High rate Thickener (existing) → Settling tank → Cooling tower (2 no.) → settling tank → Bio-reactor (proposed to modified with jet aeration system) → Chemical dosage system cum contact tank (proposed) → settling tank (proposed) → Final treated effluent tank.</p> <p>The status of progress of work as follows:</p> <ul style="list-style-type: none"> a To reduce temperature of Effluent the unit has installed one new cooling tower and revamping of old cooling

		<p>tower was under progress</p> <p>b. Conversion of existing storage tank to new aeration system by installing jet aerators was found under progress</p> <p>c. modification of existing stand by clarifier was under progress</p> <p><i>Hence the observation / direction is not Complied</i></p>
iv	In the analysis report it was observed that industry has exceeded the norms with respect to BOD and COD at ETP outlet	<p>To meet prescribed limit, the unit has taken steps to upgrade the ETP, however still Potassium per sulphate chemical oxidation process is practiced, as per analysis results of sample taken during inspection confirms the discharging of effluent having BOD of 350 mg/L and COD of 580 mg/L by violating the prescribed standards. And also the concentration TDS and Chloride at inlet and outlet confirms the dilution of treated effluent before discharging into sea.</p> <p><i>Hence the observation / direction is not Complied</i></p>
v	The unit has not received SMS alerts from server or CPCB due to improper configuration	<p>The unit has taken steps to proper configuration and also verified the connectivity and SMS alert received and action taken by the unit which confirms the functioning of OCEMS.</p> <p><i>Hence the observation/direction is Complied.</i></p>

2.2.3 Present status of operation of effluent treatment system

- The effluent from the different section are taken to high rate thickener to allow to settle the sludge, the settled lime sludge being taken to rotary drum filter for dewatering, the over flow from high rate thickener being taken to pressure sand filter to reduce SS and given , chemical dosage (potassium persulphate) @ 450mg/l to reduce BOD & COD. The overflow from clarified taken to cooling tower to reduce temperature from 70 °C to 45 °C, after reducing temperature the effluent being 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, the treated effluent is stored in the treated water tank and the same is pumped to marine pipeline to discharge into sea.
- During inspection the effluent receiving to ETP was found in the range of 85-90 m³/hr and treated effluent pumping to marine disposal system was found in the range of 75-85 m³/hr. The flow meter installed at inlet & outlet of ETP found in poor condition which is required to be replace or revamping.
- During inspection the team as collected samples to verify the present status of compliance w.r.t prescribed standards for marine disposal, the analysis results of untreated and treated effluent are depicted below:

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

Sl. No.	Parameters	Sampling Location			Marine disposal standards
		Inlet of ETP (Raw Effluent)	From bio reactor after adding potassium per sulphate	Out let of ETP	
1	pH	11.2	5.8	6.3	5.5-9.0
2	Conductivity ($\mu\text{s}/\text{cm}$)	46700	37600	23750	-
3	Total Suspended Solids (mg/L)	22	174	61	100
4	Total Dissolved Solids (mg/L)	38568	26054	14131	-
5	BOD ₅ at 27°C 3days (mg/L)	570	638	350	100
6	COD (mg/L)	1088	1280	580	250
7	Oil & Grease (mg/L)	-	-	1.66	20
8	Calcium (mg/L)	11873	-	4870	-
9	Chloride (mg/L)	19910	-	8390	-
10	Sulphates (mg/L)	206	-	218	1000
11	Fluoride (mg/L)	1.62	-	0.3	15
12	Sulfide (mg/L)	0.03	-	0.84	5.0
13	Copper (mg/L)	BDL	-	BDL	3.0
14	Cadmium (mg/L)	BDL	-	BDL	2.0
15	Total Chromium (mg/L)	BDL	-	BDL	2.0
16	Iron (mg/L)	0.6	-	0.26	3.0
17	Manganese (mg/L)	0.28	-	BDL	2.0
18	Nickel (mg/L)	BDL	-	BDL	5.0
19	Lead (mg/L)	BDL	-	BDL	2.0
20	Zinc (mg/L)	BDL	-	BDL	15
21	Cobalt (mg/L)	BDL	-	BDL	-

- As per the analysis results of samples taken from the inlet and outlet of ETP, the concentration of TDS at inlet (38568 mg/L) and out let (14131 mg/L) reveals the dilution of effluent at treated effluent storage tank as well as in the bio reactor. Similarly the concentration of Chloride (19910 mg/L at inlet & 8390 mg/L at out let) and Calcium (11873 mg/L at inlet & 4870 mg/L at out let) also confirms the dilution of effluent before discharging.
- The concentration of TDS and Chloride at inlet and outlet of ETP reveals the more than 2 times of dilution, in spite of dilution the concentration of BOD (350 mg/L) and COD (580 mg/L) is not meeting with prescribed standards.
- The concentration of BOD and COD in Treated effluent was found exceeding 3.5 and 2.32 times w.r.t prescribed standards of BOD and COD.

3.0 Over all Status of Compliance made w.r.t CPCB direction and NGT order

- As per earlier recommendations, to cross verify the total effluent discharged into sea, the unit has installed 3 new flow meters viz (a) to quantify the treated effluent discharged from MPL -I & Tamilnadu Petrochemical Ltd., (b) MPL - II & Kothari Petro Chemical Ltd, and (c) after confluence of all 4 units effluent before discharging to sea, since the marine disposal system pertains 4 units (*Photo graph no. 7*).
- The unit also procured floater with accessories to install in the sea to identify the location of diffuser installed in the sea (*Photo graph no. 8*).

Manali Petrochemicals Ltd., Unit - I

- ✓ M/s Manali Petrochemical Ltd. Unit - I found complied with 2nd & 6th directions, partially complied with 1st direction and not complied with 3rd, 4th and 5th directions of CPCB.
- ✓ The progress made towards up gradation of ETP as per NGT order was not found satisfactory, after passing 2 months of time very less progress made w.r.t construction and erection of civil structure as well as equipment's.
- ✓ The unit has not made any improvement w.r.t treatment system. The concentration of TDS and Chloride at inlet and outlet of ETP reveals the 5 times of dilution which results in reduction of BOD from 663 mg/L to 90 mg/L and COD from 1696 mg/L to 212 mg/L at out let of ETP.
- ✓ During inspection 2 compartments of aeration was under installation of liquid aeration diffusers and not in operation, chemical dosage followed by aeration was carried out in remaining 4 compartments of aeration, achieving BOD to 90 mg/L and COD to 212 mg/L is not possible rather than dilution technique.

Manali Petrochemicals Ltd., Unit - II

- ✓ M/s Manali Petrochemical Ltd. Unit - I found complied with 5th directions, partially complied with 1st direction and not complied with 2nd, 3rd and 4th directions of CPCB.
- ✓ In Plant - II, the proposed treatment system is totally differs from Plant - I, no much equipment and civil works involved in this scheme.
- ✓ The progress made towards up gradation of ETP as per NGT order was not found satisfactory. In plant - II they proposed to modify the aeration system by providing jet aerators followed by chemical dosage system which requires less construction and erection work, however this small modification also not completed even after passing 2 months time which confirms the lethargic attitude of the unit.
- ✓ The unit has not made any improvement w.r.t treatment system. *The concentration of TDS and Chloride at inlet and outlet of ETP reveals the more than 2 times of dilution, in spite of dilution the concentration of BOD (350 mg/L) and COD (580 mg/L) is not meeting with prescribed standards.*

4.0 Suggestion of Joint monitoring team for speed up of up gradation of ETP to achieve prescribed standards :

As per the compliance status of directions issued under section 5 of the E(P)A 1986 dated May 17, 2017, both plants were found noncompliance with respect to major directions. Hence the both Plants shall be directed to implement the following in a time bound manner :

- ❖ To submit time bound action plan for up gradation of ETP to meet prescribed standards along with Bank Guarantee.

or

To close all operation of both units till completion of erection and commissioning of proposed ETP

- ❖ To replace old flow meters with new flow meter having display system of instant flow as well as cumulative flow.
- ❖ To take up immediate steps to replace advanced TOC analyzer which could measure BOD & COD at any high TDS concentration in the treated effluent
- ❖ To take up regular maintenance of on line measuring equipment's such as probe sensor to prevent from scale/corrosion

H. D. Varalaxmi
(H.D. Varalaxmi)
SEE/Scientist D

List of Enclosures

Sl. No.	Caption of Annexures	Details of Enclosure
1	Annexure -A	Photographs of M/s MPL Plant -I
2	Annexure - B	Photographs of M/s MPL Plant - II
3	Annexure 1	Consent for operation under Air & Water Act (MPL - I)
4	Annexure - 2	Copy of status of online consent management system (MPL-I)
5	Annexure -3	Schematic flow diagram of proposed treatment system of MPL - I
6	Annexure -4	Status of equipment received and road map for completion of installation in MPL - I
7	Annexure -5	Consent for operation under Air & Water Act (MPL - II)
8	Annexure -6	Copy of status of online consent management system (MPL-II)
9	Annexure -7	Schematic flow diagram of proposed treatment system of MPL - II
10	Annexure - 8	Status of equipment received and road map for completion of installation In MPL -II

em Nos. 4 to 8

BEFORE THE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI

Original Application No. 19 of 2013 (SZ) (THC)

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

IN THE MATTER OF:

Meenavargal Membattu Sangam

... Applicant(s)

The Chief Secretary,
Government of Tamil Nadu,
Chennai and Others.

... Respondent(s)

Original Application No. 248/2016 (SZ)

Meenava Thanthai
K.R. Selvaraj Kumar,
Meenavar Nala Sangam.

.. Applicant(s)

The State of Tamil Nadu,
Rep. by its Secretary to Government,
Chennai and Others

... Respondent(s)

Appeal No. 51/2017 (SZ)

M/s. Manali Petrochemicals Limited

... Appellant(s)

Vs

The Central Pollution Control Board,
Ministry of Environment, Forest and Climate Change,
Government of India,
New Delhi and Others

... Respondent(s)

881

Appeal No.52 of 2017 (SZ)

M/s. Manali Petrochemicals Limited

... Appellant(s)

Vs

The Central Pollution Control Board,
Ministry of Environment, Forest and Climate Change
Government of India
New Delhi and Others.

... Respondent(s)

Original Application No. 224 of 2016 (SZ)

Meenava Thanthai
K.R. Selvaraj Kumar.

.. Applicant(s)

Vs

The Chief Secretary,
Government of Tamil Nadu,
Secretariat, Chennai and Others.

... Respondent(s)

Date of hearing: 16.06.2021

CORAM:

HON'BLE MR. JUSTICE K. RAMAKRISHNAN, JUDICIAL MEMBER
HON'BLE MR. DR. K. SATYAGOPAL, EXPERT MEMBER

Original Application No. 19 of 2013 (SZ)

For Applicant(s):

Mr. Stanley Hebzon Singh

For Respondent(s):

Dr. V.R. Thirunarayanan for R1 to R3.

Sri. Kasirajan through

Ms. D. Ashwini for R4

AR.L. Sundaresan Senior Advocate along with

M/s. A.L. Gandhimathi for R5

Mr. A. R. Ramanathan for R6

Original Application No. 248/2016 (SZ)

For Applicant(s): Mr. Stanley Hebzon Singh
 For Respondent(s): Dr. V. R. Thirunarayanan for R1 to R3 & R5,
 Sri. Kasirajan through
 Ms. D. Ashwini for R4 & R6
 Sri. AR. L. Sundaresan, Senior Advocate along
 with M/s. A.L. Gandhimathi for R7
 Mr. A. R. Ramanathan for R8

Appeal Nos. 51 & 52/2017

For Appellant(s): Sri. AR. L. Sundaresan, Senior Advocate
 along with Mrs. AL. Gandhimathi
 For Respondent(s): Mr. D.S. Ekambaram through
 Mrs. P. Jayalakshmi for R1 & R2
 Mr. Kasirajan through
 Ms. D. Ashwini for R3
 Mr. S. Saravanan represented
 Sri. Vijaya Meghanath for R4,
 Mr. Stanley Hebzon Singh for R5

Original Application No.224 of 2016

For applicant Mr. Stanley Hebzon Singh
 For Respondents ... Dr. V.R. Thirunarayanan for R1 to 3 & 5
 Mr. C. Kasirajan through
 Ms. D. Ashwini for R4 and R6
 Mr. A. L. Sundaresan, Senior Advocate
 along with M/s. AL. Gandhimathi for R7
 Mr. A. R. Ramanathan for R9

ORDER

1. The above cases have been posted to today for consideration of report along with the objections, if any to be filed and also for hearing of appeals.

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2. When the matters were taken up today through Video Conference, Mr. Stanley Hebzon Singh represented counsel for applicants in O.A.Nos.248 of 2016, 224 of 2016 and O.A. No. 19 of 2013 and fifth respondent in Appeal Nos.51 and 52 of 2017, Dr. V.R. Thirunarayanan represented respondents 1 to 3 in O.A. No. 19 of 2013 and respondents 1to 3 and 5 in O.A. No. 248 of 2016 & O.A. No. 224 of 2016, Mr. Kasirajan through Ms. D. Ashwinin represented 4th respondent in O.A. No. 19 of 2013 and respondents 4 and 6 in O.A. No. 248 of 2016 & O.A. No. 224 of 2016 and 3rd respondent in Appeal No. 51 of 2017 & 52 of 2017 and respondents 4 and 6 in O.A. No. 224 of 2016, Sri. AR. L. Sundaresan, Senior Advocate along with M/s. A.L. Gandhimathi represented the appellant in Appeal No. 51 of 2017 and Appeal No. 52 of 2017 and respondent 5 in O.A. 19 of 2013, 7th respondent in O.A. No. 248 of 2016 and 7th respondent in O.A. No.224 of 2016, Mr. D.S. Ekambaram through M/s. Jeyalakshmi represented respondents 1 and 2 in Appeal No. 51 of 2017 and Appeal No. 52 of 2017, Mr. Saravanan represented Sri. Vijaya Mehanath counsel for 4th respondent in Appeal No. 51 of 2017 and Appeal No. 52 of 2017, Mr. A. R. Ramanathan represented 6th respondent in O.A. No. 19 of 2013, 8th respondent in O.A. No. 248 of 2016 and 9th respondent in O.A. No. 224 of 2016.
3. The newly added 6th respondent had filed their objection in O.A. No. 19 of 2013. The learned counsel appearing for the 6th respondent submitted that the same can be adopted in the other cases as well in which they have been implemented.

4. The 9th respondent had filed their objection to the committee report and the 6th respondent in O. A. No. 09 of 2013 had filed their objection to the joint committee report. The other respondents wanted some time for filing their report.
5. The learned counsel appearing for the applicant submitted that no compensation has been assessed by the committee as against M/s. Manali Petrochemicals Limited though certain violations were noted by them in the earlier reports and certain remedial measures were also suggested. The applicants are directed to file their objection to the committee report, so that this Tribunal can consider and pass appropriate orders in the matter.
6. As regards Appeal No. 51 & 52 of 2017 are concerned, Appeal No. 51 of 2017 was filed against the closure order issued in respect of Plant No. 1 and Appeal No. 52 of 2017 was filed against the closure order issued in respect of Plant No. 2.
7. The learned senior counsel appearing for the appellant in both the cases submitted that as regards the closure order in respect of Plant -1 which was the subject matter in Appeal No. 51 of 2017 is concerned, later the same has been revoked by the Central Pollution Control Board (CPCB) and on that basis, they are now functioning. As regards the closure order in respect of Plant No. 2 is concerned which is the subject matter in Appeal No. 52 of 2017, Central Pollution Control Board (CPCB) had issued revocation order dated **11.02.2019** and as such there is nothing survives in these appeals. So as far as Appeal No. 51 & 52 of 2017 are concerned, there is nothing survives in the matter and the same can be closed.

8. The above submission made by the learned senior counsel appearing for the appellant in both the appeals (Appeal No. 51 & 52 of 2017) is recorded, and the other aspects regarding the compensation, if any, to be imposed for damage, if any, caused to environment on account of any violation is left open to be considered in the Original Applications pending before this Tribunal. With the above observations and directions and also recording the submissions made by the learned senior counsel appearing for the appellant in both the cases, both the appeals (Appeal No. 51 & 52 of 2017) are closed, as nothing survives in the appeal against the closure order issued which were under challenge. The parties are directed to bear their respective cost in both the appeals.

9. For filing their objections and for consideration of report in O.A. No. 19 of 2013, O. A. No.248 of 2016 and O. A. No. 224 of 2016, post on **07.07.2021**.

Sd/-

.....J.M.
(Justice K. Ramakrishnan)

Sd/--

.....E.M.
(Dr. K. Satyagopal)

O.A. No.19/2013, 224/2016,
248/2016 & Appeal Nos.51 & 52/2017
16.06.2021, Sr.

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Compliance status of NGT Committee Report dt 28.10.2020

Recommendation of the two-member expert committee was constituted with Dr. Palanivelu, Anna University, Chennai and Dr. N. Vedharaman, CLRI, Chennai as per order dated 22.7.2014 in O.A. No. 19/2013

1. Recommendation

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

Compliance status

MPL explored the possibility from different technology supplier. But It is not available for small capacity. New technology requires 4000 to 5000 crores investment for Propylene oxide plant itself. At present the market in the country is not capable of absorbing the high supply of PO. It will require another 4000 to 5000 crores investment for manufacturing the PO based products. MPL is not having required reserves to invest 9000 crores. Also, the pollution load in the new technology is also high. The COD content of the effluent Per Mt of PO production will have 1 lacs COD and the emission level also is very high compared to the present chlorohydrin route. MPL has carried out detailed study on the new process related project.

PO Alternate Technology
proposal enclosed as ANNEXURE - 13.

2. Recommendation

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.

Compliance status

MPL has carried out Disc membrane study and also took up study by CECRI for ZLD. The project cost was not viable as the cost of treated water is Rs 3000 – 4000/ KL. Since the effluent contains high calcium chloride, the technology is not suitable for treatment.

Moreover, the TDS contents of RO reject was very high. The project and recurring cost is very high and not economically viable.

All ZLD Related study Reports done by CECRI,
AQUATECH, enclosed as
ANNEXURE - 14. Also enclosed Proposals of study
from NEERI, ROCHEM enclosed as ANNEXURE - 14.

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3. Recommendation

Necessary arrangements may be made well in advance to replace the pipe according to its lifetime to ensure environmental safety.

Compliance status

The effluent line was originally laid and commissioned in the year 1990 and replaced the line in 2011. Pressure & Leak test was carried out through M/s Aquatic Diving.

Periodical testing will be carried out to ascertain the condition of the line.

M/s. Aquatic Diving Report enclosed as
ANNEXURE - 26

Recommendation of Joint Committee Report (CPCB & TNPCB) submitted on May 02, 2016 & September 2016

1. Recommendation

All units 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 same to be made available to TNPCB/CPCB during inspection

Compliance status

Plant I

Flow meters are provided at the following locations.

TTRO inlet, Metro Water inlet at WWTP, KGR water Inlet near car shed, MFL RO reject water inlet at MFL, Saponifier outlet to ETP at PO plant, Feed to Bio Reactor at WWTP & Treated effluent outlet at WWTP.

Records are being maintained for water consumption, effluent generation from different section of process along with material balance and water balance and it is available.

Plant II

Flow meters are provided at the following locations.

TTRO inlet at ETP, Metro Water inlet at Plant II gate, KGR water Inlet at ETP, Saponifier outlet to ETP at ETP, Feed to Bio Reactor at ETP & Treated effluent outlet at ETP.

Records are being maintained for water consumption, effluent generation from different section of process along with material balance and water balance and it is available.

Flow meter photographs of Unit - I & II
enclosed as ANNEXURE - 27A & 27B respectively.

2. Recommendation

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 from the units and quantity of effluent discharged. This also helps to quick identification of any leaks in the pipeline. These flow meters shall connect to TNPCB/CPCB monitoring centre.

Compliance status

Three flow meters are installed at following locations in the marine disposal pipeline.

- 1)Near MPL Plant II Gate,
- 2)Outside TPL ECH PO Plant,
- 3)Tsunami Nagar, near Ernavoor gate.

Connectivity to TNPCB/CPCB will be provided by end of July 2021.

Flow meter photographs present in
Marine disposal line enclosed as ANNEXURE-27C.
Purchase order copy for online Connectivity system
for outside flow meters enclosed as ANNEXURE-28.

3. Recommendation

To take up detailed marine study by considering the actual quality and quantity of effluent discharged to verify the availability of dilution in the sea and its impact on marine species.

Compliance status

NIOT has conducted marine impact study during 2020 and the report is attached.

(Enclosed as ANNEXURE - 9A)

Marine impact study at the point where the treated trade effluent is being discharged into sea will be carried out once in year through accredited consultants and cost of the project will be shared by all three industries (M/s. MPL, M/s. TPL & M/s. KPL).

4. Recommendation

All units are required to conduct toxicity studies for their effluent and also for combined effluents. The results shall be submitted to TNPCB including species used for the study.

Compliance status

MPL has carried out toxicity study by M/s G lens & M/s. Geo Marine Consultants & Technocrats for MPL effluent & combined effluent.

- Toxicity study Report of M/s. Geo Marine consultants & Technocrats enclosed as ANNEXURE - 21
- Toxicity study Report of M/s. Gilens Innovation Labs Pvt. Ltd enclosed as ANNEXURE - 22

Recommendation of Joint Committee Report submitted on October 28, 2020

1. Recommendation

~~M/s Kothari Petrochemicals Ltd. shall be directed to remit the interim compensation of Rs. 24 Lakhs for non-compliance.~~

Compliance status

~~Not Applicable to MPL~~

2. Short term

a. Recommendation

At present, M/s KPL is discharging the RO reject into the Marine, in order to reduce the quantum of marine discharge as well as for use of raw water, possibilities shall be explored by M/s MPL or M/s TPL for utilizing RO reject generated from M/s. KPL in their process.

(Target: One Month)

Compliance status

MPL has taken sample from KPL sea discharge point. The results of the effluent analysis reveal high chlorides, TDS, Conductivity, Silica.

The effluent with above characteristics is not suitable for MPL PO process. This will affect the process, plant operation, equipment's and product specification.

High chloride content will restrict the chlorine solubility in the process. Moreover, Ammoniacal nitrogen and Sulphate are higher in KPL effluent, which will also affect PO reaction process and create impurities.

KPL effluent analysis details enclosed as ANNEXURE - 23

b. Recommendation

If the RO Reject found suitable for utilization, then the discharge of M/s KPL shall be stopped and sent to M/s MPL or M/s TPL.

