IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Dairy Waste Management

[1] Pooja S. Sarolkar, [2] Sejal A. Narke

[1]Assitant Professor, Department of Environment Science, CSIBER Trusts CNCVCW, Kolhapur.

[2]U.G Student, Department of Environment Science, CSIBER Trust CNCVCW, Kolhapur.

Abstract:

The dairy industry contains a large number of organic components. So that it is necessary to ensure the required treatment before release into the environment. Treatment is usually divided into aerobic and anaerobic. Due to rapid industrial growth, the world economy is improving with rapid growth, but it also has an impact in terms of environmental pollution. A large concentration of pollutants in terms of quantity and quality of liquid, solid and gaseous pollutants show harmful effects on flora and fauna as well as on many areas of the environment. An industrial wastewater treatment plant installed to meet regulatory standards governed by the Pollution Control Board. Every industry has a wastewater treatment plant that helps reduce the pollution level of wastewater discharged into the environment from industrial sites. According to the pollution board standards, the industry has to comply with the standards of discharge of waste water from land and streams. For effective treatment, industry should study wastewater characterization, treatability aspects and planning of suitable units. In this study, an effort was made to evaluate one of the ETPs provided for the treatment of wastewater produced by the dairy industry. The study was limited to evaluating the performance of an ETP plant in the dairy industry.

In this research, it is briefly discussed what are the units involved in the dairy industry, what are the processes involved in it; the work done in these processes; from which processes we can get waste water and what are the sources of waste water in these units and the effect of this waste water on the environment. These industries discharge wastewater characterized by high chemical oxygen demand, biological oxygen demand, nutrients, and organic and inorganic content. Such effluents, if discharged without proper treatment, seriously pollute the receiving water bodies and disrupt the entire ecosystem. Moreover, the Government of India has put in place very strict rules and regulations for the discharge of sewage to protect the environment.

Characteristics of the Effluent Dairy Effluent:

Contains soluble organic substances, suspended solids, trace organic substances. All these components contribute greatly to their high biological oxygen demand (BODS) and chemical oxygen demand (COD). Milk wastes are white in color and usually slightly alkaline in nature and acidify relatively quickly due to the fermentation of milk sugar to lactic acid. The content of suspended substances in dairy waste is considerable mainly due to the fine curd found in cheese waste. The polluting effect of dairy waste is attributed to the immediate and high consumption of oxygen. Decomposition of casein leading to the formation of heavy black sludge and a strong butyric acid odor characterizes dairy waste pollution. Dairy waste properties include temperature, color, PH (6.5-12.0), DO, BOD, COD, dissolved solids, suspended solids, chlorides, sulfates, oil, and grease. It depends to a large extent on the amount of milk processed and the type of product produced. In addition to detergents and disinfectants used for washing, dairy waste water contains a large amount of milk components such as casein, inorganic salts. It has a high sodium content from using lye for cleaning.

Effects of Waste: Effects on The Environment:

The dairy industry is one of the most polluting industries, not only in terms of the volume of wastewater produced, but also in terms of its properties. It produces about 0.2-10 liters of wastewater per liter of milk processed with an average generation of about 2.5 liters of wastewater per liter of milk processed. Dairy wastewater is generated intermittently and the flow rates of these wastewaters vary significantly.

The concentration and composition of wastewater generated in the dairy industry depend on the type of processed product, the production program, operating methods, the design of the processing plant, the level of water management used and, consequently, the amount of water saved. This dairy industry produces various types of waste.

Production line wastewater (equipment and pipe cleaning), cooling water, domestic wastewater, sour whey and sweet. Thanks to this, with the application of the next technological cycle in the processing line, the quality and quantity of the product content in the dairy wastewater changes at a given time. With its biochemical composition rich in organic substances (lactose, proteins, phosphorus, nitrates, nitrogen), sweet whey forms the most polluting wastewater and is 60 to 80 times more polluting than domestic wastewater. In addition to detergents and disinfectants used for washing, dairy waste water contains a large amount of milk components such as casein, inorganic salts. All these components contribute greatly to their high biological oxygen demand (BODS) and chemical oxygen demand (COD). Which is much higher than the limits set by the Indian Standards Institute (ISI), now the Bureau of Indian Standard (BIS), for the discharge of industrial effluents; Since these wastes are generally discharged into a nearby stream or soil without any prior treatment, they are said to cause serious pollution problems. Dairy wastes rapidly decompose and deplete the dissolved oxygen levels of the receiving streams, immediately leading to anaerobic conditions and the release of strong odors due to nuisance conditions. The receiving water becomes a breeding ground for flies and mosquitoes carrying malaria and other dangerous diseases like dengue fever, yellow fever, guinea fowl. Higher concentrations of dairy waste are also reported to be toxic to certain species of fish and algae.

