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Performance Evaluation of Dairy Wastewater Treatment Plant

Sameer Saxena[1], Dr. Mahendra Pratap Choudhary[2]

[1]M. Tech. (Environmental) Scholar, Department of Civil Engineering, Rajasthan Technical University, Kota, India
[2]Associate Professor, Department of Civil Engineering, Rajasthan Technical University, Kota, India

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Abstract – *The dairy wastes usually contain inert, organic or toxic materials and possibly pathogenic bacteria. The effluents from dairy waste are concentrated in nature, and the major contributors these effluents are carbohydrates, proteins and fats originating from milk. The majority of the wastewater quantity is generated from cleaning of transport lines, tank trucks, washing of milk silos and other cleaning agent which have a significant influence on discharged levels of nutrients. To study the behavior of the dairy effluents we have selected various important characteristics such as:- pH, BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), TDS (Total Dissolved Solids), TSS (Total Suspended Solids), DO (Dissolved Oxygen),Total Hardness, Total Alkalinity, Oil and Grease, Kjeldahl Nitrogen, Colour and Odour.*

Key Words: **pH, TDS, DO, BOD, COD, TSS, Dairy wastewater, ETP, Oil and Grease**

1. INTRODUCTION

Wastewater treatment is closely related to the standards or expectations set for the effluent quality. Wastewater treatment processes are designed to achieve improvements in the quality of the wastewater. The various treatment processes may reduce:

- Suspended solids (physical particles that can clog rivers or channels as they settle under gravity).
- Biodegradable organics (for example BOD) which can serve as "food" for microorganisms in the receiving body. Microorganisms combine this matter with oxygen from the water to yield the energy they need to thrive and multiply; unfortunately, this oxygen is also needed by fish and other organisms in the river.
- Pathogenic bacteria and other disease causing organisms, these are most relevant where the receiving water is used for drinking, or where people would otherwise be in close contact with it.
- Nutrients, including nitrates and phosphates, these nutrients can lead to high concentrations of unwanted algae, which can themselves become heavy loads of biodegradable organic load Treatment processes may also neutralize or removing industrial wastes and toxic chemicals. This type of treatment should ideally take place at the industrial plant itself, before discharge of their effluent in municipal sewers or water courses.

The wastewater generated by the dairy industries may include:

a) Washing and cleaning operations in the tanks, trunks, pipes etc.

b) Spillage by leaks and overflow.

c) Processing loss include, sludge discharge from clarifiers discharge from bottles and washer, evaporator entrainment, splashing and container breakage in automatic packing equipment. Spoiled products, returned products or by products.

d) Detergent and other compound used in washing and sanitizing solution that are discharge as waste.

e) Waste constituents may be present in raw water which ultimately go to waste.

f) Entrainment of lubricants from conveyers, stackers and other equipment. Milk products are some time deliberately wasted sometime whey and butter milk.

2. STUDY AREA: Saras Dairy Jaipur

The Effluent Treatment Plant (ETP) of Saras dairy Jaipur has the following units to provide the effluents as per the standards of CPCB, New Delhi and RSPCB, Jaipur. The output is very much treated nearly to the drinking standards.

The various units / sections of the ETP are:-

- Equalization tank
- DAF (Dissolved Air Floatation) unit
- Fat Removal unit
- Bar Screen with Grit Chamber
- Sludge drying beds
- UASB (Up-flow Anaerobic Sludge Blanket)

- Aeration Tanks
- Clarifier
- Rapid Sand Filters
- Dosing Tanks

3. WORKING PRINCIPLE

The working principle or the mechanism of all the above units is explained in brief, as follows:

