BEFORE THE NATIONAL GREEN TRIBUNAL SOUTHERN ZONE AT CHENNAI

Appeal No. 77 OF 2022 (SZ)

M/s. Varalakshmi Starch Industries (P) Ltd.,

...Appellant

AND

Tamil Nadu Pollution Control Board
And others. …Respondents

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The documents filed above are certified as true copies of their respective originals

Dated at Chennai on this the 14th day of February, 2024.

Counsel for Appellant

BEFORE THE NATIONAL GREEN TRIBUNAL SOUTHERN ZONE, AT CHENNAI

Appeal No. 77 OF 2022

M/s. Varalakshmi Starch Industries (P) Ltd.,
Rep. by its Managing Director V.Anbalagan
Having its office at:
"Varalakshmi Tower"
No.127/1, 2nd floor,
Gandhi Road,
Salem- 636 007. ...Appellant

AND

Tamil Nadu Pollution Control Board
Rep. by its Chairperson
76, Anna Salai, Guindy Industrial Estate,
Guindy,
Chennai – 600032 & Ors., ...Respondents

AFFIDAVIT ON BEHALF OF THE APPELLANT

I, V.Anbalagan,, Son of R.Varadharajan, Hindu, aged about 68 years, having office at "Varalakshmi Tower", 2nd Floor, 127/1 Gandhi Road, Hasthampatty, Salem – 636 007, now temporarily come down to Chennai do hereby solemnly affirm and state as under: -

1. I am the Managing Director of the Appellant herein and as such fully acquainted with the facts and circumstances of the present case. I am filing this affidavit on behalf of the Appellant.

2. It is submitted that pursuant to this Hon'ble Tribunal's order dated 03.02.2023, the 1st respondent in Proceedings dated 16.02.2023 directed the Appellant to comply with certain directions (Annexure-A51).

3. The Appellant herein is respectfully submitting the status of compliance of the directions issued by the 1st respondent on 16.02.2023, as on date as follows:

For Varalakshmi Starch Industries (P) Ltd

(V. ANBALAGAN)
Managing Director

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Sl.No	Directions issued	Present status
1	The unit shall furnish a time bound action plan for completing the ETP revamping works, so as to satisfy the treated effluent standards as prescribed by the Board within a month's time	The Appellant has completed the ETP revamping work, by replacing Surface aeration systems with Diffused Aeration systems by installing around 1200 number of fine air diffusers in 8 aeration tanks to further enhance effluent treatment consistently. All ETP components that are included in the Consent Order issued by the TNPCB are in use. Going a step further, it is submitted that the Appellant has voluntarily, without the insistence of TNPCB also imported and installed a high-tech Membrane Bioreactor (MBR) technology as an extension (tertiary treatment) to the existing ETP, a first of its kind in the Sago and Starch Industry, at a cost of about Rs.3.50 crores and the same came into operation during October 2023. From August 2022 to December 2023 till date, during the current Tapioca crushing season, the Report of Analysis of the treated wastewater samples collected by the TNPCB officials (including

For Varalakshmi Starch Industries (P) Ltd

(VANDALAGAN)
Managing Director

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		during the surprise Joint Inspection of the Hon'ble District Collector on October 2023) shows that all the parameters satisfy the treated effluent standards prescribed by the TNPCB. Hence, as such the ETP is more than sufficient to satisfy the treated effluent discharge standards.
2	The unit shall furnish a time bound action plan to replace all the SeemaiKaruvelam trees in the premises with the native plant species as recommended by the Agriculture Department along with the proposal for safe disposal of entire quantity of treated effluent with adequate green belt area within 15 days.	TNPCB in its consent order dated 29.06.2007 **(Annexure.A-42)** imposed conditions to plant eucalyptus, Subabul or any suitable trees within the premises for discharge of treated wastewater. Therefore, in the year 2007, Seemakaruvelam trees which will absorb large volume of trade effluent were planted in around 38 acres of own land and they were consuming the entire discharged treated effluents. If these trees are all cut at a stretch, then sufficient irrigation land will not be available for discharge of treated wastewater. Hence, the Appellant in its affidavit of compliance dated 22.07.2023 sought for permission to remove Seemakaruvelam trees in a phased

For Varalakshmi Starch Industries (P) Ltd

(V. ANBALAGAN)
Managing Director

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		manner. Accordingly as on this date, the Appellant had removed Seemakaruvelam trees in about 14 acres out of 38 Acres of greenbelt area and planted 3500 Native tree saplings such as Pungam tree, Vembu tree, Teak tree, etc., in 9 acres of land and the process of planting the trees are in progress in the remaining land. The same process will be continued to remove the entire Seemakaruvelam trees in a phased manner in the remaining about 24 acres of greenbelt area and replant with the native trees without disturbing the production of Sago and Starch.
3	The unit shall furnish the layout of the premises marking the green area that are being maintained for utilisation of treated effluent along with the plantation details such as number of plants, name of the plant species, plantation area etc., within 15 days	The layout of the entire premises with Greenbelt area being maintained for the utilisation of treated effluent has been submitted as Annexure A-50 along with affidavit on 11.03.2023.
4	The unit shall cover the storage area of wet Tapioca	The construction of the storage area with roof shed has been completed

For Varalakshmi Starch Industries (P) Ltd

(V. ANBALAGAN)
Managing Director

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	Thippi by providing a shed within a month's time.	during August, 2023 and put to use.
5	The unit shall conduct Water and Wastewater audit through reputed institution like Anna University, Chennai/IIT Madras and furnish report to the Board. The time bound action plan for the same shall be furnished within a month's time, as the unit has made payments to The Anna University, Chennai to carry out ETP adequacy study only and not for the Water and Wastewater audit as directed by The Board vide proceeding dated 17.10.2022.	The Appellant had engaged Anna University to study the ETP. Anna University after conducting studies at the factory and analysing the treated wastewater had also confirmed through their report dated 29.05.2023 that the ETP is adequate to meet the standards prescribed by TNPCB. The Appellant had submitted the report to TNPCB. But the Centre for Environmental Studies, Anna University vide their email dated 08.07.2023 without any correspondence with the Appellant, suddenly informed that their report has been cancelled stating as "*Because there are some scientific interpretations which is in need to be carried out with respect to the TDS removal happening in your system based on the discussions with TNPCB authorities*". The Appellant had requested through email dated 10.07.2023 to the Centre for Environmental Studies, Anna University and expressed his shock at the cancellation of the adequacy report after more than a

For Varalakshmi Starch Industries (P) Ltd

(V. ANBALAGAN)
Managing Director

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		month of releasing and further requested to provide copies of the correspondence with the DEE, TNPCB regarding "scientific Interpretations on TDS" so that the Appellant could obtain technical advice from their ETP consultant from abroad. But so far, no reply has been received from Centre for Environmental Studies, Anna University. The Appellant again requested by mail dated 26.12.2023, but there is no response from CES Department, Anna University.
6	The unit shall conduct Groundwater quality study through reputed institution like Anna University, Chennai / IIT Madras in the green belt areas that are being maintained utilizing the treated effluent and furnish the report to The Board within a month's time.	Regarding the studies on Water & Wastewater audit and Groundwater quality study, the Appellant has requested the Centre for Environmental Studies, Anna University to conduct the study and give a report. In response, Anna University has accepted the Appellant's request and fees of Rs.5,66,400/- plus other allowances has been paid on 05.06.2023. But Anna University is yet to commence Groundwater Quality Study.
7	The unit shall provide adequate piezometric (monitoring) wells in the	The Appellant have provided the piezometric (monitoring) wells in the Greenbelt Area.

For Varalakshmi Starch Industries (P) Ltd

(V. ANBALAGAN)
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	green belt area to monitor the groundwater quality and furnish the report to The TNPCB regularly in view of repeated complaint received. An action plan shall be submitted within a month's time.	
8	The unit shall stop discharging treated / untreated trade effluent through the outfall located near ETP area into the Peeniyar canal immediately and shall ensure that there is no access for the treated /untreated trade effluent to nearby water bodies, outside the premises either directly and indirectly. The action taken in this regard shall be reported to The Board within a week's time.	At no point of time, the Appellant is letting out the raw effluent or treated effluent into any water bodies, nor in any public lands and the Appellant's unit is regularly discharging the trade effluent only in their own greenbelt area. The unit was also inspected by the Officials of TNPCB on several occasions and during these inspections, it was always observed that there was no flow of water in the Peeniyar jungle stream. During heavy monsoon rains, once the rainwater harvesting pond gets filled, the excess rainwater/Storm water alone used to drain through the storm water drains.
9	The unit shall dewater the stagnation of water in the pit provided for the proposed anaerobic reactors	The rainwater as and when it is stagnated in the pit of the proposed anaerobic reactors during the monsoon period has been

For Varalakshmi Starch Industries (P) Ltd

(V. ANBALAGAN)
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	immediately and shall maintain the sludge drying beds properly and shall report to The Board within a week's time.	dewatered. The 5 nos. of sludge drying beds are also being properly maintained.
10	The unit shall check the stability of the ETP, by engaging reputed institution like Anna University, Chennai / IIT Madras and furnish the report to the TNPCB within a month's time.	The Stability study of the ETP has been completed by the Government College of Engineering, Salem and a Stability Report dated 26.09.2023.
11	The unit shall install / maintain Electro Magnetic Flow meter with computer recording arrangement at the inlet and outlet of the ETP within a month's time and shall furnish monthly report to The Board.	Electro Magnetic Flow Meters in the raw effluent inlet and another one for outlet with recording are now available.
12	In order to ensure the compliance of the above directions 1 to 11, the unit shall furnish a Bank Guarantee for Rs.50 Lakhs valid for one year to the TNPCB within a month's time (Format enclosed)	Bank Guarantee of Rs.50.00 lakhs were demanded vide TNPCB proceedings dated 17.10.2022 when some small ETP revamping works were pending/ongoing. But currently the ETP is well revamped and meeting the prescribed discharge standards which has also been confirmed by

For Varalakshmi Starch Industries (P) Ltd

(V.ANBALAGAN)
Managing Director

		the report of the Anna University dated 29.05.2023 and the Report of Analysis of treated wastewater samples tested by TNPCB for the past one year and this has been achieved through the existing Primary and Secondary ETP performance. Further, around Rs.3.50 crores have been invested voluntarily for setting up a Tertiary treatment-unit by using MBR technology to meet up to international standards though it has not been made mandatory in the consent order of TNPCB. Other investments for construction of roof shed for Thippi storage is completed and other improvement works have been completed. Hence, it is humbly submitted that before completing the revamping work this earlier direction of 17.10.2022 was issued to furnish the Bank Guarantee of Rs.50.00 lakhs may please be waived as the reasons for obtaining the Bank guarantee has since abated.

For Varalakshmi Starch Industries (P) Ltd

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4. It is submitted that Centre for Environmental Studies, Anna University which undertook water and waste water audit, ground water quality study etc., issued its report on 29.05.2023. It is submitted that in the report @ Para.4.0, Anna University observed as follows;

"The monitoring data of the ETP for the quality of effluents from different units of treatment plant was carried out on 24th February 2022 by CES team. The onsite measurement data of ETP is presented in Table 3. The collected ETP samples are presented in Figure 13. The field visit photos of treatment units in ETP are shown in Figure 14 (a-h). The parameters of the collected effluent samples analyzed by CES are presented in Table 4. In ETP, the color of the raw effluent was recorded as 2.63 m-1, 2.99 m-1, 3.51 m-1 at 436 nm, 526 nm and 620 nm respectively and the colour of treated effluent from clarifier was observed to be 2.21 m-1, 3.14 m-1, 4.36 m-1 at 436 nm, 526 nm and 620 nm respectively. The pH of the effluent was varied from 5.2 to 8.6 at the clarifier outlet.

The TDS of the raw effluent was found to be 12150 mg/L. After Anaerobic treatment, TDS was reduced to 4650 mg/L and reduced to 4450 mg/L in aerobic treatment. The TDS was decreased to 1650 mg/L in clarifier outlet, which are within the permissible limit given by TNPCB (TDS – 2100 mg/L). Total suspended Solids (TSS) present in the raw effluent was found to be 7200 mg/L and the TSS was reduced to 1100 mg/L in anaerobic treatment. After Aerobic treatment, the TSS was reduced to 550 mg/L and almost complete TSS reduction was achieved in clarifier which is within the permissible limit given by TNPCB (TSS – 100 mg/L).

The organic removal in terms of COD & BOD was analyzed and the obtained data demonstrated that the COD of the raw effluent was found to be 3516 mg/L. During the anaerobic treatment process, COD was reduced to 330 mg/L and the COD was reduced to 95 mg/L at clarifier tank.

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The BOD concentrations at collection tank and clarifier outlet were observed to be 3800 mg/L and 30 mg/L. From the results, the organics are within the permissible limit given by TNPCB (COD – 250 mg/L, BOD – 30 mg/L). From this, the organic removal was found to be 97.3% of COD and 99% of BOD. The total hardness, calcium hardness and magnesium hardness of raw effluent were observed to be 1200 mg/L, 200 mg/L and 1000 mg/L respectively.

The total hardness, calcium hardness and magnesium hardness of treated effluent were observed to be 370 mg/L, 60 mg/L and 310 mg/L respectively. The concentration of chlorides present in the raw effluent was observed as 253 mg/L and it was reduced to 160 mg/L, which is less than permissible limit (1000 mg/L). The concentration of the sulphates in the raw effluent found to be 546 mg/L and it was decreased to 54 mg/L, which is less than permissible limit (1000 mg/L)."

The report of the Centre for Environmental Studies, Anna University is produced as **Annexure.A-71**. It is submitted that however, the Centre for Environmental Studies, Anna University in its email dated 08.07.2023 – **Annexure A-68** cancelled the report dated 29.05.2023 by stating that "*there are some scientific interpretations which is in need to be carried out with respect to TDS removal which is happening in the Appellant system*".

It is submitted that the appellant on many occasions represented to the Anna University to furnish whatever the doubts/clarification or interpretation about TDS required by them, to clarify their queries on getting technical/scientific assistance from the Technology provider. It is submitted that nevertheless Anna University has not so far provided their queries/doubts.

5. It is submitted that the Appellant also got assessment of structural condition and strength of structure of various treatment units in its unit by

For Varalakshmi Starch Industries (P) Ltd

(V. ANBALAGAN)
Managing Director

Department of Civil Engineering, Government College of Engineering, Salem on 26.09.2023. The assessment report of Department of Civil Engineering, Government College of Engineering, Salem dated 26.09.2023 is produced as **Annexure – 72.**

6. It is submitted that the samples collected by the respondents on 31.03.2023, 01.09.2023, 19.09.2023, 13.10.2023, 27.11.2023 & 29.12.2023 were tested and test reports came to be issued by the respondent on 13.04.2023, 10.10.2023, 17.10.2023, 20.11.2023, 13.12.2023 and 23.01.2024 respectively. It is submitted that the report shows that the parameters are within the permissible limits. The test reports dated 13.04.2023, 10.10.2023, 17.10.2023, 20.11.2023, 13.12.2023 and 23.01.2024 issued by the respondents are produced as **Annexure – A - 73 Series**.

7. It is submitted that the Appellant is producing photographs in **Annexure – A- 74 Series** to show greenbelt on the lands in which treated water has been discharged. It is submitted that similarly appellant is producing photograph of Tippi shed after completion in **Annexure – A - 75**.

8. It is submitted that during the pendency of the above appeal, the application for renewal of consent filed by the appellant came to be deleted on 05.06.2023 in OCMMS portal and Consent Fee Forfeited and the industry shall make fresh application along with consent fees. The email copy of OCMMS portal dated 05.06.2023 is produced as **Annexure - A – 76.**

9. It is submitted that thereafter, the appellant on 11.07.2023 applied afresh for renewal of consent by paying a sum of Rs.13,84,440/-. The application and receipt of payment are produced as **Annexure – A – 77**. It is submitted that unfortunately the application came to be returned with different reasons on 21.07.2023, 03.10.2023 and on 29.01.2024. The appellant is producing the rejection orders dated 21.07.2023, 03.10.2023 and 29.01.2024 as **Annexure – A – 78 to 80**.

For Varalakshmi Starch Industries (P) Ltd

(V. ANBALAGAN)
Managing Director

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10. It is submitted that Biocatalysts Laboratory, Department of Agricultural Micro Biology, Tamil Nadu Agriculture University conducted a research on the Characteristics of Sago Processing Wastewater Effluents released from different Sago Factories in Salem and Namakkal District of Tamil Nadu and in its research article confirmed the content of TDS as follows:

"*Due to its diverse densities of substances, i.e, settable, suspended and floatable solids material, the wastewater effluent samples were easily settled into three layers of notifiable upper, middle and lower layers. In general, the TS, TSS and TDS content of SWW samples in the present study were high due to the presence of rich carbohydrates, fibres and dense suspended solids, unextracted starch, cellulose (fibrous residue from pith), nitrogenous compounds, cyano glucosides and insoluble fibres.*" The Appellant is producing the Research Article as **Annexure – A 81.**

Therefore, it is humbly prayed that this Hon'ble Tribunal may be pleased to record this Affidavit and further direct the respondents to renew the order of consent by following its guidelines dated 21.02.1984, Environmental (Protection) Rules, 1986 and The Water (Prevention and Control of Pollution) Act, 1974 and thus render justice.

For Varalakshmi Starch Industries (P) Ltd

(V. ANBALAGAN)
Managing Director

Solemnly affirmed at Chennai
On this the 14th day of February,
2024 and signed his name
In my presence.

BEFORE ME

14/02/24

ADVOCATE, CHENNAI

M. LENIN
No. 503, NLC,
MHC, Chennai - 104.

CENTRE FOR ENVIRONMENTAL STUDIES
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Dr. S. KANMANI, B.E., M.E., Ph.D.
Professor & Director

Date: 29.05.2023

To
Mr. V. Anbalagan
Managing Director
Varalakshmi Starch Industries Pvt Ltd,
Varalakshmi Tower, 2nd floor,
No.127/1Gandhi Road,
Hasthampati (po),
Salem - 636007

Sir,

Sub: Consultancy work on "Design Adequacy for Existing Effluent Treatment Plant" in M/s. Varalakshmi Starch Industries Private Limited, Dharmapuri - Report sent – Reg.

*****

With reference to the above, I enclose 4 copies of the final Report on "Design Adequacy for Existing Effluent Treatment Plant" in M/s. Varalakshmi Starch Industries Private Limited, Dharmapuri. Kindly acknowledge the **Receipt** and issue the **Completion Certificate** for the consultancy work.

Thanking you,

Yours faithfully,

29/5/2023

DIRECTOR-CES

Dr. S. Kanmani, B.E.,M.E.,Ph.D
Professor & Director
Centre for Environmental Studies
Anna University, Chennai - 600 025

Encl: **Report - 4 Nos**.

DESIGN ADEQUACY REPORT FOR EXISTING EFFLUENT TREATMENT PLANT

for

M/s. VARALAKSHMI STARCH INDUSTRIES PRIVATE LIMITED, DHARMAPURI




Prepared by

CENTRE FOR ENVIRONMENTAL STUDIES
DEPARTMENT OF CIVIL ENGINEERING
ANNA UNIVERSITY, CHENNAI - 600 025

MAY 2023

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DESIGN ADEQUACY REPORT FOR EXISTING EFFLUENT TREATMENT PLANT IN M/s. VARALAKSHMI STARCH INDUSTRIES PRIVATE LIMITED

1.0 INTRODUCTION

M/s. Varalakshmi Starch Industries Private Limited is a composite, integrated and agro-based rural medium-scale industry located in Pappiredipatti of Dharmapuri district and engaged in the manufacture and export of BIS-ISI Certified Starch and Sago products at par with international standards using Tapioca Tuber and Maize Kernel and the largest producer of Tapioca Starch and Sago in India. The raw materials of Tapioca tuber (Cassava) and Maize are agricultural produce and are cultivated by small dry-land and tribal farmers predominantly in Tamil Nadu. The industry was set up in 1997 and has high-tech, automated, medium-scale operations in the fields of Tapioca and Maize. This industry has capacity to manufacture starches and modified starches at 6500 MT/month and sago and pappads at 5000 MT/month. The number of byproducts such as tapioca thippi, maize germ, maize gluten, and maize husk produced by the industry is 2000, 900, 675, and 1460 MT/month respectively.

The treatment capacity of the effluent treatment plant is 500 KLD. Since 2001, this industry has been running bio-methanation plants to treat industrial effluent as well as to generate biogas. The generated biogas is utilized for power generation as well as industrial heating, replacing furnace oil and coal. There are a total of six numbers of bio-methanation plants (Anaerobic Digesters – each 2,000 m^3 volume). This anaerobic digester is known as the Hybrid Upflow Sludge Medium Anaerobic Reactors (HUSMAR) process. This technology is provided by New Jersey Institute Technology, New York, USA. This industry is categorized as the "orange category" by TNPCB. The industrial effluent is treated organically to generate biogas and the treated wastewater is discharged into their own lands for irrigation. The findings of the CES team led by Dr. S. Kanmani, based on the data collected during the field visits on 24th February, 2023 and the interactions with ETP operational staff are presented in this report.

2.0 GEOGRAPHICAL LOCATION OF VARALAKSHMI STARCH INDUSTRIES (P) LTD

M/s. Varalakshmi Starch Industries Private Limited is situated in Pappireddipatti village, Dharmapuri district in Tamil Nadu. Geographical location of the industry is 11° 40' 18.12" N latitude and 78° 9' 18.396" E longitude of the earth's equator. Photograph of the Geographical location of industry is shown in Figure 1.

Figure 1 Aerial View of Varalakshmi Starch Industry (Source: Google)

2.1 MANUFACTURING PROCESS AT VARALAKSHMI STARCH INDUSTRY

2.1.1 MANUFACTURING PROCESS OF TAPIOCA STARCH

The manufacturing process flow diagram for Tapioca starch and sago is represented in Figure 2. The extraction of starch from tapioca is a process of separating starch granules from the tuber in their pure form. The granules are locked in cells together with other constituents of the protoplasm (proteins, soluble carbohydrates, fats, etc.,) and can only be removed by a purification process in the aqueous phase without any additives. The roots of tapioca should be processed within 48 hours after harvesting. The essential factor in the production of food grade tapioca starch is that the whole process, from harvesting the roots to completion of the final drying, should be carried out in the shortest time possible since deterioration sets in from the time of root extraction and proceeds throughout the process.

Fresh Tapioca Tuber Arrival & Dry Peeling (Cleaning)

Fresh tapioca tubers received at the factory are passed through a dry peeler, which removes the outermost skin and all soil particles adhering to the Tapioca tubers. This dry peeling and pre-cleaning not only improve the quality of the end product but also reduce the consumption of water in the washing process, thereby reducing the load on ETP to a large extent (Sand and Mud 95% removed).

Wet Washing of Tubers

The pre-cleaned tapioca tubers are peeled and washed in an automatic washer using clarified water obtained from the Decanter.

Chopping & Rasping

Washed tapioca tubers are fed into a chopper and chopped into small bits. This initial chopping reduces the load on the raspers as well as now the water requirement in the rasping process, as the Tapioca tubers are fed into the raspers for rasping in a disintegrated form, requiring less water for crushing.

The finely chopped tapioca tubers are fed into raspers, where they are crushed into a fine slurry. The SO_2 solution (not more than 80 ppm) is added through the column to prevent bacterial growth. The raspers used in the process employ modern technology using serrated, high-tensile

rasper blades. By using this method, the requirement for water is brought down considerably, as the rasper blades used here can crush the tapioca tubers into fine slurry with less water. The raspers are so designed that they can crush the tapioca tubers into micro particles, so that the Tapioca starch recovery will be high. The water usage will also be low, so the load on the decanters at the next stage of manufacturing will be reduced.

Decanting

The Fine slurry from the raspers is then fed into the high speed Centrifugal Decanters for removal of the impure fruit water from the fine slurry. This fruit water is then used as process water in the earlier stage for washing of the Tapioca tubers. This stage is introduced in the manufacturing process to reduce the washing load on the subsequent washing stage thereby leading to reduction of water consumption.

Extraction

Finely decanted tapioca slurry is passed through pulp extractors where the pulp (Thippi) is extracted from the tapioca slurry by adopting centrifugal separation method. The pulp separated here is passed through belt press where most of the remaining water from the tapioca pulp (Thippi) is removed. The tapioca pulp which comes out of the belt press is of semi solid consistency with 50-55% water.

Multistage Hydrocyclone washing

The tapioca starch milk obtained in the previous section is passed through separators which remove the 50% process water from the starch milk employing centrifugal principle. Tapioca starch milk coming out of these multistage hydrocyclone is further refined and concentrated in multi-stage hydrocyclones. In this stage, the entire impurity is removed and 70% water and 30% starch is obtained.

Centrifugal Separator

The fibre removed slurry have 5-8% matured starch, 0.1-0.2% partially matured starch and 92-94% water. The centrifugal separator removes around 50-60% process water which used for raw tapioca rasping and chopping.

Dehydrating

The concentrated tapioca starch milk is passed through centrifugal de-hydrators where water from the tapioca starch is removed by centrifugal method. The resultant wet tapioca starch will be in small lumps with about 35-40% moisture. The process water removed from the tapioca starch by de-hydrators is passed to Separators inlet (Step VI) to recover escaped tapioca starch particles.

Starch drying & Sieving

The lumps of wet tapioca starch obtained from the dehydrators are passed through a disintegrator to convert them into fine Tapioca starch powder. The powdery wet tapioca starch from the disintegrators is fed into flash dryers and dry the tapioca starch automatically using hot air generated from a hot air furnace, which is used to reduce the moisture in the finished tapioca starch to about 10%–12%.

Drying & Packing

The dried native tapioca starch powders obtained from the flash dryers is passed through feeder and sifters and gets bagged.

2.1.2 MANUFACTURING PROCESS OF TAPIOCA SAGO

The concentrated tapioca starch milk obtained in the Tapioca Starch manufacturing process is diverted for manufacturing of Tapioca Sago as follows.

De-hydrating

The concentrated tapioca starch milk is passed through centrifugal de-hydrators and Rotary drum Vacuum filters where water from the tapioca starch milk is removed. The resultant wet tapioca starch will be in small lumps with about 40 % moisture.

Sago balls making

The wet tapioca starch lumps are then made into wet Sago in the form of globules / pearls and sieved for the desired size.

Roasting

The sieved sago is roasted/boiled at high temperature in Thermic fluid oil heated Roasters.

Drying

The Roasted/Boiled Sago is dried in dryer to reduce moisture content to about 10-12%. Then the dried Sago is disintegrated to break the lumps and separate the Sago pearls.

Sieving & Packing

After disintegration the sago is sieved to remove powder and un-sized sago and then the Sago is packed.

The process flow diagram for the manufacture of Tapioca Starch and Tapioca Sago

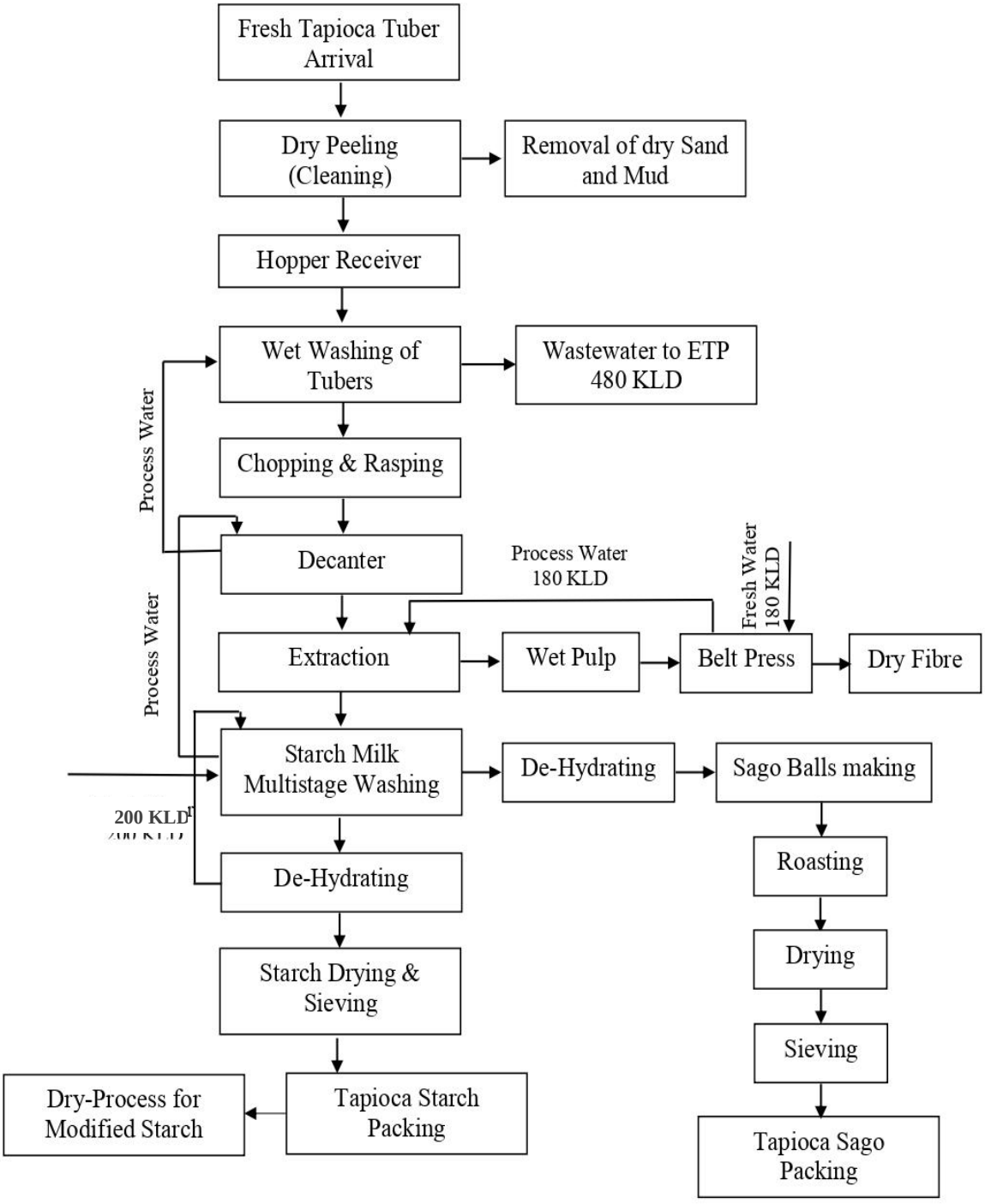


Figure 2 Manufacturing Process Flow Diagram of Tapioca starch and sago

Tube Receiver

Dry Peeler

Hopper Receiver

Root Washer

Receiver

Separator

Decanter **Centrifuge**

Dryer **Packing**

Figure 3 Manufacturing Process of Tapioca starch and sago

2.1.3 MANUFACTURING PROCESS OF MAIZE STARCH

The manufacturing process flow diagram of Maize starch is represented in Figure 4.

Unloading and Cleaning

Raw Maize received from farmers is unloaded and it is cleaned to remove solid impurities like cob, chaffs, sand and other undesirable foreign matter. The solid waste items and packing material are returned to the farmers and then cleaned maize is taken for process or stored into silos.

Maize Steeping

The cleaned maize is softened by steeping process by using recycled process water for duration of 40 to 60 hours at a temperature of 48 to 52 degree Celsius. In this process the maize absorbs water and become soft to enable easy separation of Germ. After steeping, the water from the steeping tanks is fed into biomethanation reactors to produce biogas and to reduce the BOD and COD in the effluent.

Pre-Milling and Germ Separation

The softened maize is subjected to coarse grinding/pre-milling where the maize is coarsely ground to release the germs without damaging them. As the germ is much light in density than the broken maize kernels, the germ is easily separated by using cyclones. The germ coming out of germ separating cyclones sent to dewatering section where the water from the germ is separated and sent back for steeping processing. The wet germ from the germ separation section is then dried in a germ drier and sold as a byproduct to Oil expellers for extraction of Corn Oil.

Fine Milling and Fiber Separation

The coarsely ground maize kernels free from germs are then ground through impact mill, finally to liberate maize slurry containing fiber, starch and gluten. The fiber is removed from the slurry by (Dutch State Mines) DSM Screens. The fiber thus removed is sent to fiber de-watering section where the free water from the wet fiber is removed and recycled into steeping processing. The fiber after reducing of water is either sold in wet condition or dried and sold as a byproduct for use as cattle feed.