The precipitation of casein from the waste, which further decomposes into a highly odorous black sludge, has been found to be toxic even to fish at certain dilutions. Dairy waste contains soluble organics, suspended solids and trace amounts of organics. They reduce formation, promote the release of gases, cause taste and smell, add color or turbidity, promote eutrophication. The main environmental problems related to milk production affect water pollution, air pollution and biodiversity. They often cause the growth of algae and bacteria, which use up the oxygen in the water and eventually choke the rivers, leading to the gradual disappearance of fish. This results in the need to process dairy waste through various processes.

Effects of Effluents on Water:

Organic components:

The organic components of wastewater from dairy operations can be classified as proteins, lactose and fat. These will affect the environment in different ways depending on their biodegradability and their solubility.

River oxygen and BOD5 levels:

The concentration of oxygen in the river depends both on the rate at which oxygen is consumed by microorganisms and on the rate of reaeration from the atmosphere. It is customary to conduct a series of river surveys to obtain the best fit of the oxygen depletion/reaeration equations to actual river conditions. Oxygen is very important in rivers mainly because it supports fish and other aquatic organisms. The usual lower limit for oxygen concentrations in rivers is usually about 6 g/m3. This level is based on the ability of sensitive fish species (usually trout and salmon) to survive. Fully aerated rivers at temperatures of 15 to 250 C contain an oxygen concentration of at least 8 g/m3. It is therefore essential that river discharges maintain an oxygen concentration of at least 6 g/m3. For this to be the case, the inflow into the river must not increase the BOD5 of the river by more than about 3 g/m-3 (depending on the reaeration characteristics of the river). Measures of the amount of oxygen consumed by bacteria are biochemical oxygen demand (BOD5) and chemical oxygen demand (COD). BOD5 is measured as the amount of oxygen that is consumed by bacteria during the decomposition of waste over a period of 5 days at 200°C.The COD is measured by decomposing the waste with boiling sulfuric acid and potassium dichromate in the presence of a catalyst and the result is expressed as oxygen equivalents. In both cases, the organic material is converted into carbon dioxide and water, but in the BOD5 test, some of the organic matter is converted into new bacterial cells. Organic components in dairy products.

Wastewater from processing is highly biodegradable. In waterways, bacteria consume the organic components of the waste. The biodegradation process in waterways consumes oxygen according to the following equation:

Organic material + 02 → Co2 + H20 + Bacteria

Sewage molds:

Low molecular weight organic compounds promote the growth of certain filamentous slimes in waterways. These bacterial colonies are collectively known as scum fungi. The most common bacterial species in this category is Sphaerotilusnatans. One of the main components of dairy wastewater is lactose, a low molecular weight sugar known to promote mold growth in wastewater. Fungal growth in wastewater is related to lactose concentrations in rivers using the equation: Growth/g/m2% 0.333 + 2.479 m (lactose)/g/m3 and this equation can be used to predict the extent of fungal growth in receiving wastewater.

Color and turbidity:

Wastewater that is highly colored is likely to discolor the receiving water. Dairy waste is likely to contain a slightly soluble dye, although true coloration may occur after various forms of treatment. The colloidal and particulate components in the waste reflect light back to the observer. This is known as apparent color. The concept of turbidity is closely related to this phenomenon. Dairy waste contains a significant amount of material that will result in cloudy discharges.

Inorganic components (mainly nitrogen and phosphorus):

One of the main goals of this industry is to recover protein (a component of organic nitrogen) from waste and convert it into salable products. Nitrogen is therefore a very important component of wastewater from dairy plants. Some of the protein is lost to waste streams. Bacteria convert the nitrogen in proteins into inorganic forms including ammonia and ammonium, nitrite and nitrate ions. Each of these inorganic forms of nitrogen has different effects on the environment. Nitrate ions are toxic to both humans and livestock in high concentrations.

Nitrates can be converted to the nitrate form, absorbed into the bloodstream, and convert hemoglobin to methemoglobin. Nitrogen status has various environmental effects. Nitrate ions are toxic to both humans and livestock in high concentrations. In young infants, nitrate can be converted to the nitrite form, absorbed into the bloodstream, and converted into hemoglobin. Methemoglobin cannot carry oxygen. Methemoglobinemia affects infants younger than six months of age because they lack the enzyme necessary to convert methemoglobin back to hemoglobin. For the protection of people, the usual limit for drinking water supplies is 10 g m-3 of nitrate nitrogen. Livestock can also suffer from methemoglobinemia. Because ruminants have a more neutral stomach pH and bacteria in the rumen reduce nitrates to nitrites, death from methemoglobinemia can occur. This usually results from consumption of nitrate-rich feed, although a limit of 30 g/m3 nitrate nitrogen has been proposed for stock drinking water. Inorganic forms of nitrogen (nitrate, nitrite and ammonium ions) and inorganic phosphates act as plant nutrients in waterways. To protect receiving waters from unwanted growth, it has been suggested that total inorganic nitrogen concentrations in receivers be limited to less than about 30-100 mg m-3 or that dissolved reactive phosphorus (inorganic phosphorus) concentrations be less than about 15-30 mg.