- First of all, the wastewater from the dairy plant comes into the ETP in the bar screening and grit chamber section where all the major waste products such as polythene bags, rags, wood particles etc. are prevented from entering into the water treatment section.
- Then, the water goes to the equalization tank. The purpose of this tank is to maintain the pH of the wastewater entering into the ETP.
- The pH is associated with different dosing tanks i.e. acid tank and alkali tank which becomes operative according to the situation. If the wastewater coming from plant is acidic then the alkali tank pump is opened and if the wastewater is basic then the acidic tank pump opens.
- Then the water goes to the fat removal unit where the fat is removed from wastewater which gets associated with the dairy plant operations, so the fat is removed by the gravitational action and also with the DAF section which gets deposited in fat collection tank.
- The DAF section refers to the Dissolved Air Flotation system in which an air compressor and pumps are used and coagulant and poly dosing tanks are used. The function of the coagulant and poly is that they separate the foreign particles from the water and with the air pressure; they are separated far away from the water and are sent to the fine screen section.
- Then the water goes to the UASB section which refers to the up-flow anaerobic sludge blanket, after the fine screen section water comes here for sludge treatment.
- The function of UASB is that sludge is collected through the water movement and that sludge is treated anaerobically i.e. in the absence of air and a blanket of sludge is formed which separates the sludge and water.
- Then after UASB, the water becomes a bit acidic and the level of oxygen is less, so to balance it, all the water goes to aeration tanks for increasing the oxygen level in water and again for filtration purposes.
- Then the water goes to the primary clarifier and after the clarifier, the cycle of UASB and aeration tank is repeated and secondary clarifier is the final stage.
- Clarifier is a circular shaped tank with a smaller cylindrical structure in the center and a machine is placed in that cylindrical structure which continuously settles the waste and the circular tank is filled with the overflow condition.
- After the secondary clarifier, the water is collected in the tank and finally it passes through the rapid sand filter and then is sent for reuse and gardening purposes.

4. METHODOLOGY

To study the behavior of the dairy effluents, we have selected various important characteristics such as:-

- pH
- BOD (Biochemical Oxygen Demand)
- COD (Chemical Oxygen Demand)
- TDS (Total Dissolved Solids)
- TSS (Total Suspended Solids)
- DO (Dissolved Oxygen)
- Total Hardness
- Total Alkalinity
- Oil and Grease
- Kjeldahl Nitrogen
- Colour and Odour

To determine these characteristics various methods and instruments are used such as DO meter, pH meter, Incubator, COD Digester, TDS meter, Titration with various acids and indicators have been done. Colour and odour are the physical parameters and are tested physically.

5. RESULTS AND DISCUSSION

The samples have been collected per month during May, June, July and August 2017 respectively and the findings of parameters have been compared with the standard limits as prescribed by CPCB, New Delhi. The average of parameters has been considered for comparison with standard limits.

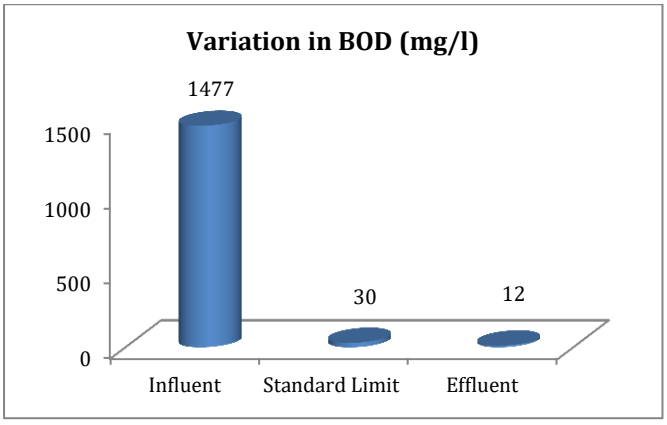
Table 1: Permissible Limits for Wastewater Discharge on Inland Surface Water Prescribed By CPCB, New Delhi

Parameter	Permissible Limits by CPCB (mg/l)
BOD	30
COD	250
Oil and Grease	10
TSS	100
Total Hardness	180
Kjeldahl Nitrogen	20
pH	7.5

