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TREATMENT OF DAIRY WASTEWATER WITH THE HELP OF LAB SCALE SEQUENCING BATCH REACTOR (SBR)

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Abstract - *In India different treatments are used like Aerobic Treatment (Activated Sludge Process), Anaerobic Treatment, Anaerobic followed by Aerobic Treatment. These treatments give good options for dairy wastewater treatment but have their own drawbacks with operation & maintenance cost, energy consumption etc.*

Sequencing Batch Reactor (SBR) which is a modification of activated sludge process is successfully used to treat the industrial wastewater. The process could be applied for nutrient removal and high biochemical oxygen demand containing industrial effluents. SBR is the most promising technology for treatment of dairy wastewater. It is basically fill and draw activated sludge process wherein equalization, aeration and sedimentation occurs in a single reactor.

SBR technology differs in various ways from conventional technologies used in biological treatment of wastewater. The most obvious difference is that in SBR technology, the reactor volume varies with time, whereas it remains constant in the traditional continuous flow system.

Key Words: **Anaerobic Treatment1, Sequencing Batch Reactor2, Reactor volume3, Dairy Wastewater4,Cycle Time5.**

1. INTRODUCTION

India is an agriculture-based country. India being the highest farm animal's population in the world with 50% of the buffaloes and 20% of the world's cattle population. Most of them are milk cows and milk buffaloes.

India's dairy industry is considered as one of the most successful development programs. India is emerging as World's largest and fast-growing markets for milk. Dairy industry is one of the most important means of providing source of revenue and nutritional security to the rural masses. Due to the advancements in veterinary science and increase in the demand for milk and milk products, there is steady growth in the production of milk per head of cattle. This has caused enormous growth of dairy industries in India. (Ministry of Food Processing Industries) As a result, the amount of wastewater generated and discharged from these industries has also increased. The dairy industry comprises of processing raw milk into products such as consumer milk, butter, cheese, yogurt, condensed milk, milk powder and ice cream by various processes such as chilling, pasteurization, and homogenization. Typical by-products include buttermilk, whey, and their derivatives. The dairy industry is one of the most polluting industries, not only in terms of the volume of wastewater generated, but also in terms of its characteristics as well. It generates about 0.2–10 liters of wastewater per liter of processed milk with an average generation of about 2.5 liters of wastewater per liter of the milk processed. It depends mostly on the quantity of milk processed and type of product manufactured. The wastewater from the dairy originate from the sections namely receiving station, bottling plant, cheese plant, butter plant, casein plant, condensed milk plant, dried milk plant (Rao and Datta 1987).

The focus should be made primarily on the chemical, biological and physical treatment of wastewater. In India different treatments are used like Aerobic Treatment (Activated Sludge Process), Anaerobic Treatment, Anaerobic followed by Aerobic Treatment. But these treatment have their own drawbacks with operation & maintenance cost, energy consumption etc.

Dairy industry is among the most polluting of the food industries in regard to its large water consumption. Considering the increased milk demand, the dairy industry in India is expected to grow rapidly and have the waste generation and related environmental problems are also assumed to increase. Waste water generated in a dairy contains highly putrescible organic constituents. This necessitates prompt and adequate treatment of the wastewater before its disposal to the environment. The dairy wastewater is amenable to biological treatment-either aerobic or anaerobic. Rapid growth of industries has not only enhanced the productivity but also resulted in the production and release of pollutants into the environment, creating health hazards and affected flora and fauna.

Before discharging the treated effluent on to the land or any surface water body the industries should meet the effluent discharge standard norms. In order to have proper processes in the ETP, characterization of waste water, treatability studies and planning of proper units and processes for effluent treatment is very much necessary.

Objectives

- To analyze the characteristics of raw and primary treated dairy wastewater.
- To develop an experimental set up for aerobic SBR for primary treated dairy wastewater.
- To optimize the cycle regime in aerobic SBR.