Effects of Effluents on Land:

Land application of wastewater is a common method of waste management in the dairy industry.

1. Nutrients (nitrogen and phosphorus):

The main mechanisms of nutrient removal in tillage systems are: - uptake by plants and incorporation into animal products adsorption and immobilization in the soil losses to the atmosphere - losses to groundwater (leaching) Nitrogen uptake by plants reaches up to 500 kg ha -1 year -1. For phosphorus, the amount is about 30 phosphorus. If the animal subsequently consumes the pasture, up to 90% of the nitrogen and phosphorus is recycled to the pasture. Nitrogen is lost to the atmosphere through volatilization of ammonia from urine and faeces and through the process of denitrification. Denitrification is the process by which microorganisms reduce nitrates to either nitrous oxide or nitrogen gas. This occurs under anoxic conditions (i.e., lack of oxygen) and when a suitable supply of organic carbon is available.

Denitrification rates can be quite high at wastewater irrigation sites. At some irrigation sites, losses of nitrogen (mainly in the form of nitrates) to groundwater may occur, depending on the amount of nitrogen removed by other means. A factor usually limiting the disposal of nitrogen-containing wastes into soils is the contamination of groundwater with nitrates, which are subsequently used as a water supply for people or supplies. in these circumstances it is usual to use normal drinking water guidelines. Phosphorus does not usually cause a leaching problem into groundwater due to the high retention and immobilization of phosphates in soils.

2. Sodium and other minerals:

Sodium, potassium, calcium and magnesium are immobilized by soils and occupy cation exchange sites on colloids and clays.

Effects on the atmosphere:

1. **Gaseous emissions:**

Manufacturing operations can lead to a number of emissions into the atmosphere. Boiler plants release carbon dioxide, sulfur oxides and nitrogen oxides into the atmosphere. Methane can be emitted from anaerobic waste treatment systems and nitrous oxide (N20) is emitted from soil at wastewater irrigation sites.

2. Dust/odor:

Particulate materials can be emitted from boiler stacks, powder dryers, etc. Particulate material losses can also occur from other manufacturing processes. If particulate matter emissions are high, then surrounding buildings are covered in dust and powder, which is not only undesirable, but can also be corrosive. Smoke and fumes from factories can also be considered a form of visual pollution. In places of industrial processing, it is necessary to take into account the emission of undesirable odors. Many waste treatment facilities can produce undesirable odors.

Need to treat the Wastewater:

Wastewater from dairies and the cheese industry mainly contains organic and biodegradable materials that can disrupt aquatic and terrestrial ecosystems. Due to the high pollution of dairy effluents, the milk processing industry discharging untreated/partially treated effluents causes serious environmental problems. Therefore, it is important to make whey treatment as a starting point to optimize a simple and economical way to treat all dairy wastewater, moreover, the Indian government has introduced very strict rules and regulations for the discharge of wastewater to protect the environment. Therefore, appropriate treatment methods are required to meet effluent discharge standards. Wastewater treatment, which does not bring any financial benefits to the owners of the dairy industry, discharges it directly into nearby waterways or onto land (ie nature) by providing only part of the primary treatment; due to lack of awareness in this regard and lack of funds. In my research work, I wish to minimize the cost of a treatment plant using coir as a medium in a fixed film fixed bed reactor that develops an anaerobic digestion process that releases methane gas. I will use the standard methods given in APHA to characterize the wastewater at different stages.

Treatments

Treatment Plant Process Description:

On the basis of the characteristics of effluent, location of the milk Processing plant, climatic factors for treatment and performance of similar treatment system, adoption in dairy industry the following treatment scheme based upon Combination of anaerobic followed by aerobic treatmentsystem is described.

Primary treatment:

The line wastewater generated in the dairy will be led from the last manhole to the entrance to the wastewater treatment plant. The waste water will be piped into the existing waste water collection pit. From this unit, the waste water will be pumped to the degreasing unit to remove the free-floating oil grease and fatty material from the degreasing tank. The waste water will be piped into the existing equalization tank. The tanks are designed for dosing alkaline or acidic solutions according to the pH adjustment requirement. Waste water flows from the buffer tank into the existing feed tank. Effluent from the feed tank is pumped to the UASB digestion tank. (Old and new digestion tank. The old one is 600 m^3 and the new one is 900 m^3).