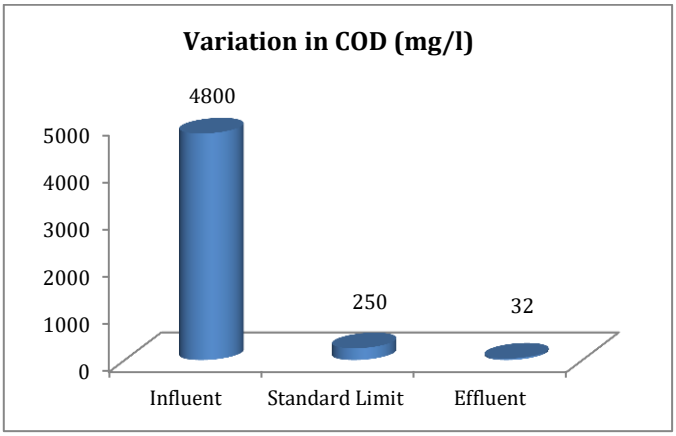
Table 2: Average Values of Parameters of ETP, Saras Dairy Jaipur (in mg/l)

S. N.	Parameter	Influent	Effluent
1	BOD	1477	12
2	COD	4800	32
3	TDS	2214	1035
4	TSS	1203	7
5	pH	6.20	7.60
6	DO	0.5	9
7	Oil and Grease	63	2.5
8	Total Alkalinity	847	290
9	Total Hardness	510	75
10	Kjeldahl Nitrogen	100	8

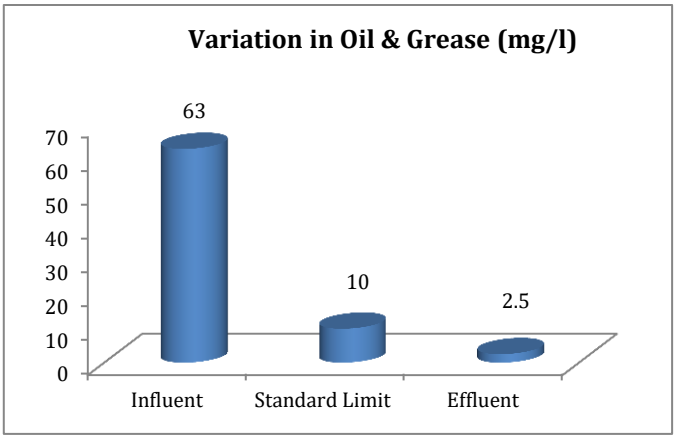
The graphical representation of major characteristics is given below:



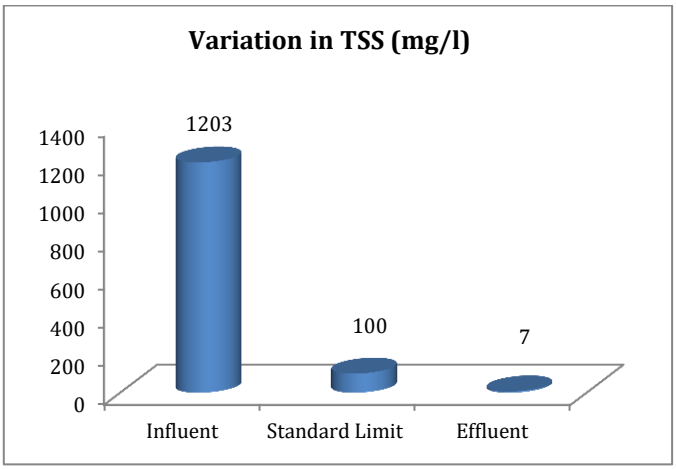
The influent BOD of 1477 mg/l is reduced to 12 mg/l, against the requirement of 30 mg/l as per the standards.



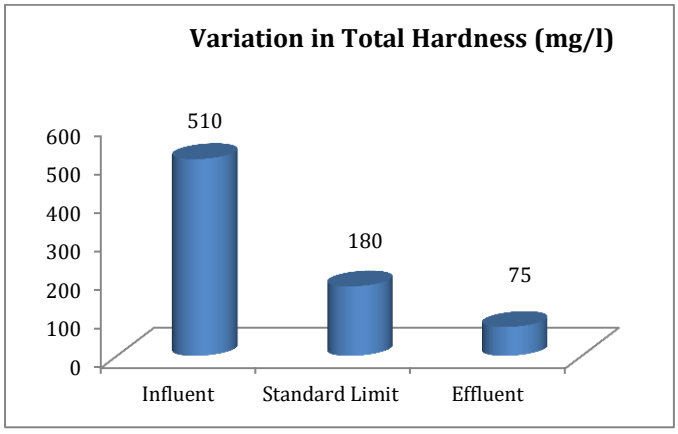
The influent COD of 4800 mg/l is reduced to 32 mg/l, against the requirement of 250 mg/l as per the standards.