~~(Target: Two Month)~~

~~Compliance status~~

Not Applicable to MPL

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c. Recommendation

Action plan on phase wise revamping of treatment units of the ETP in M/s MPL Unit I and M/s TPL (all three plants HCD, LAB & ECH – PO) shall be submitted, since physical damages found during the visit. Action plan shall be submitted within a month. **(Target: Two Year)**

Compliance status

MPL is taking action for refurbishing High-Rate Thickener. It will take around 18 months to complete the job. (Before April 2022)

Relevant offers obtained for HRT refurbishing works enclosed as ANNEXURE - 29

d. Recommendation

~~Since M/s TPL is reusing the treated effluent generated from HCD & LAB plant in the ECH – PO plant, online flow meters shall be installed at HCD & LAB plant to quantify the utilization of treated effluent. Moreover, the online effluent monitoring system installed for the parameters pH, TSS, COD, BOD etc. at HCD/LAB plant shall be relocated to the common discharge pipeline after confluence of all treated effluent and installation of display board showing effluent quality to the general public. (Target: Three Months)~~
(Target: Three Months)

Compliance status

Not Applicable to MPL

e. Recommendation

In order to assess the sea water quality, Continuous Marine Water Quality Monitoring system shall be installed at discharge point for the parameters Temperature, Conductivity, Salinity, Turbidity and Total Dissolved Solids (TDS), Dissolved Oxygen (DO), pH, Chlorophyll, fluorescent Dissolved Organic Matter (fDOM) and phycoerythrin-a pigment of blue-green algae etc. The recorded data shall be shared to NIOT & TNPCB for assessing the marine quality. (Target: Six Month)

Compliance status

The installation of the Continuous Marine Water Quality Monitoring system will be at the diffuser point in the sea and the safety/security of the sensors will be at stake since the area is unmanned. The sensors are very costly and there is a chance of security threat. Moreover, most of the reputed vendors are not willing to quote as they could not analyse many parameters given in the list. Hence, we will be representing the NGT to consider installation of the Continuous Marine Water Quality Monitoring system in the effluent line of the common discharge point (in the land) for assessing the given parameters. Based on the NGT's direction, we are ready to implement the system for monitoring the parameters and share the recorded data.

Offer obtained from M/s. NEXT for installation of CMWQMS enclosed as ANNEXURE -30

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f. Recommendation

MPL plant I & II and M/s TPL: A pilot scale study shall be carried out with DISC membrane or any other suitable technology for reducing the discharge of treated effluent in to the sea. Possibilities shall also be explored for achieving complete or partial ZLD. Action plan shall be submitted within a month. **(Target: One Year)**

Compliance status

MPL has carried out Disc membrane study and also took up study by CECRI for ZLD. The project cost was not viable as the cost of treated water is Rs 3000 – 4000/ KL.

Since the effluent contains high calcium chloride, the technology is not suitable for treatment. Moreover, the TDS contents of RO reject was very high.

The project and recurring cost is very high and economically not viable.

All ZLD related study Reports by NEERI, CECRI, AQUATECH, ROHEM enclosed as ANNEXURE -14

g. Recommendation

Calibration of the flow meters installed in the discharge pipeline shall be carried out periodically and ensure no difference in each of the flow meters.

Compliance status

Flow meters are being calibrated periodically to ensure no difference in flow meters and records are being maintained.

Relevant calibration certificate copies enclosed as ANNEXURE - 25

3. Long Term

Recommendation

NIOT has suggested long term study in both the report (2015 & 2020) to assess the marine water quality and flora & fauna marine life as well as indicated the pollution from other sources also.

So, it is suggested to have a comprehensive impact assessment study to assess the quality of water and biological impacts in the receiving waters which shall cover larger extents (spatial) along the coast and two seasons (pre monsoon / post monsoon). The study area shall cover Ennore Creek, North Chennai Coastal waters from Pulicat to Muthukadu in the South to cover pollution signals during all seasons as there is northerly drift for 8 months and southerly drift for 4 months in a year. Therefore, representative samples shall be analysed to map the variation in space and time.

In order to have a detail study, it is suggested to carry out continuous study for a period of five years (twice in a year), in which the impact & sources of pollution shall be identified. Accordingly, remedial measures shall be suggested.

TNPCB shall provide list of marine outfall units & other source of pollution including source point data of industrial outfalls (including Ennore creek) and others such as municipal discharges, data from Kamarajar port, Chennai port, Fishing harbour etc. TNPCB shall utilise the Environmental Compensation fund for this study and same may be recovered after the polluter identification. The studies can be conducted by national institutes such as NIOT or any other reputed institutes.

NIOT has observed the marine life quality improvement, after dredging activity carried out during Ennore Port development. Therefore, possible means to improve the marine water / life quality shall be suggested based on data.

Compliance status

NIOT has conducted marine impact study during 2020 and the report is attached.

Marine impact study at the point where the treated trade effluent is being discharged into sea will be carried out once in year through accredited consultants and cost of the project will be shared by all three industries (M/s. MPL, M/s. TPL & M/s. KPL).

Minutes & Meeting between TNPCB & MPL, KPL, TPL and undertaking letter by MPL, TPL, KPL for periodical MIA study enclosed as ANNEXURE - 31.

responsible for polluting sea water by applying "Polluters Pay" principle and submit a report to this Tribunal within a period of three months.

Unquote:

20. The Applicant submits that the committee appointed by this Hon'ble Tribunal vide order dated 08.02.2020 has filed a report dated 28.10.2020 by observing the following:-

REPORT OF ANALYSIS

MANALI PETROCHEMICALS LIMITED - UNIT-I

S.No	Parameters	Inlet	Outlet	Permissible level
1.	BOD	1053	165	100
2.	COD	254	05	250

REPORT OF ANALYSIS

MANALI PETROCHEMICALS LIMITED - UNIT-II

S.No	Parameters	Inlet	Outlet	Permissible level
1.	BOD	1324	139	100
2.	COD	285	3.8	250

REPORT OF ANALYSIS

TAMIL NADU PETROCHEMICALS LIMITED

S.No	Parameters	Inlet	Outlet	Permissible level
1.	BOD	626	92	100
2.	COD	29	4.7	250

Report of the Committee is Annexed as Annexure-IV

21. The Applicant submits that the report of the committee emphasis that they have not conducted proper inspection as per the order of this Hon'ble Tribunal dated 08.02.2020. Further, the report states that "in the committee meeting held on 4.03.2020, it was decided to collect samples at the inlet and outlet of ETP's of all four units and requested all units to discharge the treated wastewater at same time. Accordingly, on 06.03.2020 samples were collected at the inlet and outlet of ETP and also instant readings of the flow were noted".(Page no.2 of Committee Report).

From the reading of the above lines of the report would reveals that the present committee has alerted the Respondent industries by granting advance notice two days prior to the inspection. Notwithstanding , the above lines of the report also reveals that the committee has not conducted proper inspection by taking independent water sample of each industry, instead, they have taken samples by discharging water of all units at the same time. The aforesaid way of inspection by the committee would not achieve the real intention of the inspection.

In compliance to the Hon'ble tribunal order, the committee carried out inspection & monitoring of Source Emission, ETP & Marian outfall during March 04 to 06, 2020 and submitted interim report on 11.06.2020 seeking further time to file final report.

Further Hon'ble tribunal in its order dated 11.06.2020, directed as follows;

"5. Under these circumstances, we feel it appropriate to grant two months time to the committee to submit the report along with the remediation measures if any, required on the basis of the Analysis Report and also suggest alternate methods if any, required for noncompliance of certain suggestions and recommendation given for efficient management of pollution control mechanism which they have mentioned in the 'remarks' column of the compliance of recommendation in the interim report.

The committee is directed to submit the report to this Tribunal on or before 7.9.2020"

NIOT requested further time for submission of marine study report, accordingly, CPCB has submitted request seeking further four weeks time for filing the report. Upon the request Hon'ble Tribunal has grant time till 02.11.2020 to the committee to submit the report as directed.

2. Analysis results of the sample collected in individual units:

In the committee meeting held on 4.3.2020, it was decided to collect samples at the inlet and outlet of ETPs of all the four units and requested all units to discharge the treated wastewater at same time. Accordingly, on 6.3.2020 samples were collected at the inlet & outlet of ETP and also instant readings of the flow were noted. The analytical results are given below.

M/s. Manali Petrochemicals Limited, Unit I:

Parameter	Inlet	Outlet	Marine disposal standards
pH	11.5	6.3	5.5-9.0
TSS mg/L	109	60	100
COD mg/L	1053	165	250
BOD mg/L	254	05	100
Fluoride mg/L	1.36	0.82	15
O&G mg/L	--	12.5	20
Hexavalent chromium mg/L	BDL	BDL	1.0
Sulphate mg/L	202	254	1000
Free ammonia (as NH ₃) mg/L	1.32	NIL	05
Ammonia as N mg/L	1.1	BDL	--
Phenols mg/L	BDL	BDL	5.0
Petroleum hydrocarbons mg/L	--	10.8	--

From the above analysis results, it shows that all the parameters are meeting the prescribed standards. Percent reduction of treatment efficiency in terms of BOD and COD is 98% and 84% respectively.

During the time of sample collection, flow was found to be 88.1 cubic meter/ hour. Hence, total amount of treated effluent discharged in to the sea will be 2114 cubic meter/ day. Based on flow, overall BOD load discharged in to the sea will be 10.6 kg/day.

M/s. Manali Petrochemicals Limited, Unit II:

Parameter	Inlet	Outlet	Marine disposal standards
pH	11.4	6.4	5.5-9.0
TSS mg/L	160	66	100
COD mg/L	1324	139	250
BOD mg/L	285	3.8	100
Fluoride mg/L	1.79	0.88	15
O&G mg/L	--	16	20
Hexavalent chromium mg/L	BDL	BDL	1.0
Sulphate mg/L	173	160	1000
Free ammonia (as NH ₃) mg/L	1.32	NIL	05
Ammonia as N mg/L	1.1	BDL	--
Phenols mg/L	BDL	0.03	5.0
Petroleum hydrocarbons mg/L	--	12.3	--

From the above analysis results, it shows that all the parameters are meeting the prescribed standards. Percent reduction of treatment efficiency in terms of BOD and COD is 98.5% and 89% respectively.

During the time of sample collection, flow was found to be 95 cubic meter/ hour. Hence, total amount of treated effluent discharged in to the sea will be 2280 cubic meter/ day. Based on flow, overall BOD load discharged in to the sea will be 8.7 kg/day.

M/s. Tamilnadu Petrochemicals Limited:

M/s. Tamilnadu Petrochemicals Limited has three units Epichlorohydrin Plant (ECH), Heavy Chemicals Division (HCD) & Linear Alkyl Benzene Plant (LAB). Earlier M/s TPL was discharging treated effluent from all the plants to marine. At present the treated effluent from HCD & LAB plant is used in the ECH plant process. The treated effluent from ECH is discharged to marine.

Parameter	Inlet	Outlet	Marine disposal standards
pH	11.8	6.8	5.5-9.0
TSS mg/L	91	63	100
COD mg/L	626	92	250
BOD mg/L	29	4.7	100
Fluoride mg/L	1.4	1.02	15
O&G mg/L	--	2.7	20
Hexavalent chromium mg/L	BDL	BDL	1.0
Sulphate mg/L	46.7	41.5	1000
Free ammonia (as NH ₃) mg/L	2.4	NIL	05



M/2. MPL - 2
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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

REPORT OF ANALYSIS

ANNEXURE - 20

ROA No. 151/2016-17

Dated : 09.01.2017

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Three number of samples
Date and Time of Collection : 08.11.2016 at 03.10 PM
Date and Time of Receipt : 09.11.2016 at 10.00 AM

Code No. & Point of Collection : 1. KUN-60- ETP outlet into sea - T
2. KUN-61- Near TPL gate - T
3. KUN-62 -Near Sea Shore-T

Sl.No	Parameters	Unit	1	2	3
1.	pH	Number	6.45	5.82	5.89
2.	Total Suspended Solids	mg/L	14	66	30
3.	Total Dissolved Solids	mg/L	660	24874	29616
4.	Chlorides	mg/L	310	14046	17595
5.	Sulphates	mg/L	4	3	6
6.	Oils & Grease	mg/L	2.4	1.6	2.0
7.	BOD for 3 days at 27 ^o C	mg/L	5	2	3
8.	Chemical Oxygen Demand	mg/L	48	**	**
9.	Phosphate	mg/L	<0.15	0.6	<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	52	10040	10080
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	0.39	0.43	0.40
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

8010117
Deputy CSO (L)
DEL, Manali



M/2-MPL-I-

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

REPORT OF ANALYSIS

ROA No.192 / 2015-16

Dated : 14.01.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 20.11.2015 at 11.00 AM
Date and Time of Receipt : 20.11.2015 at 5.20 PM

Code No. & Point of Collection : 1. VA16/11/2015 ETP Outlet - T

Sl.No.	Parameters	Unit	1
1.	pH	Number	6.54
2.	Total Suspended Solids	mg/L	16
3.	Total Dissolved Solids	mg/L	32916
4.	Chlorides	mg/L	16795
5.	Sulphates	mg/L	29
6.	Oils & Grease	mg/L	4.8
7.	BOD for 3 days at 27 ⁰ C	mg/L	9
8.	Chemical Oxygen Demand	mg/L	24
9.	Phosphate	mg/L	2.8
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	48
18.	Copper	mg/L	0.01
19.	Cadmium	mg/L	<0.01
20.	Lead	mg/L	0.8

Deputy CSO (L)
DEL, Manali



TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

M/S. MPA - II

908

REPORT OF ANALYSIS

ROA No.138/2015-16

Dated : 05.10.2015

Name of the Sender : DEF/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 31.08.2015 at 3.50 PM
Date and Time of Receipt : 31.08.2015 at 5.40 PM

Code No. & Point of Collection : 1. 8108 - ETP Outlet into Sea - T

Sl.No.	Parameters	Unit	1
1.	pH	Number	4.74
2.	Total Suspended Solids	mg/L	36
3.	Total Dissolved Solids	mg/L	34584
4.	Chlorides	mg/L	18244
5.	Sulphates	mg/L	450
6.	Oils & Grease	mg/L	2.4
7.	BOD for 3 days at 27 ^o C	mg/L	21
8.	Chemical Oxygen Demand	mg/L	144
9.	Phosphate	mg/L	7.3
10.	Zinc	mg/L	0.2
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.	Fluride	mg/L	<0.05
17.	Calcium	mg/L	3928
18.	Lead	mg/L	<0.01
19.	Copper	mg/L	0.2
20.	Cadmium	mg/L	<0.01

Deputy CSO (L)
DEL, Manali

06/10



M/s. MPC - Tr

clarification
needed

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

909

REPORT OF ANALYSIS

ROA No.192 / 2015-16

Dated : 14.01.2016

Name of the Sender : DEE/Ambattur
Nature and Number of sample : One number of sample
Date and Time of Collection : 20.11.2015 at 11.10 AM
Date and Time of Receipt : 20.11.2015 at 5.20 PM

Code No. & Point of Collection : 1. VA17/11/2015 ETP Outlet - T

Sl.No.	Parameters	Unit	1
1.	pH	Number	6.96
2.	Total Suspended Solids	mg/L	12
3.	Total Dissolved Solids	mg/L	31852
4.	Chlorides	mg/L	17345
5.	Sulphates	mg/L	29
6.	Oils & Grease	mg/L	5.2
7.	BOD for 3 days at 27 ^o C	mg/L	10
8.	Chemical Oxygen Demand	mg/L	32
9.	Phosphate	mg/L	2.3
10.	Zinc	mg/L	0.3
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	45
18.	Copper	mg/L	0.009
19.	Cadmium	mg/L	<0.01
20.	Lead	mg/L	0.6

Deputy CSO (L)
DEL, Manali

PROJECT TITLE

**TOXICITY STUDY & TESTING OF
TREATED EFFLEUNT FROM MANALI
PETRO-CHEMICALS LIMITED, MANALI,
CHENNAI-68 USING FISH**

11 February 2021

Prepared for



**Manali Petrochemicals Limited
Manali, Chennai-68**

Prepared By



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INTRODUCTION

Innumerable amount of chemicals, non-essential and essential continue to be released into the environment via permitted and regulated effluent discharges like ETPs etc. and through illegal and semi or untreated sources into the seas. Chemical-by-chemical controls are used for registration of chemicals in the marketplace, however most aquatic discharges are mixtures containing registered and unregistered products, by-products, transformation products, metabolites, and other contaminants. Consequently, for effluents, it is difficult to predict effects based on chemical data. Hence, a more holistic assessment is needed.

Since the 1940s, effluent toxicity testing has been used to assess potential ecological impacts of effluents and to aid in treatment and disposal of effluents in natural systems. (Hart et al. 1945). Whole-effluent toxicity (WET) testing also called as direct toxicity assessment (DTA) and whole-effluent assessment (WEA) in the European Union, was developed in the 1950s as a tool for detecting and controlling the discharge of toxic effluents has been refined in subsequent decades (Warren 1971; Bergmann et al. 1986; OSPAR Commission 2007). Knowledge of the test organisms and standardization of test methods applied in effluent assessments have steadily improved, alongside increasingly sophisticated analytical approaches and improved understanding of the chemicals/contaminants discharged into the environment.

Conventional effluent stressors such as biochemical oxygen demand (BOD), total suspended solids, ammonia, and chlorine are routinely assessed along



with established lists of known and emerging contaminants (Boxall et al. 2012). However, toxicity-based effluent assessments have become increasingly important because it is recognized that, particularly for complex discharges, physical and chemical measurements alone cannot be used to quantify the impacts on the environment or the biota.

Hence, various strategies that integrate toxicity testing (WET, DTA), bioaccumulation, and persistence potential (WEA) are used to assess the impacts on the organisms and the environment. These strategies evaluate organism responses in both the effluent and the receiving environment and are frequently paired with ecological monitoring and analytical tools. (Bergmann et al. 1986; Grothe et al. 1996; OSPAR Commission 2000; Nonet 2005; Embry et al. 2010; Volz et al. 2011; Hamers et al. 2013).

Effluent toxicity testing of wastewater discharges is mandatory in many countries, although test requirements may vary with respect to species/taxonomic groups used and duration of the test (i.e., acute or chronic). As is seen with product testing, many effluent assessment schemes include algae, invertebrate and fish tests to ensure that potential impacts to the key trophic levels (producers, primary consumers, and secondary consumers) are assessed.

In general, most approaches measure the effects of an effluent on specific test organisms' ability to survive, grow, and reproduce. Understanding the role of specific and sublethal modes of action, such as enzyme disruption, is increasingly important in regulatory assessments of wastewater effluents. For instance, in the

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European Union, there is growing interest in the use of effects-based tools and methods to improve the risk assessment of mixture present in surface waters (including pollutants of emerging concern, metabolites, and transformation products) under the auspices of the European Union Water Framework Directive (Brack et al. 2017). The idea is to develop screening methods to identify areas that warrant further investigation (Hamers et al. 2013).

Like any chemical for environmental hazard assessment, effluent toxicity testing relies on standardized yet somewhat flexible test guidelines in order to accommodate a variety of foreseeable conditions. Fish have been incorporated into many effluent toxicity assessments. Consequently, the number of fish used to conduct effluent testing can be substantial. Typically, acute and short-term definitive dilution tests will require a minimum of 10 fish. It is desirable to choose the animals in the juvenile or larval stage in order to assess the toxicity in the most vulnerable stage of the life.

Based on the MPL request, toxicity test has been carried out, for the treated effluent being discharged into the sea, based on the previous studies carried out in other parts of the world and standard procedures. The study related references have also been added at the end of the report.

EFFLUENT ASSESSMENT

Correlation to the receiving environment.

In the case of effluent assessment, consideration must be given to relationships between the effluent toxicity assessments and the responses in the field.

Test feasibility.

Most WET testing occurs in contract laboratories, where standard test methods are easily and routinely conducted. New alternative test methods must be adapted for routine, frequent testing as required for effluent assessment. Although this is also an issue for traditional methods and laboratories, the infrastructure needed for effluent assessment represents a significant challenge because of the volumes and frequency of testing.

Influence of confounding parameters.

Effluents contain factors other than the chemicals of concern that can have an impact on assay results (e.g., pH, ionic balance, suspended solids, high bacterial loads). Although these parameters and their impact on standard WET tests are well understood, the same needs to be determined in any alternative test approaches adopted.

Multiple trophic levels.

Effluent assessment requirements often require testing across multiple trophic levels. However, most of the testing methods focuses on fish. Assurance will be

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needed that alternative methods are similarly protective and correlate well with any traditional test with nonvertebrate taxa (i.e., to determine species sensitivity).

Applicability to diverse environments and organisms.

Effluent assessments must be applicable for a range of different environments (e.g., marine vs freshwater, tropical vs temperate vs cold water) and include considerations for site-specific assessment of native species in some assessments.

Ability to relate or predict acute and chronic toxicity test results.

Many traditional Whole Effluent Toxicity (WET) tests involve acute or chronic exposures that differ methodologically from those used to assess chemicals. Understanding how to relate in vitro methods with short exposure durations to predict chronic effects of effluent exposure will need to be established.

Relation of an adverse outcome pathway to whole-organism response.

Use of tests to measure key events within an adverse outcome pathway must be placed in the context of a whole-organism response, traditional WET endpoints of survival and growth, and complex mixtures. Demonstrations that the sensitivity and effects are comparable, predictable, or translatable to whole-organism responses in the field will be required.

EXPERIMENTAL DESIGN

Whole Effluent Assessment (WEA) is defined as the assessment of effluents by using a range of biological methods in order to reveal (potential) effects, based on



an assessment of persistence, bioaccumulation and toxicity (PBT-criteria). Since the entire effluent sample is tested, WEA increases the understanding of the combined effects of all known and unknown substances within effluents, especially in complex mixtures.

The sensitivity of an organism is related to route of exposure and biochemical response to contaminants. Animals dwelling in the water are exposed to water along with the toxicants in the water. In contrary sediment-dwelling organisms are exposed to interstitial water/porewater, Sediment particles in addition to the overlying water. Hence testing of animals belonging to various niches is of importance.

In addition to the contaminants in the overlying water, food type, feeding rate, assimilation efficiency and clearance rate also control toxicity in animals. Benthic invertebrates often selectively consume different particle sizes (Harkey et al. 1994) or particles with higher organic carbon concentrations, which may have higher contaminant concentrations. On the other hand, grazers and other collector-gatherers that feed on overgrowth and detritus may receive most of their body burden directly from materials attached to sediment or from actual sediment ingestion. Hence it is very important to select the correct species for testing.

Two species of fishes were chosen for the study namely *Lates niloticus* and *Terapon jarbua* were collected from pristine areas near Parangipettai and held for two days to acclimatize as a standard procedure in the laboratory. Seawater was



collected from the adjacent area and transported to laboratory. Animals were grouped into ten groups and exposed in three different tanks with a duplicate for each tank.

Every group of the experimental animals had a control or reference group that were not exposed to whole sediments and were maintained at normal room conditions.

Juvenile *Lates clacarifer* with an approximate length of 8±1cms weighing 5±2gms and Subadult *Teraponjarbua* with an approximate length of 8±1cms weighing 10gms±2gms were chosen for this study..

Animals were exposed for three sets of conditions namely

- Acute
- Sub Chronic and
- Chronic

The following series was adopted for the Effluent toxicity testing.