Sources of Wastewater

Wastewater generated from dairy industry contain organic solid due to its dilute and concentrated discharge nature. The following ways from which wastewater is generated.

1. Washing and cleaning out product remaining in tanks, tankers, cans, piping system and other equipment's which are used for processing.

2. Spillage from leakages, overflow of cans and careless handling by worker.

3. Container leakages.

4. Wastewater generation from processing unit cleaning activities.

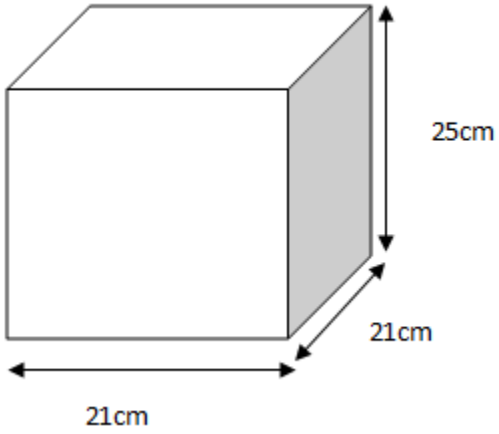
5. Spilled products, by-products like whey.

Material and Methodology

Experimental Setup

The reactor was fabricated of rectangular cross-sectional area & total volume of 11 lit (21*21*25cm) and a working volume of 10 lit (21*21*23cm). The volume of reactor was decided considering the volume of treated wastewater (reactor effluent) required for carrying out the analysis. The height of the reactor was fixed with an experimental determination of agitating depth of water by the air pump. A pipe grid was immersed into a water tub & was connected to air pump for this height determination. Aeration & mixing was provided by means of air pump and rotor that is diffused aeration.

Figure1: Experimental model



RESULTS AND DISCUSSION

Dairy Wastewater Characteristics

Table1: Characteristics of Dairy Wastewater from Dairy

Parameter	Influent	Effluent	MPCB Limit
pH	9.8	7.4	5.5-7.5
BOD	839	37	<100
COD	1700	118	<250
TDS	2156	1890	<2100
TSS	276	26	<100
O & G	42	6	<10

The Dairy Wastewater was analyzed for pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) according to Standard Methods. The average characteristics of Dairy Wastewater analyzed for the study are given in Table 1.

Cycle 1 Operation

The SBR Performance was analyzed for pH, BOD, COD, TDS and TSS with 4Hr cycle. For 4 Hr cycle BOD, COD, TDS, & TSS removal efficiency is respectively.

Table2: Four Hours Cycle Operation

Date	25/2/2020		27/2/2020		1/3/2020		5/3/2020		Avg		Avg % Removal
Parameter	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	
pH	8.65	7.13	8.56	7.23	8.21	7.26	7.54	7.32	8.24	7.23	
BOD	1100	640	950	600	1000	590	1025	660	1018.7	622.5	38.89
COD	2680	1504	2720	1624	2840	1584	2767	1648	2751.8	1592.8	42.11
TDS	2052	1426	1960	1318	1840	1378	1996	1320	1962	1360.5	30.65
TSS	438	294	376	244	480	320	396	238	422.5	274	35.14

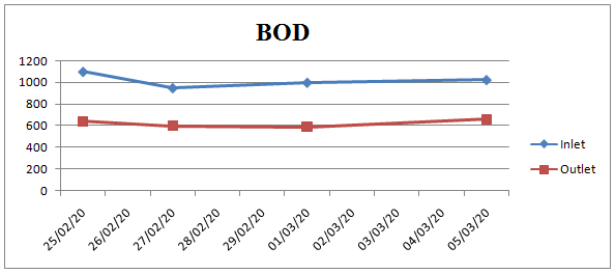


Figure1: Graph of BOD removal

For 4 hrs cycle operation the inlet BOD sample is 1100 mg/lit and outlet BOD5 is reduced to 640 mg/lit.