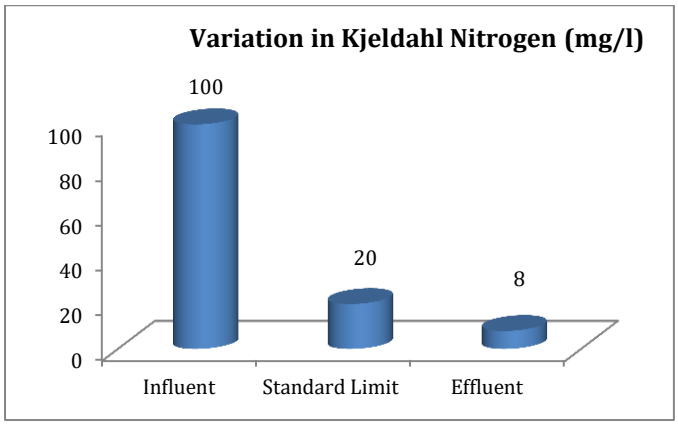
The influent oil and grease of 63 mg/l is reduced to 2.5 mg/l, against the requirement of 10 mg/l as per the standards.



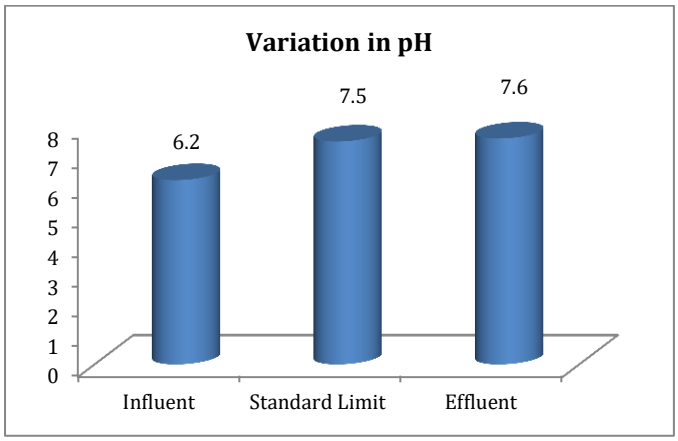
The influent TSS of 1203 mg/l is reduced to 7 mg/l, against the requirement of 100 mg/l as per the standards.



The influent total hardness of 510 mg/l is reduced to 75 mg/l, against the requirement of 180 mg/l as per the standards.



The influent kjeldahl nitrogen 100 mg/l is reduced to 8 mg/l, against the requirement of 20 mg/l as per the standards.



The influent pH of 6.2 is increased to 7.6, against the requirement of 7.5 as per the standards.

6. CONCLUSIONS

Jaipur dairy is using a modern ETP system with various tanks and systems necessary for proper treatment of wastewater for every parameter which is quite necessary. As dairies are among the most water consuming sectors, so it becomes a necessity to reuse the wastewater released by plant or to dispose it as per the standards. The performance of the ETP of Jaipur dairy has been found satisfactory and the water from the outlet of the ETP can be readily used for gardening and floor washing purposes or can be easily drained into the sewage system because it's all parameters are up to the mark as prescribed by CPCB, New Delhi and RSPCB, Jaipur.

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BIOGRAPHIES

Sameer Saxena is an M. Tech. Scholar in Environmental Engineering at the Department of Civil Engineering, Rajasthan Technical University, Kota, India. He completed his B. Tech. in Electronics Instrumentation and Control Engineering in 2014 from Global College of Technology, Jaipur with First Division.

Dr. Mahendra Pratap Choudhary is an Associate Professor in the Department of Civil Engineering, Rajasthan Technical University, Kota, India.