Exposure of animals for Effluent Toxicity testing

Tank 1 (Acute)	Ten animals were grouped into the tank and exposed for 5 days.
Tank 2 (Sub Chronic)	Ten animals were grouped into the tank and exposed for 10 days.
Tank 3 (Sub Chronic)	Ten animals were grouped into the tank and exposed for 15 days.
Control	Ten animals were maintained at normal conditions of from start to end of the experiment
Each tank had a replicate for minimizing the error.	

The exposure was terminated on the 15th day.

The following table depicts the comparison of the standard exposure and the test procedure followed for this study.

**Comparison of EPA/ASTM exposure standards and standards maintained
in laboratory**

Test Parameter	EPA/ASTM Method	This study
Water renewal	2 volume addition Continuous or intermittent	No renewal single addition of effluent to the test chamber prior to the test.
Aeration	DO<40%	DO <40%
Temperature	23±1°C	Room temperature
Light quality	Wide spectrum fluorescent	Wide spectrum fluorescent
Light intensity	500 – 1000 lux	Day light
Photoperiod	16:8 light: dark	16:8 light: dark
Chamber volume	300cm ³	3000cm ³
Overlying water volume	175cm ³	1000cm ³
Animal age	7-14	Juvenile and sub-adult
Replicates	8 for routine testing	2
Total individuals/sample	80	10 each testing
Feeding	1.5mlYCT/beaker/d	500mg/d
Duration	10d	5,10,15 d
Test end point	Lethality	Lethality, enzyme inhibition, Histopathology and Histochemistry were



CONDITIONS FOR THE EXPERIMENT

Chemical Analysis

Overlying water quality was monitored throughout both experiments. During the tests 5ml of overlying water from each replicate was removed with a pipette every 24 hour to monitor pH, salinity, DO, temperature and ammoniacal nitrogen. DO was maintained above 60% saturation.

Water Analysis

Temperature, Salinity and pH:

The physical parameters like pH, temperature and salinity were measured at lab condition. The subsurface temperature was measured with a mercury thermometer having $\pm 0.02^{\circ}\text{C}$ accuracy and the pH of water was measured by a calibrated pH pen (pH ep-3 model). Salinity was estimated using a hand refractometer (Erma Company, Japan). Water samples collected for dissolved oxygen estimation were transferred carefully to BOD bottles. The DO was immediately fixed and brought to the laboratory for further analysis.

Dissolved Oxygen (DO):

The modified Winkler's method as described by Strickland and Parsons (1972) was adopted for the estimation of dissolved oxygen. The values are expressed in mg/l.

Nitrate and Nitrite:

The nitrate and nitrite content of samples were analysed by following the method described by Strickland and Parsons (1972). The nitrite was estimated from highly coloured azo dye formed by the addition of N (1-Naphthyl) ethylene diamine dihydro-



chloride and sulfanilamide into the solution was then measured at 543 nm in a spectrophotometer. The Same procedure was followed for the estimation of nitrate. For this, nitrate was reduced to nitrite by passing the sample through copper coated cadmium column. The calculated values are expressed in μmol of Nitrogen/l

Table 1

Relevance of Water Quality Parameters

Parameter	Relevance to survival	Recommended Range	Impacts at consistently less than recommended Value	Impacts at higher values
Dissolved Oxygen (DO)	<ul style="list-style-type: none"> • Fish breathe in oxygen for their metabolism. • DO is needed to oxidise potentially toxic metabolic wastes into less toxic forms (e.g. ammonia (NH₃) to nitrite (NO₂⁻) and thennitrate (NO₃⁻) • Phytoplankton use oxygen at night during respiration. 	<p>From 4 mg/l to saturation for catfish eggs, larvae, fry and fingerlings. As catfish develop, their accessory breathing organs enable them get oxygen by gulping at the water surface when dissolved oxygen levels are low. However, even adults will perform better when the dissolved oxygen levels are adequate.</p>	<ul style="list-style-type: none"> • 0 – 1.5 mg/l can be lethal especially if exposed for long periods • 1.4 – 5 mg/l-fish survive, but reduced feed intake higher FCRs, slow growth, stress, and increased susceptibility to disease results. Build up of toxic wastes because they are not broken down (oxidised) 	<ul style="list-style-type: none"> • Gas bubble trauma when the water is supersaturated to levels of 300% and above.
Temperature	<ul style="list-style-type: none"> • Fish are cold blooded and their metabolism rate is indirectly influenced by water temperature. • Rate at which wastes in pond are broken down and chemicals dissolve is faster in warmer waters • Affects the solubility of oxygen. 	<p>26 to 32° C</p>	<ul style="list-style-type: none"> • Below 15° C. Growth stops and death occurs at extremes • 15 to 26°C. Reduced feed intake and growth rates. Higher FCRs. Fish more stressed at lower temperatures, therefore, more susceptible to disease. • Organic matter and other wastes are broken down at a slower rate when temperatures are low with high risk of eutrophication. 	<ul style="list-style-type: none"> • Lower solubility of oxygen, stress and death at extreme temperatures.



<p>pH</p>	<ul style="list-style-type: none"> Affects the solubility and chemical forms of various compounds some of which can be toxic. 	<p>6.5 to max 9</p>	<ul style="list-style-type: none"> Below 4, acid death point. 4 - 6.0. Survive but stressed, slow growth, reduced feed intake, higher FCRs. Higher proportion of Total Ammonium Nitrogen is in the form of ionized ammonia, which is less toxic for fish. Low pH indicates high levels of dissolved carbon-dioxide 	<ul style="list-style-type: none"> 9 - 11 Stressful for catfish, slow growth rate. Above 11 alkaline death point. All life, including bacteria in pond will die at this point. Higher proportion of Total Ammonium Nitrogen in the form of unionized ammonia in water, which is more toxic for the fish.
<p>Total Ammonia Nitrogen (TAN)</p>	<ul style="list-style-type: none"> Ammonia by-product of protein breakdown occurs in both a toxic form (ammonia) and nontoxic form (ammonium) depending on the pH of the water. 	<p>Not more 0.3 - 2 mg/l of the toxic form (ammonia). The proportion of TAN in the form of ammonia tends is higher as the pH of the water increases above 7</p>	<ul style="list-style-type: none"> Fish are healthy when there is no or little ammonia in water. 	<ul style="list-style-type: none"> The fish succumb more to attacks by trematodes and other parasites. The fish fail to eliminate ammonia from their blood because there is too much ammonia already in the water. Ammonia is excreted by fish as a byproduct of protein metabolism primarily through their gills. High concentrations of ammonia in water reduce the ability of the gills to do so.

Exposure tank with test media	Test systems
L.calcatifer exposed in exposure tank	L.calcatifer exposed in exposure tank
Measurement for L. calcarifer	Measurement for T.jarbua
Animals sacrificed after terminating exposure to effluent	Liver Gills and kidney collected after dissection

PRE-LAB CONDITIONS

Clean seawater was collected from the site adjacent to Sagar Island. The transport tank was vigorously aerated by a compressor mount aerator. Test animals viz. *Lates calcarifer* and *Therapan jarbua* were housed in the lab in two biologically filtered, 2000 l polypropylene holding tank temperature preference

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trials, conditions closely approximating summer field conditions. The temperature fluctuations were made minimal to a range of $\pm 0.5^{\circ}\text{C}$. Sea water was maintained at room temperature and the salinity was maintained at 25 ppt. excess salinity was neutralised by adding distilled water. Artificial lighting was used to simulate normal diurnal rhythm with 12 hours of light and dark cycles. Fishes were fed with prawns from commercial catch. Carapace was removed to avoid biofouling. Care was taken to avoid cannibalism and animals were fed optimally.

EXPOSURE OF ANIMALS

Animals were acclimatised in lab conditions for 2 days. This will help to reduce the stress during the exposure periods. Experimental animals were exposed in a glass tank (10"X7"X7"). Clean sea water with salinity of 25.0 ppt was stored in a 950 L polypropylene tank. Care was taken to maintain the temperature at 23°C . An aerator was used to provide oxygen at sufficient levels.

Water was pumped through the tanks by a submersible pump. Aerator Submersible pumps were placed in each exposure tank to maintain the water aeration and circulation. A bio-filter was installed to reduce ammoniacal nitrogen and vital water quality parameters were monitored to ensure that water quality was at optimum levels to avoid undesirable effects.

ACCLIMATISATION OF ANIMALS

Experimental protocol for fishes

Acclimatized animals were transferred to holding tanks with prediluted effluent. Effluent was diluted to 50% v/v for fishes. A group of ten animals were housed in three tanks in a glass aquarium. Grouped animals were exposed to diluted effluent treatments in three different tanks. The water was allowed to circulate using an aerator pump. Individuals were maintained in full-strength seawater (25.0 ppt) throughout the duration of the experiment were considered the control group. In all cases, transfer of fish to various tanks were completed within 10 min. To avoid crowding stress, disease or mortality associated with high ammonia levels, fish were randomly sorted and transferred individually into 30L aquaria equipped with biofilters and aeration. Fish were starved for 24 h before and after transfers, after which feeding was resumed according to the schedule 3 times a day. Fecal matter and other debris were siphoned from tanks 1 day after feeding and a 10% volume water change was performed at 48- and 96-hour prior treatment. Table 1 presents the size and weight range of experimental animals for the study.

Table 2
Length and weight of experimental animals used for effluent toxicity.

Animal	Length (cm)	Weight (mg)
<i>T. jarbua</i>	7±1.5	800 ± (4)
<i>L. calcarifer</i>	7±1	500± (2.7)

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The following table depicts the water quality of basic parameters in the test water during the period of exposure.

Table 3
Water quality parameters for the test medium.

S. No	Date	DO (mg/l)	pH	Salinity (ppt)	Temp (°C)	Ammonical Nitrogen (µmol/l)
1	08.01.2021	16	7.2	25.0	33	0.075
2	09.01.2021	15	7.0	25.0	33	0.100
3	10.01.2021	16	7.1	25.0	33	0.050
4	11.01.2021	17	7.1	25.0	33	0.025
5	12.01.2021	15	7.0	25.0	33	0.083
6	13.01.2021	14	7.1	25.0	33	0.125
7	14.01.2021	16	7.0	25.0	33	0.091
8	15.01.2021	15	7.2	25.0	33	0.066
9	16.01.2021	17	7.1	25.0	33	0.096
10	16.01.2021	15	7.1	25.0	33	0.041
11	17.01.2021	16	7.2	25.0	33	0.038
12	18.01.2021	14	7.2	25.0	33	0.033
13	19.01.2021	16	7.0	25.0	33	0.043
14	20.01.2021	17	7.1	25.0	33	0.033
15	21.01.2021	16	7.1	25.0	33	0.083
16	22.01.2021	15	7.0	25.0	33	0.025
17	23.01.2021	16	7.1	25.0	33	0.091
18	24.01.2021	15	7.0	25.0	33	0.066
19	25.01.2021	15	7.2	25.0	33	0.096
20	26.01.2021	16	7.1	25.0	33	0.083
21	27.01.2021	16	7.1	25.0	33	0.063

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EFFULENT TOXICITY TO FISHES

SURVIVABILITY OF TEST ANIMALS

A total of 10 animals were exposed to treated effluent in each tanks against 10 numbers in control. Fishes were exposed for 5,10,15 days. The animals were observed continuously over the period of exposure. Signs of distress, breathing and food intake were observed. Over a period of time grouping behaviour was also observed. All the visual parameters were checked with control. Mortality was not observed in control of both the fish species.

BEHAVIORAL EFFECTS

Animals were observed for 15 minutes every 1 hour after exposure. Animals were observed for behavioral effects like increased swimming speeds, hypoactivity and hyperactivity, diurnal rhythmicity, feeding behavior, locomotion and respiratory behavior. During the test period there was no altered behavioral behavior in fishes exposed to effluent mixture.

PHYSIOLOGICAL EFFECTS

During the first few hours of exposure there was a mild change in the depletion of DO. This shows the increased consumption of oxygen by the experimental animals. This was very low and was not observed in all the exposure tanks. This is was only during the first few hours of exposure and is due to the sudden change in the turbidity levels. After a 6-hour exposure the animals were in normal condition.

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LETHAL EFFECTS

There was no observed effect on the fishes exposed to the effluents. Survival was 100% throughout the test period for 15 days for fishes. The tanks were checked daily for mortalities and out of the initial 10 fish in each tank and all 10 fishes survived the toxicity tests. The control test tank also found to show no mortality.

Animals exposed to treated effluents were observed under a dissecting microscope for morphological changes. There were no observable changes in themorphology of the fishes. The animals sacrificed after the exposure period were dissected in a clean environment and were further subjected to histopathology, Histochemistry and Biochemistry.

Animals were dissected for liver muscles and Kidney for assessing the stress enzymes. Animals were dissected for Gills, liver and kidney and subjected to Histopathological analysis.

BIOCHEMISTRY STUDIES

Biomarkers, representing toxicant-induced changes in biological systems, serve as links between an environmental contamination (cause) and its effects, providing therefore unique information on the ecosystem health (Maria et al., 2009), and provides relevant data about possible pathological process in fish.

Toxicants may interfere in several metabolic pathways of cells and thereby induce different cellular responses depending on concentration and metal proprieties

(Almeida et al., 2002; Tagliari et al., 2004; Abdel-Tawwab et al., 2007; Bouraoui et al., 2008; Carvalho and Fernandes, 2008; Casado-Martinez et al., 2009; Monteiro et al., 2009, 2010). When an organism is subjected to chemical, physical and biological (i.e. pathogen infection) stress, sudden shortage of oxygen causes abnormal oxidative reactions in the aerobic metabolic pathways, resulting in the formation of excessive amounts of singlet oxygen (Ranby and Rabek, 1978) and other reactive oxygen species (ROS). Thus, leading to an increase in the oxygen species (ROSs) such as the superoxide anion (O_2^-), hydroxyl radical (OH^-), singlet oxygen (O_2^1) and hydrogen peroxide (H_2O_2), which may generate alterations and peroxidation of membrane lipids initiating cellular degenerative process (Storey, 1996; Liebler and Reed, 1997; Schlenk et al., 1999; Ahmad et al., 2000; Oakes and Kraak, 2003; Tagliari et al., 2004; Sanchez et al., 2005).

ROS can be detoxified by enzymatic and non-enzymatic cell defense systems can be measured as biomarkers of xenobiotic mediated oxidative stress. Defenses against ROS include scavenger compounds like

1. Lipid Peroxidase, (LPOs)
2. Superoxide dismutase (SOD),
3. Catalase (CAT),
4. Glutathione (GSH), among others (Storey, 1996).

The above-mentioned group of antioxidants is often referred to as scavenging antioxidants. They scavenge active radicals to inhibit chain initiation and break chain propagation reactions. They neutralize or scavenge free

radicals by donating electron to them, and in the process become free radicals themselves but of lesser damaging effects. These 'new radicals' are easily neutralized and made completely harmless by other antioxidants in this group. Most antioxidants are hydrophilic.

Glutathione (GSH) is present in all the tissues as the most abundant non-protein thiol that defends against oxidative stress. GSH is also a key determinant of redox signaling, vital in detoxification of xenobiotics, regulates cell proliferation, apoptosis, immune function, and fibrogenesis.

Superoxide dismutase (SOD), a cytosolic enzyme that is specific for scavenging superoxide radicals, is involved in protective mechanisms within tissue injury following oxidative process and phagocytosis. The higher the SOD value is, the more superoxide radicals need to be reacted. SOD analysis has been widely used in finfish. However, only few studies of SOD in crustaceans are related to oxidative status (Bell and Smith, 1993), immunity (Holmblad and Soderhall, 1999; Muñoz et al., 2000) and disease indication (Neves et al., 2000).

Catalase is a tetramer of four polypeptide chains, each over 500 amino acids long. [Boon et al., 2007]. It contains four iron-containing heme groups that allow the enzyme to react with the hydrogen peroxide. The optimum pH for human catalase is approximately 7, (Maehly AC, Chance B 1954) and has a fairly broad maximum: the rate of reaction does not change appreciably between pH 6.8 and 7.5 (Aebi H 1984).

Lipid peroxidation is the oxidative degradation of lipids. It is the process in which free radicals "steal" electrons from the lipids in cell membranes, resulting in cell damage. This process proceeds by a free radical chain reaction mechanism. It most often affects polyunsaturated fatty acids, because they contain multiple double bonds in between which lie methylene bridges (-CH₂-) that possess especially reactive hydrogen atoms. As with any radical reaction, the reaction consists of three major steps: initiation, propagation, and termination. The chemical products of this oxidation are known as lipid peroxides or lipid oxidation products (LOPs).

As the changes in the cell antioxidant defenses reflect the exposure to contaminants and/or their toxicity, all of them may be useful biomarkers in monitoring aquatic ecosystems (Almeida et al., 2007; Bouraoui et al., 2008; Ruas et al., 2008; Monteiro et al., 2010). When toxicants are discharged daily into water bodies, they can induce ROS production in fish, consequently, a response of antioxidant defenses (Liebler and Reed, 1997; Schlenk et al., 1999; Ahmad et al., 2000; Ruas et al., 2008; Monteiro et al., 2010). When the ROS production exceeds the basal cell levels and surpassed the defense capacity of the cell the oxidative stress occurs (Sies, 1986; Storey, 1996; Tagliari et al., 2004).

Treated fishes *L. calcarifer* and *T. jarbua* were dissected and the gills, liver, kidneys and muscle were collected and subjected to biochemical analysis. Lipid Peroxidase (LPOs), Superoxide dismutase (SOD), Catalase (CAT), Glutathione

(GSH) were assayed. The results from the exposed fishes were compared to the control where there was no addition of the effluent. This comparison helps us to understand the stress induced by the effluent in the animals.

Enzymes in Liver of TherapanJarbua

Samples	Cat (Unit/mg.of protein)	SOD (Unit/mg.of protein)	LPO (μ mole/mg.of protein)	GSH (μ mole /mg.of protein)
5 Days	30.5	5.9	1.2	5.2
10 days	29.4	6.3	1.3	5.4
15 days	29.7	6.1	1.1	5.8
Control	28.6	5.8	1	5.3

Enzymes in Muscle of TherapanJarbua

Samples	Cat (Unit/mg.of protein)	SOD (Unit/mg.of protein)	LPO (μ mole/mg.of protein)	GSH (μ mole /mg.of protein)
5 Days	8.7	1.4	1.6	1.2
10 days	7.5	1.2	1.9	1.1
15 days	8.1	1.6	1.5	1.1
Control	8.7	1.2	1.6	1.9

Enzymes in Kidney of TherapanJarbua

Samples	Cat (Unit/mg.of protein)	SOD (Unit/mg.of protein)	LPO (μ mole/mg.of protein)	GSH (μ mole /mg.of protein)
5 Days	14.4	2.3	1.3	3.8
10 days	13.8	2.5	1.5	3.2
15 days	15.9	2.1	1.2	3.3
Control	17.6	2.9	1.3	3.5

Enzymes in Liver of *L. calcarifer*

Samples	Cat (Unit/mg.of protein)	SOD (Unit/mg.of protein)	LPO (μ mole/mg.of protein)	GSH (μ mole /mg.of protein)
5 Days	25.9	6.8	2.1	4.9
10 days	26.7	6.3	2	4.2
15 days	25.8	7.6	2.3	4.3
Control	26.1	7.2	2.5	4.8

Enzymes in Kidney of *L. calcarifer*

Samples	Cat (Unit/mg.of protein)	SOD (Unit/mg.of protein)	LPO (μ mole/mg.of protein)	GSH (μ mole /mg.of protein)
5 Days	14.2	3.8	3.9	3.3
10 days	16.1	3.2	3.5	2.8
15 days	15.8	3.5	3.5	2.4
Control	16.3	3.7	3.2	2.8

Enzymes in Muscle of *L. calcarifer*

Samples	Cat (Unit/mg.of protein)	SOD (Unit/mg.of protein)	LPO (μ mole/mg.of protein)	GSH (μ mole /mg.of protein)
5 Days	8.3	1.1	1.5	2.5
10 days	8.4	1.1	1.5	2.6
15 days	7.9	1.2	1.2	2.5
Control	8.3	1.4	1.9	2.1

SOD and CAT are the primary defense against oxygen toxicity induced by xenobiotics. SOD play a key role in the defense against ROS by transforming superoxide anions into hydrogen peroxide, which is detoxified by both GPx and CAT activities. SOD and GPx activities decreased in liver and white muscle of the tilapia in relation to reference, except in gills that SOD activity increased.



Enzyme activity can be decreased by negative feedback from excess of substrate or damage by oxidative modification. However, the decreased activities of CAT and GPx enzymes favour the accumulation of H₂O₂ and this serves as a substrate for hydroxyl radical generating reaction leading to enhanced lipid peroxidation (Halliwell and Gutteridge, 1985).

The inhibition of catalase by O₂⁻ would provide an explanation for several otherwise puzzling reports of synergism between catalase and superoxide dismutase. Superoxide dismutase, which offered very little protection when acting alone, markedly enhanced the protective effect of catalase. In other words it is the coping mechanism of fish to the oxidative stress induced to the exposure to the effluent.

In the present study it is eminent that in the liver of *T. jarbua* the Catalase activity is high in the 5th day when compared to the other treatment. This is primarily because the animal has started to reduce the oxidative stress over the time period of exposure. On the 15th day it is found that the enzyme activity is almost similar to that of the control. On the contrary the SOD activity is found to be increasing along with the exposure period. Similar results were reported by (Kono and Fridovich 1982) where they particularly noted a decline in CAT activity attributed to an increase in SOD and O₂⁻ (superoxide anion) production by the pollutants. LPO (oxidation of unsaturated fatty acid) is induced by free radicals, reactive oxygen species (ROS) generally, glutathione family serve as enzyme dependent antioxidant in cell, which captures free radicals, when

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oxidants (free radicals) level exceeds anti-oxidants, cells undergo in stress condition which we call oxidatave stress. Hence the high level LPO and low level of glutathione.In L. calcarifer the enzymes were not found to be very high.

In T. jarbua and L. calcarifer all the enzymes except lipid peroxidase were found to be more in the liver followed by kidney and muscle. This suggest that there was no cell damage and lysis that leads to the enhanced levels of enzymes in the blood stream and muscles. LPO was found to be high in Kidney followed by liver and muscles. The increase in LPO is another mechanism of coping with the stress induced by the effluent.

HISTOPATHOLOGICAL STUDIES

Stored andsorted samples of gills, liver and Kidney were taken for histopathological studies. Histology is the study of tissue structure, extending from the level of the individual cell, through organs to organ systems. Histology is obviously related to cell biology (cytology) and to Anatomy; it also forms the structural basis for understanding Function (physiology) and is the preparation for the study of abnormal structure and function (pathology).

Histopathology is the microscopic examination and study of diseased biological cells and tissues. The microscopic study of tissue is an important tool in anatomical pathology, since accurate diagnosis of many diseases usually requires histopathological examination of samples.

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PREPARING FINFISH SAMPLES FOR HISTOLOGY

Fixing specimens for histology involves the handling of potentially dangerous chemical products. PPP was made mandatory while handling the chemicals and fixatives in the lab.