Gluten Separation

The mixture of Gluten and Starch slurry free from fiber and germ is sent to primary Gluten Separator. Here the Gluten is of lower density than starch and so gluten slurry and starch slurry both

are separated. The gluten slurry separated in this section is sent to Gluten concentrator (Gluten Thickening Separator) and concentration section where the excess water is removed from the Gluten and the water recycled into steeping process. The concentrated Gluten cake from vacuum belt filter is sent to Gluten drying section where it is dried as a byproduct for poultry feed use.

Starch Slurry Washing and Dewatering

The starch milk after releasing the gluten is then thoroughly washed with the help of fresh water through 12 stage Hydro cyclones. After washing, the process water is removed from the starch milk and the water is recycled into milling section processing.

Starch Dewatering

The concentrated starch milk (Starch 40% and Water 60%) is passed through De-Hydrating Centrifuge for reducing moisture content upto 35% - 40%. The outlet water contains small portion of starch and it is recycled to starch slurry dewatering section.

Starch Drying

The wet starch /starch cake with 35-40% water obtained from dewatering section is then dried in flash drier by using hot air. The dry starch with 10-12% moisture obtained from the starch drier is sieved and then fine starch powder is packed and sold as finished product.

The Process flow diagram for the manufacture of Maize Starch

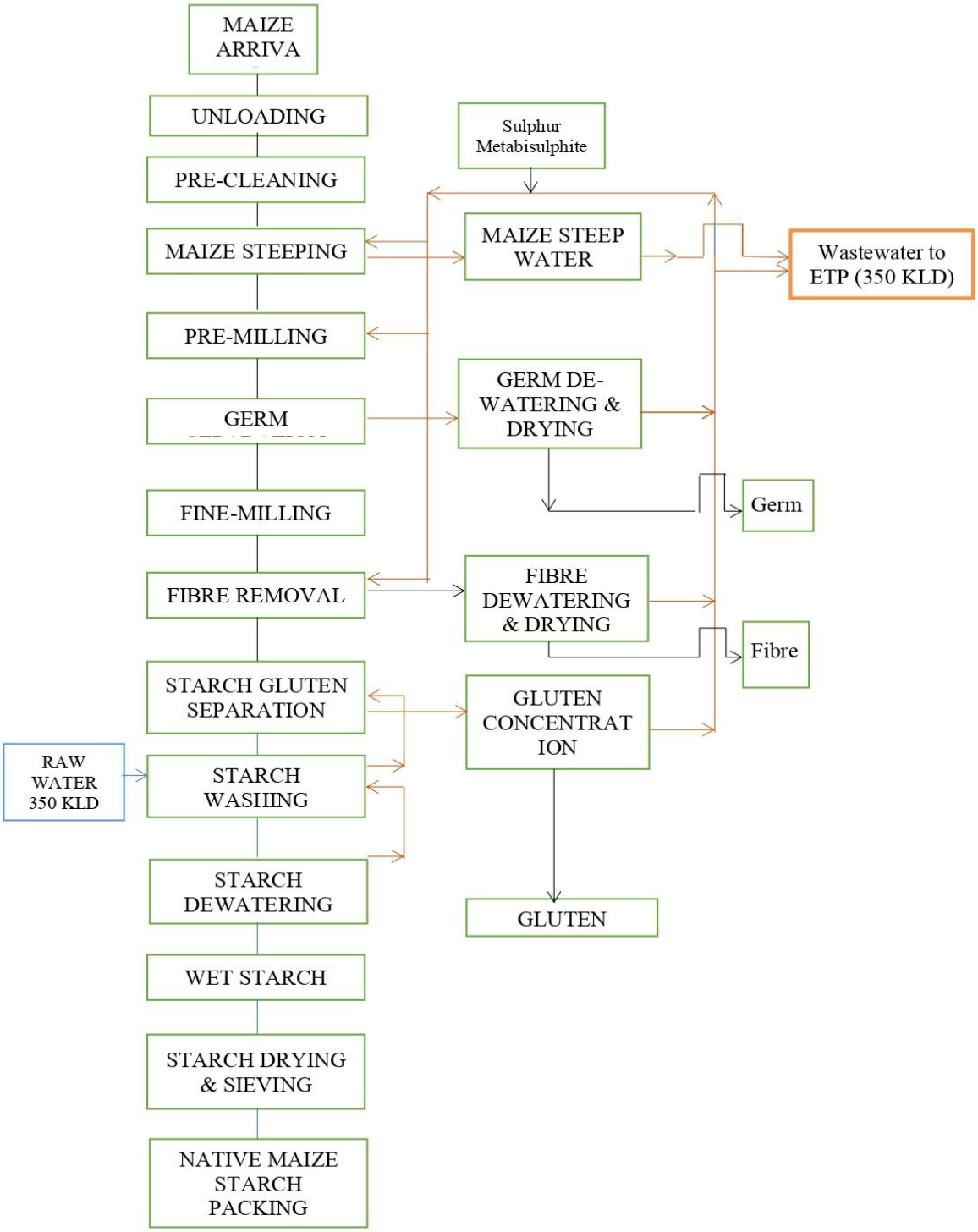


Figure 4 Manufacturing Process Flow Diagram of Maize starch

3.0 VARALAKSHMI STARCH ETP –SCENARIO

3.1 ETP TREATMENT PROCESS DESCRIPTION-CURRENT STATUS

The existing and proposed tertiary treatment process flow diagram of ETP is presented in Figures 5 and 6. Effluent treatment plant (ETP) comprises of a four-stage process such as primary treatment, secondary treatment, tertiary treatment and sludge management. The existing systems are Collection tank, Overhead equalization tank, Hybrid Upward Flow Sludge Media Anaerobic Reactor (HUSMAR), Anaerobic lagoons, Diffused Aerators, Surface Aerators, Primary settling tanks, Clarifier, Filter press, Rotary vacuum filter and Sludge trying beds. The proposed systems are Diffused aeration tank, Settling tank and submerged MBR system. The ETP layout is presented in Figure 7. The ETP Treatment unit details are presented in Table 1.

Table 1 Treatment Units Details

S.No	Treatment Units	Nos.	Dimensions	Capacity
Existing System				
Primary Treatment				
1	Collection tank	1	3.4 m×1.2 m×1.6 m	500 m^3
2	Overhead Equalization tank	1	304 m×2.6 m×1.0 m	
3	Hybrid Upward Flow Sludge Media Anaerobic Reactor (HUSMAR)	6	15.0 m dia.×16.0 m ht. (each)	2000 m^3 (each)
Secondary Treatment				
4	Anaerobic lagoons	2	30.0 m×15.0 m×3.5 m (each)	
5	Diffused Aerators	4	10.0 m dia.×3.0 m ht. (each)	400 m^3(each)
6	Surface Aerators	4	10.0 m dia.×3.0 m ht. (each)	400 m^3 (each)
7	Primary settling tanks	2	15.0 m×6.0 m×3.0 m (each)	
8	Clarifier	1	23.30 m dia.×4.2 m ht.	
Sludge Management				
9	Filter Press	2	5.25 m×0.98 m	
10	Rotary vacuum filter	1	2.50 m dia.×3.25 m length	
11	Sludge drying beds	5	10.18 m×15.24 m×1.10 m	
Proposed System				
Tertiary Treatment				
12	Diffused aeration tank	1	5.70 m×14.25m×4.40 m	
13	Settling tank	1	4.50 m×14.25m×4.40 m	
14	Submerged MBR System			
	MBR Tank	2	3.20 m×9.30 m×4.40 m	
	MBR Settling tank	2	3.20 m×4.50 m×4.40 m	
	MBR Permeate tank	2	3.20 m×4.50 m×4.40 m	

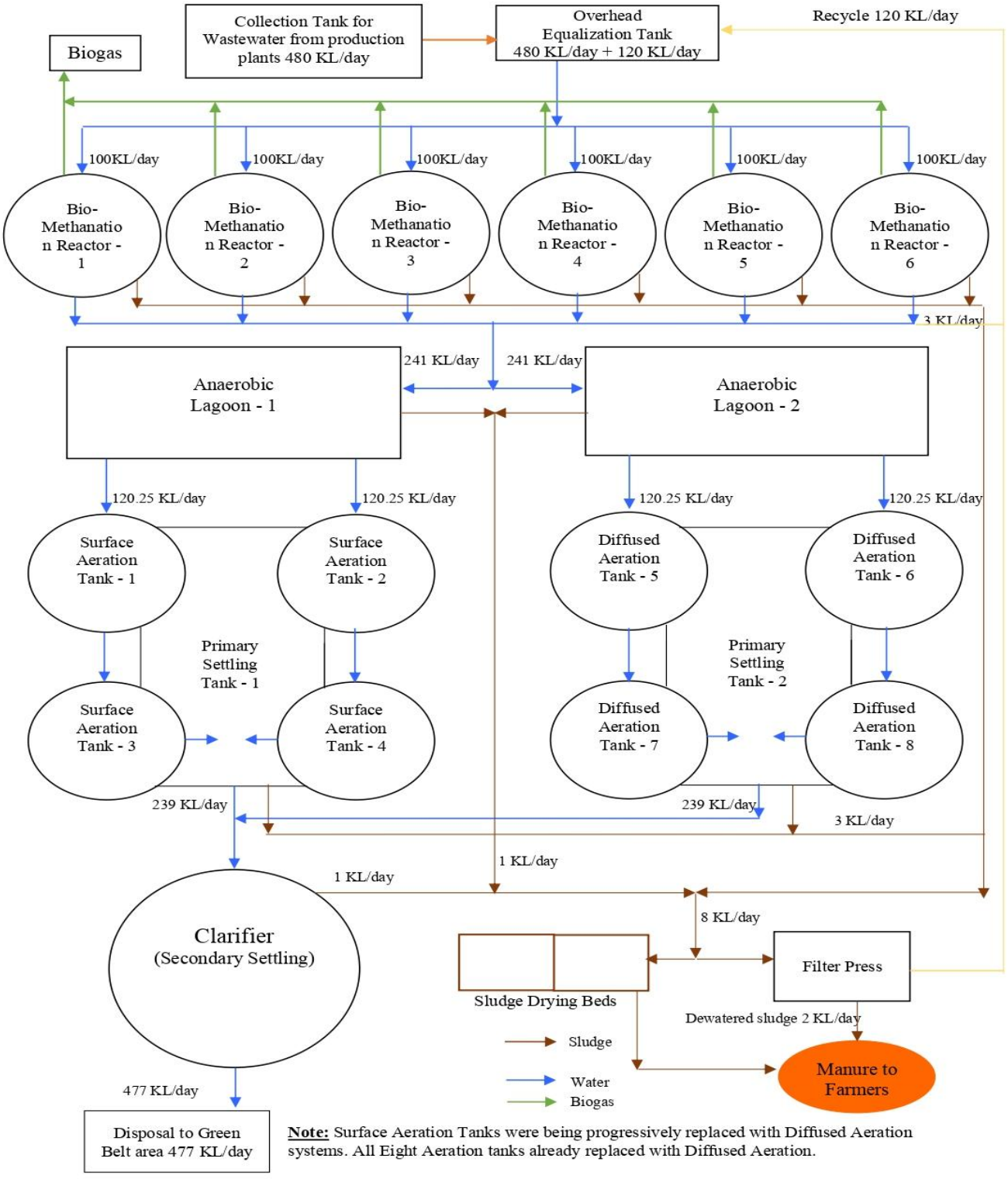


Figure 5 Treatment Process Flow diagram (Existing system)

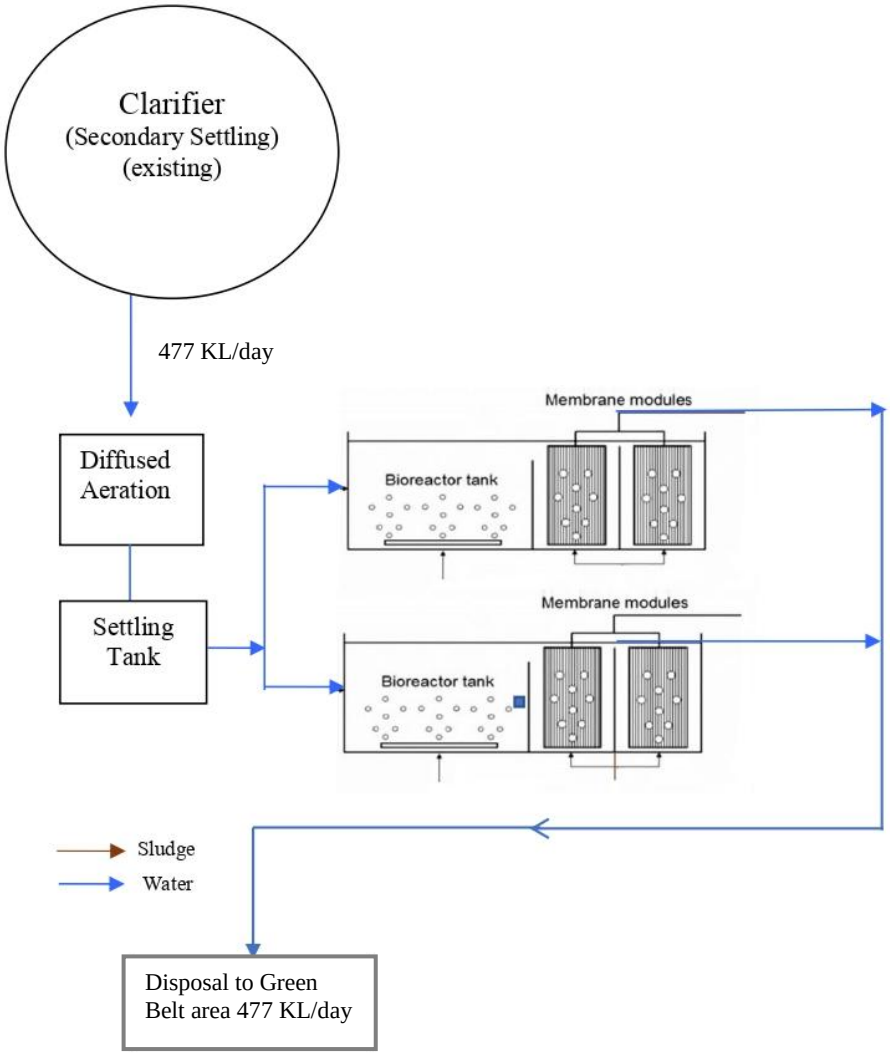


Figure 6 Tertiary Treatment Process Flow diagram (Proposed system)

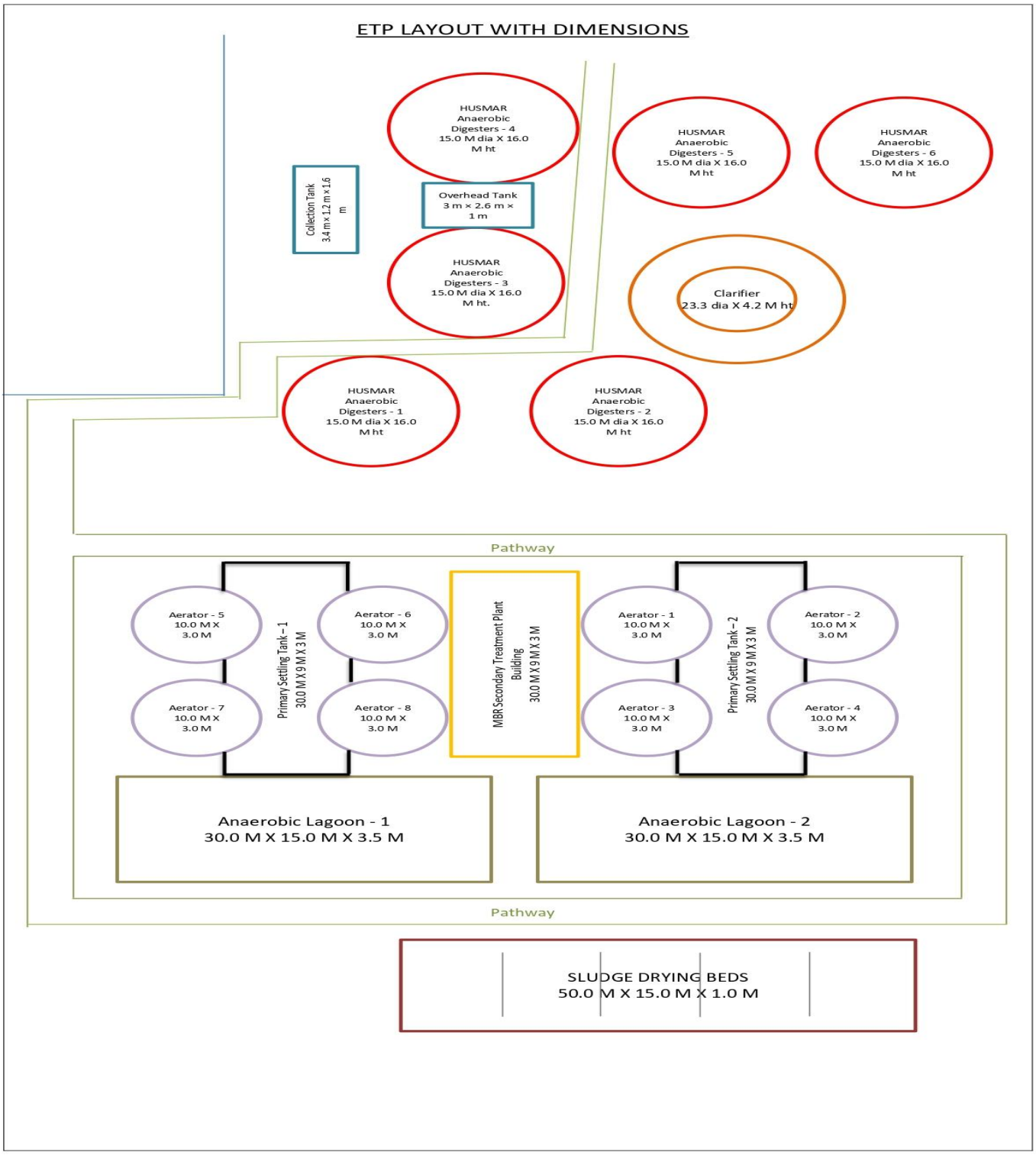


Figure 7 Plant layout

3.1.1 PRIMARY TREATMENT

High-Rate Bio-Methanation Plant

The effluent generated in the ETP from the processing of agricultural materials are organic and biodegradable where the effluent actually serves as a raw material for generation of highly valuable fuel namely Biogas which is used as a fuel for heat and power generation. Higher the reduction of COD and BOD in the effluent treatment process will lead to higher quantum of Biogas generation as use of Biogas leads to huge savings in operation of the industry through replacement of costly coal and power. Accordingly this industry is converting the wastewater into valuable byproduct as renewable energy.

Anaerobic Technology is best suited for treatment of wastewater containing organic matters. It is clean, environment friendly and highly efficient technology. It requires very low operating & maintenance costs, less land area and lesser power requirement for operation. In anaerobic treatment process, the wastewater is passed through a reactor where fermentation of organic matters takes place in the presence of acidogenic and methanogenic bacteria resulting in the formation of methane rich biogas as the end product. The biogas can be utilized for power generation due to its fairly higher energy content and thermal application depending upon the requirement. Anaerobic digestion is the step for wise conversion of large molecules of organic compounds into Methane and Carbon Dioxide by bacteria in the absence of free oxygen. This process is carried out in an airtight reactor. Wastewater introduced continuously or intermittently into the reactor is retained for varying periods of time. The stabilized wastewater is withdrawn continuously or intermittently from the reactor, which is reduced in organic and pathogen content and non-putrescible. The characteristics of the starch-processed wastewater were analyzed and anaerobic Treatment through High Rate Biomethanation Process was decided as the technically and economically viable method.

Hybrid Upward Flow Sludge Media Anaerobic Reactor (HUSMAR) Process

The HUSMAR Process is a combination of the UASB and the Upflow Fixed Film (UFF) reactors. This development is an improved evolution as it combines the strong process attributes of the UASB and Fixed Film Technologies System (extensive surface area for holding live bacteria) and minimizes the shortcomings of these systems. The HUSMAR is a cylindrical vessel. The lowermost 20-30 % of the volume is the UASB portion where a flocculent and / or granular sludge develops. Most of the organic stabilization occurs in this sludge bed. The uppermost 50 - 60 % of

the volume is the UFF section and remaining area of 20-30% for gas holder. Depending on the physical, chemical & biological properties of the effluent and the conditions of biochemical interactions prevailing in the HUSMAR, the gas composition is observed to vary. The Low heat content of gas is estimated to be about 5000 Kcal/m^3. Typical analysis of the gas composition generated from Tapioca starch and Maize starch effluents with HUSMAR is presented in the Table 2.

Table 2 Composition of Biogas from HUSMAR

S.No	Constituent Gas	Volumetric composition
1	Methane, CH_4	50-65%
2	Carbon-dioxide CO_2	34-49%
3	Hydrogen Sulphide H_2S	0.5-1%

A total of six numbers of Bio-Methanation Plants (Anaerobic Digesters - each 2,000 m^3 volume) serve dual purpose of treating the wastewater as well as to generate Biogas (waste to energy). These Digesters were put up in 3 phases, 2 digesters in the year 2002 as first of its kind Demonstration projects under United Nations Development Program (UNDP) and after being successful, 2 digesters in the year 2007 and the last 2 digesters in the year 2012 were further installed. In this stage itself, the BOD and COD are reduced and Biogas (50 – 65 % Methane) is generated and used for electric power generation and heat applications. The anaerobic digesters in primary treatment are presented in Figures 8 and 9.

Figure 8 Anaerobic digester

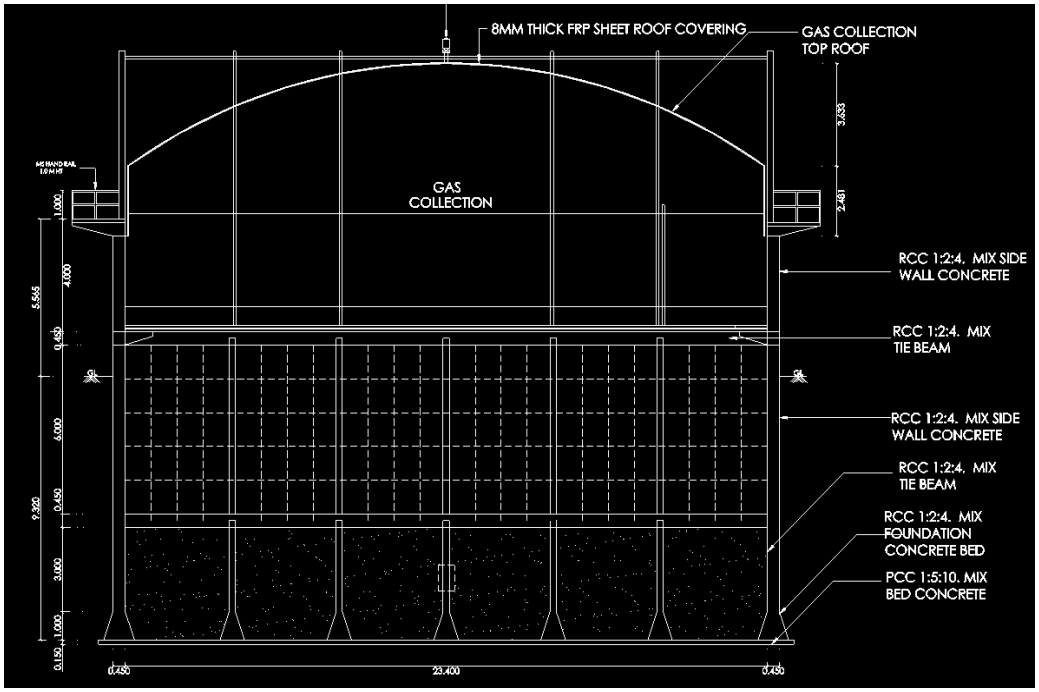


Figure 9 Anaerobic digester design

3.1.2 SECONDARY TREATMENT

Aeration and Clarification Process

After the primary treatment, the near wholly treated effluent is then subjected to Aerobic treatment in 4 nos. of Diffused aeration system and 4 nos. of surface aeration system each with a volumetric capacity of 400 m^3 and the sludge in the treated effluent is allowed to settle in Settling Tanks before it sent to the Clarifier. The alum is added in clarifier inlet to enhance the treatment performance. The aeration and settling tanks are represented in Figure 10.

Figure 10 Aeration and Settling tanks

3.1.3 TERTIARY TREATMENT (PROPOSED)

Membrane Bioreactor Technology (MBR)

Membrane bioreactor (MBR) is a combination of membrane processes like microfiltration or ultrafiltration with a biological wastewater treatment process, the activated sludge process. In the submerged membrane bioreactor (SMBR), the membrane is located inside the biological reactor, submerged in the wastewater. MBR processes can produce effluent of high enough quality for discharge into the sea, oceans, or waterways for usage in urban irrigation. Two MBR configurations exist: internal/submerged, where the membranes are immersed in and integral to the biological

reactor; and external/side stream, where membranes are a separate unit process requiring an intermediate pumping step.

The submerged configuration adopted in the ETP. Here, the filtration element is installed in the main bioreactor vessel. The modules are positioned above the aeration system, fulfilling two functions, the supply of oxygen and the cleaning of the membranes. The membranes are tubular and incorporates an online backwash system which reduces membrane surface fouling by pumping membrane permeate back through the membrane. Immersed MBR has been the preferred configuration due to its low energy consumption level, high biodegradation efficiency, and low fouling rate compared to side stream membrane bioreactors. Due to the high number of microorganisms in MBRs, better degradation is achieved in comparison to the conventional process. The industry has expanded the ETP by installing the Membrane Bioreactor (MBR) technology to enhance the treatment efficiency and meet the standards for treated wastewater reuse. The proposed Membrane Bioreactor (MBR) module is presented in Figure 11.

Figure 11 Membrane Bioreactor (MBR) Module

Specifications of MBR

Membrane Specifications

Membrane Type	:	Gemini -U
Membrane Material	:	Reinforced PVDF (Poly vinylidine difluoride)
Membrane fiber ID/OD	:	ID:1.0mm /OD:2.0mm
Nominal Pore Size	:	0.02 μm
Membrane Type	:	Immersed
Membrane configuration	:	Hollow fiber outside -in
Max Extraction pressure	:	60 kPa
Max operation temperature	:	40°C
pH resistant range	:	1~13
Membrane area module	:	31m² each
Membrane module size (LxWxH)	:	2122x 721x 70 (mm) each

Cassette Specifications

Cassette Model	:	Gemini –U26
Module per cassette	:	26 Pcs x 6 nos
Membrane Area per cassette	:	806 m² x 6 = 4836 m²

MBR Design criteria

S.No	Parameter	Inlet	Outlet
1	pH	7 .0- 8.0	> 8.0
2	TSS	100 – 1000 mg/L	< 1 mg/L
3	BOD	100 – 300 mg/L	< 100 mg/L
4	COD	200 – 1000 mg/L	< 200

3.1.4 SLUDGE MANAGEMENT

Filter Press and Drying Beds

The Sludge is removed from the Anaerobic Digesters, Anaerobic lagoon and Settling Tanks. The sludge is dewatered in Rotary Drum Vacuum Filters / Filter Presses and then the dewatered wet sludge is dried in Sludge Drying Beds. The dried sludge is given to farmers supplying Tapioca to the unit as manure. The sludge drying beds is shown in Figure 12.

Figure 12 Sludge drying beds

4.0 STATUS AND OBSERVATION OF VARALAKSHMI STARCH ETP

The monitoring data of the ETP for the quality of effluents from different units of treatment plant was carried out on 24th February 2022 by CES team. The onsite measurement data of ETP is presented in Table 3. The collected ETP samples are presented in Figure 13. The field visit photos of treatment units in ETP are shown in Figure 14 (a-h). The parameters of the collected effluent samples analyzed by CES are presented in Table 4. In ETP, the color of the raw effluent was recorded as 2.63 m^{-1}, 2.99 m^{-1}, 3.51 m^{-1} at 436 nm, 526 nm and 620 nm respectively and the colour of treated effluent from clarifier was observed to be 2.21 m^{-1}, 3.14 m^{-1}, 4.36 m^{-1} at 436 nm, 526 nm and 620 nm respectively. The pH of the effluent was varied from 5.2 to 8.6 at the clarifier outlet.

The TDS of the raw effluent was found to be 12150 mg/L. After Anaerobic treatment, TDS was reduced to 4650 mg/L and reduced to 4450 mg/L in aerobic treatment. The TDS was decreased to 1650 mg/L in clarifier outlet, which are within the permissible limit given by TNPCB (TDS – 2100 mg/L). Total suspended Solids (TSS) present in the raw effluent was found to be 7200 mg/L and the TSS was reduced to 1100 mg/L in anaerobic treatment. After Aerobic treatment, the TSS was reduced to 550 mg/L and almost complete TSS reduction was achieved in clarifier which is within the permissible limit given by TNPCB (TSS – 100 mg/L).

The organic removal in terms of COD & BOD was analyzed and the obtained data demonstrated that the COD of the raw effluent was found to be 3516 mg/L. During the anaerobic treatment process, COD was reduced to 330 mg/L and the COD was reduced to 95 mg/L at clarifier tank. The BOD concentrations at collection tank and clarifier outlet were observed to be 3800 mg/L and 30 mg/L. From the results, the organics are within the permissible limit given by TNPCB (COD – 250 mg/L, BOD – 30 mg/L). From this, the organic removal was found to be 97.3% of COD and 99% of BOD.

The total hardness, calcium hardness and magnesium hardness of raw effluent were observed to be 1200 mg/L, 200 mg/L and 1000 mg/L respectively. The total hardness, calcium hardness and magnesium hardness of treated effluent were observed to be 370 mg/L, 60 mg/L and 310 mg/L respectively. The concentration of chlorides present in the raw effluent was observed as 253 mg/L and it was reduced to 160 mg/L, which is less than permissible limit (1000 mg/L). The concentration of the sulphates in the raw effluent found to be 546 mg/L and it was decreased to 54 mg/L, which is less than permissible limit (1000 mg/L).