The average removal efficiency of BOD5is 38.89%.

This indicates that increase the aeration time of wastewater which will reduce the BOD and increase the removal efficiency.

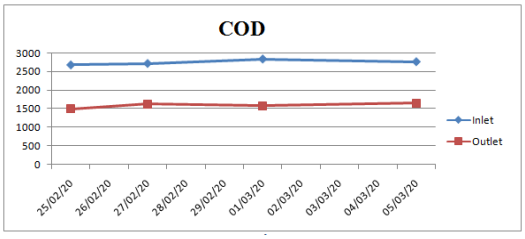


Figure 2: Graph of COD removal

The influent COD sample is 2751.8 mg/lit and outlet COD is reduced to 1592.8 mg/lit.

The above graph shows that average removal efficiency of COD is 42.11 % for 4 hrs duration.

This reading concludes that enhance the aeration time of wastewater which will reduce the COD and increase the removal efficiency.

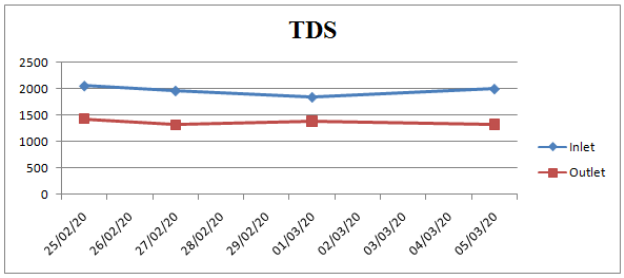


Figure3: Graph of TDS removal v/s No. of Samples

For 4 hrs cycle operation the inlet TDS sample is 1962.mg/lit and outlet TDS is reduced to 1360.5mg/lit.

The average removal efficiency of TDS is 30.65%.

Graph represents that add treatment units like filters, membrane processes etc which will reduce the TDS and increase the removal efficiency.

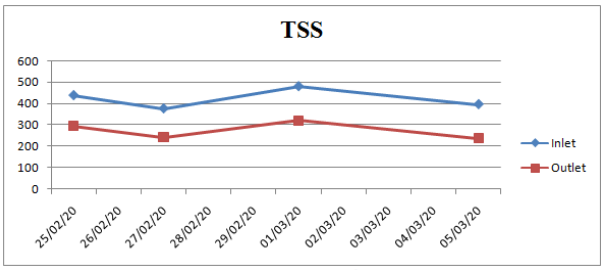


Figure4: Graph of TSS removal v/s No. of Samples

The influent TSS sample was 422.5 mg/lit and effluent TSS was reduced to 274 mg/lit.

The average removal efficiency of TSS is 35.14 % for 4 hrs duration.

Figure shows that increasing the Settling time of wastewater improves the TSS removal efficiency.

Cycle 2 Operation

The SBR Performance was analyzed for pH, BOD, COD, TDS and TSS with 5Hr cycle. For 5 Hr cycle BOD, COD, TDS, & TSS removal efficiency is respectively.

Table 3: Five hours cycle operation

Date	8/3/2020		9/3/2020		12/3/2020		14/3/2020		Avg		Avg % Removal
Parameter	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	
pH	8.55	7.33	8.46	7.13	8.11	7.36	7.64	7.42	8.19	7.31	
BOD	1100	422	1050	400	1100	420	1050	440	1075	420.5	60.88
COD	2620	1040	2700	1064	2860	1088	2740	1096	2730	1072	60.73
TDS	2038	1148	1970	1126	1888	1112	1980	1124	1969	1127.5	42.73
TSS	412	240	362	210	472	254	388	224	408.5	232	43.20

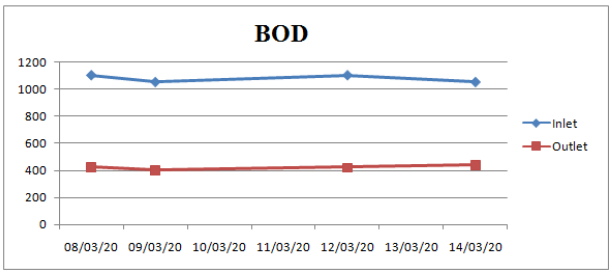


Figure 5: Graph of BOD removal v/s No. of samples

For 5hrs cycle operation the inlet BOD sample is 1100 mg/lit and outlet BOD5 is reduced to 422 mg/lit.