MATERIALS

- Disposables gloves
- Goggles
- Vials or Plastic containers of the appropriate size relevant to the size of specimens to be fixed
- Fixative solution (10% NBF)
- Dissecting instruments (scalpel, scissors, forceps, etc.)
- Labels
- Pencil

Fixative (10% neutral buffered formalin (1 Litre)):

- 100ml Formalin (37-40% stock solution)
- 900ml Water
- 4g/L NaH_2PO_4 (monobasic)
- 6.5g/L Na_2HPO_4 (dibasic/anhydrous)

SAMPLING OF FISH:

Live or moribund or recently dead (less than ½ hour to 1 hour) specimens with apparent signs of disease should be fixed for histology examination.

SAMPLE FIXATION:

- Fish samples were anaesthetized or chilled and then immediately fixed with appropriate fixative (10% NBF)

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- Fish fry- those measuring less than 3 cm can be injected fixative into abdominal cavity and placed whole fishes in fixative.
- Fish that are larger than 3 cm in body length, open up the body cavity to allow fixative to penetrate into the deeper tissues.
- Fish that are larger than 10 cm, open the body cavity and dissect the target organs like Brain, eye, Liver, Spleen, Kidney, heart & gills immediately placed into fixative.
- It is recommended that at least ten volumes of fixative for each volume of tissue samples (ratio of 1 part tissue to at least 9 parts formalin).
- Samples are allowed to fix for at least 24-48 hours before processing.
- Carefully label each samples (use pencil, do not use ink or marker pens).

Steps involved Histology

- Fixation of samples
- Tissue processing
- Paraffin embedding
- Microtome Sectioning
- H&E staining
- Mounting & observation

Fixation of samples:

The animals that show typical clinical signs should be sampled and tissue samples should be taken only from live animals because tissues of fish or aquatic invertebrates that have been dead for 30 minutes are usually already inappropriate for histology.

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TISSUE PROCESSING;

Tissue processing is done to remove water from biological tissues, replacing with a medium that solidifies, setting very hard so allowing extremely thin sections to be sliced. Treatment of the tissue is necessary to impregnate it into a solid medium so that the tissue is rendered sufficiently firm yet elastic for the tissue sections of desirable thickness to be cut on microtome.

SAMPLE DISSECTION:

STAGES OF PROCESSING:

- Dehydration.
- Clearing.
- Impregnation of wax

ROUTINE TISSUE PROCESSING;

DEHYDRATION;

- 70% Ethyl alcohol- 1 hour
- 80% Ethyl alcohol- 1 hour
- 90% Ethyl alcohol- 1 hour
- 100% Ethyl alcohol- 1 hour
- 100% Ethyl alcohol- 1 hour

CLEARING;

- Xylene-01- 1 hour
- Xylene -02 - 1 hour

IMPREGNATION OF WAX;

- Paraffin wax-01 - 1-2 hours
- Paraffin wax-02 - 1-2 hours



stained blue and cytoplasm and many extra-cellular components in shades of pink.

BASIC STEPS IN STAINING PROCESS

1. Deparaffinization
2. Hydration
3. Staining
4. Dehydration and clearing

ROUTINE H&E STAINING PROCESS

- | | |
|------------------------------|-------------------------------------|
| 1. Xylene-01 - 5 min. | 8. Hematoxylin - 4-6 min. |
| 2. Xylene-02 - 5 min. | 9. Running tap water - 4-5 min. |
| 3. 100% EtOH - 15 dips | 10. Phloxine/eosin - 45 sec -1 min. |
| 4. 90% EtOH - 15 dips | 11. 95% EtOH - 10 dips |
| 5. 80% EtOH - 15 dips | 12. 100% EtOH - 10 dips |
| 6. 60% EtOH - 15 dips | 13. 100% EtOH - 10 dips |
| 7. Distilled water - 1-2 min | 14. Xylene - 10 dips |

MOUNTING & OBSERVATION

Resinous mounting media (D.P.X) is routinely used for mounting agent. After H&E staining and clearing off the slides, add a drop of mountant on the cover slip and slides are inverted on to the cover slip. Care should be taken to avoid air bubbles.

RESULTS AND DISCUSSIONS

Alkalinity is an important criterion for determining the effect and concentration of water quality constituents and criteria; and therefore, the general suitability of a

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water source for the survivability of fish. Water of low alkalinity (<20 mg/LCaCO₃) is considered to be less suitable for fish survival due to the associated unstable water chemistry. The upper limit of alkalinity is largely defined by individual species requirements and the magnitude of the concomitant increase in pH value. In general, freshwater fish in hard water (100-150 mg/LCaCO₃) tend to spend less energy on osmoregulation, resulting in a better growth. The upper limit of alkalinity may also be related to its effect on osmoregulation at high ion concentrations (Department of Water Affairs and Forestry, 1996).

EFFLUENT TOXICITY TO FISHES

The animals did not show any major signs or symptoms in behaviour. Feeding was found to be normal during the test period. Fishes survived the whole test period. The ionic composition of water is important for all fish.

Gills of <i>L. calcarifer</i>			
Control	5 days treatment	10 days treatment	15 days treatment
Kidney of <i>L. calcarifer</i>			
Control	5 days treatment	10 days treatment	15 days treatment
Liver of <i>L. calcarifer</i>			
Control	5 days treatment	10 days treatment	15 days treatment

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HISTOPATHOLOGICAL MANIFESTATIONS

The Liver, Gills and Kidney samples were observed for any morphological or pathological abnormalities due to the effluent exposure under a microscope.

Calcium magnesium are essential elements that play a vital role in the osmolality in aquatic animals. Any imbalance in the Ca^{2+} and Mg^{2+} will have an impact on them which depends on the Ca:Mg ratio. The concentrations of the divalent cations Ca^{2+} and Mg^{2+} play a vital role in the ionic regulation of freshwater fish because these ions modulate branchial permeability. (Wendelaar et.al., 1983). Water is also an important source of the Ca^{2+} and Mg^{2+} required for fish growth. (Bijveldsetal., 1998 and Flik G. 2009) Ca^{2+} and Mg^{2+} are the main contributors to the Total Hardness (TH) of water, which is generally considered to be an important factor in fish culture. Numerous studies have demonstrated that TH has significant influences on fertilization, hatching, and larval culture. In particular, inappropriate TH has been associated with fertilization failure, (Ofor and Udeh 2012), hatching failure, (Chatakondi and Torrans 2012, Gonzai et, al., 1987, Molokwu and Okpokwasili 2002 and Spade and Bristow 1999), larval abnormality, (Molokwu and Okpokwasili 2002), retardation of growth and development, and mortality. (Molokwu and Okpokwasili 2002, Bart et. al., 2012, Townsend et.al., 2003). In addition, the relative proportions of Ca^{2+} and Mg^{2+} in the water, expressed as the Ca:Mg ratio are important in fish culture, and imbalances between Ca^{2+} and Mg^{2+} adversely affect embryonic development, (Brown and Lynam 1981, Shi et.al., 1995, Silva et.al., 2003, van

der Velden et.al., 1991, Wang et.al., 2002).larval growth, and survival (Silva et.al., 2005) An appropriate TH (i.e.)Ca:Mg ratio of the ambient water is essential for the successful culture of fish.

A Mg^{2+} hardness less than 10 mg/L $CaCO_3$ impeded the embryonic development of common carp when the Ca^{2+} hardness was 80 mg/L $CaCO_3$ (van der Velden et.al., 1991). Another study found that magnesium sulfate is toxic to aquatic organisms and that its toxicity is dependent on the Ca^{2+} concentration (van Dam et.al., 2010).. It is plausible that there is a minimum requirement for waterborne Ca^{2+} and Mg^{2+} during the early life stages of fishes. On the other hand, in the present study juvenile *L. calcarifer* and sub adult *T. Jarbua* were able to show normal growth in the test medium.

In the fish *L. calcarifer*, concentration of hemocytes was observed in the gills and it was progressive to the exposure period. The kidneys did not show observable pathological changes in *L. calcarifer*. The liver however showed progressive fatty degeneration and in the 15 days treatment it was severe forming larger globules and degeneration of the hepatocytes.

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Gills of T.jarbua			
Control	5 days	10 days	15 days
Kidney of T.jarbua			
Control	5 days	10 days	15 days
Liver of T.jarbua			
Control	5 days	10 days	15 days

In case of T.jarbua the manifestations were minimal except in the kidneys. The gills showed edema and mild congestion during the 5 days treatment. In the 10 and 15 days treatment the gills looked normal similar to that of the control. did not have any pathological manifestation throughout the exposure period. The kidneys showed hyaline degeneration. Kidney damage in the form of hyaline degeneration is characterized by swollen tubular cell, nuclear membrane, shrinking tubular lumen, the appearance of hyaline objects in some tubular lumen, and pink color in hematoxylin– eosin staining. Kidney tissue damages, such as Glomerular destruction, hemorrhagic and leucocytic infiltration are

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considered as main histopathological effect. The degeneration was progressive throughout the exposure for 15 days. This is mainly due the lab conditions where the animals were exposed under controlled conditions. This may not happen in the open seas as the possibility of mixing and dilution is more.

TO CONCLUDE

1. There have been no fatalities in fish during the study period, and hence the effluents can be considered relatively safe regarding sea discharge.
2. The present study is conducted for a period of 5, 10 and 15 days and the factors were limited to laboratory conditions.
3. The effluent disposed gets diluted and mixes rapidly with sea water.
4. This mixing is aided more by the wave dominated nature of the coromandel coast.
5. In spite of the altered histopathology, the biochemical analysis of enzymes show that the animals were under stress and didn't have any manifestations
6. The animal study shows the capability of animals to survive the conditions of 50% raw effluent mixing with the coastal waters.
7. In reality the effluent is diluted in the order of 500 times in 60 Meter distance from the outfall and it further get diluted to 1000 times at a distance of 200 Meter.
8. The impact of and the presence of other substances in the open waters may antagonise the effect of excess Ca and Mg ions in the effluent.
9. The coastal waters will however dilute the effluent and hence such an impact will not be seen in the real-world scenario.

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10. It is also suggested to periodically monitor the water quality in a radius of 10 km to find out the plume movement and relative impacts on the faunal assemblages.

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GLens Innovation Labs Pvt Ltd.

NABL ACCREDITED AS PER ISO/IEC 17025 : 2017, CERTIFIED AS PER ISO 9001:2015 & ISO 45001 : 2018

TEST REPORT

Report No : EN20070035-01 Report Date : 03 Aug 2020

SAMPLE NOT DRAWN BY LABORATORY

Customer Name : M/S.Manali Petro Chemicals Limited

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

Sample Name : Water

Sample Description : Treated Effluent Water (100 times diluted effluent)

Sample No : EN20070035-01

Sample Location : Sea disposal sample before entering to Sea Sample Received on : 28 Jul 2020

Sample Condition : Fit for Analysis Test Started on : 28 Jul 2020

Sample Quantity : 20 Litre Test Completed on : 03 Aug 2020

Test Results

Sl.No	Test Name	Test Method	Results
1	Bio Assay	IS 6582 Part 2 -2001	100% Survival of Test Species (Zebra Fish) after 96 hours in 100% Effluent
2			100% Survival of Test Species (Zebra Fish) after 96 hours in 50% Effluent
3			100% Survival of Test Species (Zebra Fish) after 96 hours in 20% Effluent
4			100% Survival of Test Species (Zebra Fish) after 96 hours in 10% Effluent
5			100% Survival of Test Species (Zebra Fish) after 96 hours in 1% Effluent
6			100% Survival of Test Species (Zebra Fish) after 96 hours in 0.1% Effluent

End of Report

Page 1 of 1.

S. Hariharasudhan
Authorized Signature

S. HARIHARA SUDHAN
ASSISTANT MANAGER

#.6/1, 1st Floor, Sri Jothi Complex, Murugesan Street, Balavinayagar Nagar, Arumbakkam, Chennai - 600 106.

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raghuramanr

From: Balaguru <balaguru@manalipetro.com>
Sent: 16 November 2020 12:06
To: pibgmo@hckgroup.com
Cc: 'M Rajavel (Whole Time Director)'; 'PIB HR'; 'PIB Safety - Karthiban'; 'G.Ravindran (PIB - Quality Control)'
Subject: Kothari effluent reg

Kind attention:

Mr Premapriyan

As per CPCB advice and based on your request, MPL has taken sample from Kothari treated effluent discharge point, for checking the suitability of using your effluent in MPL process.

Please find below the analysis report of KPL effluent.

KOTHARI RO REJECTOR				
PARAMETERS	23.10.2020	27.10.2020	28.10.2020	06.11.2020
PH	7.5	7.4	7.5	7.6
Conductivity	20500	30800	25500	20000
Total Hardness	370	410	245	366
Calcium Hardness	220	240	150	192
P.Alkalinity	NT	NT	NT	NT
M.Alkalinity	175	210	225	172
Chlorides	10180	15500	14900	11200
Silica	42.7	43.5	25.17	36.1
Phosphate	4.6	3.5	4.5	4.2
Total Iron	0.34	0.48	0.23	0.29
TDS	12540	17810	16116	12760

- Based on the analysis report, it is clear that values of Chlorides, TDS, Conductivity, Silica in the effluent are high.
- The effluent with above characteristics is not suitable for MPL PO process. This will affect our process, plant operation, equipment's and product specification.
- High chloride content will restrict the chlorine solubility in the process and also increases the final chlorides in the effluent, which can potentially impact the bio treatment process and effluent characteristics of discharged effluent.
- Moreover, Ammoniacal nitrogen and Sulphate are higher in your effluent, which will also affect our reaction process and create impurities.

At present we are using MFL RO rejects and CMWSSB Secondary treated sewage in our plant. The above mentioned parameters are well below the limits in these sources and it is suitable for our process usage.

So kindly inform CPCB that as the above mentioned parameters are high and can affect MPL process, MPL is unable to use KPL sea disposal effluent for process requirement.

**RESEARCH & DEVELOPMENT AND QUALITY ASSURANCE
DEPARTMENT**

ANALYSIS REPORT

Ref: QA/404

Date: 10.11.2020

Sample : Kothari RO rejects water
 Source : Kothari RO plant
 Received on : 06.11.2020

Characteristics	Unit	Analysis	Specification for Raw Water
PH	----	7.6	7.0-8.3
Conductivity		20100	1200max
TDS	ppm	12760	800
P alkalinity as CaCO ₃	ppm	NIL	10
M alkalinity as CaCO ₃	ppm	172	220
Total Hardness as CaCO ₃	ppm	366	350
Ca Hardness as CaCO ₃	ppm	192	200
Chloride as CaCO ₃	ppm	10180	400
Phosphate as CaCO ₃	ppm	4.2	----
Silica as SiO ₂	ppm	37	50
Total Iron as Fe	ppm	0.29	0.3

**Note: The water dose not conforms to our specification W.R.T
TDS, conductivity, chlorides.**

T.S.V.
Head (QA)



MANAL PETRO
RESEARCH & DEVELOPMENT AND QUALITY ASSURANCE DEPARTMENT

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**RESEARCH & DEVELOPMENT AND QUALITY ASSURANCE
DEPARTMENT**

ANALYSIS REPORT

Ref: QA/404

Date: 25.10.2020

Sample : Kothari RO rejects water
Source : Kothari RO plant
Received on : 23.10.2020

Characteristics	Unit	Analaysis	Specification for Raw Water
PH	----	7.5	7.0-8.3
Conductivity		20500	1200max
TDS	ppm	12540	800
P alkalinity as CaCO ₃	ppm	NIL	10
M alkalinity as CaCO ₃	ppm	175	220
Total Hardness as CaCO ₃	ppm	370	350
Ca Hardness as CaCO ₃	ppm	220	200
Chloride as CaCO ₃	ppm	10180	400
Phosphate as CaCO ₃	ppm	4.6	-----
Silica as SiO ₂	ppm	42	50
Total Iron as Fe	ppm	0.10	0.3

**Note: The water dose not conforms to our specification W.R.T
TDS, conductivity, chlorides.**

Head (QA)

REGD. OFFICE: "SPIC House" 88, Mount Road, Gandy, Chennai - 600 032.

AN ISO 9001 & 14001 CERTIFIED COMPANY

CIN: L24294TN1906PLC013087 - visit us at : www.manalpetro.com

E-mail: shaurinagathan@manalpetro.com



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ANNEXURE - 24

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI
REPORT OF ANALYSIS

MARCH 2021

ROA No. 100/ 2020-21

Dated : 27.04.2021

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Three number of samples
Date and Time of Receipt : 10.03.2021 at 10.10 AM
Code No. & Point of Collection : 1. SR-48/03 - ETP outlet into Sea - T
2. SR-49/03 - Near TPL Gate - T
3. SR-50/03 - Near Sea Shore - T

Sl. No	Parameters	Unit	1	2	3
1.	pH	Number	7.52	7.54	7.48
2.	Total Suspended Solids	mg/L	28	24	22
3.	Total Dissolved Solids	mg/L	49806	47402	48138
4.	Chlorides	mg/L	39988	40987	28991
5.	Sulphates	mg/L	194	100	103
6.	BOD for 3 days at 27 ^o C	mg/L	12	9	11
7.	Chemical Oxygen Demand	mg/L	104	80	88
8.	Phosphate	mg/L	<0.15	<0.15	<0.15
9.	Cyanide	mg/L	<0.005	<0.005	<0.005
10.	Phenolic Compounds	mg/L	<0.005	<0.005	<0.005
11.	Flouride	mg/L	1.1	1.0	1.1
12.	TRC	mg/L	<1	<1	<1
13.	Calcium	mg/L	18036	15631	16032
14.	Total Chromium	mg/L	<0.003	<0.003	<0.003
15.	Hexavalent Chromium	mg/L	<0.01	<0.01	<0.01
16.	Copper	mg/L	0.6019	0.5872	0.5912
17.	Zinc	mg/L	0.6517	0.5510	0.5672
18.	Lead	mg/L	<0.015	<0.015	<0.015
19.	Cadmium	mg/L	<0.008	<0.008	<0.008

Kanika Leonard
for CSO (L) 27/4/21
DEL, Manali



s MPL-I

9/6/4

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

REPORT OF ANALYSIS

FEB 2021

ROA No. 90 / 2020-21

Dated : 27.04.2021

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Three number of samples
Date and Time of Receipt : 19.02.2021 at 4.45 PM
Code No. & Point of Collection : 1. SR-37/02 - ETP outlet into sea - T
2. SR-38/02 - Near TPL Gate - T
3. SR-39/02 - Near Sea Shore - T

Sl.No	Parameters	Unit	1	2	3
1.	pH	Number	7.53	7.52	7.43
2.	Total Suspended Solids	mg/L	26	22	24
3.	Total Dissolved Solids	mg/L	43458	38228	40532
4.	Chlorides	mg/L	42987	37988	34989
5.	Sulphates	mg/L	135	73	93
6.	BOD for 3 days at 27 ^o C	mg/L	5	3	7
7.	Chemical Oxygen Demand	mg/L	24	16	32
8.	Phosphate	mg/L	<0.15	<0.15	<0.15
9.	Cyanide	mg/L	<0.005	<0.005	<0.005
10.	Phenolic Compounds	mg/L	<0.005	<0.005	<0.005
11.	Fluoride	mg/L	1.0	1.2	1.1
12.	TRC	mg/L	<1	<1	<1
13.	Calcium	mg/L	17234	15230	15631
14.	Total Chromium	mg/L	<0.003	<0.003	<0.003
15.	Hexavalent Chromium	mg/L	<0.01	<0.01	<0.01
16.	Copper	mg/L	<0.0015	<0.0015	<0.0015
17.	Zinc	mg/L	0.1124	0.1102	0.1019
18.	Lead	mg/L	<0.015	<0.015	<0.015
19.	Cadmium	mg/L	<0.008	<0.008	<0.008

for Kanitha Leonard
CSO (L) 27/4/21
DEL, Manali



g/s MPL - T

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

Nov 2020

REPORT OF ANALYSIS

ROA No. 52 / 2020-21

Dated : 08.12.2020

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Three number of samples
Date and Time of Receipt : 20.11.2020 at 01.15 PM
Code No. & Point of Collection : 1. SR-51/11 - ETP outlet into sea - T
2. SR-52/11 - Near TPL Gate - T
3. SR-53/11 - Near Sea Shore - T

Sl.No	Parameters	Unit	1	2	3
1.	pH	Number	7.52	7.56	7.61
2.	Total Suspended Solids	mg/L	20	18	22
3.	Total Dissolved Solids	mg/L	41326	42320	41936
4.	Chlorides	mg/L	31390	33390	30291
5.	Sulphates	mg/L	125	155	143
6.	Oils & Grease	mg/L	<1	<1	<1
7.	BOD for 3 days at 27 ⁰ C	mg/L	10	9	12
8.	Chemical Oxygen Demand	mg/L	64	56	72
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	1.24	1.20	1.18
13.	TRC	mg/L	<1	<1	<1
14.	Calcium	mg/L	12024	11623	12425
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	0.4310	0.5026	0.3316
19.	Lead	mg/L	<0.015	<0.015	<0.015
20.	Cadmium	mg/L	<0.008	<0.008	<0.008

8/12/2020
CSO (L)
DEL, Manali



MPL-I

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY MANALI

REPORT OF ANALYSIS

OCT 2020

ROA No. 41 / 2020-21

Dated : 07.11.2020

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Three number of samples
Date and Time of Receipt : 16.10.2020 at 05.20 PM

Code No. & Point of Collection : 1. SR-30/10 - ETP outlet into sea - T
2. SR-31/10 - Near TPI. Gate - T
3. SR-32/10 - Near Sea Shore - T

Sl.No	Parameters	Unit	1	2	3
1.	pH	Number	7.56	7.63	7.52
2.	Total Suspended Solids	mg/l.	26	24	22
3.	Total Dissolved Solids	mg/l.	45830	46204	46676
4.	Chlorides	mg/l.	30191	37288	35789
5.	Sulphates	mg/l.	164	180	211
6.	Oils & Grease	mg/l.	<1	<1	<1
7.	BOD for 3 days at 27 ^o C	mg/l.	12	11	10
8.	Chemical Oxygen Demand	mg/l.	64	56	48
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.	13627	15230	14028
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.	0.8650	0.9631	0.8843
18.	Zinc	mg/l.	0.3882	0.5899	0.4934
19.	Lead	mg/l.	<0.015	<0.015	<0.015
20.	Cadmium	mg/l.	<0.008	<0.008	<0.008

dw
7/11/2020

CSO (L)
DEE, Manali



M/s. MPL - I

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

REPORT OF ANALYSIS

DEC 2019

ROA No. 86 / 2019-20

Dated : 27.01.2020

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Three number of samples
Date and Time of Receipt : 27.12.2019 at 03.30 PM

Code No. & Point of Collection : 1. SR-15/12 - ETP outlet into sea - T
2. SR-16/12 - Near TPL Gate - T
3. SR-17/12 - Near Sea Shore - T