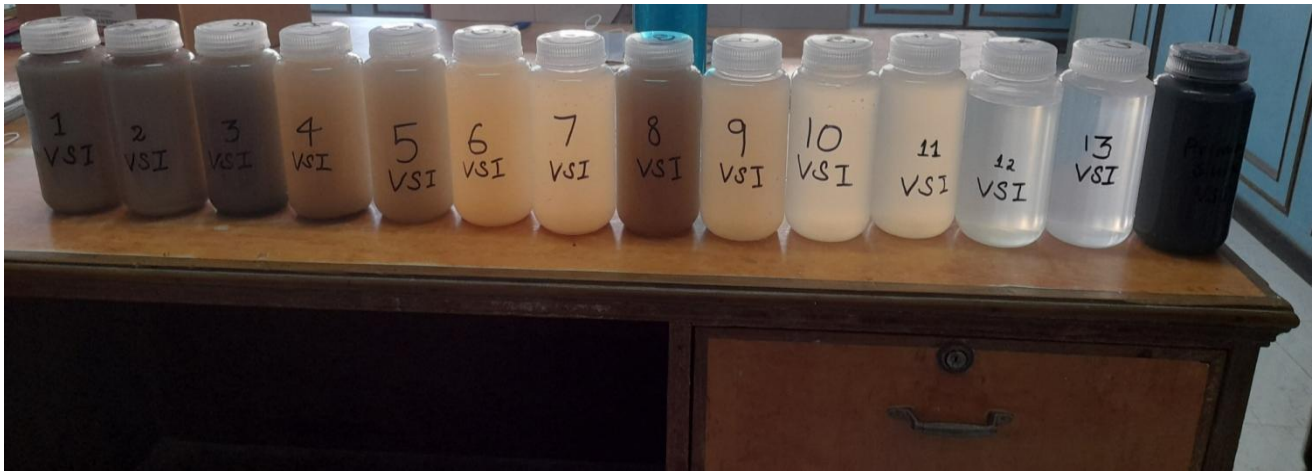
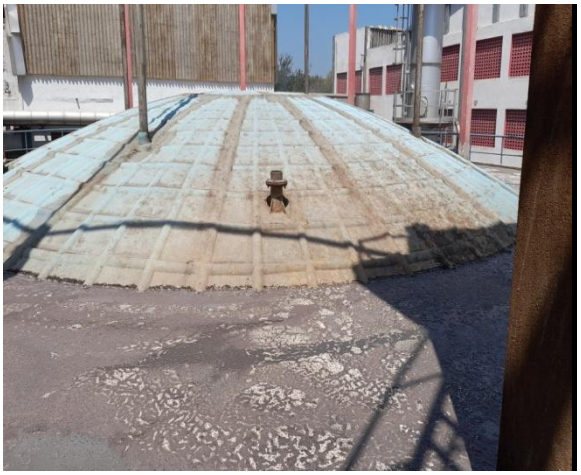


Figure 13 Samples collected from ETP on 24.02.2023

(a) Collection Tank

(b) Overhead Equalization Tank



(c) Anaerobic Digester

(d) Anaerobic lagoons

(e) Diffused Aeration tank

(f) Surface Aeration Tank

(g) Clarifier

(h) Treated effluent discharge area

(h) Proposed MBR System

Figure 14 (a-h) Treatment units of ETP on 24.02.2023

Table 3 Onsite Measurement Data for ETP Samples on 24.02.2023

Parameter	Hourly Measurement	1 Collection Tank	2 Equalization Tank	3 Anaerobic digester Outlet	4 Anaerobic lagoons 1 Outlet	5 Anaerobic lagoons 2 Outlet	6 Diffused Aeration Tank 1 Outlet	7 Diffused Aeration Tank 2 Outlet
pH	1	5.64		7.56	7.81	7.73	7.79	8.29
	2	6.37	6.37	7.63	7.82	7.81	7.94	8.47
	3	6.53		7.75	7.94	8.03	8.12	8.53
	COMPOSITE	6.50		7.40	8.29	8.33	8.48	8.76
EC (µS/cm)	1	3035		1200	1410	8015	4376	5376
	2	4437	4437	6609	6852	6430	5593	5593
	3	4307		5990	6430	6430	5553	5553
	COMPOSITE	4220		5887	6202	6202	5420	5420
TDS (mg/L)	1	1517		600	705	407	2188	2688
	2	2219	2219	3305	3426	3215	2797	2797
	3	2154		2995	3215	3215	2710	2777
	COMPOSITE	2110		2944	3101	2710	2710	2710

Table 3 Continued

Parameter	Hourly Measurement	8 Surface Aeration Tank Outlet	9 Primary settling Tank Outlet	10 Clarifier Outlet	11 Treated Water for Irrigation	12 Pond Water	13 Ground water	14 Sludge dewatering outlet
pH	1	8.27	8.15	8.49	8.56	8.72	8.31	8.39
	2	8.42	8.13	8.61				
	3	8.55	8.28	8.66				
	COMPOSITE	8.78	8.62	8.95				
EC (µS/cm)	1	5050	5376	2912	2753	899	375	5464
	2	5936	2218	3065				
	3	5050	1992	2455				
	COMPOSITE	5050	3210	2664				
TDS (mg/L)	1	2525	2688	1456	1377	450	188	2732
	2	2968	1109	1533				
	3	2525	996	1228				
	COMPOSITE	2525	1605	1332				

Table 4 Characteristics of ETP Samples on 24.02.2023

S.No	Parameters	Unit	1 Collection Tank	2 Equalization Tank	3 Anaerobic digester Outlet	4 Anaerobic lagoons 1 Outlet	5 Anaerobic lagoons 2 Outlet	6 Diffused Aeration Tank 1 Outlet	7 Diffused Aeration Tank 2 Outlet
1	**pH**		5.2	5.3	7.7	8.1	8	8.2	8.4
2	**EC**	**µS/cm**	2230	2150	2980	3060	3120	2690	2660
3	**TS**	**mg/L**	20000	18700	5800	5050	5750	6250	4600
4	**TDS**	**mg/L**	12150	11050	4650	4650	4000	4600	4450
5	**TSS**	**mg/L**	7200	7250	3650	1300	1100	600	550
6	**BOD**	**mg/L**	3800	3400	370	260	330	290	190
7	**COD**	**mg/L**	3516	2698	1697	1063	1022	1124	654
8	**Color (436 nm)**	**m^{-1}**	2.63	2.59	2.51	2.42	2.52	2.32	2.28
9	**Color (526 nm)**	**m^{-1}**	2.99	3.06	3.02	3.04	2.99	3.11	3.11
10	**Color (620 nm)**	**m^{-1}**	3.51	3.49	3.70	3.88	3.72	4.05	4.15
11	**Total Hardness**	**mg/L**	1200	1040	680	600	560	660	660
12	**Calcium Hardness**	**mg/L**	200	560	500	320	480	140	330
13	**Magnesium Hardness**	**mg/L**	1000	480	180	280	80	520	330
14	**Chlorides**	**mg/L**	253	337	295	270	312	278	262
15	**Sulphates**	**mg/L**	546	616	76	63	58	99	0
16	**Silica**	**mg/L**	1456	1676	1097	1206	897	1002	534
17	**MLSS**	**mg/L**	ND	ND	ND	ND	ND	800	ND
18	**SVI**	**mL/g**	ND	ND	ND	ND	ND	62.5	ND

Table 4 Continued

S.No	Parameters	Unit	8 Surface Aeration Tank Outlet	9 Primary settling Tank Outlet	10 Clarifier Outlet	11 Treated Water for Irrigation	12 Pond Water	13 Ground water	14 Sludge dewatering outlet
1	**pH**		8.5	8	8.6	8.4	8.6	7.6	8.2
2	**EC**	**µS/cm**	2620	1630	1050	988	427	190	2700
3	**TS**	**mg/L**	4750	3200	1850	1650	600	150	4750
4	**TDS**	**mg/L**	4400	2750	1650	1300	750	200	5450
5	**TSS**	**mg/L**	1600	250	0	100	0	0	1150
6	**BOD**	**mg/L**	240	160	30	54	48	9	180
7	**COD**	**mg/L**	818	593	95	172	0	4	981
8	**Color (436 nm)**	**m^{-1}**	2.41	2.31	2.21	2.89	0	2.33	2.33
9	**Color (526 nm)**	**m^{-1}**	3.06	3.08	3.14	3.08	0	3.18	3.11
10	**Color (620 nm)**	**m^{-1}**	3.87	4.12	4.36	4.19	0	3.89	4.02
11	**Total Hardness**	**mg/L**	540	370	320	320	230	20	540
12	**Calcium Hardness**	**mg/L**	520	60	110	80	90	10	500
13	**Magnesium Hardness**	**mg/L**	20	310	210	240	140	10	40
14	**Chlorides**	**mg/L**	287	186	160	152	110	46	270
15	**Sulphates**	**mg/L**	49	5	54	28	21	3	53
16	**Silica**	**mg/L**	800	563	636	522	317	146	1935
17	**MLSS**	**mg/L**	1400	ND	ND	ND	ND	ND	ND
18	**SVI**	**mL/g**	35.7	ND	ND	ND	ND	ND	ND

The primary and secondary sludge characteristics are presented in Table 5. The pH and EC of sludge were observed to be 7.9 and 23800 μS/cm respectively. The TSS and TDS of sludge were observed to be 280 mg/g and mg/g respectively. The moisture content of sludge was observed to be 91.65%. The Chlorides, sulphates and soluble silica of sludge were observed to be 253 mg/g, 80 mg/g and 146 mg/g respectively.

Table 5 Characteristics of Sludge on 24.03.2023

S.No	Parameters	Units	Value
1	**pH**		7.9
2	**EC**	**μS/cm**	23800
3	**TSS**	**mg/g**	280
4	**TDS**	**mg/g**	4833
5	**Moisture content**	**%**	91.65
6	**Chlorides**	**mg/g**	253
7	**Sulphates**	**mg/g**	80
8	**Soluble silica**	**mg/g**	146

Table 6 Characteristics of ETP Samples during February 2021- September 2022

Parameters	February 2021		March 2021		November 2021	December 2021			February 2022	March 2022		
	Inlet	Outlet	Inlet	Outlet	Outlet	Inlet	Anaerobic reactor	Outlet	Outlet	Inlet	Anaerobic reactor	Outlet
pH	3.83	7.85	4.03	7.38	7.18	4.19	6.33	7.36	6.65	2.46	6.11	6.24
TSS (mg/L)	2000	260	392	220	156	2612	1340	884	124	1212	564	264
TDS (mg/L)	4868	1952	4128	2944	1072	7080	1032	2332	916	4156	4256	916
Chloride (mg/L)	325	160	250	130	120	400	230	220	75	500	550	105
Sulphate (mg/L)	209	24	211	31	28	17	105	15	5	34	62	7
BOD (mg/L)	2400	315	2500	75	66	2400	660	180	115	4000	525	144
COD (mg/L)	11040	960	19840	592	368	14560	4000	752	504	25200	3520	600

Parameters	May 2022			July 2022			August 2022				September 2022		
	Inlet	Anaerobic reactor	Outlet	Inlet	Anaerobic reactor	Outlet	Inlet	Anaerobic reactor	Aeration Outlet	Outlet	Inlet	Anaerobic reactor	Outlet
pH	3.76	6.14	6.48	4.88	7.45	7.24	4.60	7.52	7.82	7.80	4.53	7.55	7.64
TSS (mg/L)	2860	860	196	2652	1184	124	1200	140	800	32	2600	460	24
TDS (mg/L)	18576	3344	1192	1704	2372	824	1620	2448	2024	1672	628	2988	664
Chloride (mg/L)	7498	450	165	445	490	173	325	450	450	290	260	725	150
Sulphate (mg/L)	162	111	22	74	70	23	157	24	46	32	5	39	5
BOD (mg/L)	9300	225	70	5250	1800	115	3900	145	108	30	168	168	8.7
COD (mg/L)	36400	1520	256	19200	14800	496	12600	1504	912	224	1440	1440	72

5.0 ELECTROMAGNETIC FLOW METER READINGS

The electromagnetic flow meter is used to measure the inlet and outlet flow of effluent in ETP. The electromagnetic flow meter for ETP inlet is shown in Figure 15. The flow meter reading was observed to be 195 m^3 in 24.02.2023.

Figure 15 Electromagnetic flow meter in ETP inlet

The flow meter readings data for January 2022 is presented in Table 7. From the table, the minimum and maximum flow was observed to be 80 m^3 and 480 m^3 respectively. Total flow was observed to be 12115 m^3 in ETP.

Table 7 Flow Meter Readings for January 2022

Days	Initial Reading in m^3	Final Reading in m^3	Flow in m^3
1	5853	6328	475
2	6328	6808	480
3	6808	7283	475
4	7283	7723	440
5	7723	8168	445
6	8168	8630	462
7	8630	9095	465
8	9095	9563	468
9	9563	10028	465
10	10028	10498	470
11	10498	10968	470
12	10968	11436	468
13	11436	11901	465
14	11901	12366	465
15	12366	12366	0
16	12366	12366	0
17	12366	12446	80
18	12446	12446	0
19	12446	12546	100
20	12546	12834	288
21	12834	13304	470
22	13304	13769	465
23	13769	14237	468
24	14237	14702	465
25	14702	15167	465
26	15167	15637	470
27	15637	16107	470
28	16107	16572	465
29	16572	17034	462
30	17034	17502	468
31	17502	17968	466
		Total	**12115**

The flow meter readings data for February 2022 is presented in Table 8. From the table, the minimum and maximum flow were observed to be 380 m^3 and 474 m^3 respectively. Total flow was observed to be 12807 m^3 in ETP.

Table 8 Flow Meter Readings for February 2022

Days	Initial Reading in m^3	Final Reading in m^3	Inlet Flow in m^3
1	17968	18435	467
2	18435	18900	465
3	18900	19368	468
4	19368	19832	464
5	19832	20297	465
6	20297	20763	466
7	20763	21230	467
8	21230	21695	465
9	21695	22155	460
10	22155	22617	462
11	22617	23080	463
12	23080	23524	444
13	23524	23960	436
14	23960	24342	382
15	24342	24814	472
16	24814	25287	473
17	25287	25759	472
18	25759	26237	478
19	26237	26713	476
20	26713	27190	477
21	27190	27656	466
22	27656	28096	440
23	28096	28566	470
24	28566	29038	472
25	29038	29448	410
26	29448	29922	474
27	29922	30395	473
28	30395	30775	380
		Total	**12807**

The flow meter readings data for March 2022 is presented in Table 9. From the table, the minimum and maximum flow were observed to be 110 m^3 and 477 m^3 respectively. Total flow was observed to be 9354 m^3 in ETP.

Table 9 Flow Meter Readings for March 2022

Days	Initial Reading in m^3	Final Reading in m^3	Flow in m^3
1	30775	31135	360
2	31135	31517	383
3	31517	31748	231
4	31748	32015	267
5	32015	32485	470
6	32485	32885	400
7	32885	33175	290
8	33175	33652	477
9	33652	33959	307
10	33959	34279	320
11	34279	34549	270
12	34549	34795	246
13	34795	35104	309
14	35104	35304	200
15	35304	35544	240
16	35544	35979	435
17	35979	36309	330
18	36309	36639	330
19	36639	36804	165
20	36804	37046	242
21	37046	37386	340
22	37386	37706	320
23	37706	38176	470
24	38176	38641	465
25	38641	39101	460
26	39101	39431	330
27	39431	39621	190
28	39621	39756	135
29	39756	39866	110
30	39866	39997	131
31	39997	40128	131
		Total	**9354**

The flow meter readings data for April 2022 is presented in Table 10. From the table, the minimum and maximum flow were observed to be 140 m^3 and 210 m^3 respectively. Total flow was observed to be 5218 m^3 in ETP.

Table 10 Flow Meter Readings for April 2022

Days	Initial Reading in m^3	Final Reading in m^3	Flow in m^3
1	40128	40320	200
2	40320	40478	150
3	40478	40688	210
4	40688	40888	200
5	40888	41088	200
6	41088	41238	150
7	41238	41398	160
8	41398	41558	160
9	41558	41708	150
10	41708	41848	140
11	41848	42008	160
12	42008	42183	175
13	42183	42361	178
14	42361	42541	180
15	42541	42691	150
16	42691	42831	140
17	42831	42981	150
18	42981	43141	160
19	43141	43311	170
20	43311	43471	160
21	43471	43641	170
22	43641	43821	180
23	43821	43981	160
24	43981	44146	165
25	44146	44316	170
26	44316	44516	200
27	44516	44716	210
28	44716	44926	210
29	44926	45126	200
30	45126	45336	210
		Total	**5218**

The flow meter readings data for May 2022 is presented in Table 11. From the table, the minimum and maximum flow were observed to be 35 m^3 and 285 m^3 respectively. Total flow was observed to be 3210 m^3 in ETP.

Table 11 Flow Meter Readings for May 2022

Days	Initial Reading in m^3	Final Reading in m^3	Flow in m^3
1	45336	45336	0
2	45336	45536	200
3	45536	45737	201
4	45737	45772	35
5	45772	45964	192
6	45964	46149	285
7	46149	46184	35
8	46184	46351	167
9	46351	46386	35
10	46386	46561	175
11	46561	46671	110
12	46671	46808	137
13	46808	46943	135
14	46943	47108	165
15	47108	47143	35
16	47143	47178	35
17	47178	47208	30
18	47208	47248	40
19	47248	47288	40
20	47288	47324	36
21	47324	47364	40
22	47364	47400	36
23	47400	47435	35
24	47435	47475	40
25	47475	47671	196
26	47671	47720	49
27	47720	47773	53
28	47773	47978	205
29	47978	48034	56
30	48034	48247	207
31	48247	48556	205
		Total	**3210**

The flow meter readings data for June 2022 is presented in Table 12. From the table, the minimum and maximum flow were observed to be 45 m^3 and 215 m^3 respectively. Total flow was observed to be 3826 m^3 in ETP.

Table 12 Flow Meter Readings for June 2022

Days	Initial Reading in m^3	Final Reading in m^3	Flow in m^3
1	48446	48616	170
2	48616	48768	152
3	48768	48918	150
4	48918	49129	211
5	49129	49274	145
6	49274	49444	170
7	49444	49489	45
8	49489	49649	160
9	49649	49824	175
10	49824	49870	46
11	49870	50072	202
12	50072	50247	175
13	50247	50412	165
14	50412	50557	145
15	50557	50692	135
16	50692	50872	180
17	50872	51077	215
18	51077	51232	145
19	51232	51387	155
20	51387	51552	165
21	51552	51704	152
22	51704	51876	172
23	51876	51976	100
24	51976	51976	0
25	51976	52081	105
26	52081	52081	0
27	52081	52081	0
28	52081	52187	106
29	52187	52187	0
30	52187	52272	85
		Total	**3826**

The flow meter readings data for July 2022 is presented in Table 13. From the table, the minimum and maximum flow were observed to be 25 m^3 and 125 m^3 respectively. Total flow was observed to be 1018 m^3 in ETP.

Table 13 Flow Meter Readings for July 2022

Days	Initial Reading in m^3	Final Reading in m^3	Flow in m^3
1	52272	52302	30
2	52302	52336	34
3	52336	52366	30
4	52366	52400	34
5	52400	52434	34
6	52434	52463	29
7	52463	52488	25
8	52488	52521	33
9	52521	52551	30
10	52551	52581	30
11	52581	52611	30
12	52611	52736	125
13	52736	52762	26
14	52762	52788	26
15	52788	52815	27
16	52815	52915	100
17	52915	52940	25
18	52940	53020	80
19	53020	53100	80
20	53100	53190	90
21	53190	53190	0
22	53190	53260	70
23	53260	53260	0
24	53260	53260	0
25	53260	53260	0
26	53260	53260	0
27	53260	53260	0
28	53260	53260	0
29	53260	53260	0
30	53260	53260	0
31	53260	53290	30
		Total	**1018**

The flow meter readings data for August 2022 is presented in Table 14. From the table, the minimum and maximum flow were observed to be 13 m^3 and 192 m^3 respectively. Total flow was observed to be 1315 m^3 in ETP.

Table 14 Flow Meter Readings for August 2022

Days	Initial Reading in m^3	Final Reading in m^3	Flow in m^3
1	53290	53290	0
2	53290	53310	20
3	53310	53310	0
4	53310	53380	70
5	53380	53393	13
6	53393	53403	10
7	53403	53473	70
8	53473	53528	55
9	53528	53583	55
10	53583	53638	55
11	53638	53683	45
12	53683	53733	50
13	53733	53773	40
14	53773	53808	35
15	53808	53843	35
16	53843	53883	40
17	53883	53933	50
18	53933	53983	55
19	53983	54041	58
20	54041	54101	60
21	54101	54141	40
22	54141	54183	42
23	54183	54201	18
24	54201	54237	36
25	54237	54274	37
26	54274	54300	26
27	54300	54356	56
28	54356	54356	0
29	54356	54408	52
30	54408	54600	192
31	54600	54600	0
		Total	**1315**

The flow meter readings data for September 2022 is presented in Table 15. From the table, the minimum and maximum flow were observed to be 3 m^3 and 192 m^3 respectively. Total flow was observed to be 2224 m^3 in ETP.

Table 15 Flow Meter Readings for September 2022

Days	Initial Reading in m^3	Final Reading in m^3	Flow in m^3
1	54600	54740	140
2	54740	54897	157
3	54897	55072	175
4	55072	55264	192
5	55264	55412	148
6	55412	55604	192
7	55604	55761	157
8	55761	55936	175
9	55936	56119	183
10	56119	56285	166
11	56285	56442	157
12	56442	56547	105
13	56547	56552	0
14	56552	56555	5
15	56555	56555	3
16	56555	56555	0
17	56555	56555	0
18	56555	56555	0
19	56555	56555	0
20	56555	56571	16
21	56571	56606	35
22	56606	56636	30
23	56636	56651	15
24	56651	56683	32
25	56683	56683	0
26	56683	56718	35
27	56718	56745	27
28	56745	56775	30
29	56775	56788	13
30	56788	56824	36
		Total	**2224**

The flow meter readings data for October 2022 is presented in Table 16. From the table, the minimum and maximum flow were observed to be 16 m^3 and 192 m^3 respectively. Total flow was observed to be 732 m^3 in ETP.

Table 16 Flow Meter Readings for October 2022

Days	Initial Reading in m^3	Final Reading in m^3	Flow in m^3
1	56824	56854	30
2	56854	56854	0
3	56854	56870	16
4	56870	56902	32
5	56902	56902	0
6	56902	56932	20
7	56932	56957	25
8	56957	56957	0
9	56957	57149	192
10	57149	57306	157
11	57306	57481	175
12	57481	57566	85
13	57566	57566	0
14	57566	57566	0
15	57566	57566	0
16	57566	57566	0
17	57566	57566	0
18	57566	57566	0
19	57566	57566	0
20	57566	57566	0
21	57566	57566	0
22	57566	57566	0
23	57566	57566	0
24	57566	57566	0
25	57566	57566	0
26	57566	57566	0
27	57566	57566	0
28	57566	57566	0
29	57566	57566	0
30	57566	57566	0
31	57566	57566	0
		Total	**732**

The power consumption data for ETP during January 2022 to October 2022 is presented in Table 17. From the table, the maximum power consumption was observed in February 2022 and the minimum power consumption was observed in June 2022.

Table 17 Monthly Power consumption data during January 2022 – October 2022

Days	January	February	March	April	May	June	July	August	September	October
	Power consumed, kW	Power consumed, kW	Power consumed, kW	Power consumed, kW	Power consumed, kW	Power consumed, kW	Power consumed, kW	Power consumed, kW	Power consumed, kW	Power consumed, kW
1	1617	1615	1575	795	0	170	751	0	772	731
2	1620	1614	1582	776	795	152	752	747	778	0
3	1617	1615	1526	800	795	150	751	0	785	726
4	1605	1614	1540	795	733	211	752	746	792	732
5	1606	1615	1618	795	792	145	752	724	775	0
6	1613	1614	1590	776	789	170	750	723	792	731
7	1615	1615	1548	779	733	45	749	746	778	729
8	1613	1614	1618	779	782	160	752	741	785	0
9	1615	1612	1555	776	733	175	751	741	788	792
10	1615	1612	1558	770	785	46	751	741	782	778
11	1616	1613	1540	779	761	202	751	736	778	785
12	1613	1603	1532	783	771	175	786	738	759	751
13	1620	1603	1557	785	770	165	749	735	0	0
14	1618	1583	1528	788	780	145	749	733	721	0
15	0	1617	1530	776	733	135	749	733	721	0
16	0	1616	1603	770	733	180	777	735	0	0
17	1470	1615	1560	776	731	215	749	739	0	0
18	0	1619	1560	779	735	145	770	740	0	0
19	1477	1618	1501	780	735	155	770	741	0	0
20	1548	1618	1530	779	733	165	773	742	726	0
21	1615	1614	1567	780	735	152	0	735	733	0
22	1613	1605	1560	788	733	172	766	736	731	0
23	1615	1618	1618	779	733	100	0	727	725	0
24	1614	1618	1614	772	735	0	0	734	732	0
25	1614	1593	1610	780	790	105	0	734	0	0
26	1618	1617	1560	795	738	0	0	730	733	0
27	1618	1618	1511	796	739	0	0	741	730	0
28	1614	1582	770	797	796	106	0	0	731	0
29	1614	1615	761	795	739	0	0	739	724	0
30	1615	1615	769	796	796	85	0	792	733	0
31	1615	1615	770	0	796	0	751	0	0	0
Total	**44863**	**49955**	**45261**	**23514**	**22749**	**3826**	**16651**	**19949**	**18104**	**6755**

6.0 GREEN BELT AREA

The total green belt area is 15.41 Hectares. The treated wastewater of 477 KLD is discharged in this green belt area. The soil types in the irrigated lands are Clay Soil and Gravel Soil and available plants are Seemai Karuvelam, Creepers and Grass. The layout of green belt is shown in Figure 16. The total green belt area utilized for treated effluent discharge is presented in Table 18. The green belt photos of Varalakshmi starch is presented in Figure 17.

Table 18 Utilization of land for Treated effluent discharge

Land for Greenbelt for disposing treated wastewater			
Village Name	**Patta No.**	**Survey No.**	**Extent in Hectares**
Pappiredipatty	206	75/2	0.95.00
Alamelupuram	18	125/1D	0.49.50
	18	125/2B	0.33.50
	18	125/3B	0.03.50
	18	128/2C	0.30.50
	18	128/5	0.14.50
	25	121/2A	1.26.50
	25	121/2B	0.76.00
	25	125/1A	2.44.00
	25	125/1C1	0.55.00
	25	125/1C2	0.07.00
	25	125/2A	0.16.50
	25	125/3A1	0.19.00
	25	125/3A2	0.04.00
	25	128/2A	0.84.00
	25	128/2B	0.36.00
	25	128/3A	0.13.50
	25	128/3B	0.14.00
	25	130/7	0.16.00
	37	128/1	0.50.00
	37	129/1	1.47.50
	37	129/2	0.68.50
	37	129/3	1.15.50
	37	130/1	0.32.00
	37	130/5	1.51.00
	37	130/6	0.11.50
		Total	**15.410**

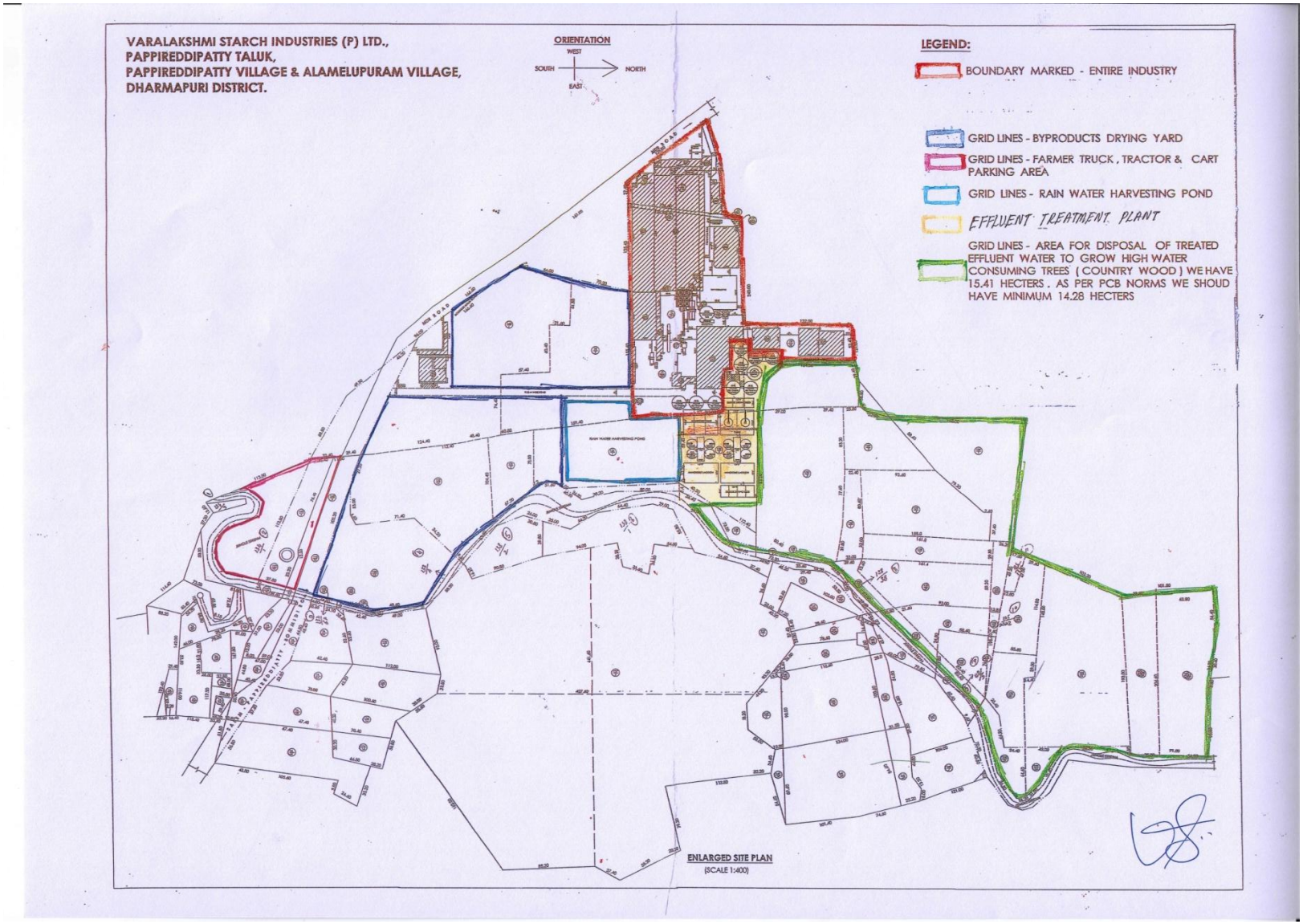


Figure 16 Green belt Area Layout

Figure 17 Green belt photos

7.0 SAFETY MEASURES

- PPE's such as Safety Boots, Safety Goggles, Rubber Gloves, Clothing, Safety Belts, First Aid Box, Fire extinguishers and Protective masks are provided to Personnel working in the ETP.
- The wastewater generated is 100% organic and biodegradable and non-hazardous.
- Therefore the needs for special safety measures are not required.

8.0 SUMMARY

M/s Varalakshmi Starch Industries Pvt Ltd. has requested the Centre for Environmental studies, Anna University, Chennai to carry out a design adequacy report for existing Effluent Treatment Plant on 19th September 2022. Varalakshmi Starch Effluent treatment plant has the capacity of 500 KLD for treating effluent from the manufacturing process of Tapioca starch, sago and maize starch. The water sources for starch production process are rainwater harvesting pond, wells and borewells. Varalakshmi Starch ETP proposed a MBR system for efficient solids and organic removal. By adopting this technique, the quality of treated effluent is expected to be meeting the reuse purposes. The overall performance analysis of ETP effluent shows that there is 100% colour removal. TDS concentration of effluent was reduced from 12150 mg/L to 1650 mg/L. TSS was found to be 7200 mg/L in the raw effluent and the almost complete TSS reduction achieved in clarifier. During the treatment process, COD of the raw effluent was reduced from 3516 mg/L to 95 mg/L at clarifier outlet and BOD concentration of raw effluent was reduced from 3800 mg/L to 30 mg/L at treated effluent. From the analysis results, the BOD and COD removal efficiencies were found to be 99% and 97.3% in the Effluent treatment plant.

Varalakshmi Starch industry used the Bio-methanation plants to treat the industrial effluent as well as to generate Biogas which is utilised for Power generation as well as for industrial heating replacing Furnace Oil and Coal. Biogas generation and Fresh water consumption records are not maintained by the industry. The industrial effluent is treated with anaerobic digestors to generate Biogas and the treated wastewater of 477 KLD is discharged in their own irrigated greenbelt lands of 15.41 Hectares. The land application of treated effluent is 30.7 m^3/d/ha, which is within the limit of standards. Biogas is used for Thermal application in the Boiler and Thermic Fluid Heaters as a substitute for Coal as well used for Power generation by using Biogas fuelled Gensets. The generated sludge is disposed as manure to the Tapioca supplying farmers. The generation of byproduct (thippi) from tapioca starch manufacturing is dried in the sunlight and stored in bags. And the stored thippi is supplied for cattle feed manufacturing. Based on process design furnished and analysis results, the effluent treatment plant with 500 KLD capacity proposed with MBR technology is expected to meet the discharge and reuse standards.

8.1 CONCLUSION

The performance study of the existing ETP in Varalakshmi Starch was evaluated by the CES Team based on field visit on 24th February 2023, and also CES team monitored and reviewed records maintained by the industry. The industry itself is regularly monitoring the performance of all the treatment units. The discharge of treated effluent into the land is found to be within the discharge limits. It may be concluded that all the treatment units as envisaged in the process flow diagram was implemented in the ETP except MBR system. The following observations were made during the period of field visit.