Biological treatment:

From equalization tank effluent is pumped to UASB digester. The effluent is mixed with sludge in the biodigester and due to anaerobic digestion process COD and BOD values are reduced, the gas generated in this process is collected in the gas holder. The effluent from the feed tank shall be pumped to the inlet of the anaerobic digester best on up flow anaerobic sludge blanket (UASB). Methanogenesis takes place where in the acetate; formate, other acid and hydrogen of the first stage are converted to methane and carbon dioxide by strict and anaerobic methanogenic bacteria. The effluent is uniformly distributed at the digester bottom. The gas generator from the digester laid to flare stack through an existing gas holder with a provision of a tapping for furtherusage.

After partial stabilization of the organic matter in the anaerobic system through microbial action. The effluent and shall flow to the aeration tank where it shall undergo extended aerobic biological treatment resulting in stabilization of the soluble organic matter in the presence of oxygen. The oxygen is supplied with the help of air blowers and find bubble diffusers and shall undergo aerobic biological treatment resulting in stabilization of the residual organics.

The mixed liquor from the aeration tank shall be taken to the centrally driven secondary clarifier for the settlement of sludge solids which shall be recirculated to the inlet of aeration tank to maintain the desert MLSS in the aeration tank. The clear supernatant (treated effluent) from the clarifier shall float to V notch chamber effluent flows to treated water collection sump. From here it is pumped to PSF and SCF. The final treatment effluent confirms to the treated effluent characteristics as specified. The system treats the effluent suitable for disposal as per the consent norms prescribed by the state pollution control board.

Excess sludge from the UASB digester is withdrawn periodically through the sludge valves provided in the digester and taken under hydrostatic pressure to the sludge drying bed.

EFFLUENT CHARACTERISTICS:

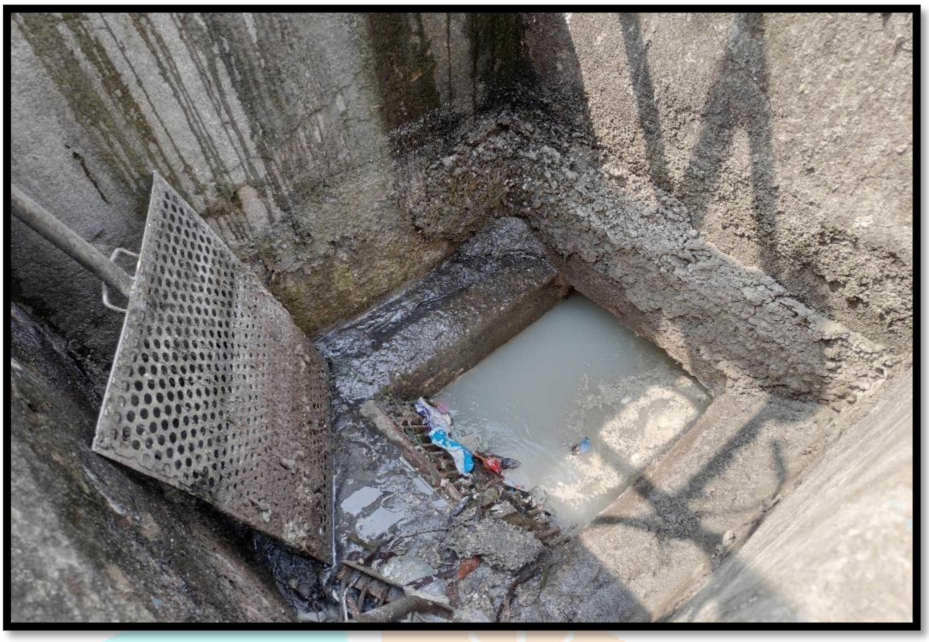
- **Raw effluent characteristics:**

low	500-1800 m^3/day
H	-11
OD	700-2500 mg/lit
OD	100-1500 mg/lit
DS	900-2100 mg/lit
SS	50-450 mg/lit
il and Grease	00-900 mg/lit

- **Treated Effluent Characteristics:**

low	500-1800 m^3/day
H	.5-7.9
OD	0-100 mg/lit
OD	0-50 mg/lit
DS	00-800 mg/lit
SS	0-120 mg/lit
Oil and Grease	0-110 mg/lit

A) BAR SCREEN CHAMBER:



- **Objective:**

To remove the floating material from the raw effluent.

- **Unit description:**

The existing shaft will receive raw waste from the dairy. From there, the waste water will flow into the bar screen chamber. Effluent from the hatch is passed through a bar screen chamber to remove floating solids. A bar screen is installed in this chamber to remove solids. The waste water will drain from the bar screen into the sump.

The figure is built in RCC. A bar screen made of SS 304 is installed in the chamber to clean the screens as needed.