Sl.No	Parameters	Unit	1	2	3
1.	pH	Number	6.89	6.90	6.87
2.	Total Suspended Solids	mg/L	20	24	32
3.	Total Dissolved Solids	mg/L	26092	27822	30586
4.	Chlorides	mg/L	20085	24706	24140
5.	Sulphates	mg/L	266	141	172
6.	Oils & Grease	mg/L	<1	<1	<1
7.	BOD for 3 days at 27 ^o C	mg/L	13	7	9
8.	Chemical Oxygen Demand	mg/L	120	40	56
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	10421	10621	13226
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	0.8219	0.6219	0.3573
18.	Zinc	mg/L	0.3969	0.2919	0.1465
19.	Lead	mg/L	<0.015	<0.015	<0.015
20.	Cadmium	mg/L	<0.008	<0.008	<0.008

R.L.G.
CSO (L) 27/1/2020
DEL, Manali

M/S - MPL - I



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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

REPORT OF ANALYSIS

Nov 2019

ROA No. 75 / 2019-20

Dated : 26.01.2020

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Three number of samples
Date and Time of Receipt : 29.11.2019 at 04.15 PM

Code No. & Point of Collection : 1. SR-20/11 - ETP outlet into sea - T
2. SR-21/11 - Near TPL Gate - T
3. SR-22/11 - Near Sea Shore - T

Sl.No	Parameters	Unit	1	2	3
1.	pH	Number	6.68	7.08	6.97
2.	Total Suspended Solids	mg/L	26	22	30
3.	Total Dissolved Solids	mg/L	21150	19340	30320
4.	Chlorides	mg/L	19767	17356	27963
5.	Sulphates	mg/L	71	87	91
6.	Oils & Grease	mg/L	<1	<1	<1
7.	BOD for 3 days at 27 ^o C	mg/L	14	10	16
8.	Chemical Oxygen Demand	mg/L	80	64	96
9.	Phosphate	mg/L	0.18	<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	0.67	0.63	0.76
13.	TRC	mg/L	<1	<1	<1
14.	Calcium	mg/L	7415	7214	12024
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	0.7316	0.5208	0.7417
18.	Zinc	mg/L	0.4009	0.3642	0.4337
19.	Lead	mg/L	<0.015	<0.015	<0.015
20.	Cadmium	mg/L	<0.008	<0.008	<0.008

[Signature]
CSO (L)
DEL, Manali
26/1/2020



M/S MPL - UNIT - I

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

REPORT OF ANALYSIS

Feb 2019

ROA No. 138 / 2018 19

Dated : 15.03.2019

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Three number of samples
Date and Time of Receipt : 06.02.2019 at 11.45 AM
Code No. & Point of Collection : 1. VRS-33/02 - ETP Outlet into sea - T
2. VRS-34/02 - Near TPL Gate - T
3. VRS-35/02 - Near Sea Shore - T

Sl.No	Parameters	Unit	1	2	3
1.	pH	Number	6.93	7.10	7.05
2.	Total Suspended Solids	mg/L	72	86	76
3.	Total Dissolved Solids	mg/L	53722	51880	54422
4.	Chlorides	mg/L	32990	36739	43986
5.	Sulphates	mg/L	963	767	415
6.	Oils & Grease	mg/L	<1	<1	<1
7.	BOD for 3 days at 27 ⁰ C	mg/L	16	11	8
8.	Chemical Oxygen Demand	mg/L	200	200	240
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	1.04	1.02	1.1
13.	TRC	mg/L	<1	<1	<1
14.	Calcium	mg/L	18437	18036	18236
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	0.8976	0.9676	0.8702
18.	Zinc	mg/L	0.4895	0.2963	0.1726
19.	Lead	mg/L	<0.015	<0.015	<0.015
20.	Cadmium	mg/L	<0.008	<0.008	<0.008

Deputy CSO (L)
DEL, Manali
11/4/19



MPL-II

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

MARCH 2021

REPORT OF ANALYSIS

ROA No. 100/2020-21

Dated : 27.04.2021

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Two number of samples
Date and Time of Receipt : 10.03.2021 at 10.10 AM
Code No. & Point of Collection : 1. SR-51/03 - ETP outlet into Sea - T
2. SR-52/03 - Near Kothari connecting Point - T

Sl. No	Parameters	Unit	1	2
1.	pH	Number	7.56	7.52
2.	Total Suspended Solids	mg/L.	28	26
3.	Total Dissolved Solids	mg/L	48736	49400
4.	Chlorides	mg/L	32990	31990
5.	Sulphates	mg/L	74	138
6.	BOD for 3 days at 27 ⁰ C	mg/L	8	5
7.	Chemical Oxygen Demand	mg/L	64	48
8.	Phosphate	mg/L	<0.15	<0.15
9.	Cyanide	mg/L	<0.005	<0.005
10.	Phenolic Compounds	mg/L	<0.005	<0.005
11.	Flouride	mg/L	1.0	1.1
12.	TRC	mg/L	<1	<1
13.	Calcium	mg/L	18036	18437
14.	Total Chromium	mg/L	<0.003	<0.003
15.	Hexavalent Chromium	mg/L	<0.01	<0.01
16.	Copper	mg/L	<0.0015	<0.0015
17.	Zinc	mg/L	0.1220	0.1612
18.	Lead	mg/L	<0.015	<0.015
19.	Cadmium	mg/L	<0.008	<0.008

CSO (L)
DEL, Manali



MPL - II

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

REPORT OF ANALYSIS

FEB 2021

ROA No. 90 / 2020-21

Dated : 27.04.2021

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Two number of samples
Date and Time of Receipt : 19.02.2021 at 4.45 PM
Code No. & Point of Collection : 1. SR-40/02 - ETP outlet into sea - T
2. SR-41/02 - Near Kothari connecting point - T

Sl.No	Parameters	Unit	1	2
1.	pH	Number	7.56	7.51
2.	Total Suspended Solids	mg/L	26	24
3.	Total Dissolved Solids	mg/L	43810	43302
4.	Chlorides	mg/L	25992	34989
5.	Sulphates	mg/L	124	118
6.	BOD for 3 days at 27 ⁰ C	mg/L	7	8
7.	Chemical Oxygen Demand	mg/L	40	48
8.	Phosphate	mg/L	<0.15	<0.15
9.	Cyanide	mg/L	<0.005	<0.005
10.	Phenolic Compounds	mg/L	<0.005	<0.005
11.	Fluoride	mg/L	1.3	1.2
12.	TRC	mg/L	<1	<1
13.	Calcium	mg/L	17635	16834
14.	Total Chromium	mg/L	<0.003	<0.003
15.	Hexavalent Chromium	mg/L	<0.01	<0.01
16.	Copper	mg/L	<0.0015	<0.0015
17.	Zinc	mg/L	0.1210	0.1104
18.	Lead	mg/L	<0.015	<0.015
19.	Cadmium	mg/L	<0.008	<0.008

for Kanitha Leonard
CSO (L) 27/4/21
DEL, Manali



9/15 MPL - II

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

REPORT OF ANALYSIS

Nov 2020

ROA No.52/2020 - 21

Dated : 08.12.2020

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Two number of samples
Date and Time of Receipt : 20.11.2020 at 01.15 PM

Code No. & Point of Collection : 1. SR-54/11 - ETP outlet into sea -T
2. SR-55/11 - Near Kothari connecting point - T

Sl.No	Parameters	Unit	1	2
1.	pH	Number	7.51	7.63
2.	Total Suspended Solids	mg/l.	24	26
3.	Total Dissolved Solids	mg/L	43954	42178
4.	Chlorides	mg/L	31790	33290
5.	Sulphates	mg/L	148	135
6.	Oils & Grease	mg/L	<1	<1
7.	BOD for 3 days at 27 ⁰ C	mg/L	13	11
8.	Chemical Oxygen Demand	mg/L	80	64
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	1.05	1.12
13.	TRC	mg/L	<1	<1
14.	Calcium	mg/L	11222	10822
15.	Total Chromium	mg/L	<0.003	<0.003
16.	Hexavalent Chromium	mg/L	<0.01	<0.01
17.	Copper	mg/L	0.2015	0.3010
18.	Zinc	mg/L	0.3124	0.3218
19.	Lead	mg/L	<0.015	<0.015
20.	Cadmium	mg/L	<0.008	<0.008

ah
8/12/2020
CSO (L)
DEL, Manali



9/15 MPL-II

973

OCT 2020

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

REPORT OF ANALYSIS

ROA No.41/2020 - 21

Dated : 07.11.2020

Name of the Sender : DEI/Ambattur
Nature and Number of sample : Two number of samples
Date and Time of Receipt : 16.10.2020 at 05.20 PM

Code No. & Point of Collection : 1. SR-33/10 - ETP outlet into sea - T
2. SR-34/10 Near Kothari connecting point - T

Sl.No	Parameters	Unit	1	2
1.	pH	Number	7.61	7.62
2.	Total Suspended Solids	mg/l.	24	22
3.	Total Dissolved Solids	mg/l.	42332	45204
4.	Chlorides	mg/l.	29191	32990
5.	Sulphates	mg/L	196	211
6.	Oils & Grease	mg/l.	<1	<1
7.	BOD for 3 days at 27 ^o C	mg/l.	14	10
8.	Chemical Oxygen Demand	mg/l.	72	64
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.	12425	13226
15.	Total Chromium	mg/l.	<0.003	<0.003
16.	Hexavalent Chromium	mg/l.	<0.01	<0.01
17.	Copper	mg/L	1.2399	1.3216
18.	Zinc	mg/L	0.5440	0.4125
19.	Lead	mg/l.	<0.015	<0.015
20.	Cadmium	mg/l.	<0.008	<0.008

7/11/2020

CSO (I.)
DEI., Manali



M/S. MPL - II

9/1/19

TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

REPORT OF ANALYSIS

DEC 2019

ROA No. 86/2019 - 20

Dated : 27.01.2020

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Two number of samples
Date and Time of Receipt : 27.12.2019 at 03.30 PM

Code No. & Point of Collection : 1. SR-18/12 - ETP outlet into sea - T
2. SR-19/12 - Near Kothari connecting point - T

Sl.No	Parameters	Unit	1	2
1.	pH	Number	7.52	6.89
2.	Total Suspended Solids	mg/L	12	24
3.	Total Dissolved Solids	mg/L	3456	28222
4.	Chlorides	mg/L	2027	20180
5.	Sulphates	mg/L	55	188
6.	Oils & Grease	mg/L	<1	<1
7.	BOD for 3 days at 27 ⁰ C	mg/L	10	11
8.	Chemical Oxygen Demand	mg/L	64	104
9.	Phosphate	mg/L	<0.15	0.56
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	1403	11022
15.	Total Chromium	mg/L	<0.003	<0.003
16.	Hexavalent Chromium	mg/L	<0.01	<0.01
17.	Copper	mg/L	0.2482	0.9138
18.	Zinc	mg/L	0.3912	0.5554
19.	Lead	mg/L	<0.015	<0.015
20.	Cadmium	mg/L	<0.008	<0.008

CSO (L) 22/1/2020
DEL, Manali



M/S. MPL - II

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TAMIL NADU POLLUTION CONTROL BOARD
DISTRICT ENVIRONMENTAL LABORATORY - MANALI

REPORT OF ANALYSIS

Nov 2019

ROA No. 75/2019 - 20

Dated : 26.01.2020

Name of the Sender : DEE/Ambattur
Nature and Number of sample : Two number of samples
Date and Time of Receipt : 29.11.2019 at 04.15 PM

Code No. & Point of Collection : 1. SR-23/11 - ETP outlet into sea -T
2. SR-24/11 - Near Kothari connecting point - T

Sl.No	Parameters	Unit	1	2
1.	pH	Number	7.15	7.03
2.	Total Suspended Solids	mg/L	24	28
3.	Total Dissolved Solids	mg/L	22506	27536
4.	Chlorides	mg/L	21695	23142
5.	Sulphates	mg/L	77	104
6.	Oils & Grease	mg/L	<1	<1
7.	BOD for 3 days at 27 ⁰ C	mg/L	13	15
8.	Chemical Oxygen Demand	mg/L	72	88
9.	Phosphate	mg/L	0.21	<0.15
10.	Cyanide	mg/L	<0.005	<0.005
11.	Phenolic Compounds	mg/L	<0.005	<0.005
12.	Fluoride	mg/L	0.88	0.72
13.	TRC	mg/L	<1	<1
14.	Calcium	mg/L	9218	11222
15.	Total Chromium	mg/L	<0.003	<0.003
16.	Hexavalent Chromium	mg/L	<0.01	<0.01
17.	Copper	mg/L	0.8947	0.5798
18.	Zinc	mg/L	0.4086	0.1477
19.	Lead	mg/L	<0.015	<0.015
20.	Cadmium	mg/L	<0.008	<0.008

CSO (L)
DEL, Manali
26/1/2020



CFC/FT-01/7.8/R3

CALIBRATION CERTIFICATE
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 Site : www.nagman.com



CC-2548

ULR-CC254821000010207F	Certificate Number : 2021-22 / CFC / 2918 / 3
Date of Issue : 26.04.2021	
Customer Name and Address	M/s.Manali Petrochemicals Limited, Plant-I, Ponneri High Road, Manali, Chennai - 600 068.
Customer Reference	E-mail Dated 11.03.2021
Details of the Instrument	
Location	ETP Outlet Plant - I
Description	Electromagnetic Flow meter
Make	Siemens
Model	SITRAN FM MAG 6000
Serial number	N1HD145118
Identification Number	-
Size	DN 150
Flow Medium	Water
Range	0 to 500 m ³ /hr
Resolution	0.1 m ³ /hr
Accuracy	±1%
Equipment received on	On Site
Condition of the equipment on receipt	Good
Method of Calibration	Comparison Method
Date of calibration	09/04/2021
Date of next calibration suggested	09/04/2022
Calibration environments	
Temperature	27.8°C
Relative humidity	56%
Standard Instrument Details	
Description	Ultrasonic Flowmeter
Make	Nagman
Type / Model	SONICNAG 6000
Serial number	81601579H
Report Number	2020-21/CFC/MASTER /109
Calibration valid till	23/09/2021
The Standards used are traceable to National / International Standards	



Authorised Signatory

D.Arun
Team Leader



CFC/FT-01/7.8/R3

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Site : www.nagman.com



CC-2546

ULR-CC254821000010207F

Certificate Number : 2021-22 / CFC / 2918 / 3

CALIBRATION DATA

Fluid Flow : Flow Measuring Devices

Test Reading (UUC)	Standard Reading	Error	Expanded Uncertainty ±	Coverage Factor
m ³ /hr	m ³ /hr	m ³ /hr	(%)	k
50.8	51.236	-0.436	1.20	2.00
153.9	155.106	-1.206	1.20	2.00
258.6	260.327	-1.727	1.20	2.00
355.6	358.015	-2.415	1.20	2.00
453.7	457.232	-3.532	1.20	2.00

Remarks:-

1. The above UUC is calibrated at Site.
2. UUC is defined as Unit Under Calibration.
3. Error = Test Reading - Standard Reading
4. The measurement confidence level is 95%.
5. The Calibration Certificate shall not be reproduced except in full without written approval of CFC.
6. The above results relate only to the item calibrated.
7. The decision rule will be applied based on the statement of conformity requested by the customer.
8. The results are provided as observed without any adjustments.

Authorised Signatory

D. Arun
D. Arun

Team Leader



Page 02 of 02

----- End of the Report -----



CFC/FT-017.8/R3

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Site : www.nagman.com



CC-2546

ULR-CC254821000010208F	Certificate Number : 2021-22 / CFC / 2918 / 4
Date of Issue : 26.04.2021	
Customer Name and Address	M/s.Manali Petrochemicals Limited, Plant-I, Ponneri High Road, Manali, Chennai - 600 068.
Customer Reference	E-mail Dated 11.03.2021
Details of the Instrument	
Location	Near ECH (TPL Plant)
Description	Electromagnetic Flow meter
Make	Siemens
Model	SITRAN FM MAG 6000
Serial number	N110305002
Identification Number	-
Size	DN 150
Flow Medium	Water
Range	0 to 500 m ³ /hr
Resolution	0.1 m ³ /hr
Accuracy	±1%
Equipment received on	On Site
Condition of the equipment on receipt	Good
Method of Calibration	Comparison Method
Date of calibration	09/04/2021
Date of next calibration suggested	09/04/2022
Calibration environments	
Temperature	27.8°C
Relative humidity	56%
Standard Instrument Details	
Description	Ultrasonic Flowmeter
Make	Nagman
Type / Model	SONICNAG 6000
Serial number	81601579H
Report Number	2020-21/CFC/MASTER /109
Calibration valid till	23/09/2021
The Standards used are traceable to National / International Standards	



Authorised Signatory

D. Arun
D. Arun

Team Leader



CFC/FT-01/7.8/R3

CALIBRATION CERTIFICATE

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Site : www.nagman.com



CC-2548

ULR-CC254821000010208F

Certificate Number : 2021-22 / CFC / 2918 / 4

CALIBRATION DATA**Fluid Flow : Flow Measuring Devices**

Test Reading (UUC)	Standard Reading	Error	Expanded Uncertainty \pm	Coverage Factor
m ³ /hr	m ³ /hr	m ³ /hr	(%)	k
60.6	59.998	0.602	1.20	2.00
127.8	126.623	1.177	1.20	2.00
215.5	213.954	1.546	1.20	2.00
322.7	320.025	2.675	1.20	2.00
418.6	415.329	3.271	1.20	2.00
457.3	453.973	3.327	1.20	2.00

Remarks:-

1. The above UUC is calibrated at Site.
2. UUC is defined as Unit Under Calibration.
3. Error = Test Reading - Standard Reading
4. The measurement confidence level is 95%.
5. The Calibration Certificate shall not be reproduced except in full without written approval of CFC.
6. The above results relate only to the item calibrated.
7. The decision rule will be applied based on the statement of conformity requested by the customer.
8. The results are provided as observed without any adjustments.



Authorised Signatory

D. Arun

Team Leader

Page 02 of 02

----- End of the Report -----



CFC/FT-01/7.0/R3

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Site : www.nagman.com



CC-2548

ULR-CC254821000010209F	Certificate Number : 2021-22 / CFC / 2918 / 5
Date of Issue : 26.04.2021	
Customer Name and Address	M/s.Manali Petrochemicals Limited, Plant-I, Ponneri High Road, Manali, Chennai - 600 068.
Customer Reference	E-mail Dated 11.03.2021
Details of the Instrument	
Location	Ernavoor Briedge Near MPL+Plant 1+Plant 2+TPL+KOTHARI
Description	Electromagnetic Flow meter
Make	Siemens
Model	SITRAN FM MAG 6000
Serial number	NIHD165087
Identification Number	-
Size	DN 200
Flow Medium	Water
Range	0 to 500 m ³ /hr
Resolution	0.1 m ³ /hr
Accuracy	±1%
Equipment received on	On Site
Condition of the equipment on receipt	Good
Method of Calibration	Comparison Method
Date of calibration	09/04/2021
Date of next callibration suggested	09/04/2022
Calibration environments	
Temperature	27.8°C
Relative humidity	56%
Standard Instrument Details	
Description	Ultrasonic Flowmeter
Make	Nagman
Type / Model	SONICNAG 6000
Serial number	81601579H
Report Number	2020-21/CFC/MASTER /109
Calibration valid till	23/09/2021
The Standards used are traceable to National / International Standards	



Authorised Signatory


D.Arun

Team Leader



CFC/FT-01/7.8/R3

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Site : www.nagman.com



CC-2548

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ULR-CC254821000010209F

Certificate Number : 2021-22 / CFC / 2918 / 5

CALIBRATION DATA

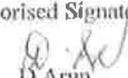
Fluid Flow : Flow Measuring Devices

Test Reading (UUC)	Standard Reading	Error	Expanded Uncertainty ±	Coverage Factor
m ³ /hr	m ³ /hr	m ³ /hr	(%)	k
102.1	101.965	0.135	1.20	2.00
217.3	218.564	-1.264	1.20	2.00
315.5	318.215	-2.715	1.20	2.00
422.8	419.968	2.832	1.20	2.00
446.9	442.851	4.049	1.20	2.00

Remarks:-

1. The above UUC is calibrated at Site.
2. UUC is defined as Unit Under Calibration.
3. Error = Test Reading - Standard Reading
4. The measurement confidence level is 95%.
5. The Calibration Certificate shall not be reproduced except in full without written approval of CFC.
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7. The decision rule will be applied based on the statement of conformity requested by the customer.
8. The results are provided as observed without any adjustments.



Authorised Signatory

 D. Arun
 Team Leader

Page 02 of 02

----- End of the Report -----

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 Site : www.nagman.com



CC-2548

ULR-CC254821000010205F		Certificate Number : 2021-22 / CFC / 2918 / 1
Date of Issue : 26.04.2021		
Customer Name and Address	M/s.Manali Petrochemicals Limited, Plant-II, Sathangadu Village, Manali, Chennai - 600 068.	
Customer Reference	E-mail Dated 11.03.2021	
Details of the Instrument		
Location	ETP Outlet Plant - II	
Description	Electromagnetic Flow meter	
Make	Yokogawa	
Model	AXFA14C	
Serial number	854C01743	
Identification Number	-	
Size	DN 150	
Flow Medium	Water	
Range	0 to 200 m ³ /hr	
Resolution	0.1 m ³ /hr	
Accuracy	±1%	
Equipment received on	On Site	
Condition of the equipment on receipt	Good	
Method of Calibration	Comparison Method	
Date of calibration	05/04/2021	
Date of next calibration suggested	05/04/2022	
Calibration environments		
Temperature	27.8°C	
Relative humidity	56%	
Standard Instrument Details		
Description	Ultrasonic Flowmeter	
Make	Nagman	
Type / Model	SONICNAG 6000	
Serial number	81601579H	
Report Number	2020-21/CFC/MASTER /109	
Calibration valid till	23/09/2021	
The Standards used are traceable to National / International Standards		



Authorized Signatory

 D.Arun
 Team Leader



CFC/FT-01/7.&IR3

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Site : www.nagman.com



CC-2548

ULR-CC254821000010205F

Certificate Number : 2021-22 / CFC / 2918 / 1

CALIBRATION DATA

Fluid Flow : Flow Measuring Devices

Test Reading (UUC)	Standard Reading	Error	Expanded Uncertainty ±	Coverage Factor
m ³ /hr	m ³ /hr	m ³ /hr	(%)	k
26.4	25.875	0.525	1.20	2.00
48.3	47.936	0.364	1.20	2.00
102.5	103.158	-0.658	1.20	2.00
153.7	154.759	-1.059	1.20	2.00
192.6	194.328	-1.728	1.20	2.00

Remarks:-

1. The above UUC is calibrated at Site.
2. UUC is defined as Unit Under Calibration.
3. Error = Test Reading - Standard Reading
4. The measurement confidence level is 95%.
5. The Calibration Certificate shall not be reproduced except in full without written approval of CFC.
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7. The decision rule will be applied based on the statement of conformity requested by the customer.
8. The results are provided as observed without any adjustments.