- The MBR system is not commissioned in the Varalakshmi starch ETP.
- After secondary treatment, the treated wastewater is directly discharged into the irrigation land.
- The chemical and biological sludge are not properly separated and treated.
- The quantity of sludge generation records is not maintained by the industry.
- The biogas generation, consumption and power generation data are not maintained by the industry.
- The flow meter is only installed in the inlet of Effluent treatment plant.
- The piezometric wells are not provided by the industry for ground water monitoring.
- The proper infrastructure facilities are not available in the industry for storage of byproducts.
- The hydraulic flow diagram is not available for the treatment systems.

Hence, it is concluded that Varalakshmi starch ETP industry is needed to commission the MBR treatment system for reusing of treated water to avoid contamination of surrounding environment. The industry is needed to provide proper infrastructure facilities for the storage and handling of by products. The industry is required to ensure appropriate safety systems and measures as proposed to avoid accidents and emergencies.

8.2 RECOMMENDATIONS

By observation of the Effluent Treatment Plant at Varalakshmi Starch, the CES is recommending the following inputs to be adopted by the industry.

- The industry is recommended to carry out the analysis of samples from all treatment units at regular intervals in order to study the performance of each operation and process.
- The presence of sulphur dioxide concentration in starch product shall monitor regularly before packing and ensure that it is within the limits of FSSAI standards.
- The industry is suggested to monitor the treated effluent parameters regularly and ensure that the all parameters are within the limit of discharge standards before which is discharged into the irrigation land.
- Hydraulic flow diagram for Effluent Treatment Plant should be prepared.
- The industry is recommended to adopt treated water reuse against discharging of treated water into the land.
- The industry shall conduct water and wastewater audit and groundwater quality study and also check the stability of the ETP.
- The industry shall provide piezometric wells in green belt area to monitor the ground water quality regularly.
- The industry shall develop the greenbelt area of 33% with local species plants as per CPCB guidelines.
- The industry is suggested to complete the MBR technology installation works for achieving effluent quality reuse standards.
- The proper infrastructure facilities shall provide for storage and handling of Thippi.
- The ETP is suggested to install the electromagnetic flow meters in inlet and outlet and check the water balance regularly.
- Biogas generation, power generation and sludge generation records should be maintained.
- Fresh water consumption and Biogas consumption records should be maintained.
- The sludge withdrawal rate of biological treatment system should be regulated so as to retain mean cell residence time in the range of 25-50 days.
- The chemical and biological sludge handling and treatment should be properly managed.

- The ETP should be operated by quality personnel and records should be maintained to establish sustained performance.
- Proper protective equipment should be given to the personnel involved in the cleaning of treatment units.
- The industry needs to implement measures to improve the Health, Safety and Environmental aspects in their unit, to the satisfactory level and practice all the mandatory safety systems, so as to protect the safety of workers and the environment.
- It is also recommended that the TNPCB shall periodically monitor the performance of the key treatment processes of the ETP and verify the monitoring and measurement being carried out by the ETP.

29/05/2023

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ANNEXURE I

DESIGN REPORT

DESIGN FOR 500 KLD ETP

	BASIS OF DESIGN		
	DESIGN PARAMETER	**DESIGN VALUE**	**UNIT**
	Total Capacity of Plant	500	m^3/day
	Operating Hours Per Day (Working Hours)	24	Hrs
	Total Average Flow rate	20.8	m^3/hr
	Peak Factor Considered	1.5	
	Peak flow rate	31	m^3/day
	CHARACTERISTICS OF TRADE EFFLUENT		
	Biological Oxygen Demand, BOD	5000	mg/L
	Total Dissolved Solids, TDS	5000	mg/L
	Total Suspended Solids, TSS	7500	mg/L
	pH	3.8 - 4.5	
1	**COLLECTION TANK**		
	Design Flow rate	20.8	m^3/hr
	Volume of Tank	**6.5**	**m^3**
	Side Water Depth (SWD)	1.6	m
	Free Board (FB)	0.4	m
	Area of Tank	4.06	m^2
	Total Height of Tank	**2**	**m**
	Detention time	**0.31**	**hr**
	Number of tanks	**1**	**No**
	Provided size of tank	**3.4 x 1.2 x 2.0**	**m**
2	**OVERHEAD EQUALIZATION TANK**		
	Design Flow rate	20.8	m^3/hr
	Volume of Tank	**8**	**m^3**
	Side Water Depth (SWD)	1	m
	Free Board (FB)	0.5	m
	Area of Tank	7.80	m^2
	Total Height of Tank	**1.50**	**m**
	Detention time	**0.37**	**hr**
	Number of tanks	**1**	**No**
	Provided size of tank	**3.0 x 2.6 x 1.5**	**m**

3	**ANAEROBIC HUSMAR DIGESTERS**		
	Design Flow rate	500	m^3/day
	Operating Hours	24	Hrs
	Average Flow rate	20.8	m^3/hr
	Yield Coefficient	0.58	kg VSS/kg BOD
	Decay Coefficient	0.05	per Day
	Inlet BOD	5000	mg/L
	Outlet BOD	1200	mg/L
	Removal Efficiency of BOD	76	%
	BOD Load	2500	kg/d
	BOD removal Load	1900	kg/d
	Hydraulic Retention Time Considered	15	Days
	Volume of Tank Based on HRT	**7500**	**m^3**
	Volume of Tank provided	**9600**	**m^3**
	Number of Tanks/Unit	6	Nos
	Volume of Each Tank	1600	m^3
	Side Water Depth (SWD)	13	m
	Free Board (FB)	0	m
	Area of Tank	755	m^2
	Total Height of Tank	**13**	**m**
	Number of Tanks	**6**	**Nos**
	Provided size of anaerobic round tank	**12.5 x 13**	**m**
4	**ANAEROBIC LAGOON - 1**		
	Design Flow rate	250	m^3/day
	Operating Hours	24	Hrs
	Average Flow rate	10.4	m^3/hr
	Yield Coefficient	0.58	kg VSS/kg BOD
	Decay Coefficient	0.05	per Day
	Inlet BOD	1200	mg/L
	Outlet BOD	450	mg/L
	Removal Efficiency of BOD	62.5	%
	BOD Load	300	kg/d
	BOD removal Load	187.5	kg/d
	Hydraulic Retention Time Considered	13	Days
	Volume of Tank Based on HRT	**3250**	**m^3**
	Volume of Tank provided	**4300**	**m^3**
	Side Water Depth (SWD)	3	m
	Free Board (FB)	0.3	m
	Area of Tank	1433.33	m^2

	Total Height of Tank	**3.3**	**m**
	Number of Tanks	**1**	**No**
	Provided size of tank	**32 x 45 x 3.3**	**m**
5	**ANAEROBIC LAGOON - 2**		
	Design Flow rate	250	m^3/day
	Operating Hours	24	Hrs
	Average Flow rate	10.4	m^3/hr
	Yield Coefficient	0.58	kg VSS/kg BOD
	Decay Coefficient	0.05	per Day
	Inlet BOD	1200	mg/L
	Outlet BOD	450	mg/L
	Removal Efficiency of BOD	62.5	%
	BOD Load	300	kg/d
	BOD removal Load	187.5	kg/d
	Hydraulic Retention Time Considered	13	Days
	Volume of Tank Based on HRT	**3250**	**m^3**
	Volume of Tank provided	**3650**	**m^3**
	Side Water Depth (SWD)	3	m
	Free Board (FB)	0.3	m
	Area of Tank	1216.67	m^2
	Total Height of Tank	**3.3**	**m**
	Number of Tanks	**1**	**No**
	Provided size of tank	**32 x 38 x 3.3**	**m**
6	**AERATION TANKS**		
	Design Flow rate	500	m^3/day
	Operating Hours	24	Hrs
	Average Flow rate	20.8	m^3/hr
	Sludge Age (15 - 25 Days)	25	Days
	Yield Coefficient	0.58	kg VSS/kg BOD
	Decay Coefficient	0.05	per Day
	Inlet BOD	450	mg/L
	Outlet BOD	70	mg/L
	Removal Efficiency of BOD	84.4%	
	BOD Load	225	kg/d
	BOD removal Load	190	kg/d
	Food/Micro Organsims, F/M ratio	0.12	
	Mixed Liquid Suspended Solids, MLSS	3500	mg/L
		3.5	g/L

	Percentage of MLVSS/MLSS	60%	
	Hydraulic Retention Time Considered	4	Days
	Volume of Tank Based on HRT	**2000**	**m^3**
	Volume of Tank Based on F/M & MLSS	**536**	**m^3**
	Volume of Tank provided	2880	m^3
	Volume Considered (Max Volume)	**2880**	**m^3**
	Number of Tanks/Unit	8	Nos
	Volume of Each Tank	360	m^3
	Side Water Depth (SWD)	3.2	m
	Free Board (FB)	0.2	m
	Area of Tank	346	m2
	Total Height of Tank	**3.4**	**m**
	Number of Tanks	**8**	**Nos**
	Provided size of each aeration tank	**12 x 3.4**	**m**
	OPTION - I		
	AIR REQUIREMENT FOR AERATION		
	Average Flow rate	20.8	m^3/hr
	Max Inlet BOD	450	mg/L
	Outlet BOD	70	mg/L
	Oxygen required to remove BOD load	190	kg/day
		7.9	kg/hr
	Oxygen Requirement	2	kg/kg of BOD
	Total Oxygen required	15.83	kgs/hr
	Density of Air	1.2	kg/m^3
	% of Oxygen in air (23%)	0.23	
	Alpha Factor	0.65	
	Beta Factor	0.95	
	Tolerance of Air Blower (95%)	0.95	
	Oxygen Transfer Efficiency	0.2	
	Air requirement for Aeration	**489**	**m^3/hr**
	Number of Tanks	8	Nos
	OPTION - II		
	AIR REQUIREMENT FOR AERATION		
	Average Flow rate	20.8	m^3/hr
	Max Inlet BOD	450	mg/L
	Outlet BOD	70	mg/L
	Oxygen required to remove BOD load	190	kg/day
		7.9	kg/hr

	Density of Air	1.201	kg/m^3
	Oxygen Fraction in air (% by weight)	13	kg/m^3
	Design Temperature	28	Deg C
	Alpha Factor	0.65	
	Beta Factor	0.95	
	SOTE value for Diffusers	32	
	Saturation value of DO at MSl at 27 Deg C	7.95	mg/L
	Saturation value of DO at Field Conditions	7.31	mg/L
	DO Saturation Concentration for Tap Water	9.08	mg/L
	DO Saturation Concentration for Field Condition	10.13	mg/L
	Standard DO for Sewage water at Field Conditions	8.16	mg/L
	Minimum DO to be maintain in the Tank	2.00	mg/L
	Value of Factor	1.015	
	Field Oxygen Transfer Efficiency	18	%
	Actual Oxygen required	44	kg/hr
	Total Quantity of air required	340	kg/hr
	Density of Air	1.201	kg/m^3
	Total Quantity of air required	283	m3/hr
	Tolerance of Air Blower (85%)	0.85	
	Air requirement for Aeration	**333**	**m^3/hr**
	Air requirement for Aeration (Max)	**489**	**m^3/hr**
	AERATION SYSTEM (DIFFUSERS)		
	Total Air requirement for tanks	489	m^3/hr
	Fine Bubble Diffusers volume	1.70	m^3/hr
	Total Diffusers provided	1184	Nos
	Number of Tanks	**8**	**Nos**
	Air blowers capacity provided for AT and EQT	**2000**	**m^3/hr**
7	**PRIMARY SETTLING TANKS**		
	Design Flow rate	500	m^3/day
	Design Flow rate	20.8	m^3/hr
	Volume of each Tank	**1150**	**m^3**
	Side Water Depth (SWD)	3	m
	Free Board (FB)	0.4	m
	Area of Tank	383.33	m^2
	Total Height of Tank	**3.40**	**m**
	Number of Tanks	**2**	**No**
	Provided size of each tank	**32 x 12 x 3.4**	**m**

	RETURN SLUDGE TRANSFER PUMP		
	RAS Recycle ration	0.5	
	Return Sludge Transfer Pump Flow rate	10.4	m^3/hr
	No of Pumps	2	Nos
8	**CLARIFIER**		
	Design Flow rate	500	m^3/day
	Surface overflow rate	35	m^3/ m^2/day
	Area of tank required	**14.3**	**m^2**
	Diameter of Tank	**4.3**	**m**
	Side Water Depth (SWD)	3	m
	Free Board (FB)	0.4	m
	Total Height of Tank	**3.4**	**m**
	Number of Tanks	**1**	**No**
	Area of Tank provided	**69.9**	**m^2**
	Volume of Tank	**209.7**	**m^3**
	Detention time	**10.08**	**Hrs**
	Provided size of tank	**23.3 x 3**	**m**
9	**MEMBRANE BIOREACTOR (MBR) EXTENSION**		
9A	**DIFFUSED AERATION TANK**		
	Design Flow rate	500	m^3/day
	Operating Hours	24	Hrs
	Average Flow rate	20.8	m^3/hr
	Sludge Age (15 - 25 Days)	25	Days
	Yield Coefficient	0.58	kg VSS/kg BOD
	Decay Coefficient	0.05	per Day
	Inlet BOD	70	mg/L
	Outlet BOD	20	mg/L
	Removal Efficiency of BOD	71.4	%
	BOD Load	35	kg/d
	BOD removal Load	25	kg/d
	Food/Micro Organisms, F/M ratio	0.12	
	Mixed Liquid Suspended Solids, MLSS	3500	mg/L
		3.5	g/L
	Percentage of MLVSS/MLSS	60%	
	Hydraulic Retention Time Considered	0.5	Days
	Volume of Tank Based on HRT	250	m^3
	Volume of Tank Based on F/M & MLSS	83	m^3

	Volume of Tank provided	350	m^3
	Volume Considered (Max Volume)	**350**	**m^3**
	Number of Tanks/Unit	1	Nos
	Volume of Each Tank	350	m^3
	Side Water Depth (SWD)	4.4	m
	Free Board (FB)	0.2	m
	Area of Tank	346	m^2
	Total Height of Tank	**4.6**	**m**
	Number of Tanks	**1**	**Nos**
	Provided size of each aeration tank	**14.25 X 5.7 X 4.6**	**m**
	OPTION - I		
	AIR REQUIREMENT FOR AERATION		
	Average Flow rate	20.8	m^3/hr
	Max Inlet BOD	70	mg/L
	Outlet BOD	20	mg/L
	Oxygen required to remove BOD load	25	kg/day
		1.0	kg/hr
	Oxygen Requirement	2	kg/kg of BOD
	Total Oxygen required	2.083	kgs/hr
	Density of Air	1.2	Kg/m^3
	% of Oxygen in air (23%)	0.23	
	Alpha Factor	0.65	
	Beta Factor	0.95	
	Tolerance of Air Blower (95%)	0.95	
	Oxygen Transfer Efficiency	0.2	
	Air requirement for Aeration	**64**	**m^3/hr**
	Number of Tanks	1	No
	OPTION - II		
	AIR REQUIREMENT FOR AERATION		
	Average Flow rate	20.8	m^3/hr
	Max Inlet BOD	70	mg/L
	Outlet BOD	20	mg/L
	Oxygen required to remove BOD load	25	kg/day
		1.5	kg/hr
	Density of Air	1.201	kg/m^3
	Oxygen Fraction in air (% by weight)	13	kg/m^3
	Design Temperature	28	Deg C
	Alpha Factor	0.65	

	Beta Factor	0.95	
	SOTE value for Diffusers	32	
	Saturation value of DO at MSl at 27 Deg C	7.95	mg/L
	Saturation value of DO at Field Conditions	7.31	mg/L
	DO Saturation Concentration for Tap Water	9.08	mg/L
	DO Saturation Concentration for Field Condition	10.13	mg/L
	Standard DO for Sewage water at Field Conditions	8.16	mg/L
	Minimum DO to be maintain in the Tank	2.00	mg/L
	Value of Factor	1.015	
	Field Oxygen Transfer Efficiency	18	%
	Actual Oxygen required	6	kg/hr
	Total Quantity of air required	45	kg/hr
	Density of Air	1.201	kg/m^3
	Total Quantity of air required	37	m^3/hr
	Tolerance of Air Blower (85%)	0.85	
	Air requirement for Aeration	**44**	**m^3/hr**
	Air requirement for Aeration (Max)	**64**	**m^3/hr**
	AERATION SYSTEM (DIFFUSERS)		
	Total Air requirement for tanks	64	m^3/hr
	Fine Bubble Diffusers volume	1.70	m^3/hr
	Total Diffusers provided	125	Nos
	Number of Tanks	**1**	**Nos**
	Air blowers capacity provided for AT and EQT	**500**	**m^3/hr**
9B	**SETTLING TANK**		
	Design Flow rate	500	m^3/day
	Design Flow rate	20.8	m^3/hr
	Volume of Tank	**280**	**m^3**
	Side Water Depth (SWD)	4.4	m
	Free Board (FB)	0.2	m
	Area of Tank	63.64	m^2
	Total Height of Tank	**4.60**	**m**
	Number of Tanks	**1**	**No**
	Provided size of each tank	**14.25 X 4.5 X 4.6**	**m**
9C	**MBR SUBMERSIBLE TANK**		
	Design Flow rate	500	m^3/day
	Average Flow rate	20.8	m^3/hr
	Volume of Tank	**130**	**m^3**

	Side Water Depth (SWD)	4.4	m
	Free Board (FB)	0.2	m
	Area of Tank	29.55	m^2
	Total Height of Tank	**4.60**	**m**
	Number of Tanks	**1**	**No**
	Provided size of each tank	**9.3 X 3.2 X 4.6**	**m**
	Membrane Module Type		
	Number of Membrane Cassette	6	No
	Number of Membrane Modules per Cassette	26	Nos
	Membrane area per module	**31**	**m^2**
	Total Membrane Area per cassette	**806**	**m^2**
	Membrane Material		
	Membrane fiber ID	1.0	mm
	Membrane fiber OD	**2.0**	**mm**
	Nominal Pore Size	0.02	µm
	Membrane Type		
	Membrane configuration		
	Max Extraction pressure	**60**	**kPa**
	Max operation temperature	**40**	**Deg c**
	Membrane module size	2.1 x 0.7 x 0.07	m
	Each Cassette Dimension	2.1 x 0.8 x 2.5	m
9D	**SETTLING TANK**		
	Design Flow rate	500	m^3/day
	Design Flow rate	20.8	m^3/hr
	Volume of Tank	**120**	**m^3**
	Side Water Depth (SWD)	4.4	m
	Free Board (FB)	0.2	m
	Area of Tank	27.27	m^2
	Total Height of Tank	**4.60**	**m**
	Number of Tanks	**2**	**No**
	Provided size of each tank	**4.5 x 3.2 x 4.6**	**m**
9E	**PERMEATE TANK**		
	Design Flow rate	500	m^3/day
	Average Flow rate	20.8	m^3/hr
	Volume of Tank	**120**	**m^3**
	Side Water Depth (SWD)	4.4	m
	Free Board (FB)	0.2	m
	Area of Tank	27.27	m^2

	Total Height of Tank	**4.60**	**m**
	Detention Time	**5.8**	**Hrs**
	Number of Tanks	**2**	**Nos**
	Provided size of each tank	**4.5 x 3.2 x 4.6**	**m**
10	**Sludge Drying Beds**		
	BOD Load	2500	kg/d
	Sludge produced (30% of BOD load)	750	kg/day
	Sludge consistency	1.0	%
	Sludge generated	75	m^3/day
	Sludge height	**0.8**	**m**
	Area required	**93.75**	**m^2**
	Area provided	**154.7**	**m^2**
	Number of beds	**5**	**Nos**
	Provided Size of beds	**10.18 ×15.24 ×1.10**	**m**

ANNEXURE II

STANNDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE

EFFLUENT TREATMENT PLANT

OBJECTIVE / SCOPE

To ensure that the trade effluent from the Production unit is being treated, managed, and maintained in the ETP.

RESPONSIBILITY

Operation / Maintenance Personnel

SAFETY INFORMATION

All necessary protective clothing must be worn as required during operation and maintenance.

- Safety Footwear
- Gloves
- Headgear (when required)
- Safety Goggles (when required)
- Uniforms are to be always worn on company property.

PROCEDURE

EFFLUENT TREATMENT PLANT (ETP) MANAGEMENT

1. Collect the trade effluent in collection tank and pump to the Overhead equalization tank. Ensure the operating pump is in operation and the standby spare pumps are ready for operation.
2. The effluent from the Overhead equalization tank is to be equally distributed to all the six Anaerobic Digesters for Anaerobic biological bacterial treatment which degrades organic matter present in the effluent and reduced COD and BOD from the effluent in turn generating renewable Biogas fuel.
3. Ensure that the Methane containing Biogas generated in each Anaerobic Digester are conveyed by Blowers either for Thermal use or Power Generation.
4. Ensure that the partly treated effluent from the Anaerobic Digesters are fed evenly to the two Anaerobic Lagoons for further biological bacterial treatment for reduction of further COD and BOD.
5. From the Anaerobic Lagoons, ensure the partly treated effluent is fed equally to the downstream eight Aeration Tanks for Aerobic bacterial treatment where biological culture

is developed which degrades organic matter present in the effluent and reduced COD and BOD from the effluent.

6. Carry out aeration by positive displacement air blowers by means of diffused aeration. Monitor the Dissolved Oxygen level using ORP sensor, MLSS and Sludge Volume. Required quantity of RAS is to be circulated back to the Aeration Tanks for maintenance of bacterial load.
7. The partly treated effluent from the Aeration tanks are to be allowed in the subsequent Primary settling tanks from where sludge is to be allowed to settle by gravity and then drained from the bottom of the settling tank to the sludge beds.
8. Allow the partly treated effluent to be clarified in the secondary clarifier and sediment from clarifier to be sent to sludge bed.
9. Before clarification, dosage of Alum / Ferrous sulphate is to be added in a flocculation tank. Make up flocculant mix in dosing tank and feed to the flocculation tank.
10. The treated wastewater from the clarifier is then disposed to the greenbelt maintained within the unit.
11. Monitor the quality and flow through the ETP and effluent discharge and adjust the plant equipment accordingly.
12. Keep the Effluent plant area in a tidy condition.
13. Report any faults to the Plant Manager.
14. Effluent sample to be collect once per day once plant has been running. Sample is to be taken in a bottle which can be obtained from the lab. Sample then to go to the laboratory for testing.

PRE-OPERATIONAL CHECKING

1. Check the requisite materials in the First Aid Box and ensure the expiry period.
2. Check the refilling time or expiry of fire extinguishers.
3. Check for any broken parts or damage in equipments and if found then inform to the supervisor immediately.
4. Check the moving parts with covers or guards in position.
5. Be careful while stepping to see the effluent level in the treatment tanks.
6. Carefully walk over the platforms of the Digesters, Aeration tanks and Clarifier.
7. If see any leakage from any ETP treatment systems or pipeline, then make immediate

arrangement for stopping and reporting the same.

8. Ensure that areas, such as chemical mixing room, pump room and electrical control room and ETP surroundings are properly lighted and safe to work.

HOUSEKEEPING / CLEANING

1. ETP plant area to be cleanly maintained.
2. ETP plant area to be cleaned weekly.
3. Supplies and materials those used at the ETP plant should be stored in a neat and orderly manner.
4. Extraneous materials not in use shall be cleared from operational areas.
5. Avoid the floors to be slippery due to water or aqueous solutions.
6. Other areas around the effluent treatment plant to be kept tidy by removing any rubbish and removal of weeds.

ENVIRONMENTAL ASPECTS

1. The company accepts an obligation to comply with all relevant environmental legislation, and statutory requirements.
2. The company regards the protection of the environment, and the prevention of pollution, as a mutual objective between management, employees, and all other interested parties.

DEPARTMENT OF TECHNICAL EDUCATION, TAMILNADU
GOVERNMENT COLLEGE OF ENGINEERING, SALEM-11

From
The Principal
Govt. College of Engineering
Salem – 636 011

To
The Managing Director
Varalakshmi Starch Industries (P) Ltd
Pappireddipatti
Dharmapuri District.

Lr.No.: GCE/CIVIL/SML/Consultancy/ 2023/C-712 Dt: 26 .09.2023.

Sir,

Sub: Assessment of the structural condition and Strength of the Structures in Varalakshmi Starch Industries (P) Ltd, Pappireddipatti, Dharmapuri District -Non-Destructive Tests (NDT) - Consultancy Report furnished – reg.

Ref: Your Letter No.: NIL Dated: 01-08-2023

...

With reference to your letter cited above, the report on the assessment of the structural condition and Strength of structure of various treatment units in Varalakshmi Starch Industries(P) Ltd, Pappireddipatti, Dharmapuri District by Non-Destructive Tests conducted on Overhead Tank, Anaerobic Tank, Aeration Tank, Settling Tank, Clarifier Tank, Sludge Drying bed and MBR Building are enclosed. The receipt of the report may kindly be acknowledged.

26/9/2023

for Principal

Professor of Civil Engineering
Government College of Engineering
Salem - 636 011.

Enclosure: As above

26/9/23

Department of Civil Engineering
Salem - 636 011
Government College of Engineering

DEPARTMENT OF TECHNICAL EDUCATION

GOVERNMENT OF TAMIL NADU

Assessment of the structural condition and Strength of Structure of various treatment units in Varalakshmi Starch Industries (P) Ltd., Pappireddipatti, Dharmapuri District by Non-Destructive Test

CONSULTANCY REPORT

DEPARTMENT OF CIVIL ENGINEERING
GOVERNMENT COLLEGE OF ENGINEERING, SALEM
(An Autonomous Institution affiliated to Anna University, Chennai)
Ph. No.: 0427-2346102, 0427-2346157 Fax No.: 0427-2346458
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DEPARTMENT OF CIVIL ENGINEERING
GOVERNMENT COLLEGE OF ENGINEERING
SALEM-636011
STRUCTURAL ENGINEERING LABORATORY

CONSULTANCY REPORT

Lr. No.: GCE/CIVIL/SML/Consultancy/ 2023/C-712 Date: 26.09.2023

Name of the Party : The Managing Director
Varalakshmi Starch Industries (P) Ltd.,
Pappireddipatti
Dhramapuri District.

Reference : Your Letter No: Nil Dated: 01-08-2023

Nature of Consultancy : Assessment of the structural condition and Strength of Structure of various treatment units in Varalakshmi Starch Industries(P) Ltd, Pappireddipatti, Dharmapuri District.

REPORT

In the letter cited under reference, the Managing Director, Varalakshmi Starch Industries (P) Ltd, Pappireddipatti, Dharmapuri District had requested to assess the structural condition and Strength of structure of various treatment units in Varalakshmi starch Industries (P) Ltd, Pappireddipatti, Dharmapuri District.

Based on the request, Dr.D.Shoba Rajkumar, Professor, Dr.S.Sundari Associate Professor, faculty members of the Department of Civil Engineering, Government College of Engineering, Salem along with a team of technical staff members conducted Non Destructive tests using rebound hammer on 16.08.2023 and 13.09.2023 to ascertain the quality and strength of the Overhead Tank, Anaerobic Tank, Aeration Tank, Settling Tank, Clarifier Tank, Sludge Drying bed Tank and MBR Building, Varalakshmi Starch Industries(P) Ltd, Pappireddipatti, Dharmapuri District.

Department of Civil Engineering
Salem - 636 011
Government College of Engineering

NON-DESTRUCTIVE TESTING OF CONCRETE REBOUND HAMMER TEST AS PER IS13311(PART 2):1992

Objective:

The rebound hammer test method was used for:

1) Assessing the likely compressive strength of concrete in the beams, slabs & column with the help of suitable co-relations between rebound index and compressive strength
2) Assessing the uniformity of concrete
3) Assessing the quality of the concrete in relation to standard requirements

Principle of test:

When the plunger of rebound hammer is pressed against the surface of the concrete, the spring-controlled mass rebounds and the extent of such rebound depends upon the surface hardness of concrete. The surface hardness and therefore the rebound is taken to be related to the compressive strength of the concrete. The rebound is read off along a graduated scale and is designated as the rebound number or rebound index.

Procedure:

1. The point of impact was selected at a distance of 20mm away from any edge or shape discontinuity.
2. Measurement was taken using rebound hammer by holding it at right angles to the surface of the concrete member. The test was thus conducted horizontally on vertical surfaces, vertically upwards and downwards on horizontal structural elements.
3. Rebound hammer test was conducted around the selective points for observation on the structural element. Around each point of observation, four readings of rebound indices were taken and average of those readings after deleting outliers as per IS 8900:1978 gives the rebound index for the selected point of observation.

BRIEF DESCRIPTION ABOUT THE INDUSTRY

The Industry was established in the year 1995 as a Rural Agro based Medium Scale Export Oriented Industry for the manufacture of Super High-Grade Tapioca Starch. The Industry was further expanded to manufacture Tapioca Sago (Sabudana), Maize Starch and Modified Starches from Tapioca Tubers and Maize Kernels.

The factory building typically consists of various facilities and has collection tank with dimension of 3.4m x 1.2m x 1.6m; overhead tank with the dimension of 3m x 2.6m x 1m; 6 nos. of anaerobic tanks with diameter 15m and 16m height; 8 nos. of aeration tank each tank of 10 m diameter and 3 m height; 2 nos. of settling tanks with the dimension of 15m x 6m x 3m each approximately; 1no. of clarifier tank with diameter of 23.3m, 4.2m height and 1 no. of sludge drying bed tank with the dimension of 10.18m x 15.24m x 1m.

NON-DESTRUCTIVE TESTING RESULTS FOR TREATMENT UNITS

REBOUND HAMMER TEST FOR OVERHEAD TANK

Overhead tank:

The purpose of overhead water tank is to maintain proper distribution of water, to maintain constant pressure and water flow.

Table 1 Rebound Hammer Test Result for the Overhead Tank

No. of Location	Overhead Tank Identification	Rebound hammer Test as per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1	OTSW 1	36	Good
2	OTSW 2	35	Good
3	OTSW 3	36	Good
4	OTC 1	30	Good
5	OTC 2	34	Good
6	OTC 3	32	Good
7	OTC 4	31	Good
8	OTBS 1	31	Good
9	OTBSB 1	32	Good

OTSW - Overhead tank sidewall. OTBS - Overhead tank Base slab.

OTC - Overhead tank column. OTBSB - Overhead tank. Base slab beam

Inference:

The compressive strength of concrete in Overhead tank possesses good compressive strength (Greater than 30 N/mm^2). In the bottom of the circular tank, spalling of cover concrete was observed which may be repaired by cement plastering.

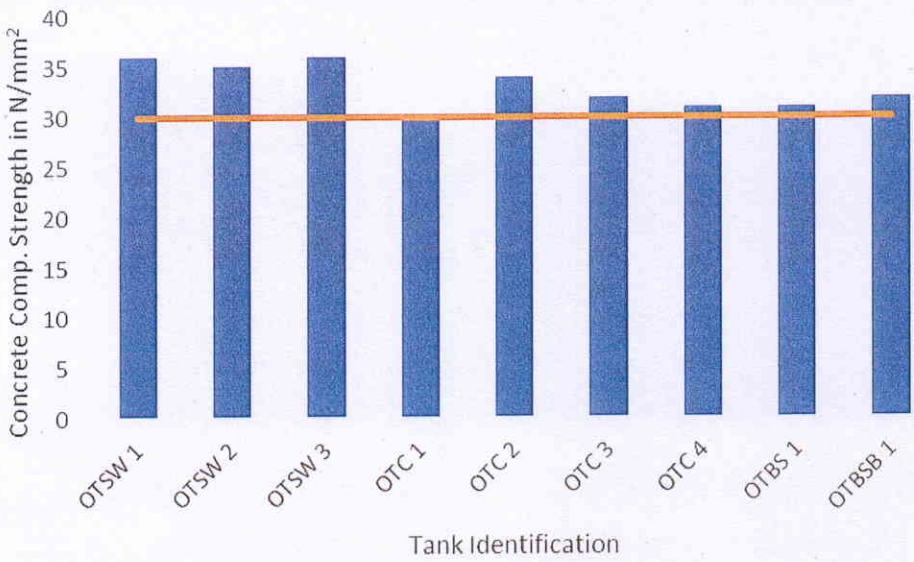

Fig.1 Compressive strength of concrete for Overhead Tank

Fig.2 Rebound Hammer Test conducted on Overhead Tank

REBOUND HAMMER TEST RESULTS FOR ANAEROBIC TANK

Anaerobic tank:

Anaerobic digesters are enclosed structures where anaerobic break down of organic matter takes place. The anaerobic microorganisms convert the organic matter into biogas, which then can be captured and utilized for energy as a flammable gas.