COLLECTION SUMP:

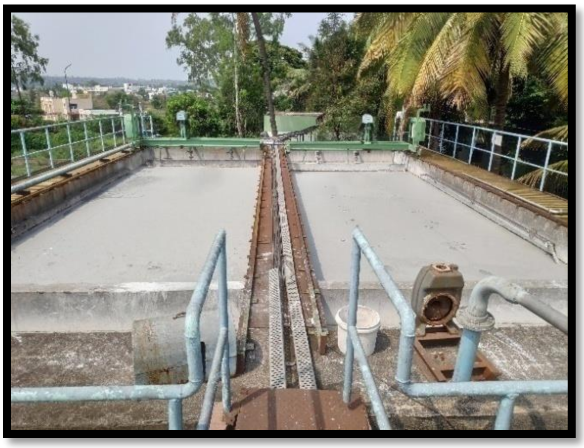
Objective:

The tank is provided to receive the effluent from bar screen chamber.

Unit description:

The effluent from bar screen chamber is collected in this tank. The tank is provided with raw effluent transfer pump to pump the effluent from tank to fat removal unit.

B) FAT REMOVAL UNIT:



- **Objective:**

To remove floating fat from raw effluent.

- **Unit description:**

The unit is constructed in RCC. It is provided with baffle walls, fat collection launder, drain connection and all-around walk way platform. The air is purged in the unit by providing separate blowers. A travelling bridge oil skimmer is provided on the unit for removing the fat collected on the top of effluent surface. The fat collected in the launder which is floating will be sent to a collection chamber nearby.

➢ **The air blower specifications are as below**

Iachine Model	'R-160 (air)
apacity	)0 m³/hr
ɿuantity	no.s

Procedure for normal operation

1. Switch on the raw effluent pump provided near raw effluent collection sump.
2. Ensure the effluent flows at the inlet point in the oil skimmer baffle wall.
3. When the unit is filled with effluent up to the top of launder the fats starts collecting.
4. Switch on the travelling bridge oil skimmer. Observe and adjust the speed of the movement of arm. Ensure that all the fat is removed and sent into the collection launder.

Procedure for shut down

1. Switch of the raw effluent pump.
2. Operate the fat seal skimmer for Few more minutes so that all the fat collected on the top are removed.
3. Drain out the effluent from the unit so that cleaning and maintenance can be taken up.
4. Clean the arm of the oil skimmer properly. Clean the rail provided on the top of tank, trolley and the wheels.
5. Grease and oil as required for the oil skimmer shall be applied for smooth operation.

C) EQUILIZATION TANK:

- **Objective:**

The tank is provided to receive the effluent from fat removal unit and to make effluent homogenous qualitatively and quantitatively.

- **Unit description:**

The effluent from fat removal unit is collected in this tank. Here chemicals are added to maintain pH from chemical dosing system. The tank is provided with raw effluent transfer pump to pump the effluent from tank to flash mixer, from here again it overflows tank along with chemicals dosed for pH correction. The effluent from the equalization tank flows to feed tank.

D) UASB DIGESTER:

900 m³ Digester

600 m³ Digester

1200 m³ Digester

Anaerobic Sludge Blanket In the up-flow anaerobic sludge blanket (UASB) process, wastewater flows upward through a sludge cloud composed of biologically generated granules or particles. The treatment produced under anaerobic conditions (primarily methane and carbon dioxide) causes an internal circulation that helps in the formation and maintenance of biological granules. Some of the gas produced in the flake cloud binds to the biological granules. Free gas and particles with attached gas rise to the top of the reactor.

Factors Affecting Anaerobic Digestion:

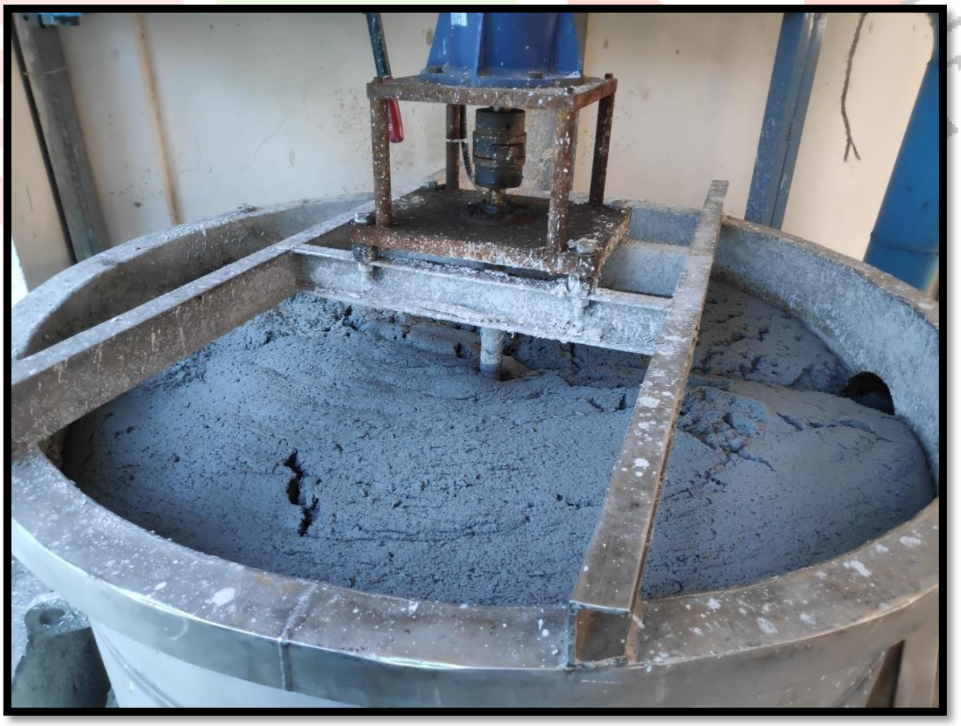
A. Environmental factors:

1. PH & Alkalinity
2. Volatile acid concentration
3. Temperature
4. Nutrient Availability
5. Toxic materials

B. Basic Factors:

1. Bacteria
2. Food
3. Contact
4. Time

E) FLOCCULATOR TANK:



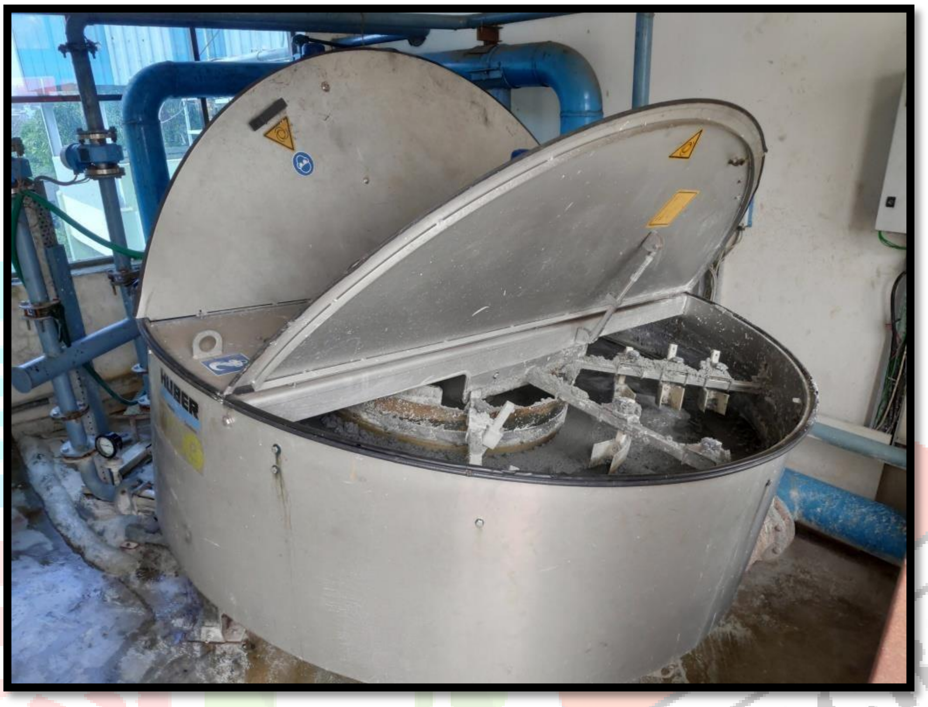
- **Objective:**

To promote the agglomeration of fine particles, present in a solution, creating a floc, which then floats to the surface or settles to the bottom.

- **Unit description:**

The process generally takes place in a tank equipped with a mixer that provides mixing. This shaking should be thorough enough to promote particle-to-particle contact, but gentle enough to prevent disintegration of existing flocculated particles. Particles grow by colliding with other particles and sticking together. Detention time is essential for floc formation. The longer the residence time, the larger the flake. Temperature and pH also affect the flocculation process.

F) DISC THICKNER:



- **Objective:**

To increase the solids concentration and decrease the free water. This step minimizes the load on the downstream processes, such as sludge dewatering and digestion.

Unit description:

There are various processes used in sludge thickening. Each depends on the downstreamprocess, the size of the wastewater plant, and the physical limitations associated with it.

Thickening tanks have slow-moving vertical paddles. Sludge flows into the thickening tank,and eventually, it removes excess water from the solids collecting at the bottom.