Authorised Signatory

D. Arin
D. Arin

Team Leader

Page 02 of 02

----- End of the Report -----

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CFC/FT-01/7.8/R3

CALIBRATION CERTIFICATE

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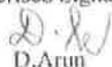


CC-2549

ULR-CC254921000010206F	Certificate Number : 2021-22 / CFC / 2918 / 2
Date of Issue : 26.04.2021	

Customer Name and Address	M/s.Manali Petrochemicals Limited, Plant-II; Sathangadu Village, Manali, Chennai - 600 068.
Customer Reference	E-mail Dated 11.03.2021
Details of the Instrument	
Location	Plant - II TES O/L
Description	Electromagnetic Flow meter
Make	Siemens
Model	SITRAN FM MAG 6000
Serial number	NIHD145114
Identification Number	-
Size	DN 150
Flow Medium	Water
Range	0 to 200 m ³ /hr
Resolution	0.1 m ³ /hr
Accuracy	±1%
Equipment received on	On Site
Condition of the equipment on receipt	Good
Method of Calibration	Comparison Method
Date of calibration	05/04/2021
Date of next calibration suggested	05/04/2022
Calibration environments	
Temperature	27.8°C
Relative humidity	56%
Standard Instrument Details	
Description	Ultrasonic Flowmeter
Make	Nagman
Type / Model	SONICNAG 6000
Serial number	81601579H
Report Number	2020-21/CFC/MASTER /109
Calibration valid till	23/09/2021
The Standards used are traceable to National / International Standards	



Authorised Signatory

 D.Arjun
 Team Leader

986



CFC/FY-01/7.8/R3

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CC-2548

ULR-CC254821000010206F Certificate Number : 2021-22 / CFC / 2918 / 2

CALIBRATION DATA

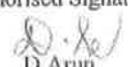
Fluid Flow : Flow Measuring Devices

Test Reading (UUC)	Standard Reading	Error	Expanded Uncertainty ±	Coverage Factor
m ³ /hr	m ³ /hr	m ³ /hr	(%)	k
30.2	29.952	0.248	1.20	2.00
52.6	52.223	0.377	1.20	2.00
102.8	101.967	0.833	1.20	2.00
152.9	151.556	1.344	1.20	2.00
194.1	192.457	1.643	1.20	2.00

Remarks:-

1. The above UUC is calibrated at Site.
2. UUC is defined as Unit Under Calibration.
3. Error = Test Reading - Standard Reading
4. The measurement confidence level is 95%.
5. The Calibration Certificate shall not be reproduced except in full without written approval of CFC.
6. The above results relate only to the item calibrated.
7. The decision rule will be applied based on the statement of conformity requested by the customer.
8. The results are provided as observed without any adjustments.



Authorised Signatory

 D.Arun
 Team Leader



AQUATIO DIVING

Underwater Inspections Hull Cleaning and Leak Repairs, Video, Photography, Salvage, Plugging & Engineering Works

INC/AD/21/2019-20

24.03.2020

TREATED EFFLUENT DISPOSAL LINE INSPECTION REPORT

This is to certify that, we the under signed M/s. AQUATIO DIVING, did the Effluent Disposal line inspection as per the request of M/S. MANALI PETROCHEMICALS LIMITED from Plant I to Sathyamoorthy Nagar, from Plant II to Sathyamoorthy Nagar and from Sathyamoorthy Nagar to Surface sea discharge Point. Inspection carried out from 09.03.2020 to 18.03.2020.

INSPECTION SUMMARY:

M/S. MANALI PETROCHEMICALS LIMITED, AND M/S. AQUATIO DIVING did joint inspection at about every 500 meters distance of the HDPE pipe line. In the inspection point we had excavated and checked the welding joints, in the flange area and stub end area and found to be normal. After that we have done pressure test carried out at 5 Kg/cm² pressure. Inspection Schedule for treated effluent disposal line and detail inspected area and points are attached in the annexure.

CONCLUSION

During the hydro test up to discharge point, the pipe line inspected for every 500m intervals. No leakage found in the welding joints and flange joints. No external crack found in the HDPE pipe lines, no indentation, or damages was observed.

The same type of survey to be carried out after three years. Based on the survey the action to be taken.

For AQUATIO DIVING

 AUTHORIZED SIGNATORY



AQUATIC DIVING

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Underwater Inspectors Hull Cleaning and Leak Repairs, Video, Photography, Salvage, Plugging & Engineering Works

ANNEXURE

SCHEDULE FOR TREATED EFFLUENT DISPOSAL LINE

Plant I to Sathyamoorthy Nagar
Plant II to Sathyamoorthy Nagar
Plant I & II Junction Area (Sathyamoorthy Nagar) to Surface sea discharge point

I. The inspection details from Plant I to Sathyamoorthy Nagar

PIPE LINE DESCRIPTION : TREATED EFFLUENT DISPOSAL LINE
HDPE PIPE (IS4984 PE100 PN10)
LENGTH : 1860 MTRS
OVER ALL DIA : 315 MM

MPL PLANT 1 TO TPL-ECH

No of Points inspected : 01 Point
Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.

TPL-ECH TO IAL OPPOSITE

No of Points inspected : 01 Point
Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.

IAL OPPOSITE TO SATHYAMOORTH NAGAR

No of Points inspected : 01 Point
Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.



AQUATIO DIVING

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Underwater Inspectors Hull Cleaning and Leak Repairs, Video, Photography, Salvage, Plugging & Engineering Works

II. The inspection details from Plant II to Sathyamoorthy Nagar

PIPE LINE DESCRIPTION : TREATED EFFLUENT DISPOSAL LINE
HDPE PIPE (IS4984 PE100 PN10)
LENGTH : 4170 MTRS
OVER ALL DIA : 280 MM

PLANT II TO BACKINGHAM CANEL

No of Points inspected : 02 Points
Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.

BACKINGHAM CANEL TO CARBAGE DUMP YARD

No of Points inspected : 02 Points
Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.

CARBAGE DUMP YARD TO RAJAJI NAGAR

No of Points inspected : 02 Points
Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.



AQUATIO DIVING

990

Underwater Inspectins Hull Cleaning and Leak Repairs, Video, Photography, Salvage, Plugging & Engineering Works

RAJAJI NAGAR TO KARGIL NAGAR

No of Points inspected : 02 Points

Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.

KARGIL NAGAR TO SATHYAMOORTHY NAGAR

No of Points inspected : 02 Points

Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.

III. The inspection details from Sathaymoorthy Nagar To Sea discharge Point

PIPE LINE DESCRIPTION : TREATED EFFLUENT DISPOSAL LINE
HDPE PIPE (IS4984 PE100 PN10)
LENGTH : 4400 MTRS
OVER ALL DIA : 400 MM

SATHYAMOORTHY NAGAR TO JOTHI NAGAR

No of Points inspected : 02 Points

Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.

991



AQUATIO DIVING

Underwater Inspectins Hull Cleaning and Leak Repairs, Video, Photography, Salvage, Plugging & Engineering Works

JOTHI NAGAR TO KAMARAJAR NAGAR

No of Points inspected : 02 Points

Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.

KAMARAJAR NAGAR TO RAILWAY TRACK

No of Points inspected : 01 Point

Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.

RAILWAY TRACK TO BHARATHIYAR NAGAR

No of Points inspected : 02 Points

Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.

BHARATHIYAR NAGAR TO SURFACE SEA DISCHARGE POINT

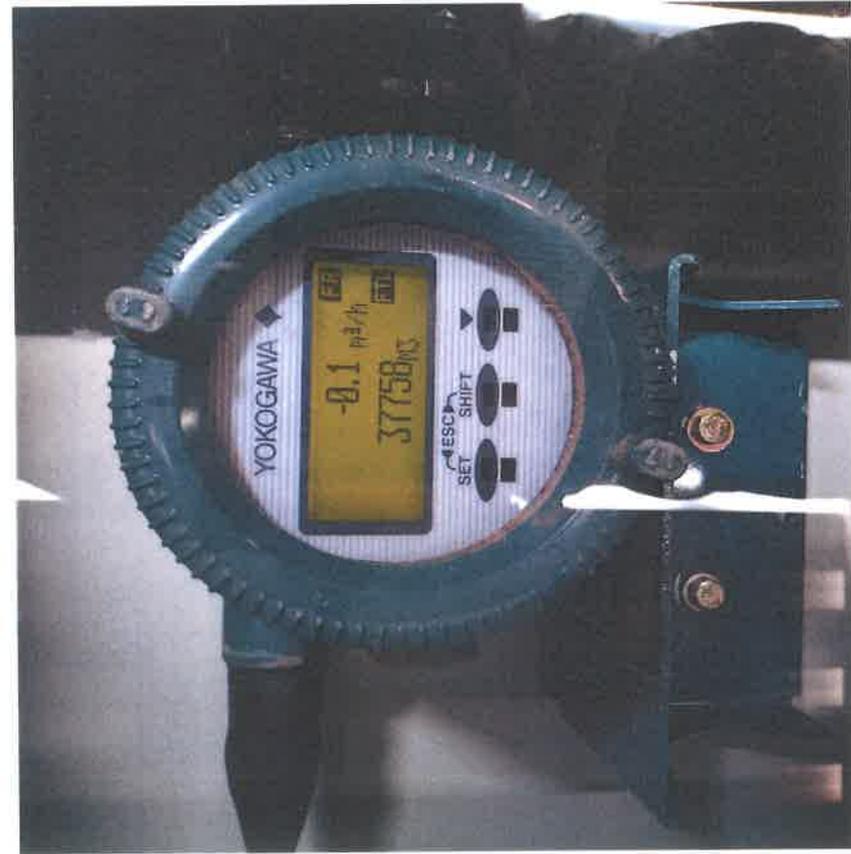
No of Points inspected : 01 Point

Remarks : No leakage observed in the welding joints,
No abnormality, No indentation and No
Surface crack was observed.

For

AQUATIO DIVING
AUTHORITY SIGNATORY

Metro Water Inlet

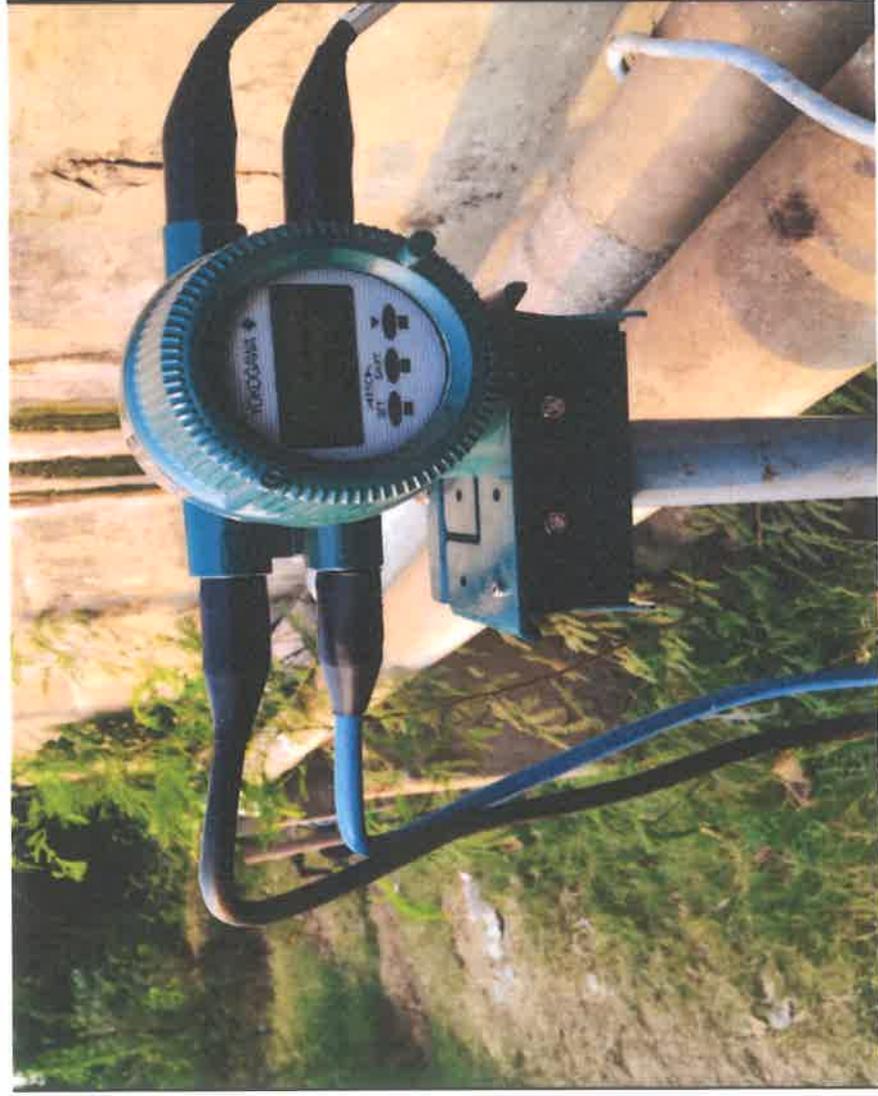


KGR Water Inlet at Plant-I



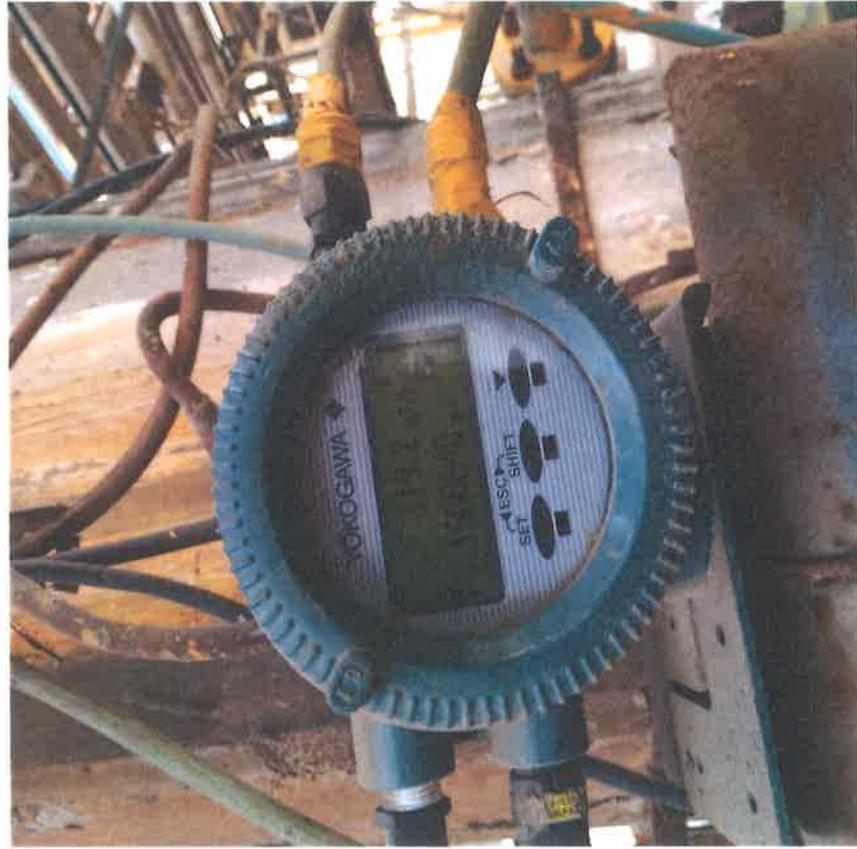
994

MFL RO Reject water



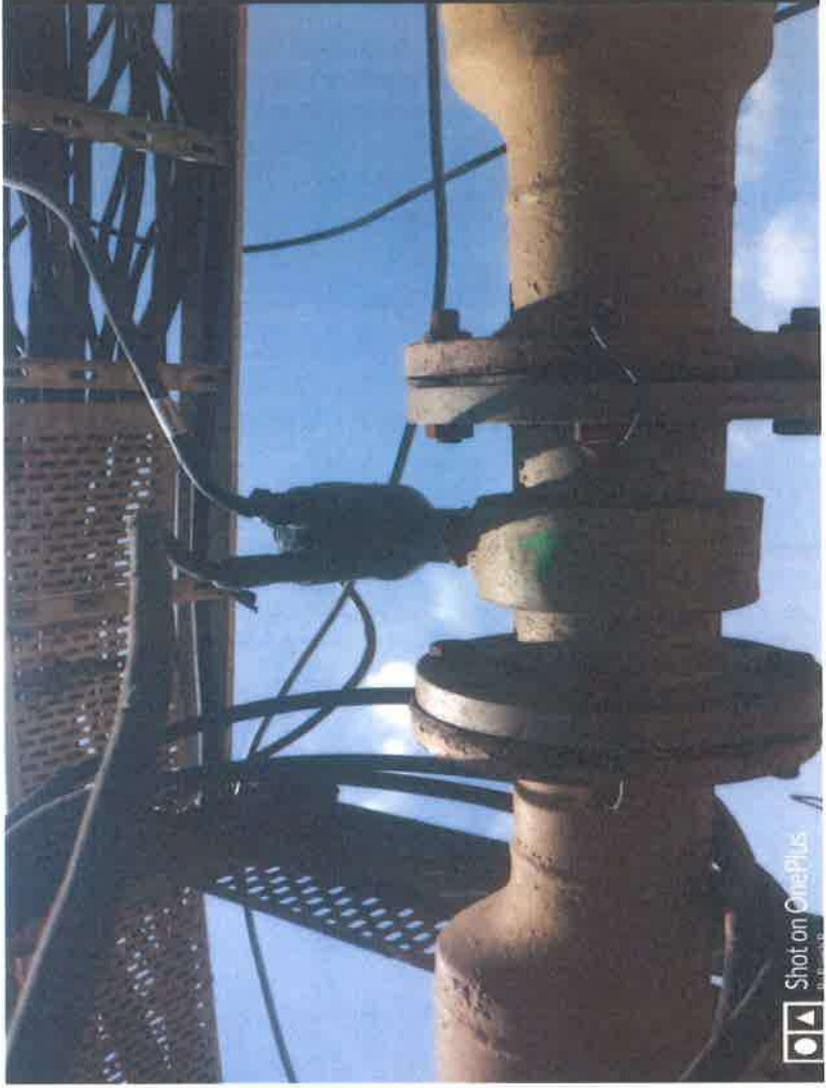
995

Saponifier Outlet to ETP



996

Feed to Bio-reactor – Plant -I



997

Treated effluent Outlet to Sea – Plant -I



8/6/2

TTRO Water Inlet-Plant -II



1000

1000

Metro water Inlet



KGR Water inlet at plant-02



10001

1002

Saponifier outlet to ETP

1002



Treated effluent outlet to Sea (Plant - 11)



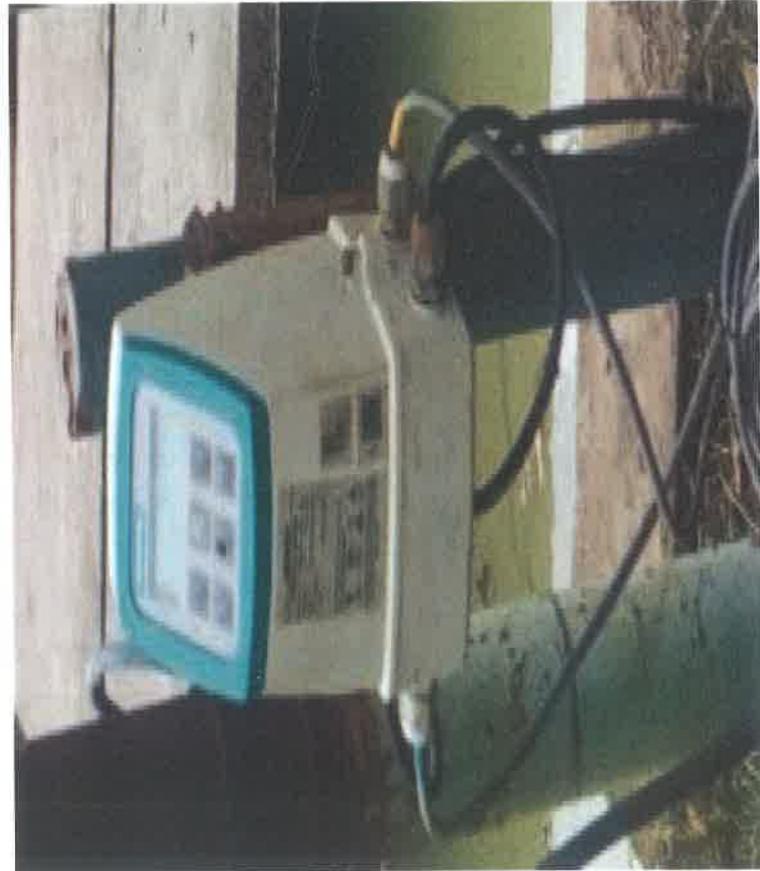
1004

Feed to Bio-reactor



1004

Near MPL Plant-II Gate

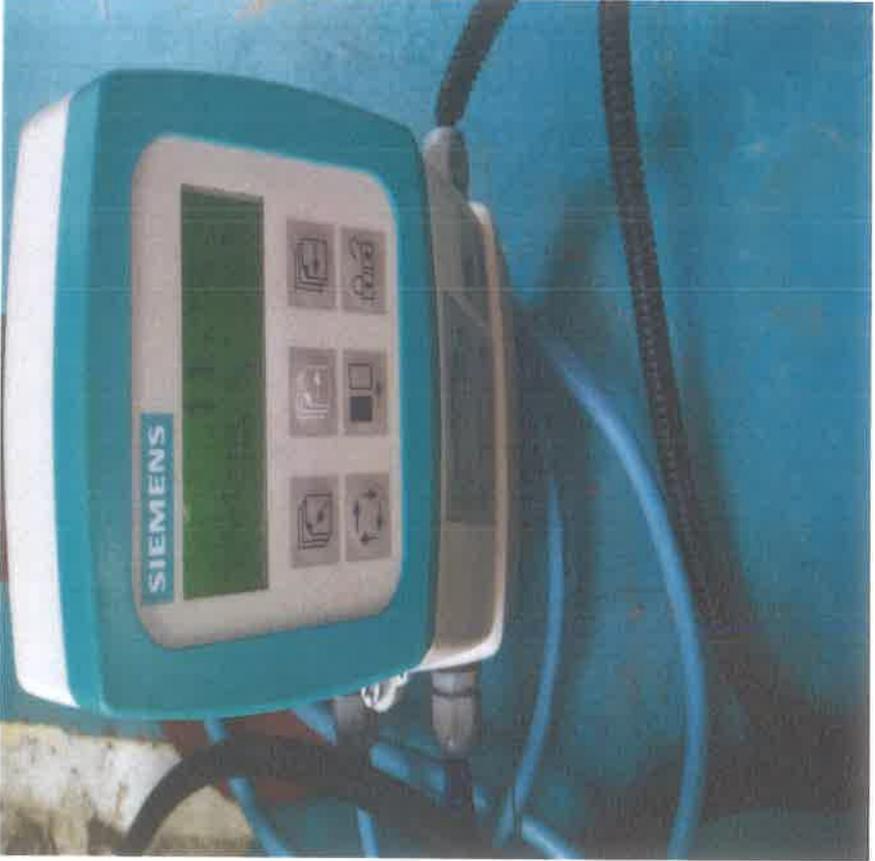


ANNEXURE - 27C

1005

1006

Outside TPL ECH PO Plant



1006

Tsunami Nagar, near Ernavoor gate



1007

ANNEXURE - 28

1008


MANALI PETROCHEMICALS LIMITED

Plant-1 PONNERI HIGH ROAD, MANALI, CHENNAI - 600068

TEL: 25941025 / FAX : 044-25941199

GSTIN No : 33AAACM3404D1Z9

To: IDEATEC AUTOMATION PRIVATE LIMITED
 5 OKS BUILDINGS COLLEGE ROAD SECOND
 TIRUPUR - 641602
 GSTIN NO : 33AADCI5770P1Z4

Purchase Order	
PO Number / Date	6200003442 / 24.02.2021
Contact Mail	
Mail :	
Tel :	
Your Reference	
Your Quotation Date	
Our Reference	

Dear Sir/s,

We are pleased to accept your above offer and confirm our order for the following material/service as per our terms and conditions given below and in the annexure. Please return the duplicate copy duly signed as token of your acceptance, or provide us order acceptance failing which this order will be deemed to have been accepted by you.