ANAEROBIC TANK -1 (REACTOR 1)

Table 2 Rebound Hammer Test Result for the Anaerobic Tank -1 (Reactor 1)

No. of Location	Reactor 1 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1	ANT1P1	39	Good
2	ANT1P2	37	Good
3	ANT1P3	43	Good
4	ANT1P4	28	Moderate
5	ANT1P5	38	Good
6	ANT1P6	37	Good
7	ANT1P7	35	Good
8	ANT1P8	33	Good
9	ANT1P9	32	Good
10	ANT1P10	33	Good
11	ANT1P11	34	Good
12	ANT1P12	37	Good

ANT1P1 - Anaerobic Tank 1 point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Anaerobic Tank -1 (Reactor 1) with moderate strength at few locations.

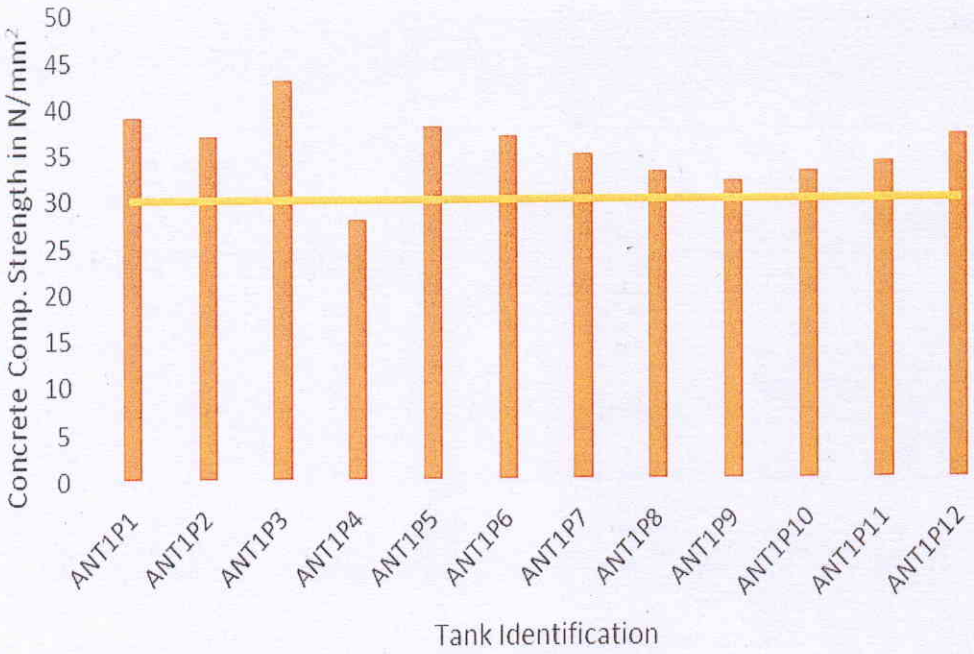

Fig.3 Compressive strength of concrete for Anaerobic Tank 1

Fig.4 Rebound Hammer Test conducted on Anaerobic Tank 1

2	ANT2P2	41	Good
3	ANT2P3	38	Good
4	ANT2P4	37	Good
5	ANT2P5	42	Good
6	ANT2P6	31	Good
7	ANT2P7	35	Good
8	ANT2P8	27	Moderate
9	ANT2P9	30	Good
10	ANT2P10	32	Good

ANT2P1 - Anaerobic Tank 2 point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Anaerobic ank -2 (Reactor 2) overall with moderate strength at few locations.

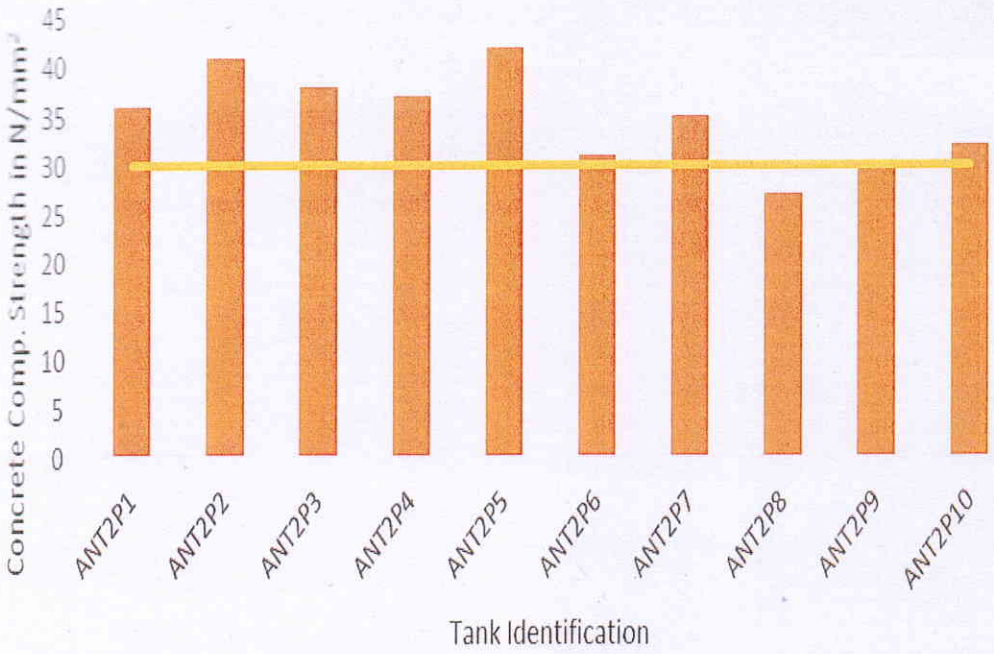

Fig.5 Compressive strength of concrete for Anaerobic Tank 2

Fig.6 Rebound Hammer Test conducted on Anaerobic Tank 2

ANAEROBIC TANK -3 (REACTOR 3)

Table 4 Rebound Hammer Test Result for the Anaerobic Tank -3 (Reactor 3)

No. of Location	Reactor 3 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1	ANT3P1	33	Good
2	ANT3P2	34	Good
3	ANT3P3	40	Good
4	ANT3P4	28	Moderate
5	ANT3P5	32	Good
6	ANT3P6	34	Good
7	ANT3P7	34	Good
8	ANT3P8	35	Good
9	ANT3P9	36	Good
10	ANT3P10	40	Good
11	ANT3P11	35	Good
12	ANT3P12	39	Good
13	ANT3P13	38	Good
14	ANT3P14	37	Good
15	ANT3P15	36	Good
16	ANT3P16	32	Good
17	ANT3P17	38	Good
18	ANT3P18	37	Good
19	ANT3P19	36	Good
20	ANT3P20	38	Good
21	ANT3P21	31	Good
22	ANT3P22	33	Good

ANT3P1 -AnaerobicTank 3 point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Anaerobic -3 (Reactor 3) overall with moderate strength at few locations.

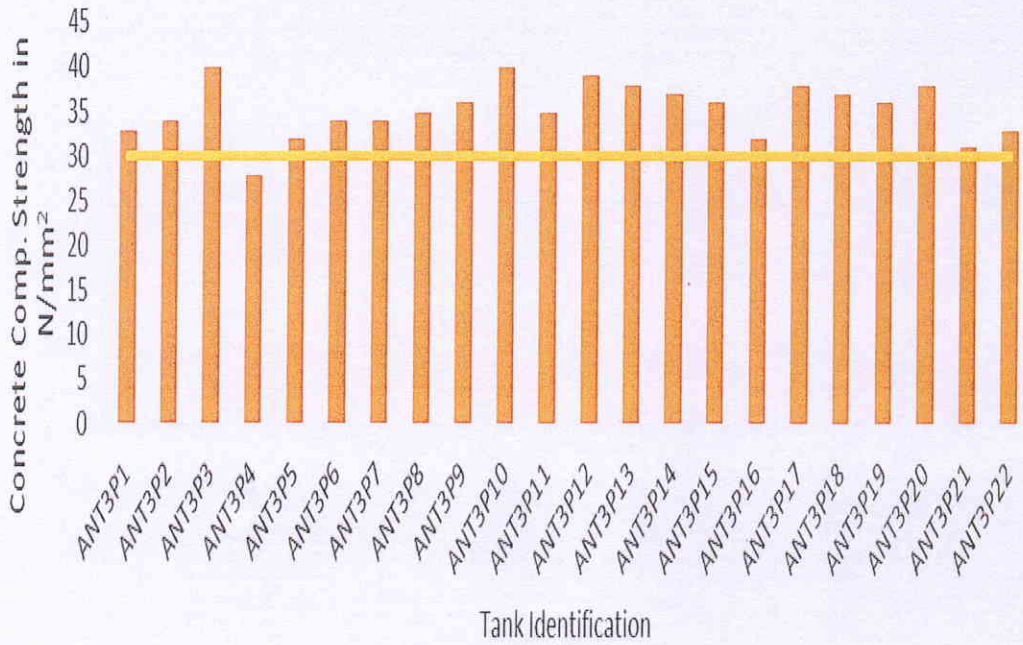

Fig.7 Compressive strength of concrete for Anaerobic Tank 3

Fig.8 Rebound Hammer Test conducted on Anaerobic Tank

ANAEROBIC TANK - 4 (REACTOR 4)

Table 5 Rebound Hammer Test Result for the Anaerobic Tank -4 (Reactor 4)

No. of Location	Reactor 4 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1	ANT4P1	38	Good
2	ANT4P2	38	Good
3	ANT4P3	38	Good
4	ANT4P4	33	Good
5	ANT4P5	41	Good
6	ANT4P6	42	Good
7	ANT4P7	40	Good
8	ANT4P8	41	Good
9	ANT4P9	36	Good
10	ANT4P10	43	Good
11	ANT4P11	38	Good
12	ANT4P12	32	Good
13	ANT4P13	36	Good
14	ANT4P14	38	Good
15	ANT4P15	38	Good
16	ANT4P16	36	Good
17	ANT4P17	41	Good
18	ANT4P18	36	Good
19	ANT4P19	31	Good
20	ANT4P20	41	Good

ANT4P1 - Anaerobic Tank 4 point 1

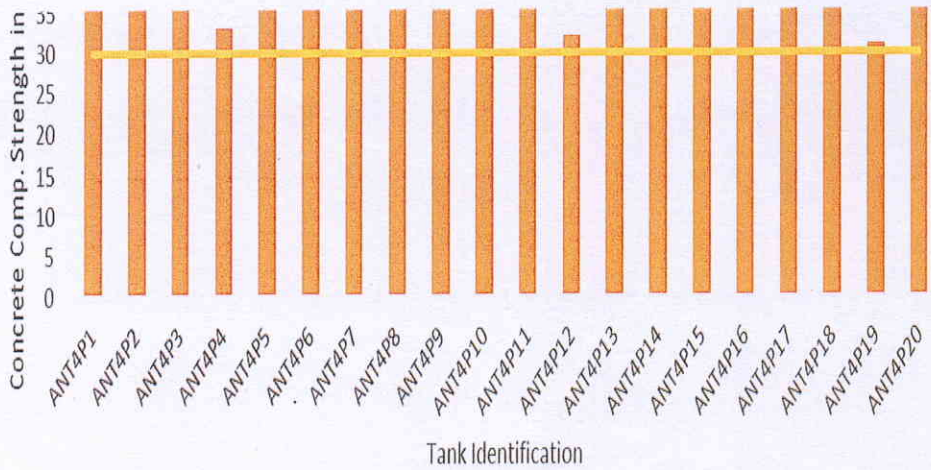

Fig.9 Compressive strength of concrete for Anaerobic Tank 4

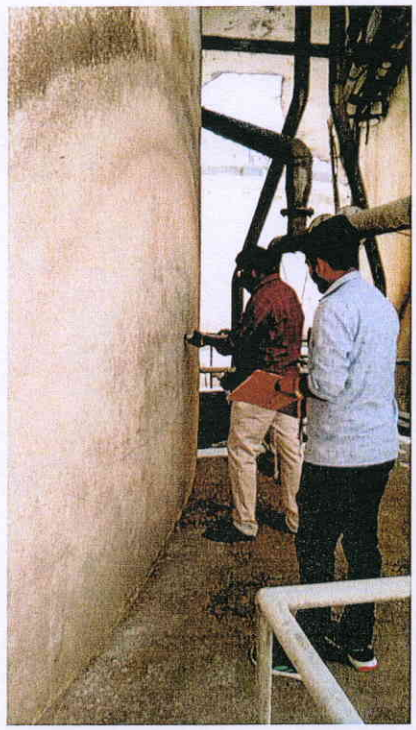

Fig.10 Rebound Hammer Test conducted on Anaerobic Tank 4

ANAEROBIC TANK -5 (REACTOR 5)

Table 6 Rebound Hammer Test Result for the Anaerobic Tank -5 (Reactor 5)

No. of Location	Reactor 5 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1	AT5P1	31	Good
2	AT5P2	38	Good
3	AT5P3	33	Good
4	AT5P4	30	Good
5	AT5P5	26	Moderate
6	AT5P6	36	Good
7	AT5P7	30	Good
8	AT5P8	35	Good
9	AT5P9	31	Good
10	AT5P10	31	Good
11	AT5P11	32	Good
12	AT5P12	34	Good
13	AT5P13	34	Good
14	AT5P14	28	Moderate
15	AT5P15	33	Good
16	AT5P16	35	Good
17	AT5P17	30	Good
18	AT5P18	35	Good
19	AT5P19	31	Good
20	AT5P20	31	Good
21	AT5P21	30	Good
22	AT5P22	32	Good

AT5P1 - Anaerobic Tank 5 point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Anaerobic Tank - 5 (Reactor 5) overall with moderate strength at few locations.

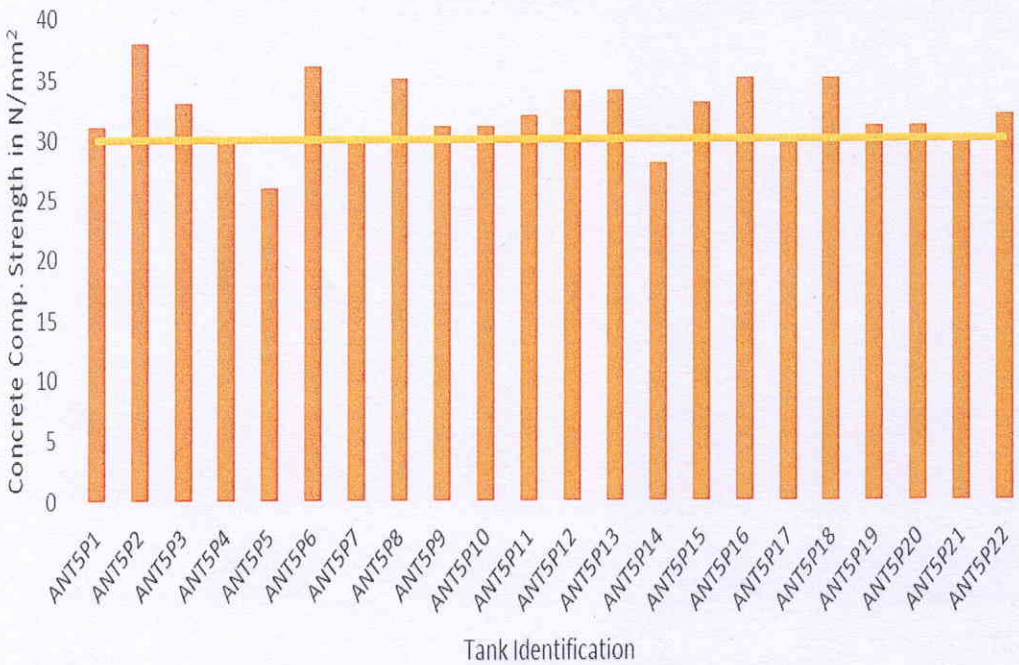

Fig.11 Compressive strength of concrete for Anaerobic Tank 5

Fig.12 Rebound Hammer Test conducted on Anaerobic Tank 5

ANAEROBIC TANK -6 (REACTOR 6)

Table 7 Rebound Hammer Test Result for the Anaerobic Tank -6 (Reactor 6)

No. of Location	Reactor 6 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1	AT6P1	31	Good
2	AT6P2	30	Good
3	AT6P3	26	Moderate
4	AT6P4	30	Good
5	AT6P5	36	Good
6	AT6P6	32	Good
7	AT6P7	38	Good
8	AT6P8	39	Good
9	AT6P9	35	Good
10	AT6P10	46	Good
11	AT6P11	31	Good
12	AT6P12	39	Good
13	AT6P13	35	Good

AT6P1 - Anaerobic Tank 6 point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Anaerobic Tank -6 (Reactor 6) overall with moderate strength at few locations.

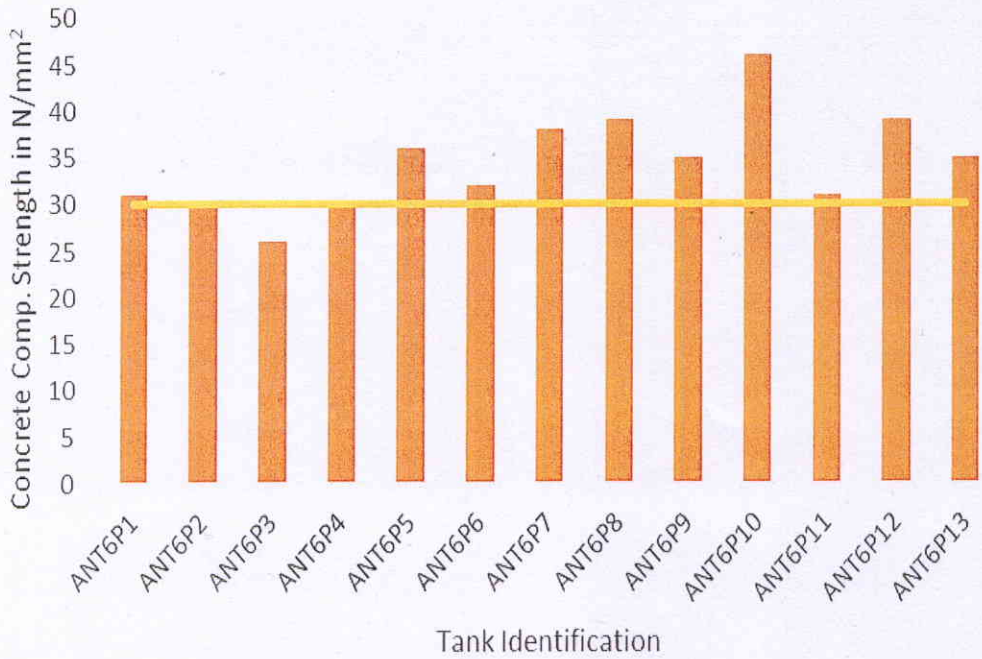

Fig.13 Compressive strength of concrete for Anaerobic Tank 6

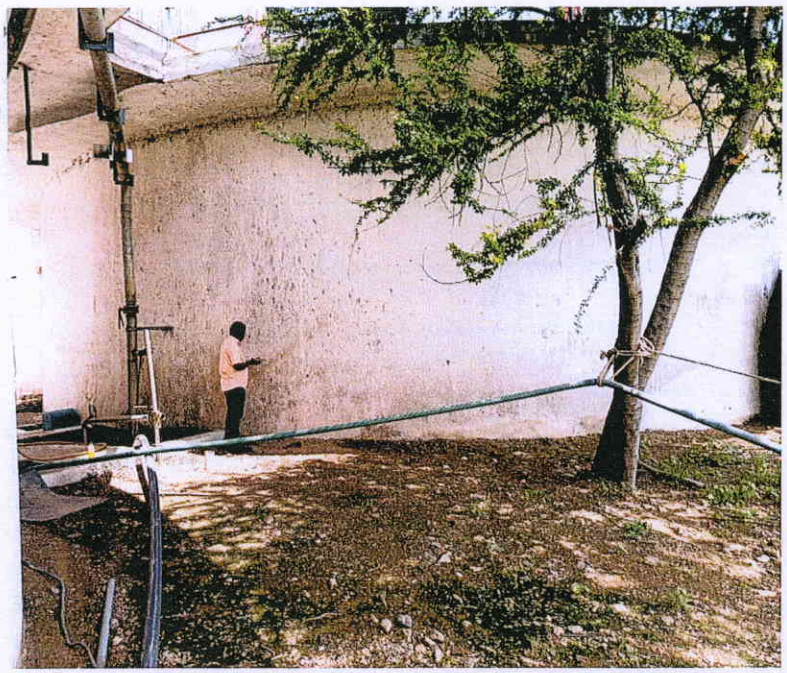

Fig.14 Rebound Hammer Test conducted on Anaerobic Tank 6

REBOUND HAMMER TEST RESULTS FOR AERATION TANKS

Aeration Tanks:

In the Aeration Tank occurs an activated sludge process where air is added into the water to encourage microbial growth. The microbes in the water feed on the organic material and form flocs that settle down.

AERATION TANK -1

Table 8 Rebound Hammer Test Result for the Aeration Tank -1

No. of Location	Aeration Tank-1 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1.	AT1P1	50	Good
2.	AT1P2	35	Good
3.	AT1P3	32	Good
4.	AT1P4	46	Good
5.	AT1P5	50	Good
6.	AT1P6	46	Good
7.	AT1P1	50	Good
8.	AT1P2	39	Good
9.	AT1P3	27	Moderate
10.	AT1P4	46	Good
11.	AT1P5	46	Good
12.	AT1P6	42	Good
13.	AT1P7	42	Good
14.	AT1P8	31	Good
15.	AT1P9	32	Good
16.	AT1P10	36	Good
17.	AT1P11	46	Good
18.	AT1P12	42	Good

19.	AT1P13	42	Good
20.	AT1P14	28	Moderate
21.	AT1P15	38	Good
22.	AT1P16	39	Good
23.	AT1P17	46	Good
24.	AT1P18	46	Good
25.	AT1P19	50	Good
26.	AT1P20	35	Good
27.	AT1P21	22	Moderate
28.	AT1P22	46	Good

AT1P1: Aeration Tank 1 Point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Aeration Tank 1 overall with moderate strength at few locations.

Fig.15 Compressive strength of concrete for Aeration Tank 1

AERATION TANK -2

Table 9 Rebound Hammer Test Result for the Aeration Tank -2

No. of Location	Aeration Tank-2 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1.	AT2P1	54	Good
2.	AT2P2	28	Moderate
3.	AT2P3	44	Good
4.	AT2P4	35	Good
5.	AT2P5	32	Good
6.	AT2P6	28	Moderate
7.	AT2P7	44	Good
8.	AT2P8	42	Good
9.	AT2P9	32	Good
10.	AT2P10	42	Good
11.	AT2P11	46	Good
12.	AT2P12	32	Good
13.	AT2P13	32	Good
14.	AT2P14	35	Good
15.	AT2P15	32	Good
16.	AT2P16	32	Good
17.	AT2P17	35	Good
18.	AT2P18	27	Moderate
19.	AT2P19	32	Good
20.	AT2P20	32	Good
21.	AT2P21	42	Good
22.	AT2P22	32	Good
23.	AT2P23	32	Good
24.	AT2P24	39	Good

AT2P1: Aeration Tank 2 Point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Aeration Tank 2 overall with moderate strength at few locations.

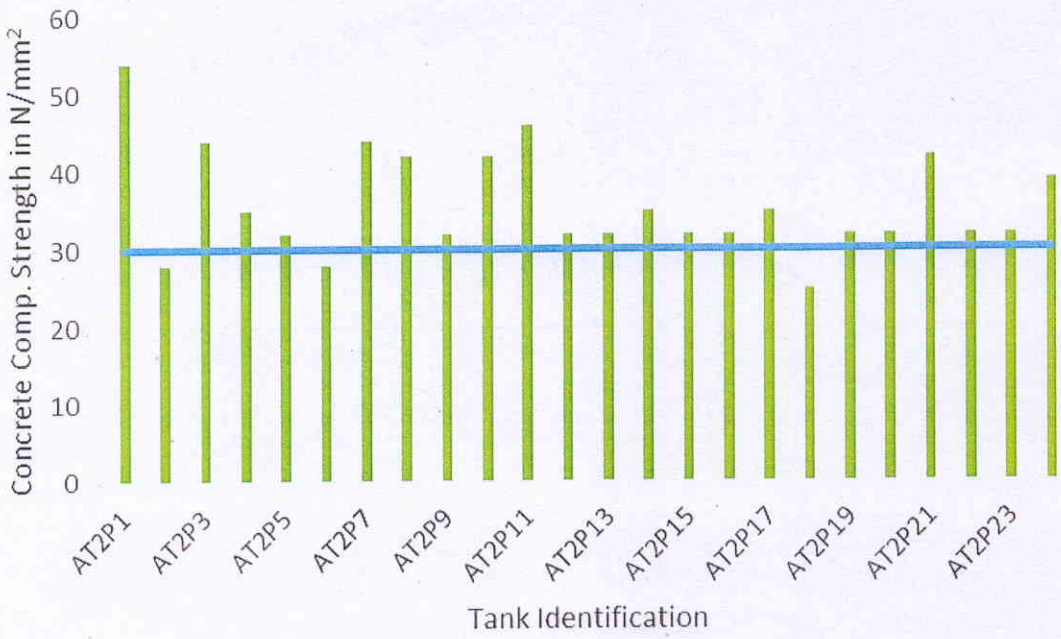

Fig.16 Compressive strength of concrete for Aeration Tank2

AERATION TANK -3

Table 10 Rebound Hammer Test Result for the Aeration Tank -3

No. of Location	Aeration Tank-3 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1.	AT3P1	32	Good
2.	AT3P2	35	Good
3.	AT3P3	28	Moderate
4.	AT3P4	35	Good
5.	AT3P5	35	Good

6.	AT3P6	28	Moderate
7.	AT3P7	38	Good
8.	AT3P8	35	Good
9.	AT3P9	35	Good
10.	AT3P10	46	Good
11.	AT3P11	39	Good
12.	AT3P12	28	Moderate
13.	AT3P13	32	Good
14.	AT3P14	39	Good
15.	AT3P15	39	Good
16.	AT3P16	35	Good
17.	AT3P17	48	Good
18.	AT3P18	39	Good
19.	AT3P19	32	Good
20.	AT3P20	38	Good
21.	AT3P21	42	Good
22.	AT3P22	42	Good
23.	AT3P23	32	Good
24.	AT3P24	46	Good

AT3P1: Aeration Tank 3 Point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Aeration Tank 3 overall with moderate strength at few locations.

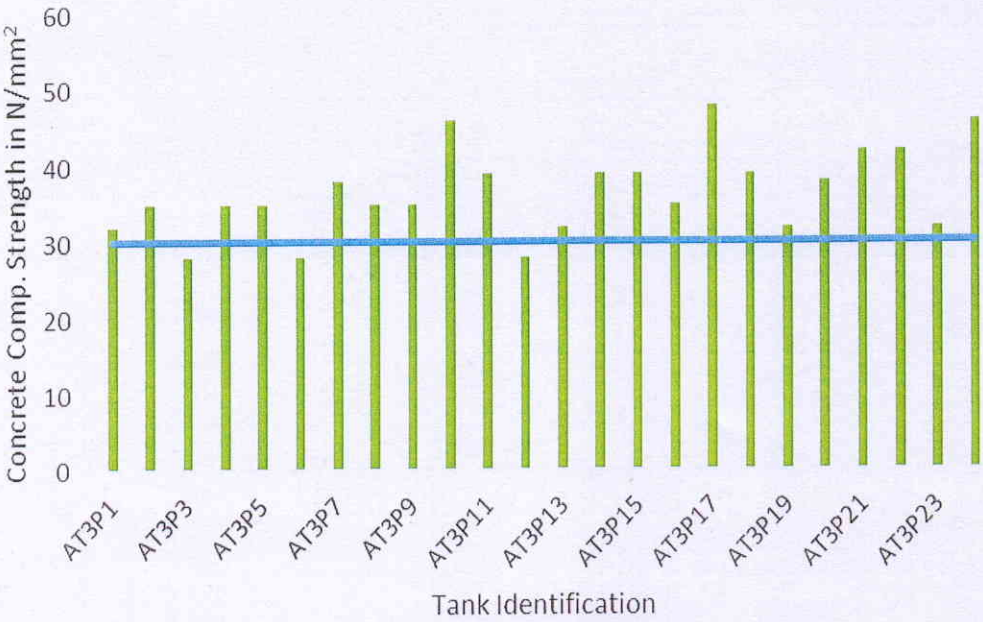

Fig.17 Compressive strength of concrete for Aeration Tank3

AERATION TANK -4

Table 11 Rebound Hammer Test Result for the Aeration Tank -4

No. of Location	Aeration Tank-4 Identification	Rebound hammer Test As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1.	AT4P1	40	Good
2.	AT4P2	46	Good
3.	AT4P3	44	Good
4.	AT4P4	46	Good
5.	AT4P5	44	Good
6.	AT4P6	46	Good
7.	AT4P7	40	Good
8.	AT4P8	35	Good
9.	AT4P9	42	Good
10.	AT4P10	40	Good
11.	AT4P11	31	Good

12.	AT4P12	42	Good
13.	AT4P13	38	Good
14.	AT4P14	30	Good
15.	AT4P15	38	Good
16.	AT4P16	32	Good
17.	AT4P17	38	Good
18.	AT4P18	39	Good
19.	AT4P19	32	Good
20.	AT4P20	38	Good
21.	AT4P21	32	Good
22.	AT4P22	32	Good
23.	AT4P23	32	Good
24.	AT4P24	41	Good

AT4P1: Aeration Tank 4 Point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Aeration Tank 4 in allthe points tested.

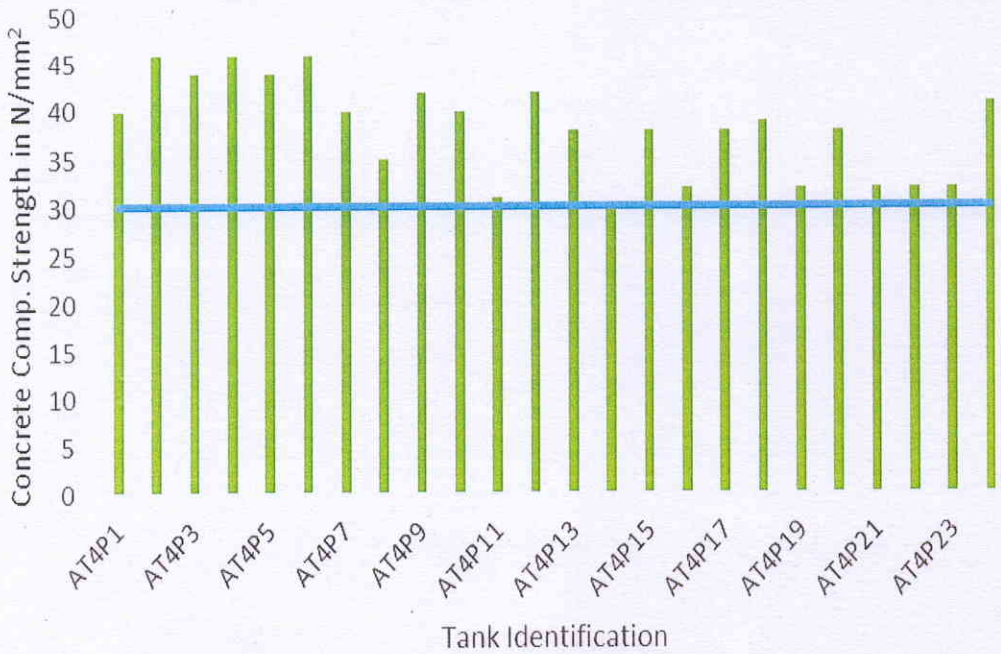

Fig.18 Compressive strength of concrete for Aeration Tank4

Fig.19 Rebound Hammer Test conducted on Aeration Tank 1, 2, 3 & 4.