G) AERATION TANK:

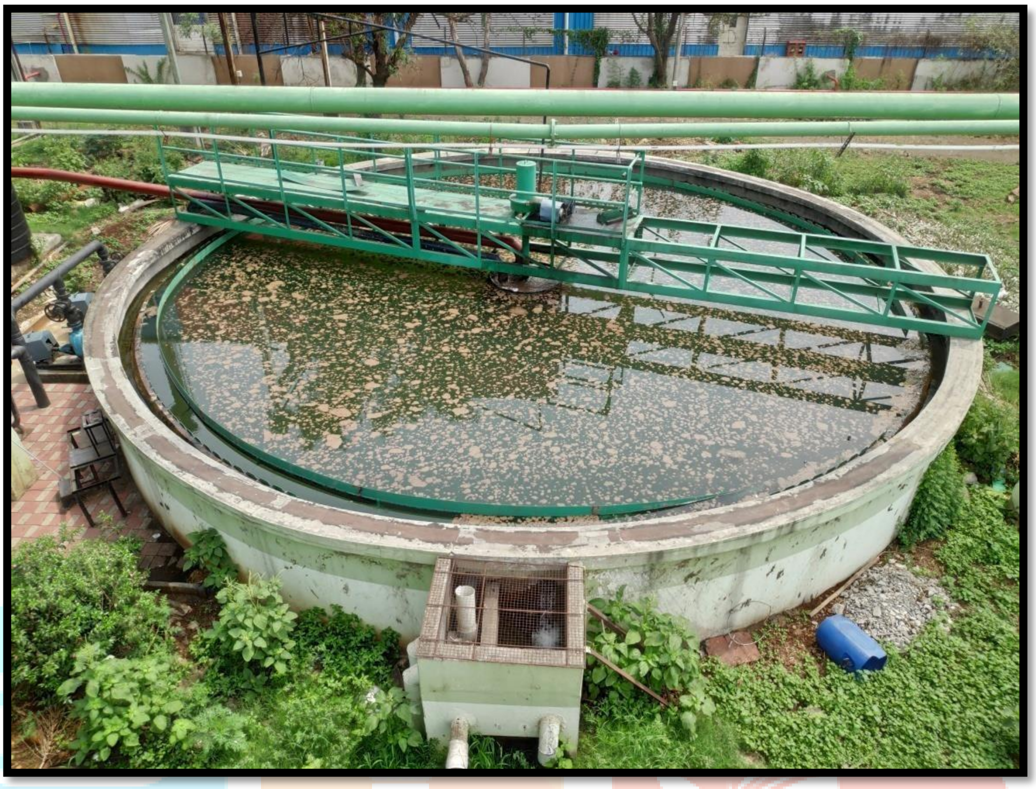
- **Objectives:**

This unit is provided to remove majority of biodegradable organics balanced after anaerobictreatment, contributed by soluble BOD & COD.

- **Unit description:**

The aeration system is extended aeration. The aeration tank is provided fine bubble type of aeration system. The aeration tank is in RCC construction. The unit is provided with an RCC inlet and outlet launders. The tank is provided with staircase and hand rail.

H) CLARIFIER:



- **Objective:**

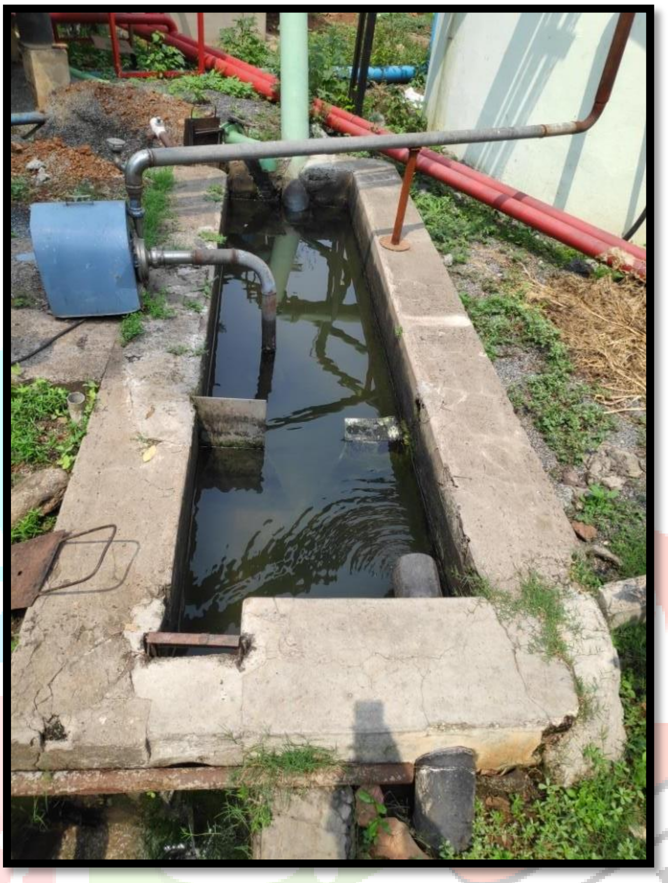
The secondary clarifier unit is provided for the purpose of separating the bio sludge solids from the effluent. The recirculation pumps are provided to recirculate bio-sludge from the bottom of the unit in to the aeration tank such that, the desired MLSS i the aeration tank is maintained.