SI.NO	ITEM CODE	DESCRIPTION	HSN/SAC CODE	QUANTITY	UOM	RATE (INR)	AMOUNT (INR)
10	CNT0006003	SOLAR SYSTEM FOR 48Hr BACKUP FLOWMETER	85411000	3.000	NO	38,000.00	114,000.00
		CGST : 9.0 %					10,260.00
		SGST : 9.0 %					10,260.00
		SOLAR SYSTEM FOR 48Hr BACKUP FLOWMETER					
		Quality Inspection:					
		Delivery Date	30.03.2021				
		Gross Price		40000.00		120000.00	
		Trade Disc.Gross (%)		5.00- %		6000.00-	
		Total Value for Item - CNT0006003 134,520.00					
20	CNT0006004	SOFTWARE FOR ETP FLOWMETER CONNECTIVITY	9973	1.000	NO	47,500.00	47,500.00
		CGST : 9.0 %					4,275.00
		SGST : 9.0 %					4,275.00
		SOFTWARE CUSTOMIZATION FOR OUTSIDE ETP FLOWMETER CONNECTIVITY					
		Quality Inspection:					
		Delivery Date	30.03.2021				
		Gross Price		50000.00		50000.00	
		Trade Disc.Gross (%)		5.00- %		2500.00-	

Special Instruction :

This PO is subject to Terms and conditions Forming Part of this PO.

Our PO Number and Material Number is to be Mentioned on Invoice

This is a computer Generated and Approved Purchase Order and hence no signature is required.

Regd.Office.SPIC House, 88 Mount Road Guindy, Chennai 600 032

CIN : L24294TN1986PLC013087 www.manalipetro.com

Page:1 / 4

Printed by : P10246MM on 01.07.2021 13:13:51



Purchase Order

PO Number / Date
6200003442 / 24.02.2021

10009

Total Value for Item - CNT0006004 66,050.00

30	CNT0006005	TOTALIZER IoT DEVICE METER HOUSING	8537	3.000	NO	42,750.00	128,250.00
		CGST :	9.0 %				11,543.00
		SGST :	9.0 %				11,543.00

TOTALIZER IoT DEVICE METER HOUSING
Quality Inspection:

Delivery Date 30.03.2021

Gross Price	45000.00	135000.00
Trade Disc.Gross (%)	5.00- %	6750.00-

Total Value for Item - CNT0006005 151,336.00

Total Order Value :
341,906.00 (INR)

Amount in Words : Rupees THREE HUNDRED FORTY-ONE THOUSAND NINE HUNDRED SIX ONLY

Price Basis : FREE DELIVERY PL I
Payment Terms : 35 DAYS CREDIT
Terms of Delivery :

Special Instruction :

This PO is subject to Terms and conditions Forming Part of this PO.
Our PO Number and Material Number is to be Mentioned on Invoice
This is a computer Generated and Approved Purchase Order and hence no signature is required.

Regd.Office.SPIC House, 88 Mount Road Guindy, Chennai 600 032
CIN : L24294TN1986PLC013087 www.manalipetro.com

10/10

TERMS AND CONDITIONS:**I. ACKNOWLEDGEMENT:**

Please return the duplicate of this Purchase Order duly signed as a token of your acceptance.

II. DESPATCHING:

1. While despatching the consignment please ensure that the copy of Invoice, Delivery challan giving full description of the material, PO Number, GST Registration number along with the value should be sent with the carriers, as otherwise the consignment will be seized by the Check post Authorities resulting in heavy penalties which will be to your account.
2. ALL CONSIGNMENTS SHOULD BE BOOKED TO MANAGER (MM) Manali Petrochemicals Limited, as per the address given in the Purchase order.
3. The Transporter's copy of GST Invoice duly authenticated is to be submitted directly or forwarded along with the consignment.
4. The details given below should be mentioned on label or Tag and attached without fail on each Item:-
a) Sl. No. & Description b) MPL item code Number c) Respective quantity d) Batch Number e) Manufacturing Date
5. No consignment should be sent by VPP / Courier service without our prior approval.

III. CORRESPONDENCE:

1. All correspondence (queries, clarification regarding the supply of materials and P.O. conditions) shall be addressed to the Officer concerned as given in this purchase order.
All Queries regarding payment should be addressed to DGM (F) and a copy to DGM (P) M/S. Manali Petrochemicals Limited, Ponneri High Road, Manali, Chennai-600 068 INDIA.
3. In the case of payment against delivery, a copy of the Signed Invoice along with delivery charges in duplicate and LR/RR/GCN in original should be directly sent to DGM (P) M/S. Manali Petrochemicals Limited, Ponneri High Road, Manali, Chennai-600 068.
4. Whenever documents are negotiated through bank the original bill along with delivery charges in duplicate and LR/RR/GCN should be routed through bank and one set of copies should be sent directly to DGM(P) & DGM(F) M/s. Manali Petrochemicals Limited, Ponneri High Road, Manali, Chennai - 600 068.
5. If it is to be insured by MPL, please Fax/Mail the despatch details/packing particulars and value to our under writers, immediately after the despatch to address given in the annexure.
6. In case you are an MSME Vendor, Please provide confirmation along with copy of your registration certificate.

IV. CONDITIONS:

1. Prices are firm till the execution of the entire order and no escalation in prices will be permitted. Any increase in price etc. beyond stipulated delivery period is to your account.
2. The Vendor agrees to furnish licence number or other pertinent details as to whether he has valid licence to manufacture machinery and equipment under industries (Development and Regulation) Act 1951 or whether he is an authorised representative of licensed manufacturers who have availed license.
3. The terms and conditions stipulated herein shall be binding on the vendor unless otherwise specifically agreed to by the Company in writing. Verbal commitment on either side shall be disregarded and shall not be acted upon.
4. Partial deliveries shall not be accepted unless specifically authorised by the Company.
6. The vendor agrees and accepts to carry out any suggestions or modifications or changes in the specification of goods under the purchase order if they do not involve costs additional to the invoiced prices
Failure to adhere to delivery schedule may result in cancellation of this purchase order entirely or in part and Manali Petrochemicals Limited., Manali, Chennai -600 068 shall in no event be liable for any loss, damage or inconvenience caused by such cancellation, unless a delivery delay waiver is agreed upon.
7. The vendor agrees and hereby indemnify Manali Petrochemicals Limited., Manali, Chennai - 600 068 against any and all loss or damage or repayment of any sums of money on account of or in connection with or as a result of the receipt of a defective article sold and delivered to under this purchase order.
8. Should there be any question of infringement of title, patent right, trademarks, copy rights or any current applicable law arises, seller hereby indemnifies
the MPL and agrees to save the harmless MPL any way and all loss, cost or expenses on account of any such claims, suits, judgements etc.
9. The vendor agrees and accepts that Manali Petrochemicals Limited., Manali, Chennai - 600 068 shall have the right of inspection of goods before such goods are despatched by the vendor or during the process of their manufacture with a view to accept, suggest modifications or reject them.

Special Instruction :

This PO is subject to Terms and conditions Forming Part of this PO.

Our PO Number and Material Number is to be Mentioned on Invoice

This is a computer Generated and Approved Purchase Order and hence no signature is required.

20/1

10. Any dispute arising out of this order will be subject to the jurisdiction of an appropriate Court in Chennai only.

V. ENVIRONMENTAL REQUIREMENTS:

1. Hazardous material truck drivers should have explosive material handling training. Certificate of analysis, MSDS (Material Safety data Sheet) should be attached along with documents and trump card should be available in the vehicle.
2. Vehicle emission check Certificate, valid driving license for driver, valid permit and valid vehicle FC should be available for checking at entry point/any place of need..
3. Vehicle carrying cargo is to be clean from any oil leakages/spillages etc.

VII. Dispute Resolution:

All disputes arising out of or in connection with this order, including any question regarding its existence, validity or termination, shall, unless amicably settled between the parties, be finally settled through arbitration. The Parties shall mutually agree and appoint a sole arbitrator. In case no consensus is arrived at on naming a single arbitrator within 30 days of invocation of arbitration, each Party shall appoint one arbitrator and the two arbitrators so appointed shall appoint the third and presiding arbitrator. The arbitration proceedings shall be conducted as per the extant provisions of Arbitration and Conciliation Act 1996. The seat of arbitration shall be Chennai and the language English. Unless otherwise determined in the arbitral award (a) fees to the counsels shall be paid and borne by the respective parties and (b) all the other expenses of the arbitration process shall be shared equally between the Parties.

Each party submits to the jurisdiction of courts of Chennai for the purposes only of compelling compliance with the above arbitration provisions and for enforcement of any arbitration award made in accordance with the above provision.

VIII. Governing Law:

This order shall be governed by and construed in accordance with the laws of India

Special Instruction :

This PO is subject to Terms and conditions Forming Part of this PO.

Our PO Number and Material Number is to be Mentioned on Invoice

This is a computer Generated and Approved Purchase Order and hence no signature is required.

Regd. Office. SPIC House, 88 Mount Road Guindy, Chennai 600 032

CIN : L24294TN1986PLC013087 www.manalipetro.com

HP
ANNEXURE - 29



SATHYA HITEC SOLUTIONS LLP

10/2

222, CHINNAMMAL NAGAR, EDAYARPALAYAM VADAVALLI ROAD, COIMBATORE-641041
PH:0422-7401731,2405225,2405196 MOBILE:0091-9994924939 E-MAIL: sathyaec@gmail.com

SHSLLP/MPL/001/2021

16.2.2021

To

M/S.MANALI PETRO CHEMICALS LIMITED,
Ponneri High Road,

Manali,Chennai - 600068

Kind Attn : Mr.T. Muthukumarasamy – DGM

Dear Sir,

Sub: Turnkey quote for protective coating in internal side of HRT

Ref: Site visit & further discussions we had

Thank you for considering our products & services. As per your requirement we have provided our techno commercial quote below along with the Specification.

DETAILED TECHNICAL SPECIFICATION & COMMERCIALS FOR PROTECTIVE COATING TO INTERNAL SIDE OF HRT:

- Loosely held coatings & dirt will be cleaned using mechanical power tools.
- One coat of Low viscosity penetrating Primer CPS- CONCRETE PENETRANT SEALER will be applied.
- All cracks, honeycombs, crevice will be filled using SCPL- EPM 6000 GROUT- specialty Novolac-phenolic epoxy with fine quartz sand.
- Two coats of Highly chemical & temperature resistant SCPL-EPM 6000 – Novolac-phenolic epoxy-based coating will be applied for 500 microns thickness to provide excellent impermeability & temperature resistance.

Cost per Sq.ft for above mentioned specification for standard grey colour : Rs 162 + 18% GST

* Necessary Scaffolding as required to be provided by client. Safety Belt & accessories will be our scope.

1743/m²

TERMS OF OUR OFFER:

- THE ABOVE PRICES ARE VALID FOR A PERIOD OF 60 DAYS FROM THE DATE OF QUOTE
- ALL THE RATES MENTIONED ABOVE ARE INCLUSIVE OF TOTAL SCOPE OF WORK UPTO HANDING OVER. GST EXTRA AS MENTIONED ABOVE.
- WORK CAN BE STARTED WITHIN 5 WORKING DAYS OF YOUR CONFIRMATION ALONG WITH PO & 40% ADVANCE PAYMENT BEFORE COMMENCEMENT OF WORK
- WORK WILL BE COMPLETED AS PER MUTUALLY AGREED SCHEDULE
- YOU HAVE TO PROVIDE FREE OF COST- SCAFFOLDING, ELECTRICITY FOR OUR POWER TOOLS, NECESSARY GOOD QUALITY WATER, POWER, SAFE PLACE FOR STORING MATERIALS AND EQUIPMENTS

PAYMENT TERMS:

- 40% Advance before commencement of work for mobilisation of required Materials & manpower
- 60% Immediately on completion of work against our invoice

For Sathya Hitec Solutions LLP

G.Vivek

Authorised Signatory

Mobile: 9994924939



UNIQUE CIVITECH SYSTEMS (P) LTD.,

Phone : 24742200
24713044
Tele / Fax : 24716044

Regd. & Admn. Off. No. 4, (Old No. 295/2, 38th Street, 7th Sector, K.K.Nagar, Chennai – 600 078.
Email: mail@uniquecivitech.com Website: www.uniquecivitech.com

10/13

UCSPL/201/TN/025/21-21

27th April, 2021

M/s. Manali Petrochemicals Ltd.,
Ponneri High Road,
Manali,
Chennai – 600 068.

Kind Attn: Mr. Sivakumar

Dear Sir,

**Sub: Special Repairs & Application of Water Proofing Treatment @ New HRT Tank ,
Plant – 1 (T - 3115) - Reg.**

We thank you very much for your above enquiry.

In continuation to the same, please find enclosed our quotation for above work for your kind approval.

We do hope the details are in line with your requirement and please call us for any further details.

Look forward to the favourable response and assuring you of our best services always.

Thanking you,

Yours faithfully,
For **UNIQUE CIVITECH SYSTEMS (P) LTD.,**

V.CHANDRASEKR.

**Authorised
Applicators for:**



Fosroc Chemicals (India) Pvt. Limited

Unique Engineers in Specialised Civil Engineering Works

POLY

Quotation

S.No	Description	Unit	Qty	Rate	Amount
01.	<p>Scaffolding: All the areas which are under consideration for the repair & rehabilitation are to be provided with double legged scaffolding independent of the work having two sets of vertical supports. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed. Supply and fixing of scaffolding with bracing including cost of all material, all labour charges etc., complete to the entire height of the building. The pipes are of C class 40mm dia with required working platform of 40mm thick wooden planks of width not less than 300mm, with hand rails for the safety measures.</p>	Sq.m	400	181.00	72,400.00
02.	<p>PU Grouting : Providing and applying injection grouting into the cracks & leak spots on structural elements.</p> <p>Cracks greater than 1.0 mm width on the exposed concrete surfaces shall be sealed using suitable epoxy putty, 75 mm deep holes at a spacing of 600 mm have to be drilled along the length of the crack, and 8 mm dia. nozzles of length 75 mm have to be fixed in each hole using epoxy putty. Pressure grouting has to be done using suitable grouting pumps till the refusal. After grouting all nozzles to be cut and sealed with fast curing mortar.</p> <p>a) Drilling holes and fixing of non return grout ports.</p> <p>b) Providing V groove in the cracks and filling the same using Epoxy / Polyester putty material.</p> <p>c) Injection of PU foam resin by mixing the two component and injecting using electrically operated positive displacement grout pump of CON</p>	No	150	190.00	28,500.00
		Rmt	200	250.00	50,000.00
		Kg	100	2300.00	2,30,000.00

1015

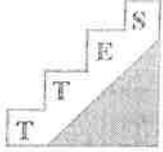
REPAIR/ CHRYSO / BASF make.					
03.	Waterproof coating treatment using Fosroc Polyurea WH200: Supply and application of Polyurea system for water proofing. Surface shall be prepared by mechanical cleaning using grinding machine, Mixing and application of primer NITOPRIME 31/30 by spray method / manually using rollers. Polyurea Membrane of FOSROC / TEVO / HUNTSMAN Make shall be applied @ 2 mm thick utilizing high-pressure, heated plural component spray proportioning equipment and applied in a cross directional (North & South, East and West) method.	Sq.m	400	2050.00	8,20,000.00
04.	Charges towards removing the existing coating by grinding / scrapping using proper tools and to expose the parent concrete surface.	Sq.m	400	100.00	40,000.00
TOTAL AMOUNT				RS.	12,40,900.00

Note: 1) GST will be extra @ 18% on the bill value.
2) GST SAC CODE: 995479.

10/16

TERMS AND CONDITIONS.

1. Work will commence within ten days on receipt of your written order.
2. Water and electricity to be provided by you free of cost.
3. **GST will be extra @ 18% on the bill value**
4. One room for stocking of our chemicals machines and tools to be provided at site.
5. Measurements taken jointly by the representatives of both parties will form the basis of our bill.
6. The Tank to be emptied for minimum two weeks for execution of the work inside the tank.
7. Our waterproofing work will carry performance guarantee for twelve months.
8. **Payment:**
 - o 100% on completion of work.



TEAM TRUST ENGINEERING SERVICES

#73 (O), 119 (N), 'Anugraha', Ramachandran Street, Vasudevan Nagar, Jafferkanpet, Ashok Nagar, Chennai - 83. T.N.
Phone : 044 - 2471 2354 / 2471 2355 E-mail : team_trustengg@yahoo.co.in, ttes_2006@yahoo.co.in

Ref: TTES/QUO/003/2021-22 Dt: 28.06.2021

GSTIN: 33AQDPS8652H1ZK

Manali Petrochemicals Limited
Ponneri High Road,
Manali,
Chennai - 600 068.

1017

Kind Attn: Mr. John Rathnaraj. V, Senior Manager (Civil Projects)

Sir,

Sub: Gunting to 'HIGH RATE THICKENER - HRT' tank on the outside located at Plant I - Reg.

This has reference to your enquiry and our site visit and the discussion had, we are pleased to furnish the specification and our least rate offer for the above said work. The following are the details.

Sl No	Particulars	Estimated Qty	Unit	Unit Rate Rs. P	Amount Rs. P
01.	<u>Acrylic Grouting:</u> Providing acrylic based injection grouting on the sidewalls, bottom slab of 'HRT' tank including, i. Drilling and fixing in nozzles - Non return valve - NRV. ii. Mixing Acrylic agents - Part A (packing 20 Kgs) and Part B (concentrated powder of 350 gms, added/mixed with plain water of 19.65 ltrs to get 20 litres of liquid solution - Part B) and Part C (catalyst/accelerant 300 gms) making total pack of 20.650 Kgs. Note: The mixing/dosage of accelerant may vary depending on the temperature. The correct mix required for site condition using accelerator shall be done at site. iii. Injecting mixed acrylic agents through the fixed nozzles using special electrically operated grouting equipment manufactured only for Acrylic grouting - ACY800, under pressure.				

Contd - 2

Sl No	Particulars	Estimated Qty	Unit	Unit Rate Rs. P	Amount Rs. P
	<p>Note: The quantity estimated is approximate only, the material input depends on the site condition to arrest the live leakage / dampness / seepage at site. Only the actual quantity of material used at site shall be considered for measurement and payment.</p>	200	Kgs	2,430.00	4,86,000.00
02.	<p>Guniting: Providing Guniting to RCC outerwall and bottom slab area including, Fixing of weld mesh of 2" x 2" opening and 2.4mm thick (commercial gauge as available in the market) on to the surface under treatment to act as tensile reinforcement and also as mechanical bond between the existing wall/slab and reinstating mortar and drilling and fixing in position with shear connector of 6mm dia. Applying gunite material at 1:3 ratio using Gun and compressor for a thickness of 40-50mm and curing the surface with water and all complete.</p>				
	<p>Note: Actual quantity of work executed at site shall only be considered for measurement and payment.</p>	450	Smtr	3,960.00	17,82,000.00
Total Estimated Cost:					22,68,000.00

Note:

1. We are using Quality construction chemicals manufactured by reputed company and applied by trained applicators at site.
2. The rate is inclusive of material and labour.

Terms and Conditions:

1. We request you to provide good water, electricity, lighting and storage place free of cost at site.
2. Finishing measurement shall be considered for payment.
3. As this is a repair work any other requirement based on site condition needs to be provided by the client.
4. Payment has to be made based on actual quantity of work executed at site.

1019

Payment Terms:

We request you to release 20% payment along with work order, 40% payment immediately after the delivery of materials at site and balance on progress of work.

Retention Amount:

No retention amount is to be withheld for this repair work.

ESI/PF/Insurance:

We will take Insurance coverage to workers as suggested from your end.

TDS:

TDS can be deducted (Proprietorship concern).

Applicable Taxes Extra:

Goods and Services Tax (GST) shall be applicable and extra at CGST @ 9% and SGST @ 9%, Total 18% for the Total Bill amount.

Note: The tax shall be applicable as per govt. norms on the date of billing and has to be paid accordingly by the client.

We earnestly hope our offer is in line with your requirement and looking forward to receive your valued order.

Thanking you

For Team Trust Engineering Services

Santhosh

for **Y. B. Ganapathy**
Chief Executive

Sivakumar

From: Green Care Projects <vp@greencare.biz>
Sent: 19 December 2020 12:11
To: 'Sivakumar'
Cc: karthikeyan@manalipetro.com; tmuthukumarasamy@manalipetro.com; 'BALAGURU T'; cs@greencare.biz; chandru.tv79@gmail.com
Subject: Offer for RCC tank leak arrest -Reg
Attachments: HNB RCC Tanks PC.pdf; Manali Petrochemicals Proposal.pdf; Service order.pdf; UPJN Performance certificate.pdf

Dear sir,

Based on previous mail, herewith attached techno commercial offer for your kind perusal

Thanks and Regards

Perumal V
383330836
GCE

From: Sivakumar [mailto:sivakumars@manalipetro.com]
Sent: Monday, December 14, 2020 11:47 AM
To: vp@greencare.biz
Cc: karthikeyan@manalipetro.com; tmuthukumarasamy@manalipetro.com; BALAGURU T
Subject: FW: ETP plant site visit -Reg

Sir,

As discussed, please note the following RCC structure storage tank area (Approximate)

- a) Bio-reactor – 450 m2 outer area
- b) HRT tank - 330 m2 internal area/ 350 m2 outer area
- c) Thickener - 260 m2 internal area/ 280 m2 outer area

Kindly send your details of process treatment to arrest the RCC tank leak and to withstand the Temperature up to 90 degree heat and also please forward your earlier experience certificate in this type of work

S.Sivakumar
Civil-Plant I

From: Green Care Projects [mailto:vp@greencare.biz]
Sent: 04 December 2020 17:57
To: balaguru@manalipetro.com
Cc: sivakumar@manalipetro.com
Subject: ETP plant site visit -Reg

Dear sir,

As per yesterday site visit, required following details for ETP plant

- 1.Capacity of ETP plant
- 2.PID/PFD of ETP

3. Raw effluent characteristics (pH, COD, TSS, BOD, O & G Ammonical nitrogen, SO4, Cl, PO4, Hardness, TDS, silica, temperature etc
4. All tank dimension
5. Blower air flow rate (working and standby)
6. Details of chemical used (stage wise)
7. MLSS /MLVSS
8. treated effluent characteristics
9. Specific issue being encountered in ETP
10. BOD/COD after HRT

1024

Thanks & Regards
V.PERUMAL
+91-6383330836



GREEN CARE
ENGINEERING INDIA PVT., LTD.