AERATION TANK -5

Table 12 Rebound Hammer Test Result for the Aeration Tank -5

No. of Location	Aeration Tank-5 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1.	AT5P1	32	Good
2.	AT5P2	39	Good
3.	AT5P3	39	Good
4.	AT5P4	30	Good
5.	AT5P5	35	Good
6.	AT5P6	32	Good
7.	AT5P7	33	Good
8.	AT5P8	32	Good

9.	AT5P9	32	Good
10.	AT5P10	32	Good
11.	AT5P11	36	Good
12.	AT5P12	35	Good
13.	AT5P13	37	Good
14.	AT5P14	35	Good
15.	AT5P15	35	Good
16.	AT5P16	35	Good
17.	AT5P17	33	Good
18.	AT5P18	32	Good

AT5P1: Aeration Tank 5 Point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Aeration Tank 5 in allthe points tested.

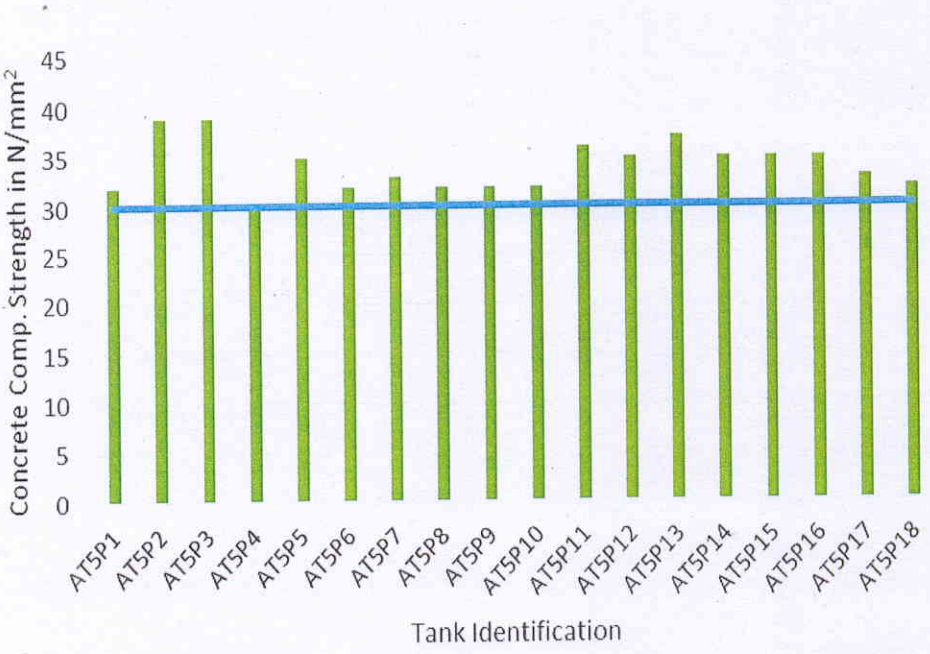

Fig.20 Compressive strength of concrete for Aeration Tank 5

AERATION TANK -6

Table 13 Rebound Hammer Test Result for the Aeration Tank -6

No. of Location	Aeration Tank-6 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1.	AT6P1	29	Moderate
2.	AT6P2	30	Good
3.	AT6P3	30	Good
4.	AT6P4	33	Good
5.	AT6P5	34	Good
6.	AT6P6	33	Good
7.	AT6P7	32	Good
8.	AT6P8	34	Good
9.	AT6P9	30	Good
10.	AT6P10	32	Good
11.	AT6P11	30	Good
12.	AT6P12	36	Good
13.	AT6P13	29	Moderate
14.	AT6P14	30	Good
15.	AT6P15	30	Good

AT6P1: Aeration Tank 6 Point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Aeration Tank overall with moderate strength at few locations.

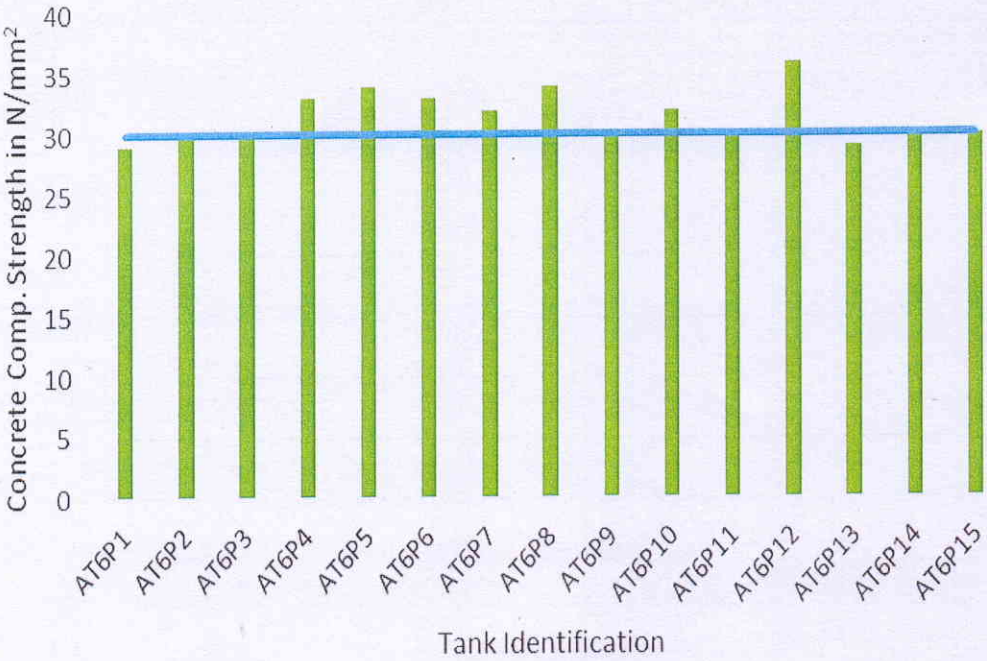

Fig.21 Compressive strength of concrete for Aeration Tank 6

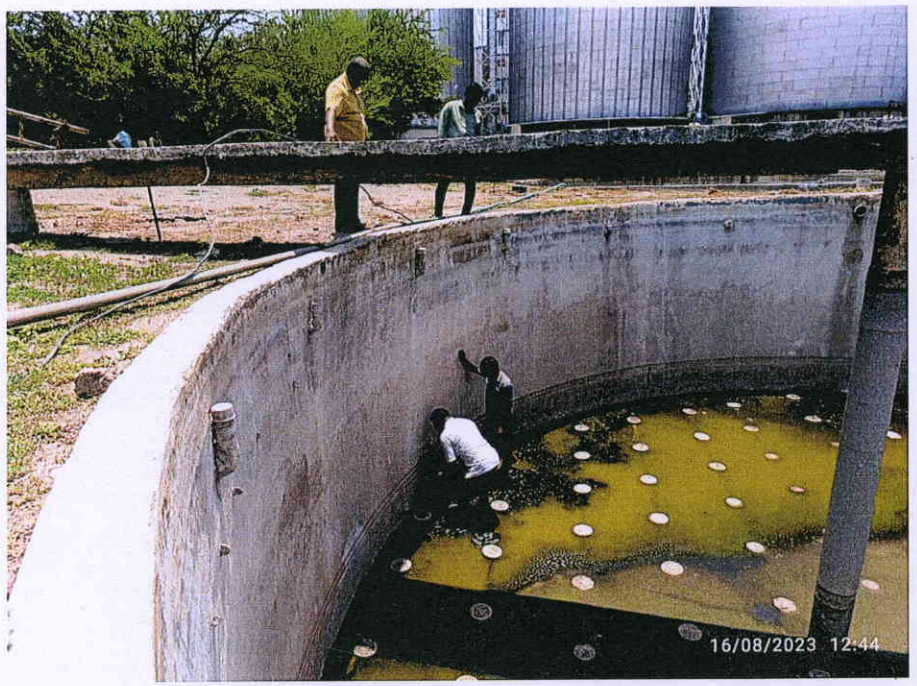

Fig. 22 Rebound Hammer Test conducted on Aeration Tank 6

AERATION TANK -7

Table 14 Rebound Hammer Test Result for the Aeration Tank -7

No. of Location	Aeration Tank-7 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1.	AT7P1	32	Good
2.	AT7P2	35	Good
3.	AT7P3	33	Good
4.	AT7P4	27	Moderate
5.	AT7P5	31	Good
6.	AT7P6	39	Good
7.	AT7P7	32	Good
8.	AT7P8	32	Good
9.	AT7P9	33	Good
10.	AT7P10	36	Good
11.	AT7P11	32	Good
12.	AT7P12	35	Good
13.	AT7P13	35	Good
14.	AT7P14	27	Moderate
15.	AT7P15	35	Good

AT7P1: Aeration Tank 7 Point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Aeration Tank 7 overall with moderate strength at few locations.

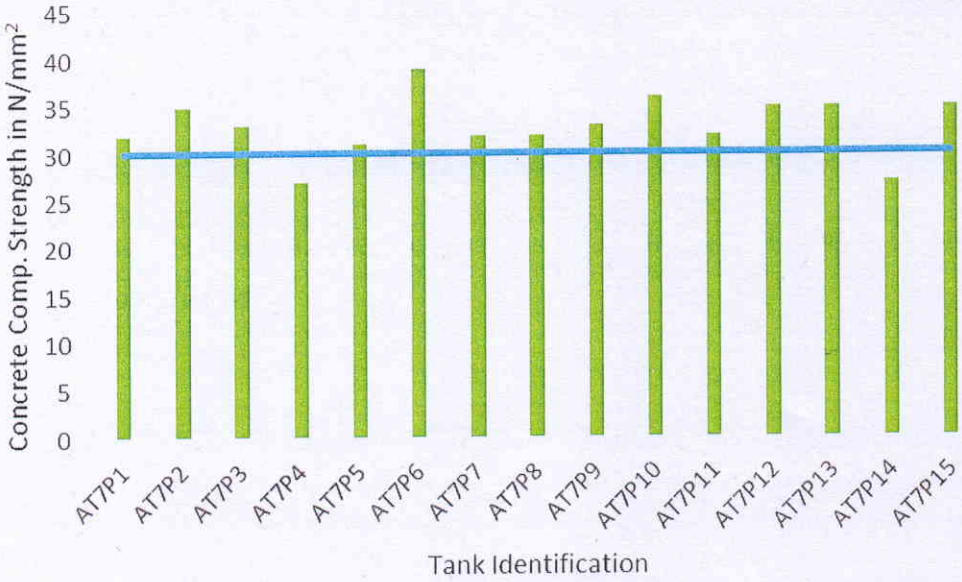

Fig.23 Compressive strength of concrete for Aeration Tank 7

AERATION TANK -8

Table 15 Rebound Hammer Test Result for the Aeration Tank -8

No. of Location	Aeration Tank-5 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1.	AT8P1	38	Good
2.	AT8P2	36	Good
3.	AT8P3	32	Good
4.	AT8P4	42	Good
5.	AT8P5	46	Good
6.	AT8P6	35	Good
7.	AT8P7	46	Good
8.	AT8P8	46	Good
9.	AT8P9	42	Good
10.	AT8P10	46	Good
11.	AT8P11	42	Good
12.	AT8P12	44	Good
13.	AT8P13	33	Good

14.	AT8P14	32	Good
15.	AT8P15	30	Good

AT8P1: Aeration Tank 3 Point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Aeration Tank 8 in allthe points tested.

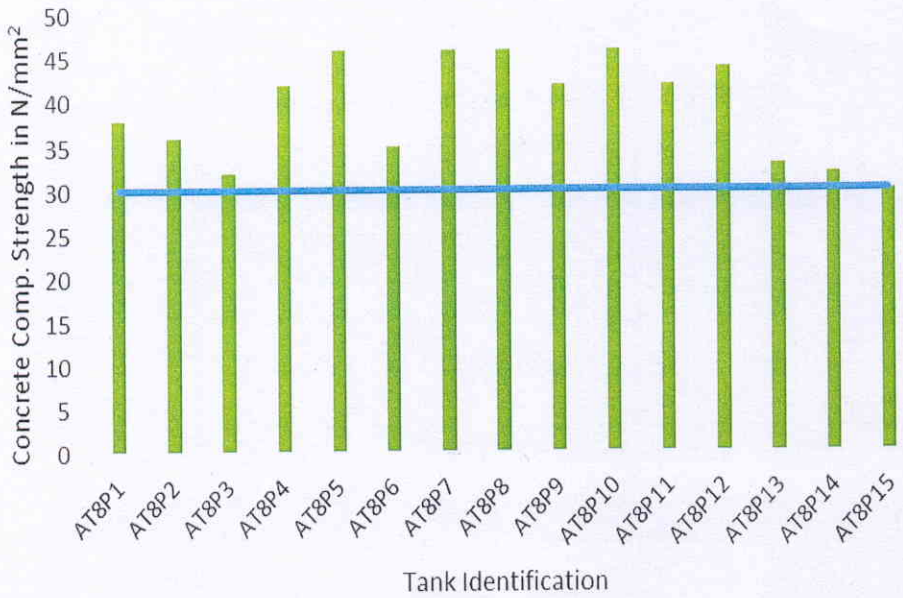

Fig.24 Compressive strength of concrete for Aeration Tank 8

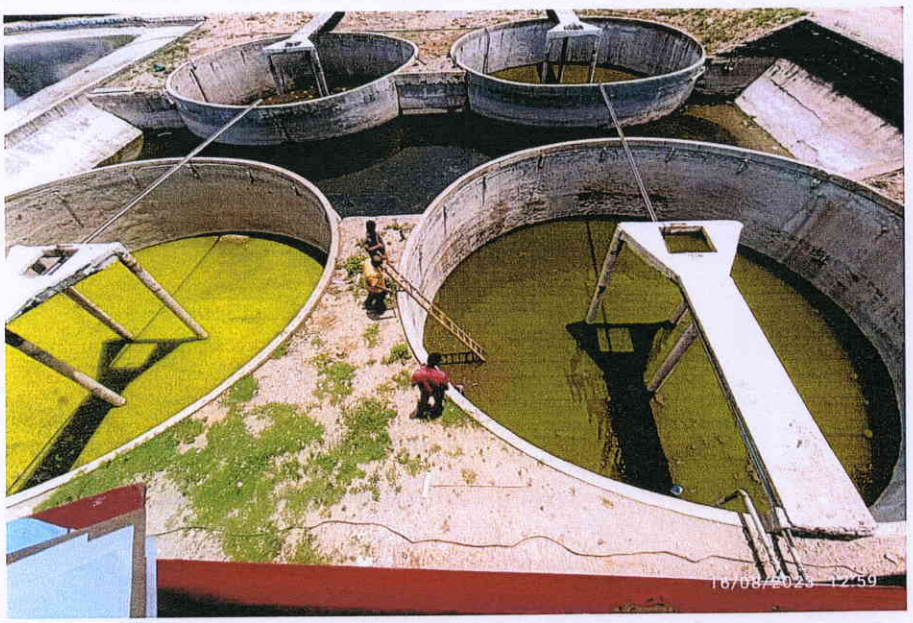

Fig.25 Rebound Hammer Test conducted on Aeration Tank 5, 6, 7 & 8

REBOUND HAMMER TEST RESULTS FOR SETTLING TANKS

Sedimentation tank (Settling Tank):

A sedimentation tank allows suspended particles to settle out of wastewater as it flows slowly through the tank, thereby providing some degree of purification. A layer of accumulated solids, called sludge, forms at the bottom of the tank, and is periodically removed.

SETTLING TANK- 1

Table 16 Rebound Hammer Test Result for the Settling Tank- 1

No. of Location	Settling Tank - 1 Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1.	SET1P1	36	Good
2.	SET1P2	38	Good
3.	SET1P3	33	Good
4.	SET1P4	28	Moderate
5.	SET1P5	28	Moderate
6.	SET1P6	37	Good
7.	SET1P7	33	Good
8.	SET1P8	39	Good
9.	SET1P9	36	Good
10.	SET1P10	33	Good
11.	SET1P11	37	Good
12.	SET1P12	33	Good

SET1P1: Settling Tank 1 Point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Settling Tank 1 overall with moderate strength at few locations.

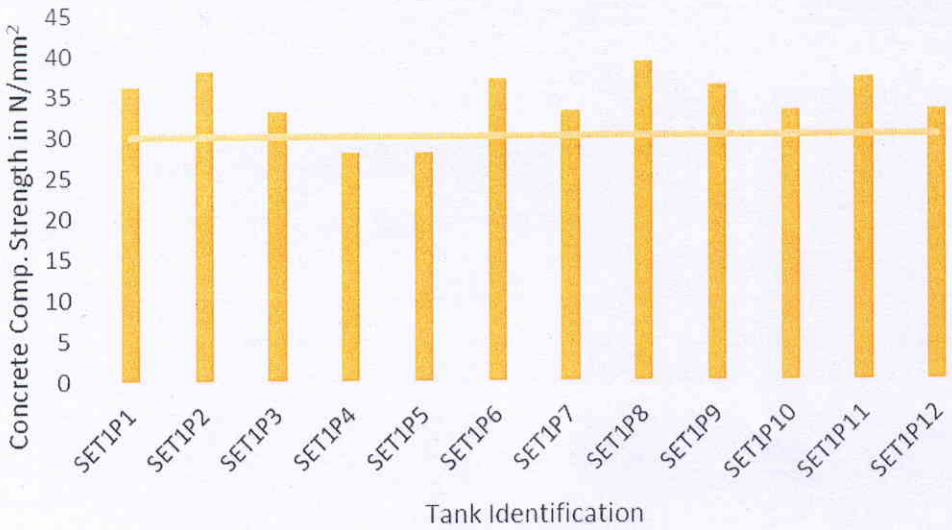

Fig.26 Compressive strength of concrete for Settling Tank 1

SETTLING TANK- 2

Table 17 Rebound Hammer Test Result for the Settling Tank - 2

No. of Location	Settling Tank - 2 Identification	Rebound hammer Test as per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1.	SET2P1	42	Good
2.	SET2P2	46	Good
3.	SET2P3	38	Good
4.	SET2P4	35	Good
5.	SET2P5	35	Good
6.	SET2P6	42	Good
7.	SET2P7	35	Good
8.	SET2P8	38	Good

9.	SET2P9	38	Good
10.	SET2P10	39	Good
11.	SET2P11	36	Good
12.	SET2P12	39	Good
13.	SET2P13	36	Good
14.	SET2P14	35	Good
15.	SET2P15	38	Good
16.	SET2P16	42	Good
17.	SET2P17	32	Good

SET2P1: Settling Tank 2 Point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Settling Tank 2 in allthe points tested.

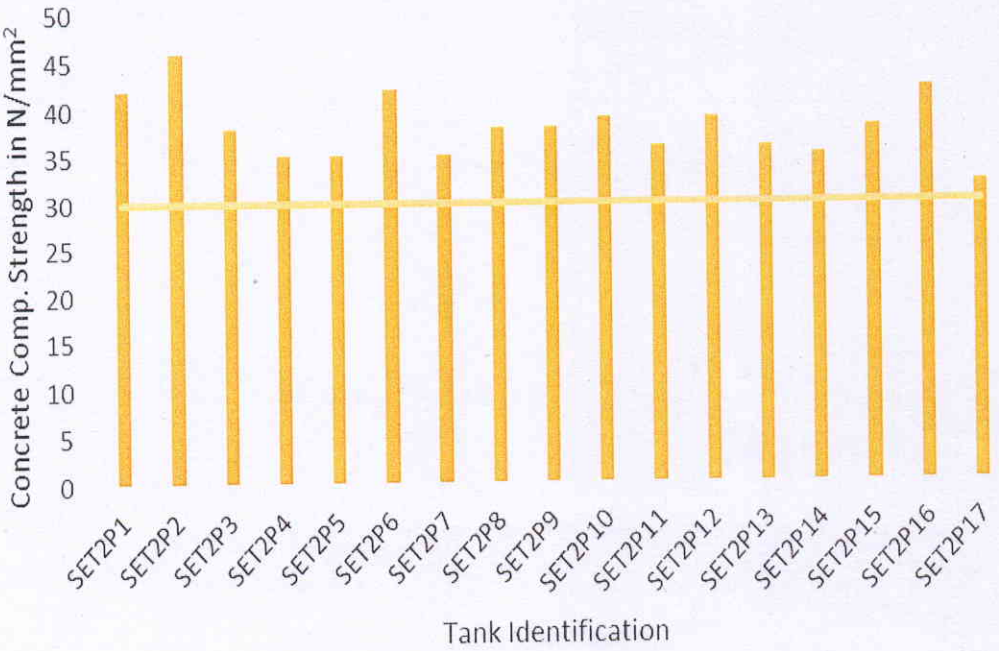

Fig.27 Compressive strength of concrete for Settling Tank 2

Fig.28 Rebound Hammer Test conducted on Settling Tank 1 & 2

REBOUND HAMMER TEST RESULTS FOR CLARIFIER TANK

Clarifier Tank:

Clarifiers are settling tanks built with mechanical means for continuous removal of solids being deposited by sedimentation. A clarifier is generally used to remove solid particulates or suspended solids from liquid for clarification.

Table 18 Rebound Hammer Test Result for the Clarifier Tank

No. of Location	Clarifier Tank Identification	Rebound hammer Test as per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1	CLTP1	30	Good
2	CLTP2	33	Good
3	CLTP3	35	Good
4	CLTP4	36	Good
5	CLTP5	31	Good
6	CLTP6	31	Good
7	CLTP7	36	Good
8	CLTP8	36	Good
9	CLTP9	35	Good
10	CLTP10	35	Good
11	CLTP11	35	Good
12	CLTP12	36	Good
13	CLTP13	37	Good
14	CLTP14	30	Good
15	CLTP15	34	Good
16	CLTP16	30	Good
17	CLTP17	28	Moderate
18	CLTP18	32	Good
19	CLTP19	32	Good

CLTP1: Clarifier Tank 1 Point 1

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Clarifier Tank overall with moderate strength at few locations.

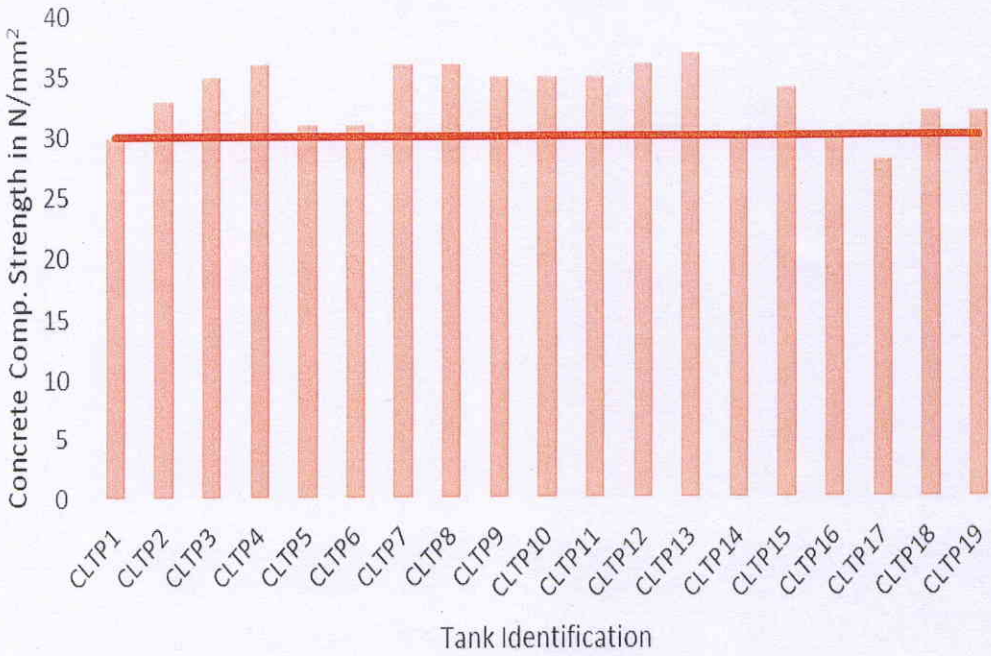

Fig.29 Compressive strength of concrete for Clarifier Tank

Fig.30 Rebound Hammer Test conducted on Clarifier Tank

REBOUND HAMMER TEST RESULTS FOR SLUDGE DRYING BED

Sludge Drying Bed:

Sludge-drying beds provide the simplest method of dewatering. Digested sludge slurry is spread on an open bed of sand and allowed to remain until dry. Drying takes place by a combination of evaporation and gravity drainage through the sand.

Table 19 Rebound Hammer Test Result for the Sludge Drying Bed

No. of Location	Sludge Drying Bed Identification	Rebound hammer Test. As per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1	SDBTP1	35	Good
2	SDBTP2	35	Good
3	SDBTP3	35	Good
4	SDBTP4	42	Good
5	SDBTP5	32	Good
6	SDBTP6	42	Good
7	SDBTP7	39	Good
8	SDBTP8	42	Good
9	SDBTP9	39	Good
10	SDBTP10	32	Good
11	SDBTP11	46	Good
12	SDBTP12	32	Good
13	SDBTP13	39	Good
14	SDBTP14	32	Good
15	SDBTP15	32	Good
16	SDBTP16	28	Moderate

17	SDBTP17	30	Good
18	SDBTP18	30	Good
19	SDBTP19	30	Good
20	SDBTP20	35	Good
21	SDBTP21	39	Good
22	SDBTP22	39	Good
23	SDBTP23	35	Good
24	SDBTP24	38	Good
25	SDBTP25	37	Good
26	SDBTP26	36	Good
27	SDBTP27	39	Good
28	SDBTP28	33	Good
29	SDBTP29	37	Good
30	SDBTP30	36	Good
31	SDBTP31	33	Good
32	SDBTP32	33	Good
33	SDBTP33	37	Good
34	SDBTP34	30	Good
35	SDBTP35	36	Good
36	SDBTP36	36	Good

SDBTP1: Sludge Drying Bed Point

Inference:

The compressive strength of concrete was good (Greater than 30 N/mm^2) for the Sludge Drying Bed Tank overall with moderate strength at few locations.

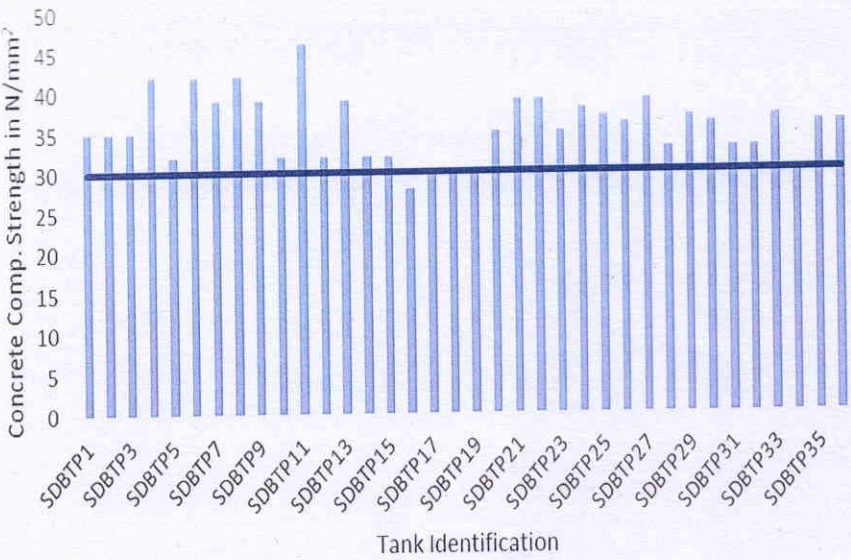

Fig.31 Compressive strength of concrete for Sludge Drying Bed Tank

Fig.32 Rebound Hammer Test conducted on Sludge Drying Bed Tank

REBOUND HAMMER TEST RESULTS FOR THE MBR BUILDING

Table 20 Rebound Hammer Test Result for the MBR Building

No. of Location	MBR Building Identification	Rebound hammer Test as per IS13311 (Part-2):1992	
		Concrete Compressive Strength in N/mm^2	Remarks
1	MBRBC1	20	Good
2	MBRBC2	21	Good
3	MBRBC3	22	Good
4	MBRBC4	21	Good
5	MBRBC5	20	Good
6	MBRBC6	19	Moderate
7	MBRBC7	23	Good
8	MBRBC8	20	Good
9	MBRBC9	21	Good
10	MBRBC10	21	Good
11	MBRBC11	21	Good
12	MBRBC12	22	Good
13	MBRBC13	20	Good
14	MBRBC14	19	Moderate
15	MBRBC15	22	Good
16	MBRBC16	19	Moderate
17	MBRBC17	22	Good
18	MBRBC18	20	Good
19	MBRBB1	25	Good
20	MBRBB2	24	Good
21	MBRBB3	27	Good
22	MBRBB4	25	Good
23	MBRBB5	23	Good

MBRBC1: MBR Building Column 1

MBRBB1: MBR Building Beam 1

Inference:

The concrete in the Columns and Beams possess good compressive strength (Greater than 20 N/mm^2) with moderate strength of concrete in three columns of MBR building. Very small deflection was observed in two intermediate beams.

Fig.33 Compressive strength of concrete for MBR Building

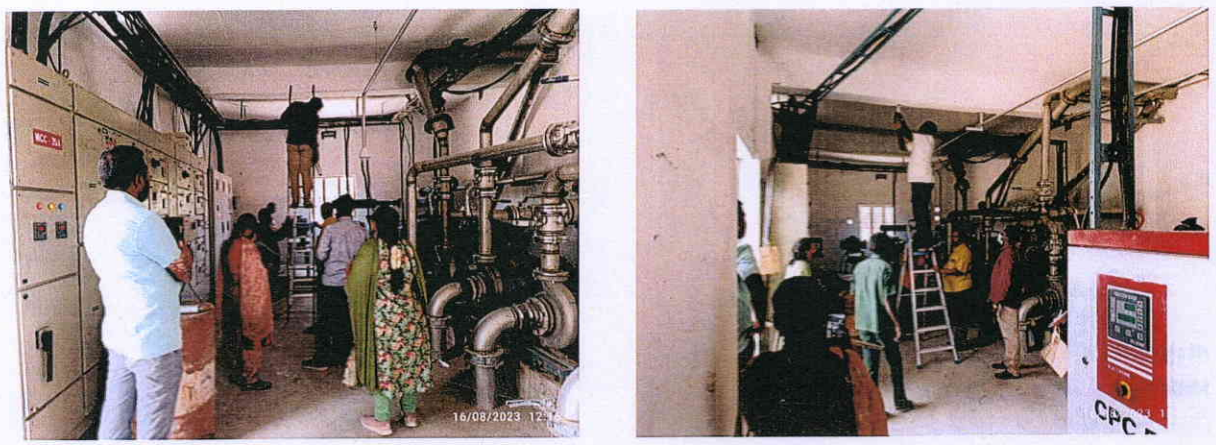

Fig.34 Rebound Hammer Test conducted on MBR Building

Department of Civil Engineering
Salem - 636 011.
Government College of Engineering

Conclusion:

From the above rebound hammer test results shown in tables 1 to 20 and also from figures 1 to 34, based upon the physical observation and assessment of the structural condition and the strength of Structure of various treatment units in Varalakshmi Starch Industries (P) Ltd, Pappireddipatti, Dharmapuri District by Non-Destructive Test (Rebound Hammer Test), the compressive strength of concrete in Overhead tank, Anaerobic tank, Aeration tanks, Settling tanks, Clarifier tank, Sludge drying bed is good (Greater than 30 N/mm^2) with moderate strength at few locations. The structural members of the MBR Building is good (Greater than 20 N/mm^2) with moderate strength of concrete in three columns of MBR building.

Recommendations:

To enhance the life of the structures, the following points are suggested which can increase the life span of the structure.

1. For every three years once, the treatment Units should be repaired and maintained properly.
2. The structural stability should be checked once in four years or if any visible distress occurs in any of the structural elements.
3. If any leakages in the treatment units, it should be repaired immediately to avoid any damage.
4. Remove all loose weak concrete with chisel and hammer and reconcrete with a rich mix.
5. All cracks should be grouted with cement slurry.

26/9/2023

Salem- 636 011.