The average removal efficiency of BOD5 is 60.88%. Which is somewhat increased.

Graph exhibits that increase in aeration time increases the BOD removal efficiency.

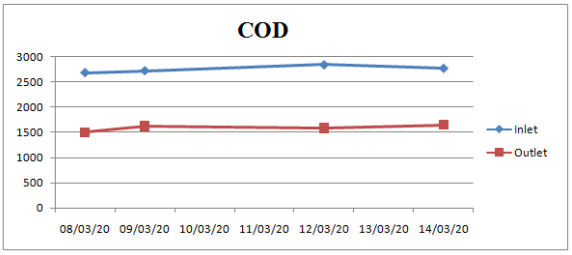


Figure 6: Graph of COD removal v/s No.of samples

The influent COD sample is 2730 mg/lit and outlet COD is reduced to 1072 mg/lit.

The above graph shows that average removal efficiency of COD is 60.73% for 5hrs

Graph shows that the efficient of COD is somewhat increased than previous duration cycle.

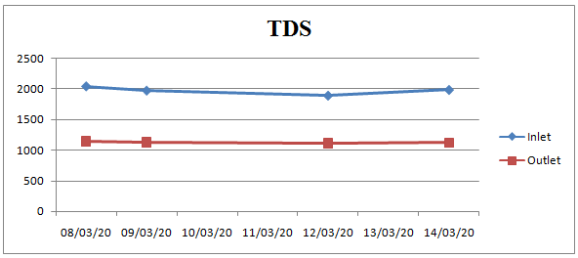


Figure 7: Graph of TDS removal v/s No. of samples

For 5hrs cycle operation the inlet TDS sample is 1969.mg/lit and outlet TDS is reduced to 1127.5mg/lit.

The average removal efficiency of TDS is 42.73%.

Graph indicates that increase in aeration time have not shown considerable reduction in TDS removal.

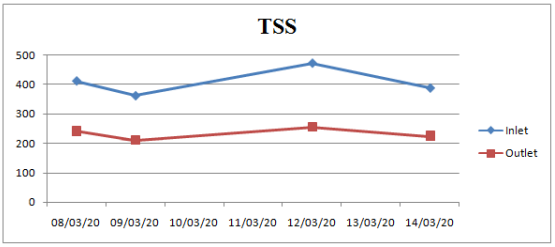


Figure 8: Graph of TSS removal of v/s No. of samples

The influent TSS sample was 408.5 mg/lit and effluent TSS was reduced to 232 mg/lit.

The average removal efficiency of TSS is 43.20 % for 5hrs duration.

Graph shows that 4 hrs cycle the TSS removal efficiency is 35.14 % and 5 hrs cycle the TSS removal efficiency is 43.20 %.

CONCLUSIONS

With the present study it can be concluded that SBR is applicable for dairy wastewater treatment. The lab scale model plant operated on 4 hrs and 5 hrs cycle time by using the SBR technique.

During cycle operation SBR performance was analyzed for pH, BOD, COD, TDS, and TSS for 4 hr cycle. BOD, COD, TDS, TSS removal efficiency is 38.89%, 42.11 %, 30.65%, 35.14% respectively.

During cycle operation SBR performance was analyzed for pH, BOD, COD, TDS, and TSS for 5hr cycle. BOD, COD, TDS, TSS removal efficiency is 60.88%, 42.11 %, 42.73%, 43.20% respectively. The further cycles could reveal more optimum results.

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