No.3, Maniam Mango Grove, 10th Cross Street,
Wood Creek County, Nandambakkam,
Chennai - 600 016,
T: +91-8940497137 | E: akv@greencare.biz
www.greencare.biz

GST No. 33AAGCG3076K1ZI

Manali Petrochemicals Limited

Registered Office:
"SPIC HOUSE",
No.88, Mount Road, Guindy,
Chennai - 600 032.
Telefax: 044-22351098
Website: www.manalipetro.com
CIN: L24294TN1986PLC013087

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GREEN CARE
ENGINEERING INDIA PVT., LTD.

Techno Commercial Proposal
For
Coating of Tanks
At
Manali Petrochemicals Limited

Green Care Engineering India Pvt Ltd.
No. 8/9, F-3, Ekambaram Street, Pammal, Chennai – 600075,
Tel: +91-6383330836, +31685561270 (Netherlands)
www.greencare.biz, E-mail:vk@greencare.biz, akv@greencare.biz

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GREEN CARE
ENGINEERING INDIA PVT., LTD.

To,

M/s Manali Petrochemicals Limited,

Chennai

Subject: Technical Proposal for External and Internal Coating of RCC Tanks

Dear Sir,

We thank you for giving us this coveted opportunity to present our technology at your esteemed organisation.

Considering the requirement we hereby enclose the below mentioned details:-

1. Methodology for Internal Coating of the RCC Tanks.
2. Methodology for External Coating of the RCC Tanks.
3. Commercial Proposal
4. Relevant Test Reports
5. Relevant Performance certificates.

Looking forward to hear from you.

Yours Truly,

For Green Care Engineering India Pvt Ltd.,

V.PERUMAL

6383330836

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GREEN CARE
ENGINEERING INDIA PVT., LTD.

Methodology for Protective Coating of RCC Tanks:-

Internal Coating :-

The methodology consists of a combination of 5 products to ensure full proof rehabilitation and ensure zero water leakages and enhanced life of concrete in the future. The application includes treatment in the below mentioned format.

Surface Preparation :-

1. Cleaning using water jet and Steripure 100. This will remove loose concrete particles which will cause debonding if kept on concrete surface. This process also ensures removal of mold, mildews, algae and fungi, if any.

Surface Coating :-

1. Primer Coat of The crack filling is done by modified UV stable epoxy named Kelox R101 and Kelox H404

The DFT for this coating is 600 microns and is ideally suitable for crack filling due to its high elasticity and good bonding strength with concrete.

The bond strength achieved in Kelox is 46 N/mm²

2. After filling cracks with Kelox Epoxy we apply a 5 mm thick coat of our patented Polymer technology PICC (Poly Ironite Ceramic Cementitious) on the internal walls of the RCC tanks. This coat of PICC on internal side ensures protection of the walls from harmful acids like H₂SO₄, HCl and CO₂ and also withstands variation in pH from 1.5 pH to 14 pH.

PICC has a very low porosity of 10⁻¹² cm/sec (less than 1%) which ensures zero leakage or seepage of water hence protecting the concrete below it from the after effects.

PICC also demonstrates extreme inertness to harmful acids like H₂SO₄, HCl and CO₂

PICC owing to its zero vegetation growth property also safeguards the concrete from the dangerous putrefying bacteria generated in the anaerobic reaction.

PICC due to its anti carbonation property also restricts penetration of CO₂ and other carbon related emissions.

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Justification of Product selection alongwith relevant Test Reports:-

1. Kelox (Water Based Epoxy) for crack sealing and corrosion protection.

Parameter	Kelox Property	Relevant Test Report
Crack Sealing	Good Elasticity because of Epoxy	NA
Acids Reactivity	Good chemical resistance to 10% H ₂ SO ₄ having pH 1 and 30% NaCl / 30% NaOH having pH 12.	National Test House Physical properties Report
H ₂ S Reactivity	Good Inertness to H ₂ S	IIT BHU Test Report
Corrosion Resistance	Good Anti corrosion properties shown by Kelox 1. Electrochemical Impedance test value of Kelox is 2.36×10^9 Ohms.cm ² whereas that of stainless steel is 23 Ohms.cm ²	Steel Authority of India Limited report
	2. Salt Spray Life is 2000 hrs and passes the ASTM b117 standards	National Test House Corrosion Report
	3. Kelox passes the accelerated salt spray test as per ASTM B117 standards	National Test House Physical properties Report

2. PICC(blend of Ceramic Ironite and modified Polymers for H₂S Protection and Impermeability)

Parameter	PICC Property	Relevant Test Report
Impermeability	PICC displays supreme impermeability of 10^{-12} cm/sec. PICC displays this permeability for even water which cannot be compressed hence the premise would be that it would display the equivalent property for gases which can be compressed.	CWPRS Test report
Acids Reactivity	Good chemical resistance to 10% H ₂ SO ₄ having pH 1 and 30% NaCl / 30% NaOH having pH 12.	National Test House Physical properties Report
	PICC displays good chemical inertness to Spentwash which is having pH of 1.5	National Test House spentwash report
H ₂ S Reactivity	Good Inertness to H ₂ S	IIT BHU Test Report
Corrosion Resistance	Good Anti corrosion properties shown by PICC	National Test House Physical properties Report
	PICC passes the accelerated salt spray test as per ASTM B117 standards	National Test House Physical properties Report

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GREEN CARE
ENGINEERING INDIA PVT. LTD.

External Coating :-

Surface Preparation :-

Cleaning using water jet and Steripure 100. This will remove loose concrete particles which will cause debonding if kept on concrete surface. This process also ensures removal of mold, mildews, algae and fungi, if any.

Surface Coating :-

1. Saturn WC-Solvent free epoxy for making concrete non porous. Serves as primer coat.
2. Saturn 540-Solvent free epoxy for concrete protection. Available in various colours.

Advantages of Unico's methodology:-

1. Tried and tested for arresting leakages in RCC tanks at Bhagwanpur site and Dinapur site of Uttar Pradesh Jal Nigam and HNB Engineers various sites at Noida, Allahbad and Ahmedabad.
2. Porosity of PICC is less than 1% (Normal RCC porosity ranges between 15- 21%). Hence PICC restricts leakage of harmful chemicals and acts as a protective barrier between the harmful gases and the concrete.
3. Kelox and PICC both are having excellent resistance to damage caused by Harmful chemicals. The tests for these have been carried out at Institutes and Laboratories of national repute like CWPRS, National Test House, Nirma, MERI (Nashik)
4. Zero vegetation growth guarantee ability of PICC also prevents growth of algae fungi and restricts the harmful effects of the putrefying bacteria thus enhancing the life of concrete.

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ENGINEERING INDIA PVT., LTD.

Bio Reactor External Epoxy Coat						
Sr. No.	Description	Qty Required per Sq metre	Area (Sq m)	Price / kg	Price Per Sq metre	Total Price
1	Wetcrete	0.2	450	2291	459	2,06,550.00
2	Saturn 540	0.2	450	2781	560	2,52,000.00
Total					1019	4,58,550.00

HRT tank inner-PICC Coating 5 mm thickness						
Sr. No.	Description	Qty Required per Sq metre	Area (Sq m)	Price / kg	Price Per Sq metre	Total Price
1	Steripure-100	0.006	330	3094	19	6270
2	Kelox R101	0.40	330	1491	596	196680
3	Kelox H404	0.20	330	1491	299	98670
4	Nicomix 100	7.20	330	291	2100	693000
5	Cement	4.20	330	11	48	15840
6	Kelmar A80	0.05	330	1084	49	16170
7	Nicoat PC	0.06	330	240	15	4950
Total					3126	10,31,580

400m² 3126 12,50,400 =

HRT tank outer Epoxy Coating						
Sr. No.	Description	Qty Required per Sq metre	Area (Sq m)	Price / kg	Price Per Sq metre	Total Price
1	Wetcrete	0.2	350	2291	459	160650
2	Saturn 540	0.2	350	2781	556	194600
Total					1015	355250

Thickener (Inner) PICC coating 5 mm thickness						
Sr. No.	Description	Qty Required per Sq metre	Area (Sq m)	Price / kg	Price Per Sq metre	Total Price
1	Steripure-100	0.006	260	3093	18	4680
2	Kelox R101	0.40	260	1491	596	154960
3	Kelox H404	0.20	260	1491	299	77740
4	Nicomix 100	7.20	260	291	2100	546000
5	Cement	4.20	260	11	47	12220
6	Kelmar A80	0.05	260	1084	49	12740
7	Nicoat PC	0.06	260	240	15	3900
Total					3124	812240

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GREEN CARE
ENGINEERING INDIA PVT. LTD.

Thickener (Outer) Epoxy coating						
Sr. No.	Description	Qty Required per Sq metre	Area (Sq m)	Price / kg	Price Per Sq metre	Total Price
1	Wetcrete	0.2	280	2291	459	128520
2	Saturn 540	0.2	280	2781	556	155680
Total					812	2,84,200

Sr. No.	Description	Area	Rate/Sq metre	Total
1	Labour Work for PICC/Epoxy	1,670	290	4,84,300

40 25% 1,16,000

Terms and Conditions :-

GST :- @18% on above prices.

Freight : To your Account.

Payment Term: 50% advance with order and balance 50% before Dispatch for Material.

For Labour 7 Days credit.

Delivery : Within 7 days from receipt of payment.

Yours Truly,
For Green Care Engineering India Pvt Ltd.,

V.PERUMAL
6383330836

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Email Id- pmgppdsns@yahoo.com



UTTAR PRADESH JAL NIGAM

Office of the Project Manager, Ganga Pollution Prevention Division,
Bhagwanpur, Varanasi-221005

Letter No 761 / उत्तरांचल जल 102

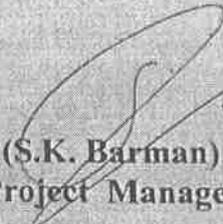
Date 25/08/2020

PERFORMANCE CERTIFICATE

This is to certify that M/S UNICO ENGINEERING SOLUTIONS, Sr. No. 116/6/2, Parkhe Chambers, Behind Sai Leela Hotel, Sus Road, Pune-411021, has successfully executed rectification/repairing work by applying coating of Poly Ironite Ceramic Cementitious (PICC) on the Scum box of Primary Clarifier-B of 8 MLD STP Bhagwanpur, Varanasi as Pilot Project on dt. 20.12.2019.

Poly Ironite Ceramic Cementitious (PICC) has completely resolved leakage issues and no seepage or dampness is observed till date.

I wish them bright future ahead.


(S.K. Barman)
Project Manager

25/8/2020



HNB ENGINEERS PVT. LTD.

Engineers & Turnkey Contractors

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Regd. Office : 'Henabh Centre', 1326, Shukrawar Peth, Off. Bajirao Road, PUNE : 411 002 (INDIA).
Tel. : 24473299 (5 lines) 24474696 (Voice Mail) Fax : 0091-20-24473185,
E-Mail : hnbc@hnbc.in Web Site : www.hnbc.in

CIN:U29299PN2005PTC020745

HNBEPL/885/HO

28/11/2017

To,
Dimple Chemicals & Services Pvt Ltd,
Block 3 & 4, Sreenivas Classic,
Baner Road, Baner, Pune 411045

*Sub. : Performance of Poly Ironite Ceramic Cementitious (PICC) mortar as grout
for Foundation Bolt Fixing.*

Dear Sir,

We had used Poly Ironite Ceramic Cementitious (PICC) mortar as grout for fixing of foundation bolt in ETP/STP/WTP.

Following are the observations.

1. PICC is a self curing mortar hence curing by watering is not required.
2. This mortar gives better bond with concrete as well as metal surface.
3. This mortar has high compressive strength as well as very low (less than 1%) porosity.
4. This gives better chemical resistance even after spillage of chemicals.
5. Initial setting time this mortar is very low (4 to 6 hours).

We are satisfied and recommend PICC mortar for fixing of foundation bolt, internal surface coating of concrete tanks as chemical resistance coating.

With regards,

FOR HNB ENGINEERS PVT, LTD.,

H.N. BHAT
MANAGING DIRECTOR

To,
Mr. T. Balaguru
M/s Manali Petrochemicals Limited
 "SPIC HOUSE",
 No.88, Mount Road, Guindy,
 Chennai - 600 032.

QUOTATION

Date: 01.01.2021
 Ref No. : NEXT/VP/2021/02

We thank you for your enquiry.
 We have pleasure in submitting our quotation as below

Sales Person	Delivery Period	Delivery Terms	Payment Terms	Due Date
Mr. Varun Patel	8 Weeks excluding shipping time	Paid	Mentioned in Terms	30 Days

SR.	DESCRIPTION	QTY	PRICE in INR	
Quotation for Sea Water Quality Monitoring				
1. WQMS-UAERIC: Xylem Water Quality Monitoring Data Buoy				
A. Data Buoy with Solar Power and Navigational Aids				
A.1	Xylem DB 1750 data buoy, yellow, 1750 mm diameter Includes tower section with hatch door, battery section, buoy float, two black moon pool tubes (tube diameter 150mm & 220mm), topmark - X, Solamax-3 class 3 self-contained lantern, Lantern guard, radar reflector 2 x solar panels (50W/12V), 1 x battery (12V/100AH), solar regulator with cable & connectors, solar panel mounts & Roxtec Glands - EZENTRY 10/10	1	56,50,000.00	
A.2	Single point mooring kit upto 15m of water depth. Note: Customer needs to provide an sea state parameters (like max. wave height, wave period, max. wind speed, currents, tide, depth and seabed type) for doing actual mooring calculation.	1		
A.3	1 ton sinker (with hook to connect 26mm to 32mm shackle).	1		
B. Datalogger with GPRS Telemetry Modem				
B.1	Campbell Scientific CR310-CELL215 Measurement and Control Datalogger with - CELL215 w/4G LTE CAT1. Note : Customer needs to arrange a local mobile SIM card with GPRS data package	1		
B.2	External GPRS Antenna	1		
B.3	Campbell Scientific LoggerNet Datalogger Support Software	1		
C. Multiparameter Water Quality Sonde				
C.1	EXO3 Sonde, No Depth, 5 Sensor Ports, Central Wiper Compatible - No depth sensor installed - No AUX Port / Compact Battery Compartment - Contains: Sonde, 2 "D" Batteries, Calibration Cup, Tool Kit, 3 port plugs, USB drive loaded with User Manual and KOR Software	1		
C.2	EXO Wiped Conductivity/Temperature Sensor - Purpose-built for combating sensor fouling in long-term monitoring applications	1		

	<ul style="list-style-type: none"> - Designed and engineered for compatibility with EXO3 Sonde's Central Wiper - Additional Central Wiper Brush and Spacing Kit included - Salinity : Calculated from Conductivity and Temperature -Total Dissolved Solids (TDS) : Calculated from Conductivity and Temperature 		
C.3	EXO pH Sensor Assembly, Unguarded, It <ul style="list-style-type: none"> - Compatible with any EXO sonde - Patented user replaceable sensor head - Incorporates wet-mate connector and welded titanium housing 	1	
C.4	EXO Optical DO Sensor, It <ul style="list-style-type: none"> - Compatible with any EXO sonde - User replaceable sensor cap (installed) - Incorporates wet-mate connector and welded titanium housing 	1	
C.5	EXO Turbidity Sensor, It <ul style="list-style-type: none"> - Compatible with any EXO sonde - Wide range Sensor reads from 0-4000 FNU - Incorporates wet-mate connector and welded titanium housing 	1	
C.6	EXO Total Algae - PE Sensor, Ti <ul style="list-style-type: none"> - Optimized for Saltwater use - Phycoerythrin- Includes chlorophyll and blue green algae sensors in a single Sensor - Incorporates wet-mate connector and sealed welded titanium design 	1	
C.7	EXO fDOM Sensor, Ti <ul style="list-style-type: none"> - AKA CDOM or UV Fluorometer - Incorporates wet-mate connector and sealed welded titanium design 	1	
C.8	EXO Central Wiper, EXO3, It <ul style="list-style-type: none"> - Installs in center wiper port on EXO3 sonde only - Includes two wiper brushes and installation tool - Used in unattended monitoring deployments to reduce bio-fouling 	1	
C.9	EXO 10 meter Flying Lead Cable- Connects EXO sonde to DCP Signal Output Adapter	1	
C.10	Mounting bracket (SS-316L) for Water Quality Sonde with nuts, bolts and washers	1	
Assembly and Functional Test at Xylem Abu Dhabi Facility			
D.1	System Manual	1	
A. Web-Based Environmental Data Display Software			
E.1	YSI HydroSphere™ Software : scalable collaborative data visualization platform for outdoor water monitoring on cloud based platform - HydroSphere™ NEW Account 1 MONTH Service QTY 01 DATA Sour	12 months	
2. Installation, Training & Maintenance			
F.1	Supply of Xylem Engineer to supervise assembly & installation of data buoy and training & maintenance of buoy. Notes: Customer needs to arrange permit to work, food, ground & offshore transport, accommodation for Xylem Engineer. Customer needs to provide the suitable vessel/barge with crane (min. 3 ton capacity), local manpower & diving support team for installation of data buoys. Customer needs to provide suitable training room and projector for conducting the	1	3,00,000.00

	training course. Customer needs to provide suitable boat/vessel/barge, local manpower (every month) & diving support team (every 03 months) for maintenance of data buoys.		
3. Renewal of Web-Based Environmental Data Display Software			
G.1	YSI HydroSphere™ Software: scalable collaborative data visualization platform for outdoor water monitoring on cloud based platform - HydroSphere™ Renewal 1 MONTH Service QTY 01 DATA Source	12 months	60,000.00
Spares & consumables and Calibration Solutions for maintenance Water Quality Monitoring Data Buoy for one year and renewal of web based environmental data display software			
A.1	EXO Wiped Conductivity/Temperature Sensor - Purpose-built for combating sensor fouling in long-term monitoring applications - Designed and engineered for compatibility with EXO3 Sonde's Central Wiper - Additional Central Wiper Brush and Spacing Kit included - Salinity : Calculated from Conductivity and Temperature -Total Dissolved Solids (TDS) : Calculated from Conductivity and Temperature	1	8,50,000.00
A.2	EXO Flying Lead Cable- Connects EXO sonde to DCP Signal Output Adapter	1	
A.3	EXO pH Sensor Replacement Module, Un-Guarded - User replaceable tip for 577602	1	
A.4	DO Sensor Cap Replacement Kit - Replacement sensor cap for EXO optical dissolved oxygen sensor includes 599118, hydrating cap, and quick start guide	1	
A.5	Anti-Fouling Copper Tape	1	
A.6	Copper Wire mesh	1	
A.7	Turbidity Std. , - 0 NFU, 0 NTU (All turbidity probes) , - 1 Gallon	2	
A.8	Turbidity Std. - 124 FNU (EXO), 126 NTU (6-Series), - 1 Gallon	2	
A.9	Conductivity Calibrator - 50,000 umhos/cm (8 ea, pint)	2	
A.10	pH 7 Buffer - Box of 6 pints	2	
A.11	pH 10 Buffer - Box of 6 pints	2	
A.12	EXO Signal Output Adapter - USB- Allows connections between EXO sonde and a PC- Allows connections between EXO handheld and a PC	1	
B.1	Renewal of Web-Based Environmental Data Display Software YSI HydroSphere™ Software: scalable collaborative data visualization platform for outdoor water monitoring on cloud based platform - HydroSphere™ Renewal 1 MONTH Service QTY 01 DATA Source	12 months	

Note: Any accessories required will be charged extra at actual.

All specifications will be as per manufacturer's standard and attached datasheet

Minutes of the meeting held with the representatives of the industries M/s.Tamilnadu Petroproducts Limited, M/s.Manali Petrochemicals Limited and M/s.Kothari Petrochemicals Limited, Manali, Chennai District in the chamber of JCEE(M), TNPCB, Chennai on 21.04.2021 at 11.30AM.

Present:

TNPCB Officials

1.	Thiru M.Malaiyandi,	JCEE(M), Chennai
2.	Thiru S.Vijayarajan,	EE(M), O/o JCEE(M), Chennai

Industry Representatives

1.	Thiru M.Rajavel,	Whole Time Director,	M/s. Kothari Petrochemicals Ltd
2.	Thiru P.Premapiriyar,	Vice President - Operations,	M/s. Kothari Petrochemicals Ltd
3.	Thiru V.Murugeswaran,	Manager - HR&Admin,	M/s. Kothari Petrochemicals Ltd
4.	Thiru M.Karthikeyan,	Whole Time Director,	M/s. Manali Petrochemicals Ltd
5.	Thiru A.Rajakumar,	Manager - Safety,	M/s. Tamil Nadu Petroproducts Ltd

In order to comply with the recommendations of the Joint committee formed by the Hon'ble NGT in OA.No.19 of 2013 and OA.No.248 of 2016, regarding the conductance of marine impact assessment study, the Board has directed the Joint Chief Environmental Engineer (M), Chennai to organize a meeting with M/s. Manali Petrochemicals Limited, M/s. Tamilnadu Petroproducts Limited and M/s. Kothari Petrochemicals Limited to conduct the study at the cost of the above 3 industries.

In this regard, a meeting was held with the representatives of the above 3 industries on 21.04.2021 at 11.30AM in the O/o.Joint Chief Environmental Engineer(M), Chennai.

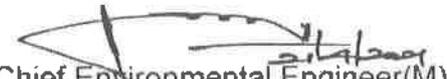
1. During the meeting, all the three industries were insisted to conduct the marine impact assessment study at the common disposal point of treated trade effluent into sea at the cost of the 3 industries.

11036

All the 3 units have accepted the same and furnished an undertaking for conducting the above study through accredited agency once in a year and the cost will be borne by the 3 industries (Copy enclosed).

2. Also, all the 3 industries were requested to furnish the latest compliance status on the various recommendations of the joint committees formed by the Hon'ble NGT in O.A.No.19/2013 and O.A.No.248 of 2016 within 2 days.

 21/4/21


Joint Chief Environmental Engineer(M),
Tamil Nadu Pollution Control Board,
Chennai Zone.

To

1. M/s.Tamilnadu Petroproducts Ltd(ECH Plant)
2. M/s.Manali Petrochemicals Ltd, Unit-I & Unit-II
3. M/s.Kothari Petrochemicals Ltd

Copy submitted to: Member Secretary, TNPC Board, Chennai – With reference to Lr.No.T5/F.011AMB/17 Category/2021 dated 09.04.2021.

Copy to: DEE/TNPCB/Ambattur

**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 II**

**M/S. AL. GANTHIMATHI
COUNSEL FOR RESPONDENT**