Dated: 26 .09.2023

Professor and Head/ Civil Engineering

Dr D SHOBA RAJKUMAR, M.E.,Ph.D.
Professor and Head,
Department of Civil Engineering,
Government College of Engineering
SALEM - 636 011

26/9/23

Dr. S. SUNDARI, M.E.(Structures).,Ph.D.,
Associate Professor
Department of Civil Engineering
Government College of Engineering
Salem - 636 011

The officials of TNPCB, Dharmapuri, The DEE / AEE collected the Treated effluent samples periodicaly in our factory themselves during various surpise inspections and sent the same collected samples to their own laboratory. The DEE/AEE was providing The test reports after getting the demanded testing fees from us. In the test reports they have reported around 14 parameters. And now we are submitting the important parameters which are are under issue as exceeding such as BOD, COD,TDS , Chlorides, Sulphates in the following statements received from April 2023 to January 2024, Such treated water discharged only in our Green Belt Land.

REPORT NO.1

Sample Collection Date 31.03.2023								
TNPCB Lap Report Reference No. & Date - ROA No. 13/AEL-SLM/2023-24 dt: 13.04.2023								
			As per PCB Act, Surface water discharge Standards	As per PCB Act, Ownland discharge Standards	Our Treated Effluent	Where discharged whether Own Land or Surface water	Exceeds	Remarks
	Lab Code No				6			
Sl.No	Parameters	Units						
1	BOD	mg/l	30	100	18	Own Land	Nil	WITHIN THE LIMIT
2	COD	mg/l	250	-	368	Own Land	Nil	WITHIN THE LIMIT
3	TDS	mg/l	2100	2100	1452	Own Land	Nil	WITHIN THE LIMIT
4	Chlorides	mg/l	1000	600	360	Own Land	Nil	WITHIN THE LIMIT
5	Sulphates	mg/l	1000	1000	<5	Own Land	Nil	WITHIN THE LIMIT

ADVANCED ENVIRONMENTAL LABORATORY,
TAMILNADU POLLUTION CONTROL BOARD
SALEM – 636 004.
Accredited by NABL – (ISO/IEC 17025:2017)

TC9899

ROA NO. 13/AEL – SLM/2023 – 24 Dt. 13.04.2023

ULR-TC98992300000003

1.	Name and address of the sender	The District Environmental Engineer,
		Tamilnadu Pollution Control Board,
		Dharmapuri.
2.	Date and time of collection	31.03.2023 at 06.00 PM
3.	Date and time of receipt at Lab.	01.04.2023 at 10.30 AM
4.	Condition of seal, fastening and Container	Sealed / Unfastened Condition in Polythene carbuoy 2.5 Lits X 1 No.
5.	Nature and Number of samples	1 No. of Trade Effluent Sample.
6.	Date of Analysis	01.04.2023 – 10.04.2023

DEE Code No.	Lab Code No.	Point of Collection	Whether Untreated/ Treated
BLA/72/31-03	6	ETP Outlet	-

Test Report

Sl. No.	Parameters	Unit	Test Sample Code No. 6/BLA/72/31-03	Test Method
01.	pH at 25°C	mg/l	8.91	APHA 23rd Edn (4500H+)
02.	TSS at 103°C – at 105°C	mg/l	12	APHA 23rd Edn (2540 D)
03.	Total Dissolved Solids at 180°C	mg/l	1452	APHA 23rd Edn (2540 C)
04.	Chloride as Cl	mg/l	360	APHA 23rd Edn (4500 Cl B)
05.	Sulphates as SO_4	mg/l	<5	APHA 23rd Edn (4500 SO_4 –E)
06.	Oil & Grease	mg/l	<3	APHA 23rd Edn (5520 B)
07.	BOD (at 27°C for 3 days)	mg/l	18	IS3025 (Part -44)
08.	COD	mg/l	368	APHA 23rd Edn (5220 B)
09.	Ammonical Nitrogen as NH_3-N	mg/l	2.8	APHA 23rd Edn(4500-NH_3 C)
10.	Total Kjeldahl Nitrogen	mg/l	8.4	APHA 23rd Edn (4500-Norg-B)
11.	Cyanide	mg/l	<0.08	APHA 23rd Edn (4500- CN E)

Note: < Indicates Less than Minimum Detectable Limit.
* Results relate only to the items tested samples.

Checked by
17/5/23
Environmental Scientist

Authorized Signatory
Chief Scientific Officer,
Dy. Quality Manager.

- End of Test Report –

REPORT NO.2

Sample Collection Date 31.08.2023								
TNPCB Lap Report Reference No. & Date - ROA No. 442/TNPCB/AEL-SLM/2022-23 dt: 10.10.2023								
			As per PCB Act, Surface water discharge Standards	As per PCB Act, Ownland discharge Standards	Our Treated Effluent	Where discharged whether Own Land or Surface water	Exceeds	Remarks
	Lab Code No				1600			
Sl.No	**Parameters**	**Units**						
1	BOD	mg/l	30	100	19	Own Land	Nil	WITHIN THE LIMIT
2	COD	mg/l	250	-	104	Own Land	Nil	WITHIN THE LIMIT
3	TDS	mg/l	2100	2100	604	Own Land	Nil	WITHIN THE LIMIT
4	Chlorides	mg/l	1000	600	166	Own Land	Nil	WITHIN THE LIMIT
5	Sulphates	mg/l	1000	1000	30	Own Land	Nil	WITHIN THE LIMIT

ADVANCED ENVIRONMENTAL LABORATORY,
TAMILNADU POLLUTION CONTROL BOARD,
SALEM – 636 004.

ROA No. 442/TNPCB/AEL – SLM/2022– 23 Dt. 10.10.2023

1.	Name and address of the sender	The District Environmental Engineer, Tamilnadu Pollution Control Board, Dharmapuri.
2.	Date and time of collection	31.08.2023 at 12:30 PM and 12:35 PM
3.	Date and time of receipt at Lab.	01.09.2023 at 11:00 AM
4.	Condition of seal, fastening and Container	Sealed/Unfastened Condition in Polythene carbuoy 2.5 lits X 2 Nos.
5.	Nature and Number of samples	2 Nos. of Trade effluent Samples.
6.	Date of Analysis	01.09.2023 - 13.09.2023

DEE Code No.	Lab Code No.	Point of Collection	Whether Untreated/ Treated
BLA/195/31-08	1599	Anaerobic Lagoon Outlet	-
BLA/196/31-08	1600	Aeration Tank Outlet	-

TEST REPORT

Sl. No.	Parameters	Unit	Test sample code Nos.		Test Method
			1599/BLA/ 195/31-08	1600/BLA/ 196/31-08	
1.	pH at 25°C	Number	**7.75**	**7.08**	APHA 23rd Edn 2017 (4500 H+)
2.	Total Suspended Solids at 103°C – at 105°C	mg/l	**64**	**32**	APHA 23rd Edn 2017 (2540 -D)
3.	Total Dissolved Solids at 180°C	mg/l	**2888**	**604**	APHA 23rd Edn.2017 (2540 C)
4.	Chloride as Cl	mg/l	**705**	**166**	APHA 23rd Edn.2017 (4500 Cl B)
5.	Sulphates as SO_4	mg/l	**186**	**30**	APHA 23rd Edn.2017 (4500 SO4-E)
6.	BOD (at 27°C for 3 days)	mg/l	**156**	**19**	IS 3025 (Part-44)
7.	COD	mg/l	**1040**	**104**	APHA 23rd Edn 2017 (5220 B)
8.	Ammonical Nitrogen as NH_3-N	mg/l	**7.28**	**2.8**	APHA 23rd Edn. 2017 (4500 - NH_3C)
9.	Total Kjeldahl Nitrogen	mg/l	**21.28**	**8.4**	APHA 23rd Edn. 2017 (4500 -N_{org} B)
10.	Total Hardness as $CaCO_3$	mg/l	**460**	**190**	APHA 23rd Edn. 2017 (2340 C)

Sl. No.	Parameters	Unit	Test sample code Nos.		Test Method
			1599/BLA/ 195/31-08	1600/BLA/ 196/31-08	
11	Calcium as Ca	mg/l	**48**	**16**	APHA 23rd Edn. 2017 (3500 B)
12	Magnesium as Mg	mg/l	**83**	**37**	APHA 23rd Edn. 2017 (2340 C)
13	% Sodium	%	**73**	**32**	TNPCB/AELSLM/SOP/35 Issue No.1, DT: 25 April 2014
14	Cyanide	mg/l	**<0.008**	**<0.008**	APHA 23rd Edn. 2017 (4500 CN E)

Note: < = Indicates Less than Minimum Detectable Limit.

Checked by

M.D 7/11/10/23

Environmental Scientist

Authorized Signatory

S.D 11/10/2023

Chief Scientific Officer (a/c),
AEL, TNPCB, Salem.

- End of Test Report –

REPORT NO.3

Sample Collection Date 19.09.2023								
TNPCB Lap Report Reference No. & Date - ROA No. 506/TNPCB/AEL-SLM/2022-23 dt: 17.10.2023								
			As per PCB Act, Surface water discharge Standards	As per PCB Act, Ownland discharge Standards	Our Treated Effluent	Where discharged whether Own Land or Surface water	Exceeds	Remarks
	Lab Code No				1796			
Sl.No	**Parameters**	**Units**						
1	BOD	mg/l	30	100	6	Own Land	Nil	WITHIN THE LIMIT
2	COD	mg/l	250	-	96	Own Land	Nil	WITHIN THE LIMIT
3	TDS	mg/l	2100	2100	1988	Own Land	Nil	WITHIN THE LIMIT
4	Chlorides	mg/l	1000	600	625	Own Land	Nil	WITHIN THE LIMIT
5	Sulphates	mg/l	1000	1000	87	Own Land	Nil	WITHIN THE LIMIT

ADVANCED ENVIRONMENTAL LABORATORY,
TAMILNADU POLLUTION CONTROL BOARD,
SALEM – 636 004.

(2)

ROA No. 506 /TNPCB/AEL – SLM/2022– 23, Dated. 17.10.2023

1.	Name and address of the sender	The District Environmental Engineer, Tamilnadu Pollution Control Board, Dharmapuri.
2.	Date and time of collection	19.09.2023 at 04:10 PM
3.	Date and time of receipt at Lab.	20.09.2023 at 10:10 AM
4.	Condition of seal, fastening and Container	Sealed/Unfastened Condition in Polythene carbuoy 2.5 lits X 1 No.
5.	Nature and Number of samples	1 No. of Trade effluent Sample.
6.	Date of Analysis	20.09.2023 - 17.10.2023

DEE Code No.	Lab Code No.	Point of Collection	Whether Untreated/ Treated
BLA/203/19-09	1796	Water in Primary Clarifier (not in operation)	-

TEST REPORT

Sl. No	Parameters	Unit	Test sample code Nos. 1796/BLA/ 203/19-09	Test Method
1.	pH at 25°C	Number	**7.88**	APHA 23rd Edn 2017 (4500 H+)
2.	Total Suspended Solids at 103°C – at 105°C	mg/l	**32**	APHA 23rd Edn 2017 (2540 -D)
3.	Total Dissolved Solids at 180°C	mg/l	**1988**	APHA 23rd Edn.2017 (2540 C)
4.	Chloride as Cl	mg/l	**625**	APHA 23rd Edn.2017 (4500 Cl B)
5.	Sulphates as SO_4	mg/l	**87**	APHA 23rd Edn.2017 (4500 SO4-E)
6.	BOD (at 27°C for 3 days)	mg/l	**6**	IS 3025 (Part-44)
7.	COD	mg/l	**96**	APHA 23rd Edn 2017 (5220 B)
8.	Total Kjeldahl Nitrogen	mg/l	**5.04**	APHA 23rd Edn. 2017 (4500 -N_{org} B)
9.	Total Hardness as $CaCO_3$	mg/l	**620**	APHA 23rd Edn. 2017 (2340 C)
10.	% Sodium	%	**46**	TNPCB/AELSLM/SOP/35 Issue No.1, DT: 25 April 2014
11.	Cyanide	mg/l	**<0.008**	APHA 23rd Edn. 2017 (4500 CN E)

Note: < = Indicates Less than Minimum Detectable Limit.

Checked by

M.D 26/10/23
Environmental Scientist

Authorized Signatory

26/10/2023
Chief Scientific Officer (a/c),
AEL, TNPCB, Salem.

- End of Test Report –

REPORT NO.4

Sample Collection Date 13.10.2023								
TNPCB Lap Report Reference No. & Date - ROA No. 592/TNPCB/AEL-SLM/2023-24 dt: 20.11.2023								
			As per PCB Act, Surface water discharge Standards	As per PCB Act, Ownland discharge Standards	Our Treated Effluent	Where discharged whether Own Land or Surface water	Exceeds	Remarks
	Lab Code No				2306			
Sl.No	**Parameters**	**Units**						
1	BOD	mg/l	30	100	3.3	Own Land	Nil	WITHIN THE LIMIT
2	COD	mg/l	250	-	24	Own Land	Nil	WITHIN THE LIMIT
3	TDS	mg/l	2100	2100	1592	Own Land	Nil	WITHIN THE LIMIT
4	Chlorides	mg/l	1000	600	607	Own Land	Nil	WITHIN THE LIMIT
5	Sulphates	mg/l	1000	1000	47	Own Land	Nil	WITHIN THE LIMIT

ADVANCED ENVIRONMENTAL LABORATORY,
TAMILNADU POLLUTION CONTROL BOARD,
SALEM – 636 004.

(3)

ROA No. 592/TNPCB/AEL – SLM/2023– 24, Dated. 20.11.2023

1.	Name and address of the sender	The District Environmental Engineer, Tamilnadu Pollution Control Board, Dharmapuri.
2.	Date and time of collection	13.10.2023 at 12:55 PM and 01:00 PM
3.	Date and time of receipt at Lab.	13.10.2023 at 06:45 PM
4.	Condition of seal, fastening and Container	Sealed/Unfastened Condition in Polythene carbuoy 2.5 lits X 2 Nos.
5.	Nature and Number of samples	2 Nos. of Trade effluent Samples.
6.	Date of Analysis	16.10.2023 - 20.11.2023

DEE Code No.	Lab Code No.	Point of Collection	Whether Untreated/ Treated
BLA/226/13-10	2306	MBR outlet	-
BLA/227/13-10	2307	Stagnated water at green belt (Lat:11897045, Long: 78.375809)	-

TEST REPORT

Sl. No.	Parameters	Unit	Test sample code Nos.		Test Method
			2306/BLA/ 226/13-10	2307/BLA/ 227/13-10	
1.	pH at 25°C	Number	**7.88**	**7.99**	APHA 23rd Edn 2017 (4500 H+)
2.	Total Suspended Solids at 103°C – at 105°C	mg/l	**4**	**64**	APHA 23rd Edn 2017 (2540 -D)
3.	Total Dissolved Solids at 180°C	mg/l	**1592**	**2904**	APHA 23rd Edn.2017 (2540 C)
4.	Chloride as Cl	mg/l	**607**	**947**	APHA 23rd Edn.2017 (4500 Cl B)
5.	Sulphates as SO_4	mg/l	**47**	**82**	APHA 23rd Edn.2017 (4500 SO4-E)
6.	BOD (at 27°C for 3 days)	mg/l	**3.3**	**21**	IS 3025 (Part-44)
7.	COD	mg/l	**24**	**480**	APHA 23rd Edn 2017 (5220 B)
8.	Ammonical Nitrogen as NH_3-N	mg/l	**1.12**	**1.12**	APHA 23rd Edn. 2017 (4500 - NH_3C)
9.	Total Kjeldahl Nitrogen	mg/l	**3.36**	**3.36**	APHA 23rd Edn. 2017 (4500 -N_{org} B)
10.	Total Hardness as $CaCO_3$	mg/l	**440**	**950**	APHA 23rd Edn. 2017 (2340 C)

Sl. No.	Parameters	Unit	Test sample code Nos.		Test Method
			2306/BLA/ 226/13-10	2307/BLA/ 227/13-10	
11	Calcium as Ca	mg/l	**48**	**40**	APHA 23rd Edn. 2017 (3500 B)
12	Magnesium as Mg	mg/l	**78**	**207**	APHA 23rd Edn. 2017 (2340 C)
13	Alkalinity as $CaCO_3$	mg/l	**388**	**784**	APHA 23rd Edn. 2017 (2320 B)
14	Nitrate Nitrogen as NO_3	mg/l	**0.065**	**0.097**	APHA 23rd Edn. 2017 (4500 NO_3-B)
15	Cyanide	mg/l	**<0.008**	**<0.008**	APHA 23rd Edn. 2017 (4500 CN E)

Note: < = Indicates Less than Minimum Detectable Limit.

Checked by

27/11/23

Environmental Scientist

Authorized Signatory

27/11/2023

Chief Scientific Officer (a/c),
AEL, TNPCB, Salem.

- End of Test Report –

REPORT NO.5

Sample Collection Date 27.11.2023								
TNPCB Lap Report Reference No. & Date - ROA No. 688/TNPCB/AEL-SLM/2023-24 dt: 13.12.2023								
			As per PCB Act, Surface water discharge Standards	As per PCB Act, Ownland discharge Standards	Our Treated Effluent	Where discharged whether Own Land or Surface water	Exceeds	Remarks
	Lab Code No				2625			
Sl.No	Parameters	Units						
1	BOD	mg/l	30	100	16	Own Land	Nil	WITHIN THE LIMIT
2	COD	mg/l	250	-	128	Own Land	Nil	WITHIN THE LIMIT
3	TDS	mg/l	2100	2100	1392	Own Land	Nil	WITHIN THE LIMIT
4	Chlorides	mg/l	1000	600	508	Own Land	Nil	WITHIN THE LIMIT
5	Sulphates	mg/l	1000	1000	52	Own Land	Nil	WITHIN THE LIMIT

ADVANCED ENVIRONMENTAL LABORATORY,
TAMILNADU POLLUTION CONTROL BOARD,
SALEM – 636 004.

ROA No. 688/TNPCB/AEL – SLM/2023– 24, Dated. 13.12.2023

1.	Name and address of the sender	The District Environmental Engineer, Tamilnadu Pollution Control Board, Dharmapuri.
2.	Date and time of collection	27.11.2023 at 02:25 PM and 02:30 PM
3.	Date and time of receipt at Lab.	27.11.2023 at 06:00 PM
4.	Condition of seal, fastening and Container	Sealed/Unfastened Condition in Polythene carbuoy 2.5 lits X 2 Nos.
5.	Nature and Number of samples	2 Nos. of Trade effluent Samples.
6.	Date of Analysis	28.11.2023 - 13.12.2023

DEE Code No.	Lab Code No.	Point of Collection	Whether Untreated/ Treated
BLA/262/27-11	2625	Clarifier Outlet	-
BLA/263/27-11	2626	MBR Outlet	-

TEST REPORT

Sl. No	Parameters	Unit	Test sample code Nos.		Test Method
			2625/BLA/ 262/27-11	2626/BLA/ 263/27-11	
1.	pH at 25°C	Number	**7.67**	**7.75**	APHA 23rd Edn 2017 (4500 H+)
2.	Total Suspended Solids at 103°C – at 105°C	mg/l	**28**	**16**	APHA 23rd Edn 2017 (2540 -D)
3.	Total Dissolved Solids at 180°C	mg/l	**1392**	**968**	APHA 23rd Edn.2017 (2540 C)
4.	Chloride as Cl	mg/l	**508**	**352**	APHA 23rd Edn.2017 (4500 Cl B)
5.	Sulphates as SO_4	mg/l	**52**	**32**	APHA 23rd Edn.2017 (4500 SO4-E)
6.	BOD (at 27°C for 3 days)	mg/l	**16**	**4.8**	IS 3025 (Part-44)
7.	COD	mg/l	**128**	**32**	APHA 23rd Edn 2017 (5220 B)
8.	Ammonical Nitrogen as NH_3-N	mg/l	***	***	APHA 23rd Edn. 2017 (4500 -NH_3C)
9.	Total Kjeldahl Nitrogen	mg/l	***	***	APHA 23rd Edn. 2017 (4500 -N_{org} B)
10.	Total Hardness as $CaCO_3$	mg/l	**620**	**430**	APHA 23rd Edn. 2017 (2340 C)

Sl. No.	Parameters	Unit	Test sample code Nos.		Test Method
			2625/BLA/ 262/27-11	2626/BLA/ 263/27-11	
11	% Sodium	%	**34**	**36**	TNPCB/AEL-SLM/SOP/35, Issue No:1, Dated 25 April 2014.
12	Nitrate Nitrogen as NO_3	mg/l	**0.778**	**0.243**	APHA 23rd Edn. 2017 (4500 NO_3-B)
13	Cyanide	mg/l	***	***	APHA 23rd Edn. 2017 (4500 CN E)

Note: < = Indicates Less than Minimum Detectable Limit.

*** **Not Performed.**

Checked by

15/12/23

Environmental Scientist

Authorized Signatory

S.21 — 15/12/2023

Chief Scientific Officer (a/c),
AEL, TNPCB, Salem.

- End of Test Report –

REPORT NO.6

Sample Collection Date 29.12.2023								
TNPCB Lap Report Reference No. & Date - ROA No. 820/TNPCB/AEL-SLM/2023-24 dt: 23.01.2024								
			As per PCB Act, Surface water discharge Standards	As per PCB Act, Ownland discharge Standards	Our Treated Effluent	Where discharged whether Own Land or Surface water	Exceeds	Remarks
	Lab Code No				3091			
Sl.No	**Parameters**	**Units**						
1	BOD	mg/l	30	100	8	Own Land	Nil	WITHIN THE LIMIT
2	COD	mg/l	250	-	128	Own Land	Nil	WITHIN THE LIMIT
3	TDS	mg/l	2100	2100	568	Own Land	Nil	WITHIN THE LIMIT
4	Chlorides	mg/l	1000	600	105	Own Land	Nil	WITHIN THE LIMIT
5	Sulphates	mg/l	1000	1000	25	Own Land	Nil	WITHIN THE LIMIT

ADVANCED ENVIRONMENTAL LABORATORY,
TAMILNADU POLLUTION CONTROL BOARD,
SALEM – 636 004.

ROA No. 820/TNPCB/AEL – SLM/2023– 24, Dated. 23.01.2024

1.	Name and address of the sender	The District Environmental Engineer, Tamilnadu Pollution Control Board, Dharmapuri.
2.	Date and time of collection	29.12.2023 at 12:40 PM and 12:45 PM
3.	Date and time of receipt at Lab.	29.12.2023 at 05:30 PM
4.	Condition of seal, fastening and Container	Sealed/Unfastened Condition in Polythene carbuoy 2.5 lits X 2 Nos.
5.	Nature and Number of samples	2 Nos. of Trade effluent Samples.
6.	Date of Analysis	29.12.2023 - 23.01.2024

DEE Code No.	Lab Code No.	Point of Collection	Whether Untreated/ Treated
BLA/298/29-12	3090	Aeration Tank Outlet	-
BLA/299/29-12	3091	Clarifier Outlet	-

TEST REPORT

Sl. No	Parameters	Unit	Test sample code Nos.		Test Method
			3090/BLA/ 298/29-12	3091/BLA/ 299/29-12	
1.	pH at 25°C	Number	**7.55**	**7.79**	APHA 23rd Edn 2017 (4500 H+)
2.	Total Suspended Solids at 103°C – at 105°C	mg/l	**56**	**36**	APHA 23rd Edn 2017 (2540 -D)
3.	Total Dissolved Solids at 180°C	mg/l	**616**	**568**	APHA 23rd Edn.2017 (2540 C)
4.	Chloride as Cl	mg/l	**95**	**105**	APHA 23rd Edn.2017 (4500 Cl B)
5.	Sulphates as SO_4	mg/l	**34**	**25**	APHA 23rd Edn.2017 (4500 SO4-E)
6.	BOD (at 27°C for 3 days)	mg/l	**12**	**8.0**	IS 3025 (Part-44)
7.	COD	mg/l	**152**	**128**	APHA 23rd Edn 2017 (5220 B)
8.	Ammonical Nitrogen as NH_3-N	mg/l	**1.12**	**0.56**	APHA 23rd Edn. 2017 (4500 -NH_3C)
9.	Total Kjeldahl Nitrogen	mg/l	**3.36**	**1.68**	APHA 23rd Edn. 2017 (4500 -N_{org} B)
10.	Total Hardness as $CaCO_3$	mg/l	**400**	**370**	APHA 23rd Edn. 2017 (2340 C)

Sl. No.	Parameters	Unit	Test sample code Nos.		Test Method
			3090/BLA/ 298/29-12	3091/BLA/ 299/29-12	
11	% Sodium	%	**20**	**35**	TNPCB/AEL-SLM/SOP/35, Issue No:1, Dated 25 April 2014.
12	Nitrate Nitrogen as NO_3	mg/l	**0.432**	**0.389**	APHA 23rd Edn. 2017 (4500 NO_3-B)
13	Cyanide	mg/l	**<0.008**	**<0.008**	APHA 23rd Edn. 2017 (4500 CN E)

Note: < = Indicates Less than Minimum Detectable Limit.

Checked by

Environmental Scientist

Authorized Signatory

06/02/2024

Chief Scientific Officer (a/c),
AEL, TNPCB, Salem.

- End of Test Report –

VARALAKSHMI STARCH INDUSTRIES (P) LTD.

An ISO 9001 : 2008, 14001 : 2004, BS OHSAS 18001 : 2007 Certified Company

MRFS. & EXPORTERS : SUPER HIGH GRADE TAPIOCA SAGO, TAPIOCA STARCH, MAIZE STARCH & MODIFIED STARCHES

VSIPL/PCB/2022-23/38

06/06/2023

To
The District Environmental Engineer
Tamilnadu Pollution Control Board
Dharmapuri

Respected Madam,

Sub: Re submission of our online Renewal Application .

Ref:

1. Return of the application vide your letter no. DEE/TNPCB/DMP/F.No.0013/2023 dated 07/03/2023.

2. VSIPL / PCB / 2022-23 / Online Application Filed dated 05/06/2023.

With reference the above subject, for our consent Renewal upon we submitting our resubmission letter cited in second reference above, Today our covering letter got successfully uploaded and it prompted us to enter the payment details vide. Re-started to enter the details" Internal Error" we have been directed out some the online portal. At the same time we received the auto generate mail as follows.

Auto mail generated on 05/06/2023 from the Application for CTO (Air & Water) no. 41395491 has been deleted and consent fee forfeited and industry shall make fresh application along with consent fees

Hence now we request your goodselves to kindly let us know the consent fee we have to pay consent fee for the period of 5 years from 1-4-2023 and make the payment immediately and conodone for delay for filling renewal maybe one or two days based your consent fee amount information, we will pay immediately and refill our renewal application.
Kindly acknowledge.

Thanking you
Yours Faithfully,
For VARALAKSHMI STARCH INDUSTRIES (P) LTD.,

(V.Anbalagan)
Managing Director.

06 JUN 2023

Subject: Application Deletion(OCMMS)
From: ocmms-tnpcb@gov.in
Date: 05/06/2023, 17:56
To: office@varalakshmistarch.com

Dear ANBALAGAN V,

Your Applicaion for CTO (Air & Water) no. 41395491 has been deleted and consent fee forfeited and industry shall make fresh application along with consent fees.

Thanks & Regards:

TNPCB

This is computer generated mail. Do not send any mail to this email ID

VARALAKSHMI STARCH INDUSTRIES (P) LTD.

An ISO 9001 : 2008, 14001 : 2004, BS OHSAS 18001 : 2007 Certified Company

MRFS & EXPORTERS SUPER HIGH GRADE TAPIOCA SAGO TAPIOCA STARCH, MAIZE STARCH & MODIFIED STARCHES

To:

Date: 11.07.2023

The District Environmental Engineer,
Tamilnadu Pollution control Board,
Dharmapuri

Dear Sir,

Sub.:- Request for Water and Air Consent Renewal – Reg.

Ours is a Rural Agro Based Starch and Sago Food Products and its by products Manufacturing Industry located in the Industrial Backward Taluk of Dharmapuri District. We are manufacturing Starch and Sago Products as per ISI Specified standards as well as FSSAI standard and Exporting with International Standards.

We are Procuring Raw materials Tapioca Tuber and Raw Maize Directly from the Farmers.

From the Tapioca and Maize, starches are derived into Tapioca Starch, Maize Starch and Sago by Imported Hi -Tech Modern Technology and Machinery.

We are continuously uploading our application for renewal for two years and consent fee was paid upto 2023.

Hence, we are submitting our fresh renewal application for Water and Air Consent for 6 Years i.e. 2023-2024, 2024-2025, 2025-2026, 2026-2027, 2027-2028, 2028-2029 through OCMMS web portal. We have arrived the fee for six year if any our fee calculation is wrong, please inform. Accordingly the balance payable if any we will pay the fees immediately. Based on your kind information.

We have uploaded all the required annexures along with our application and for the necessary consent fees, we have drawn DD No. 697318 dated 10.07.2023 for Rs.13,84,440/- drawn on State Bank of India payable at Dharmapuri.

All the uploaded documents with application in original along with DD for consent fee are send through post.

12 JUL 2023

Regd. Office : " Varalakshmi Tower ", II Floor, No. 127/1, Gandhi Road, Salem - 636 007. T.N. India.
Ph. (Off.) : 0427 - 4031073
Email : office@varalakshmistarch.com
Factory : No. 7/114-126, Bommidi Main Road, Pappireddipatti (Po), Dharmapuri Dt. - 636 905.
CIN No. U01532TZ1995PTC006136 www.varalakshmistarch.com

IS : 899 CM/L-6100012769

IS : 1319 CM/L-6299891

We kindly request you to peruse and consider our application and issue the Water and Air Consent Order at the earliest as the consents are called for by Bank and other departments.. All the Directions of TNPCB and NGT South Zone are complied.

The Project given to Anna University to conduct water audit, waste water audit and ground water quality study they have raised demand that demand also we paid. The project will be completed within six months.

If any further details required, we will provide the same under your request.

Thanking you.

For VARALAKSHMI STARCH INDUSTRIES PVT LTD.

(V. ANBALAGAN)
Managing Director

Encl: 1. Anna University – CES- The consultancy work to conduct water audit, Wastewater Audit and Ground Water Quality Study - Demand.