Excess sludge is sent to the sludge sump. The clarified effluent shall be discharged into the collection sump via V notch.

- **Unit description:**

The unit is circular in shape and made of RCC. Wastewater enters from above through the inlet shaft. The drain is allowed to flow slowly and continuously through the tank radially from the center to the periphery. Clean waste is discharged through the RCC peripheral outlet chute. The slope of the bottom is 1:12 for efficient sludge removal and scraping. Sludge is scrapped into a central sludge collection channel. From the bottom of the tank by rotating the scraping arm. The scraper moves using a central driven mechanism. The superstructure consists of a steel structural bridge up to half the length of the tank diameter. The gathering arms are carried from the bridge and are made of M.S.E.P. The arms of the rakes are equipped with neoprene troughs for efficient raking of solids. Bio sludge from the underflow of the unit is directly pumped via horizontal/centrifugal pumps into the aeration tank.

K) TREATED EFFLUENT COLLECTION SUMP:



- **Objective:**

The treated effluent collection sump is provided to collect and store treated effluent.

- **Unit description:**

Here the treated effluent is received and stored, it acts like the buffer feed tank to the pressuresand filter as the treated effluent from this tank is further feed to PSF by pumps

J) FILTERS (PSF & ACF):

1. Pressure Sand Filter (PCF):

- **Objective:**

To remove the excess suspended solid from treated effluent.

- **Unit description:**

PSF is provided with inlet, outlet, backwash and air vent connections. There is a man hole on thetop of PSF is filled with graded filter media of sand, gravel and grit. Butter fly valves are provided for operation of the PSF. The PSF is painted with 2 coats of epoxy from inside.

2. Activated Carbon Filter (ACF):

- **Objective:**

To remove the odour from treated effluent.

- **Unit Description:**

The filter is fabricated in MS and coated epoxy. The ACF tank receives the effluent from the top. The ACF is filled with activated carbon with 900 iodine valves. This will remove the odor from the effluent. A backwash provision is provided to clean the carbon so that removal efficiency is maintained. After ACF the treated effluent is collected in final treated water tank.

Result & Conclusion:

This study deals with ETP performance evaluation for the dairy industry. It can be stated that the overall performance of the wastewater treatment plant was satisfactory. The individual units also work well and their removal efficiency is satisfactory. The treated wastewater meets the MPCB standard for discharge into inland surface water, so it can be said that the facility is operating efficiently. This treatment plant has a high potential for reducing PH, temperature, TDS and COD. Thus, this treatment technology can be considered as a potential device for the treatment of dairy wastewater.

References:

1. A.G. Vlyssides *et al.* Anaerobic digestion of cheese dairy wastewater following chemical oxidation Biosystems Engineering (2012)

2. B. Sarkar *et al.* Wastewater treatment in dairy industries—possibility of reuse Desalination (2006)

3. Raghunath B, Punnagaiarasi A, Rajarajan G, Irshad A, Elango A. (2016) . *Mahesh kumar G. Impact of Dairy Effluent on Environment—A Review. Integrated Waste Management in India* 239-249.

4. Shete Bharati, N P Shinkar, et.al (2013). Dairy industry wastewater sources, characteristics & its effects on environment. , *Int. J. Curr. Eng. Technol* 3, 1611-1615.

5. Slavov Kolev, A. (2017) Overview of general properties and possible wastewater treatment procedures of the dairy industry. *Food Technology and Biotechnology* 55(1), 14-28.

6. Wojdalski J, Dróżdż B, Piechocki J, Gaworski M, Zander Z. (2013) Determinants of water consumption in the dairy industry. , *Polish Journal of Chemical Technology* 15(2), 61-72.
7. M, M N Esfahany, Behzad T, Sedaqatvand R. (2012) Single chamber microbial fuel cell with spiral anode for dairy wastewater treatment. , *Biosensors and Bioelectronics* 38(1), 264-269.

8. P K Tiwari. (1994) An agenda for pollution control in dairy industry. , *Indian Dairyman* 46, 617-617.

9. S, P S, Gulati V, J F Kennedy. (2001) Development of bench scale technology for the treatment of dairy waste waters by Candida parapsilosis MTCC. , *Indian Journal of Microbiology* 41(4), 285-287.

10. A S Sutar, R K Mulla, A C Ranveer. (2015) Effluent Treatment Plant of Dairy Wastewater–A Performance Evaluation. , *International Research Journal of Engineering and Technology* 2(8), 837-840.
11. Ewing T, J T Babauta, Atci E, Tang N, Orellana J. (2014) Self-powered wastewater treatment for the enhanced operation of a facultative lagoon. *Journal of Power Sources* 269, 284-292.

12. M G Healy, Rodgers M, Mulqueen J. (2007) Treatment of dairy wastewater using constructed wetlands and intermittent sand filters. *Bioresource technology* 98(12), 2268-228.