2. Anna University Acknowledge mail copy.

Receipt Voucher

No. : **115** Dated : **18-Jul-23**

Particulars	Amount
Account :	
Consent Fees	**4,61,480.00**
Consent Fee - Advance	**9,22,960.00**
Through :	
IOB-Collection	
On Account of :	
BEING CONSENT FEES RS 1384440/- PAID BY M/S VARALAKSHMI STARCH INDUSTRIES PVT LTD , BOMMIDI MAIN ROAD,PAPPIREDDIPATTI PO, DHARMAPURI.	
Bank Transaction Details:	
Cheque/DD 697318 10-Jul-23 **13,84,440.00**	
Amount (in words) :	
INR Thirteen Lakh Eighty Four Thousand Four Hundred Forty Only	
	₹ 13,84,440.00

Authorised Signatory

Environmental Engineer
Tamil Nadu Pollution Control Board
DHARMAPURI

Scrutiny Details

Date Time: 21-07-2023 09:24

Scrutiny Description: On scrutiny of application for renewal of consent, it was noticed that the unit has made changes in the product details, Quantity of trade effluent generated and disposed, Source of Emission and fuel consumption, inclusion of survey number, etc. Hence the unit shall clarify/furnish the following details 1. The unit shall furnish the land documents pertaining to the survey number, extent of land & ownership, since there is an addition of survey number in the application. The unit shall furnish the details of total extent of area of the unit, its built up area, solid waste storage area and green belt area with the breakup of each survey number and its extent. 2. The unit shall furnish the revised lay out, site plan, building plan and topo sketch along with the details of survey number, machineries installed. 3. The unit shall furnish the Layout plan showing the location of various process equipments, utilities like boiler, generator etc, effluent treatment plant, outlet location, non-hazardous and hazardous waste storage yard. 4. The unit shall furnish the Topo sketch showing the distance of water bodies, roads, existing/proposed residential areas, agricultural lands, important religious locations, educational institutions, ancient monuments, archeological places and other sensitive areas for 1 KM. radius from the units. 5. The unit shall enter the manufacturing process for each product in the application 6. The unit shall furnish the details of Material balance for each products and process. 7. The unit shall furnish the details of all the raw material used, its material balance and detailed manufacturing process for each product with machineries details. 8. The unit shall clarify the production of modified starch and the status of machineries installed since the unit has removed the product from its application. 9. The unit shall clarify the inclusion of the product "Generation of fuel (biogas)" in the product details since Generation of Power with quantity is already included. 10. The unit shall furnish the necessary approval for water drawl from the competent authority, since there is change in the details of raw water source in the application as well & bore well. 11. The unit shall furnish the details of the treatment system adopted to treat the raw water for process and also the treated and disposal details of effluent generated from raw water treatment system. 12. The unit shall furnish the details of Water Balance and wastewater balance for process with details of water consumption for each process and the source of effluent generated from each process with its quantity, since there is a change in the trade effluent quantity as 477 KLD instead of 500.1KLD (consented) of trade effluent. 13. The unit shall correct the components of effluent treatment plant provided to treat the effluent generated from the process as per the provision inside the unit's premises and shall furnish the adequacy report of Effluent treatment plant so as to meet the standards prescribed by the Board from the reputed agency, Also, the Director, CES, Anna University vide E-mail dated 08.07.2023 has stated that the adequacy report was cancelled and further detailed study required to make some scientific interpretations which is in need to be carried out with respect to the TDS removal happening in the unit's system. 14. The unit shall furnish the layout of greenbelt area with details of pipeline distribution system for the utilization of treated effluent within the unit's premises. 15. The unit shall clarify changes made in the fuel usage in the application and furnish the details of fuel used & point of use to carry out consented production. 16. The unit shall furnish the details and date of installation of 16T Boiler mentioned in the application replacing 30 T Boiler from the existing consent order and the details of its APC measure provided and fuel usage for the boiler. 17. The unit shall furnish the date of installation of 2nd sulphitation plant and details of its APC measures, since the consent was issued to one sulphitation plant only. 18. The unit shall correct the land use classification of the site in the application as per the classification made by the competent authority. 19. The unit shall clarify and furnish the details for changes made in stack height of 15L Kcal thermic fluid heater 2 nos. attached with stack no.15-16 mentioned in the application 20. The unit shall clarify and furnish the details of treatment and disposal system adopted for wet scrubber blowdown from the sulphitation plant. 21. The unit shall furnish the details of stacks and Air pollution control measures provided for the emission sources such as Boiler, thermic fluid heater, sulphitation plant, DG set, etc. 22. The unit shall clarify the details of gross fixed asset value mentioned in the application and in the balance sheet. 23. The unit shall furnish the present status of compliance for the directions issued to the unit vide Board proceeding dated 18.04.2022, 17.10.2022 and 16.02.2023 with supporting documents and relevant photographs. 24. The unit shall furnish the details of action taken to dispose the treated effluent uniformly for green belt development without any stagnation as per the Board's direction. 25. The unit shall furnish the status of cover to thippy storage area as per the directions issued. 26. The unit shall furnish the status of compound wall around the green belt area and effluent treatment plant area as per the Board's direction. 27. The unit shall furnish the status of storm water drain to restrain the rain water mixing with trade effluent generated from the process as per the Board's direction. 28. The unit shall furnish the status of computer arrangement provided to assess the inlet and outlet of flow of ETP as per the Board's direction. 29. The unit shall furnish the status of provision of piezometric (monitoring) well in the greenbelt area as per the direction issued. 30. Latest renewal consent issued to the unit is valid upto 31.03.2021 only and further RCO application submitted by the unit got deleted and the consent fees got forfeited. Hence, the unit shall remit necessary forfeited consent fees. 31. The unit shall correct the category of the unit in the application as per the pollution index score calculation of CPCB. 32. The unit shall clarify the by products manufactured, since the unit has furnished production detail of Maize Husk (Fibre wet) in the application (which is not a consented by product). Hence the application filed may be returned for want of additional particulars and further clarification.

Scrutiny Details

Date Time: 03-10-2023 10:48

Scrutiny Description: On scrutiny of application resubmitted by the unit, it was noticed that the unit has not furnished the reply for all the clarification raised vide note history dated 21.07.2023. Further the unit was inspected by the DEE and AE, TNPCB on 19.09.2023. In this regard, the unit is requested to clarify the observations noticed during inspection along with the details as called vide note history dated 21.07.2023 1.The unit shall furnish the all documents/particulars requested vide note history dated 21.07.2023. 2.The unit shall furnish the commencement date of the crushing season for the current year, since the unit is in operation and has started tapioca crushing during inspection. 3.The unit shall furnish the production details for the period 2021-22, 2022-2023, 2023 till date. 4.The unit shall upload the present compliance status of all the conditions stipulated in the Board's direction dated 16.02.2023 with supporting documents and relevant photographs since it is incomplete. 5.The unit shall furnish the detailed manufacturing process of each product along with raw material used and material balance for each product, since the use of sulphur/SMBS in the sulphitation plant was noticed during inspection. Hence it is requested to include all the raw materials used for the manufacturing of the product. 6.The unit has provided machineries to manufacture dextrin, pre gelatinized starch, carboxy methyl starch in the premises. Hence it is requested to include the details of the product and its raw materials in the application. 7.The unit shall include the raw material details as per the application filed for the issue of consent order dated 14.06.2012. since the unit has informed that there is no change in raw material detail after expansion of the unit. 8.The unit shall furnish the details of Water Balance and wastewater balance for process with details of water consumption for each process and the source of effluent generated from each process with its quantity. 9.The additional stacks in the maize plant from gluten dryer, flash drier, etc were noticed during inspection and hence the unit shall include the emission sources details and its APC measures in the application. 10.The unit shall furnish the status of commissioning of MBR, operable condition of Clarifier, since both are not put in use during inspection. 11.The unit shall furnish the Flow chart of Effluent Treatment Plant along with treatment components details. 12.The unit is yet to furnish the time bound action plan to remove seemai karuvelam trees in the green belt area as per the direction. Hence it is requested to furnish the same. 13.The unit is yet to furnish the monthly report of EMFMs reading provided at the inlet and out let of ETP as per the Bd's direction dated 16.02.2023. Hence, the same shall be uploaded. 14.The unit shall upload the layout of the premises marking the green belt area that are being maintained for utilization of treated effluent along with the plantation details such as number of trees/plants, name of the trees/plants species, plantation area etc. Hence it is requested to furnish the same. 15.The unit shall furnish the layout of the pipeline distribution system provided in the unit to collect, treat and discharge the effluents generated from the unit's activity and for even distribution of treated effluent in the green belt area without any stagnation as per the Board's direction. 16.The unit shall furnish the layout of the storm water drains including collection points, conveyance channel/pipeline and the discharge points provided etc. 17.The unit has provided Membrane Bio-reactor as a component of ETP. Hence it is requested to include the MBR details in the application. 18.The unit shall furnish the details of action taken for preventing mixing of rainwater with trade effluent in the ETP area, since the aeration tank level is lower than the ground level. Hence, the application filed is returned for want of above details.

29-01-2024 03:35

The application is returned for want of the following corrections/clarifications/ additional details as requested by the DEE.

1. The unit has been already requested to correct the application and furnish the all documents/particulars requested vide note history dated 21.07.2023 and 03.10.2023. But the unit has not furnished/corrected the details called for and the application submitted is incomplete.

2. The unit shall add all the raw material used to manufacture each product in the application as per the Anna University report 2009, since the unit has informed that that there is no change in raw material and product detail after expansion of the unit.

3. The unit uses sulphur/SMBS in the sulphitation plant to steep the maize before getting the maize starch and other by products and hence the unit shall add the details of sulphur/SMBS usage in the application

4. The unit shall enter the manufacturing process of modified starch along with raw material used since the unit has informed that only dry process is being followed to manufacture modified starches.

5. The unit has provided Membrane Bio-reactor, Filter Press as a component of ETP. Hence, the unit shall include the MBR and other component details installed for the treatment of effluent in the application.

6. The unit shall include the additional stacks in the maize plant from gluten dryer, flash drier, etc noticed in the emission sources details and its APC measures in the application.

7. The unit has not yet to furnished the report of water and wastewater audit study as per the Bd’s direction issued vide Proc. dated 16.02.2023.

8. The unit has not yet to furnished the report of ground water quality study in the green belt area that are being maintained utilizing the treated effluent as per the Bd’s direction issued vide Proc. dated 16.02.2023.

9. The unit has not yet to furnished the monthly report of EMFMs reading provided at the inlet and out let of ETP as per the Bd’s direction dated 16.02.2023. Hence, the same shall be uploaded.

10. The unit in its compliance status of Bd’s direction dated 16.02.2023 in S.no.7 it was informed that “have already provided piezometric (monitoring well) in the greenbelt area”. However, the unit has not enclosed any document showing the location of the same the same. Hence, the unit shall furnish the detail of piezometric well provided.

11. The unit shall furnish the present status of compliance for the violations noticed in closure order dated 08.11.2022. Further, the cases filed before the Hon’ble NGT (SZ) vide Appeal No.77/2022 (against the closure order of the Board by the unit) and vide O.A.47/2023 (Against the operation of the unit by the Complainant Thiru Suresh) were pending. Also, Still Complaints have been received against the operation of the unit in every Farmers Grievances day meeting. Hence the application is returned for correction in the application , want of additional particulars and compliance of the Board's directions.

VARALAKSHMI STARCH INDUSTRIES (P) LTD.

An ISO 9001 : 2008, 14001 : 2004, BS OHSAS 18001 : 2007 Certified Company

MRFS. & EXPORTERS : SUPER HIGH GRADE TAPIOCA SAGO, TAPIOCA STARCH, MAIZE STARCH & MODIFIED STARCHES

VSIPL/CES/AU/2023-2024/338 13.02.2024

Dr.S.Kanmani
Professor & Director
Centre for Environmental Studies
Anna University
Chennai-600 025

Respected mam,

Sub: Your Adequacy Report dated 29.05.2023 on the ETP of Varalakshmi Starch Industries, Pappireddipatti

Ref: Discussions you had with our MD Mr.Anbalagan on 12.02.2024 and our earlier emails dated 26.12.2023 and 06.02.2024

As a follow up to our earlier mails and the latest discussions you had with our Managing Director Mr.Anbalagan regarding scientific interpretation of TDS, please find enclosed a RESEARCH ARTICLE published by Tamilnadu Agricultural University (Department of Renewable Energy) in the Madras Agricultural Journal titled***"Characteristics of Sago Processing Wastewater Effluents releasedfrom different Sago Factories in Salem and Namakkal District ofTamil Nadu, India".***

This article contains detailed studies on all the physio-chemical characteristics of wastewater generated in four similar Sago and Starch manufacturing industries located in Tamilnadu. In Page No.4 of the Article, under RESULTS and DISCUSSIONS, it has been stated that ***"In general, the TS, TSS, and TDS content of SWW samples in the present study were high due to the presence of rich carbohydrates, fibres and dense suspended solids, unextracted starch, cellulose (fibrous residue from pith), nitrogenous compounds, cyano glucosides and insoluble fibres."*** This study clearly shows that the TDS presence in the wastewater in such Sago and Starch industries are purely organic emanating naturally from the agricultural raw material of Tapioca roots during processing for extraction of Starch and Sago products. Similarly, the organic solids present in our wastewater are destroyed in our ETP through Anaerobic and Aerobic treatment systems which has also been reflected in your Adequacy Report. We hope this Article published by another reputed university would make clear about the source, type and scientific interpretation of TDS present in the wastewater of Sago and Starch processing Industries.

Thanking You,
Sincerely,

(A.Vinothkumar)
Director

Enclosed: Research Article published in Madras Agric. J., 2020; doi:10.29321/MAJ.2020.00382

Madras Agric. J., 2020; doi:10.29321/MAJ.2020.000382

RESEARCH ARTICLE

Characteristics of Sago Processing Wastewater Effluents released from different Sago Factories in Salem and Namakkal District of Tami Nadu, India

Naganandhini Srinivasan[1*], Kiruthika Thangavelu[2], Ashika Sekar[1] and Sivakumar Uthandi[1]
[1]Biocatalysts Lab Department of Agricultural Microbiology, Tamil Nadu Agricultural University, Coimbatore-641 003
[2]Department of Renewable Energy Engineering, AEC&RI, Tamil Nadu Agricultural University, Coimbatore - 641 003

Received : 17th August, 2020
Revised : 08th September, 2020
Accepted : 23rd September, 2020

ABSTRACT

A study was undertaken to determine the physico-chemical characteristics of sago wastewater (SWW) from various sago industries in Salem and Namakkal districts of India. Besides, different SWW (raw wastewater, aerobic wastewater, treated wastewater and starch wastewater) from within the industry were evaluated. The results concluded that effluents from this region are whitish and greyish brown in color with majority supra-colloidal or settable suspended solids with high TS, TSS, and TDS. The ammoniacal, nitrate, and nitrite nitrogen ranged from 2.7 to 6.5, 4.5 to 19.1, and 0.4 to 2.8 mg.L^{-1}. The total nitrogen content of SWW samples was ranged from 180- 650 mg.L^{-1}. The phosphate level of SWW was very high (640-1096 mg.L^{-1}). The COD and BOD content of SWW from all the industries ranged from 2560 to 3200 mg.L^{-1} and 34000 to 76000 mg.L^{-1} indicates its high organic nature. SWW effluents are acidic in nature (pH 4.3-5.2). The free cyanide (CN) content was ranged from 1.2 to 5.2 mg.L^{-1}. The treated wastewater had neutral pH (pH - 6.2), and had a reduced level of EC, starch content, TSS, COD and BOD.

Keywords: *Sago wastewater; Organic load; Treatment; Characteristics; Pollutants*

INTRODUCTION

Cassava (*Manihot esculenta* spp.), a perennial root shrub belonging to the Euphorbiaceae family, has a starch content of 90 per cent (dry weight). It is a cheap source of nutritional carbohydrate energy (720-1012 kJ. day^{-1}) and ranks fourth after rice, sugarcane, maize, and stands fifth amid the starch crops in global production. Many starch factories based on cassava are located in tropical countries. Cassava is grown over an area of about 3 lakh hectares, with the tubers production rate of 58-60 lakhs tonnes. In Tamil Nadu, it is cultivated as an irrigated crop around an area of 82,000 hectares with 800 processing units.

During the extraction of the starch from tapioca tuber, about 20,000 to 30,000 L of water is required per ton of sago, eventually produced the same quantity of wastewater, with high chemical oxygen demand (COD) up to 25 g L^{-1} (Sen and Suttar, 2012), biodegradable starch (4-7 g. L^{-1}) and cyanide (5 mg. L^{-1}). Cyanide is extremely toxic, and it has a significant impact even at very low concentrations (1-2 mM) on many species (Potivichayanon et al., 2020). The untreated effluents released from the sago industries affect the soil health, plants, animals, natural ecosystems, and human beings (Ruban *et al.*, 2013). The fermentation of residues can lead to the production of CO_2, acetic, and lactic acids, which add to intense odors (Cumbana *et al.*, 2007); it leads to serious environmental pollution.

Therefore, a considerable effort is needed to identify economic methods to reduce this pollution load. First of all, clear knowledge of the quality, quantity, and temporal changes in the composition of the effluent is needed for the successful treatment of wastewater. Physicochemical characterization is essential in order to finely identify the characteristics of a treatment method going to apply. Additionally, certain physico-chemical characteristics present a preliminary evaluation of the quality and degree of pollution of wastewater. The objective of the present study is, therefore the characterization and quantification of the organic contaminants (BOD, COD, TSS, nitrate, phosphate, cyanide, etc.,) of the sago processing wastewater.

MATERIAL AND METHODS

Study Area

Salem and Namakkal districts in Tamil Nadu are the tapioca processing clusters in India where large-scale production and tapioca processing is carried out. Nearly 34,000 acres of land is under tapioca

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cultivation and popularly called for the land of sago. The present study was carried out in Salem and Namakkal Sago cluster areas. Site selection is based on the intensity of the small-scale manufactures in producing sago and wastewater disposal locations directly to the environment.

Collection of sago processing wastewaters from different locations

The sago processing wastewater (SWW) was collected in the airtight container from different sago industries located at the Salem and Namakkal districts of Tamil Nadu, India. The industry name, area, and geographical location are presented in Table 1 and Figure 1a. The different SWW such as raw wastewater, aerobic wastewater, treated wastewater, and starch wastewater were collected from different unit operation within the industry (TA Perumal starch industry) Figure 1b. The collected wastewaters were immediately stored at 4 °C until used for further experiments and analysis.

Physico-chemical property analysis

The physicochemical parameters (pH, EC, TDS, TS, salinity, total soluble starch, COD, and BOD) of SWW samples collected from various sago industries and different unit operations within the industry were analyzed as per the standard method of examining water and wastewater analysis (APHA, 2005). Macronutrients such as nitrogen (ammoniacal and nitrated) and phosphorous in wastewater were estimated in accordance with the supplier's protocol by the probe photometer kits (Palintest 7500 Photometer, USA).

Cyanide estimation

The cyanide content was calculated by modifying the picric acid method (Fisher and Brown, 1952). A linear calibration curve was obtained with the standard cyanide solutions as follows: aliquots (0.05 mL) of cyanide solutions (after centrifugation at 15,000 g for 10 min at 4 °C) were added to 0.1 mL aliquots of a solution containing 0.5% (w/v) picric acid and 0.25 M Na_2CO_3. The resulting solution was put in a boiling water bath for 5 min, diluted to 1 mL with 0.85 mL of distilled water, and cooled for 30 min in tap water. At 520 nm, the absorbance was read against a blank of distilled water and picric acid reagent along with samples.

Statistical analysis

All experiments were performed in triplicate, and the average values with standard deviation were considered. Statistically significant differences between the physico-chemical properties between the industries were examined using one-way analysis of variance (ANOVA) and Duncan's multiple range test (DMRT) at 5% significance level.

RESULTS AND DISCUSSION

Physico-chemical characteristics of SWW from various sago industries

The physico-chemical characters of SWW from various industries are presented in Table 2. From the results, it was known that every industry had released its unique characteristic wastewater that depends on processing steps and raw materials.

Table 1. Industry name, geographical coordinates and area of the SWW collection sites used in the present study

Google map code	Name of industry	Geographical coordinates of sampling site		Area detail
		Latitude	Longitude	
A	SreeSelliamman sago factory	11.50 N	78.10 E	Thatchankadu, Alavaipatti, Nammakal, Tamil Nadu-637505
B	TA Perumal starch industries	11.65 N	78.11 E	Ezhil Nagar, Sivathapuram, Kanthampatty, Salem, Tamil Nadu-636005
C	Sri Senthil Andhavar sago factory	11.59 N	78.61 E	Eachampatti road, Attur taluk, Salem, Tamil Nadu-636141
D	S.R.T. Sago factory	11.55 N	78.63 E	Attur - Rasipuram - Erode Rd, Tamil Nadu 636108

During the sago extraction process, tapioca roots are washed, debarked, rasped before milling or pulping process. The starch in the slurry is removed in these processes and left to be resettled, than compacted and agglomerated (Patle and Lal, 2008). During the entire production process, a large amount of water (20 litres of wastewater per kg of sago starch production) would be discharged as sago wastewater effluents.

The color of the SWW effluent samples observed in the present study was greyish to dark brown with whitish settlements due to the fermentation of remaining starch in the SWW. The changes of color are most probably due to the degradation of organic content in the effluents reacted to the microbial activities and anaerobic conditions (Tchobanoglous et al., 2014). SWW temperature ranges from 26.1- 28.0°C; this is the optimum temperature for

microbial growth. The pH of SWW from all the four factories was highly acidic ranged from 4.3 to 5.4 due to the release of hydrogen cyanide (HCN) from cassava tubers and the addition of sulphuric acid during the extraction process.

Table 2. Physico-chemical characteristics of SWW collected from different sago industries.

Properties	Sago Industries			
	A*	B	C	D
Color	Greyish	Greyish	Brown	Dull white
Odor	Pungent	Pungent	Pungent	Pungent
PH	4.7 (0.1) ^{b}	4.3(0.0) ^{c}	4.3 (0.0)^{c}	5.4 (0.0) ^{a}
EC (dSm^{-1})	6.2 (0.1) ^{a}	3.3(0.1) ^{b}	6.2 (0.0)^{a}	3.7 (0.0) ^{b}
Salinity (mg. L^{-1})	4656.7 (80.1) ^{a}	2460.0`(0.123) ^{b}	4533.3 (33.3)^{b}	4100.0 (100.0) ^{b}
Temperature (C)	24.9 (0.3) ^{a}	26.9(0.3)^{a}	24.8 (0.3)^{a}	24.7 (0.2)^{a}
Ammonium N_2 (mg. L^{-1})	5.2 (0.0) ^{a}	ND	2.7 (0.0)^{b}	6.5 (1.1)^{a}
Nitrate N_2 (mg. L^{-1})	4.5 (0.0)^{c}	ND	19.1 (0.9)^{a}	7.9 (0.2)^{b}
Nitrite N_2 (mg. L^{-1})	0.4 (0.0)^{c}	ND	2.8 (0.6)^{a}	1.7 (0.0)^{b}
Phosphate (mg. L^{-1})	1096.0 (58.4)^{a}	128.3 (31.1)^{c}	1056.7 (37.1)^{a}	640.0 (17.3)^{b}
Total N_2 (mg. L^{-1})	650.0 (23.1)^{a}	180.0 (34.9)^{c}	436.7 (12.0)^{b}	383.3 (14.5)^{b}
TDS (mg. L^{-1})	4053.3 (61.7)^{a}	2311.9 (12.1)^{b}	4073.3 (6.7)^{a}	2423.3 (3.3)^{b}
TSS (mg. L^{-1})	310.0 (37.9)^{d}	2420.8 (234.0)^{c}	6666.7 (833.3)^{a}	4166.7 (833.3)^{b}
TS (mg. L^{-1})	5066.7 (159.0)^{b}	5921.0 (54.1)^{b}	6900.0 (100.0)^{a}	2316.7 (447.5)^{c}
DO (mg. L^{-1})	8106.7 (53.3)^{a}	6200.9 (12.2)^{b}	7840.0 (576.9)^{a}	8213.3 (232.5)^{a}
BOD (mg. L^{-1})	2613.3 (106.7)^{a}	4650.0 (67.1)^{a}	2560.0 (461.9)^{a}	3200.0 (160.0)^{a}
COD (mg. L^{-1})	34000.0 (2000.0)^{b}	11625.0 (256.1)^{c}	76000.0(6928.2)^{a}	74666.7(8110.4)^{a}
Soluble starch (mg.L^{-1})	4820.0 (390.0)^{c}	3233.0 (0.7)^{c}	6100.0 (0.8)^{b}	12930.0(0.1)^{a}

Values represent mean (±standard error) (n=3) and values followed by the same letter in each column are not significantly different from each other as determined by DMRT (p □ 0.05).

ND - Not determined, EC - Electrical Conductivity, dSm-1, DeciSiemens per metre. TDS – Total dissolved solids, TSS - Total suspended solids, TS - Total solids, DO – Dissolved oxygen, BOD - Biological oxygen demand, COD - chemical oxygen demand.

* Adopted from published data Kiruthika et al., 2020

The entire process emitting obnoxious awfull smell thus cause pollution and deteriorating the environment quality globally (Ibrahim et al., 2006 ; Yunus et al., 2014). The EC and (3.3 - 6.2 dSm^{-1}) and salinity of SWW (2460.0- 4656.7 mg. L^{-1}) were varied, highest recorded in the industry A and C.

Table 3. Physiochemical characteristics of different types of SWW collected from different unit operation within industry

Properties	Raw wastewater	Aerobic wastewater	Treated wastewater	Starch wastewater
Color	Dirty White	Dirty White	Dark Brown	Dirty White
Odour	Pungent	Light pungent	Light pungent	Pungent
pH	4.5	6.4	6.9	4.1
EC (dsm^{-1})	3.07	2.60	2.56	2.67
Salinity (mg. L^{-1})	2271	1962	1930	2024
Temperature (°C)	26.9	26.1	26.4	26.7
Total N_2 (mg. L^{-1})	693.1	440.2	880.4	117.4
TSS (mg. L^{-1})	1272	1858	1414	1472
DO (mg. L^{-1})	6.4	6.4	7.2	6.4
BOD (mg. L^{-1})	4800	4000	3200	4800
COD (mg. L^{-1})	8800	6400	5600	7200
Soluble starch (mg. L^{-1})	3767	2348	1698	4067

EC - Electrical Conductivity, TSS - Total suspended solids, DO – Dissolved oxygen, BOD - Biological oxygen demand, COD - chemical oxygen demand.

The nutrients such as nitrogen (ammoniacal and nitrate) and phosphorus were sufficiently present in all the industrial effluents to support microbial growth. The ammoniacal, nitrate, and nitrite nitrogen ranged from 2.7 to 6.5 mg. L^{-1}, 4.5 to 19.1 mg. L^{-1} and 0.4 to 2.8 mg. L^{-1}, respectively. The total nitrogen

content of SWW samples was ranged from 180-650 mg. L^{-1}. The phosphate level of SWW was very high (640-1096 mg. L^{-1}) in all the industries compared to its nitrogen content.

Due to its diverse densities of substances, i.e., the settable, suspended, and floatable solids material, the wastewater effluent samples were easily settled into three layers of notifiable upper, middle, and lower layers. In general, the TS, TSS, and TDS content of SWW samples in the present study were high due to the presence of rich carbohydrates, fibres and dense suspended solids, unextracted starch, cellulose (fibrous residue from pith), nitrogenous compounds, cyano glucosides and insoluble fibres.

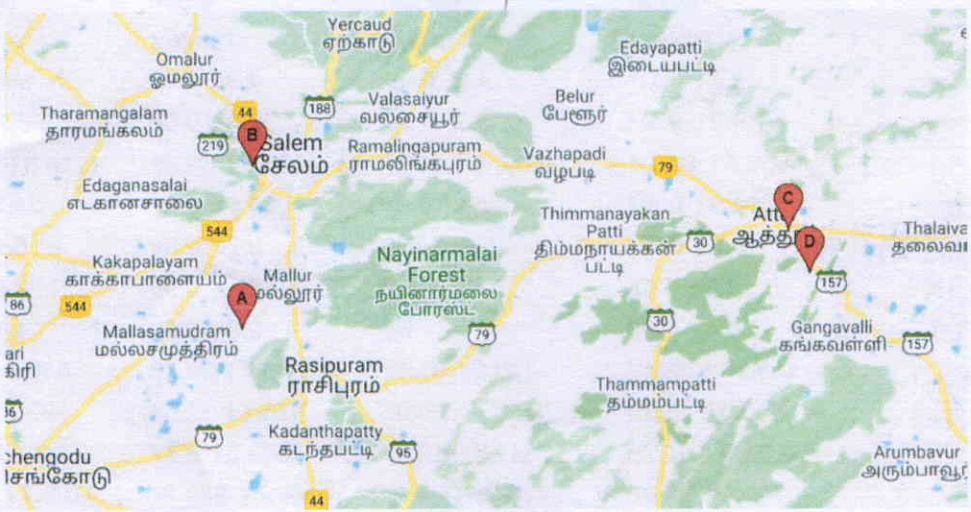

Fig. 1b. Geographical location of the industries in Google map

The COD and BOD content of SWW from all the industries ranged from 2560 to 3200 mg. L^{-1} and 34000 to 76000 mg. L^{-1} indicates the high organic nature of SWW. The content of BOD and COD has exceeded the quality standard recommended by the central pollution control board (100 and 300 mg. L^{-1}).

Physico-chemical characteristics of SWW collected from different unit operation within the industry

Different sago industries released their unique SWW vary in their properties. Similarly, within the industry, every unit operation has an impact on the

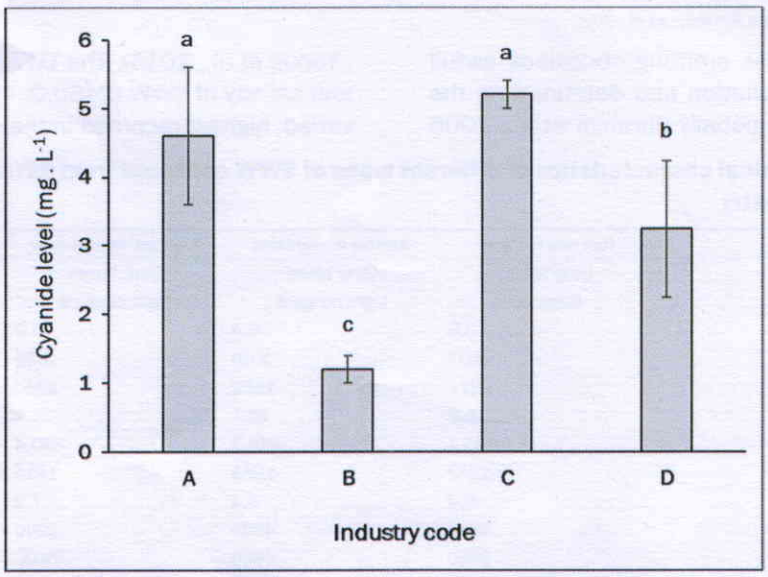

Figure 2. Cyanide level observed in different sago industries

characteristics of wastewater. To study their impact in detail, four kinds of wastewaters were collected within the industry itself. Raw wastewater, which was released entirely after the starch extraction process into the wastewater storage tank 2. Aerobic water, which was collected from the initial

wastewater aerobic treatment system, 3. Treated water, collected from final anaerobic treatment system 4. Starch water is directly collected from the starch settling tank. The results are presented in Table 3. When comparing their properties, the treated wastewater had neutral pH (pH - 6.2), and had a reduced level of EC, starch content, TSS, COD. The soluble starch content in the treated wastewater was low compared to other wastewater due to the microbial fermentation process. Surprisingly the total nitrogen content of treated water was high compared to other wastewater may be due to the release of both organic and mineral nitrogen during the anaerobic treatment process.

Cyanide toxicity level

The potential cyanide content in tapioca varies with the variety, the environmental conditions, and the time of harvest. During the starch extraction process, cyanide bounded in tapioca roots was hydrolyzed with hydrogen cyanide released into the wastewater by linamarase in the tapioca tissue (Arotupin 2007; Sujatha Kandasamy et al., 2015). The level of release depends on the concentration of the enzyme. In the present study, the significant ($p < 0.05$) difference observed in the cyanide level, the free cyanide (CN) content was ranged from 1.2 to 5.2 mg. L^{-1} (Figure 2). In other studies, the cyanide concentration in SWW has been reported to range between 10.4 and 274 mg.L^{-1} depending on the cyanoglycoside content of the tapioca varieties (Siller and Winter, 1998; Balagopalan and Rajalekshmy 1998).

CONCLUSION

The present study demonstrated a detailed physico-chemical variations of sago wastewater from the different scaled industrial units. The various parameters of SWW were possessed higher values than the levels stipulated by the Tamil Nadu Pollution Control Board. Hence, necessary action should be taken to treat the wastewater effectively, which could be recycled. The treated wastewater had neutral pH (pH - 6.2) and had a reduced level of EC, starch content, TSS, COD and BOD.

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Ethics statement

No specific permits were required for the described field studies because no human or animal subjects were involved in this research.

Originality and plagiarism

Authors should ensure that they have written and submit only entirely original works.

Consent for publication

All the authors agreed to publish the content.

Competing interests

There was no conflict of interest in the publication of this content

Data availability

All the data of this manuscript are included in the MS.

Author contributions

Research grant, Idea conceptualization- US; Experiments- SN, KT, AS; Guidance- US; Writing-original draft- SN, KT; Writing- reviewing &editing -US.

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BEFORE THE NATIONAL GREEN TRIBUNAL SOUTHERN ZONE AT CHENNAI

Appeal No. 77 of 2022 (SZ)

M/s. Varalakshmi Starch Industries (P) Ltd.,
Rep. by itsDirectorA.Vinoth Kumar
Having its office at:
"Varalakshmi Tower"
No.127/1, 2nd floor,
Gandhi Road,
Salem- 636 007.

...Appellant

AND

Tamil Nadu Pollution Control Board
Rep. by its Chairperson
76, Anna Salai, Guindy Industrial Estate,
Guindy,
Chennai – 600032.
And 3 others.

…Respondents

AFFIDAVIT ALONG WITH ANNEXURES

M/s. K.INDU PRIYA (E.No.1385/13)
K.R.NISHANTH (E.No.708/14)
S.SATCHITHANANTHAM (E.No.7267/21)
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