Performance evaluation of Activated Sludge Process in Dairy Waste water Treatment

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Abstract— *Wastewater from dairy industries generally has oils and greases in high concentration and contains high concentration of biochemical oxygen demand (BOD) and chemical oxygen demand (COD). This experimental study is being initiated to evaluate an Activated Sludge Process (ASP) with mixed bacteria for dairy waste water treatment. A three phase study was carried out by varying hydraulic retention time (HRT). The study is being undertaken in two steps in which the bacteria is being cultured in a medium by the process of acclimatization. The later stage will be the determination of the operating parameters. The characteristics of dairy industry waste water were studied and the performance was analyzed. A lab-scale ASP was set up for the study of the performance in treatment of effluent. The effect of various aeration time phases were analyzed in the lab scale Aeration Process for the HRT time of (2, 4, 6) hrs respectively. ASP efficiently removes BOD, COD and nutrients when designed and professionally operated according to local requirements. From the effects of various HRT, the 6 hrs HRT was more efficient in removal of the organic matter. The removal efficiency of COD, BOD and TSS were 97%, 97.5% and 96% respectively. In this process all the parameters were within the standard discharge limits. Hence, the enhancement of organic removal from dairy effluent using ASP was found feasible*

Keywords— Aeration, BOD, COD, Dairy Wastewater, HRT.

I. INTRODUCTION

A dairy industry processes the raw milk received from farmers so as to extend its marketable life or to prepare dairy products such as butter, cheese, yogurt etc. The two main processes are involved in the industry are pasteurization and homogenization. Pasteurization is the process of heating up milk either to 62° C for 30 minutes or 71° C for 15 seconds and then quickly cooling it down to 4°C. It eliminates the presence of certain bacteria such as Salmonella, E.Coli and Listeria which may be present in unpasteurized milk. Homogenization is a process which breaks down the fat molecules in milk so that they resist separation. The dairy industry is one of the largest sources of wastewater generation. The volume of waste generated from it is around one to three times the volume of milk processed in the industry. Roughly, every year around 3.739 to 11.217 million m3 of waste is generated from the milk industry. As the demand for milk is increasing in all the countries, the dairy industry is flourishing which ultimately leads to an increase in the generation of dairy wastewater.

II. ENVIRONMENTAL IMPACTS OF DAIRY EFFLUENTS

The organic components of the wastewater from the dairy processing operations can be classified as proteins, lactose and fat. These will affect the environment in different ways depending upon their biodegradability and solubility. Wastewater application to soil is a threat to the environment. Plant uptake of nitrogen amounts to up to 500 kg/ ha/ year. For phosphorous, the amount is about 30 kg of phosphorous. If animals subsequently consume the pasture, 90 % of the nitrogen and phosphorous is recycled to the pasture.

Losses of nitrogen (principally in the nitrate form) to groundwater can occur at some irrigation sites depending on the amounts of nitrogen removed by other means. The factor usually limiting the disposal of nitrogen containing wastes to soils is nitrate contamination of groundwater that is subsequently used as water supplies for humans or livestock.

Phosphorous usually does not cause a problem by leaching to groundwater because of the high retention and immobilization of phosphorous by the soil.

III. METHODOLOGY OF TREATMENT OF DAIRY WASTEWATER

The dairy wastewater sample was collected from the equalization tank at the effluent treatment plant in the dairy industry near Chennai. The fresh wastewater sample was collected and stored/preserved in 4°C to prevent changes in its properties. The activated sludge was collected from the secondary clarifier of the ETP in a dairy industry near Chennai and was used as the seed for the reactor. The acclimatization process was done by using this activated sludge. Chemicals and reagents used for the analysis and the study were Sodium Thiosulphate, Manganese Sulphate, Concentrated Sulphuric Acid, Starch solution and Alkaline Iodide.

A mechanical stirrer was used to uniformly spread the effluent and increased the contact between the effluent substrate and biomass during the aerobic phase. In anoxic phase, mechanical mixing alone had done without aeration in such a manner to uniformly distribute the biomass throughout the liquid phase. However, the oxygen absorption during anoxic operation was maintained as low as possible to prevent the destruction of the anoxic condition by maintaining the speed of the mechanical stirrer without creating much of turbulence.

The air pump was used in this study to supply air. TID-15 model pump was used which flow was 15 lpm, speed-1440 RPM and the motor capacity of 1/20 HP. Compressed air was supplied through the diffusers. A typical air requirement calculation for SBR design was mentioned

3.1 Experimental setup

For the present study laboratory scale with a total volume of 17.5 L (25cm x 20cm x 35cm) and working volume of 1.25 L, 2.5 L, 3.75 L, 5 L and 15 L were used. It was complemented by an influent feeding tank, and an air diffuser pump. The reactor was made up of acrylic plastic which was enabled easy observation and experimentation of settling or floatation behavior of sludge. Aeration was provided from the base of reactor by an air compressor. The photographic representation of experimental setup is shown in the fig 1.

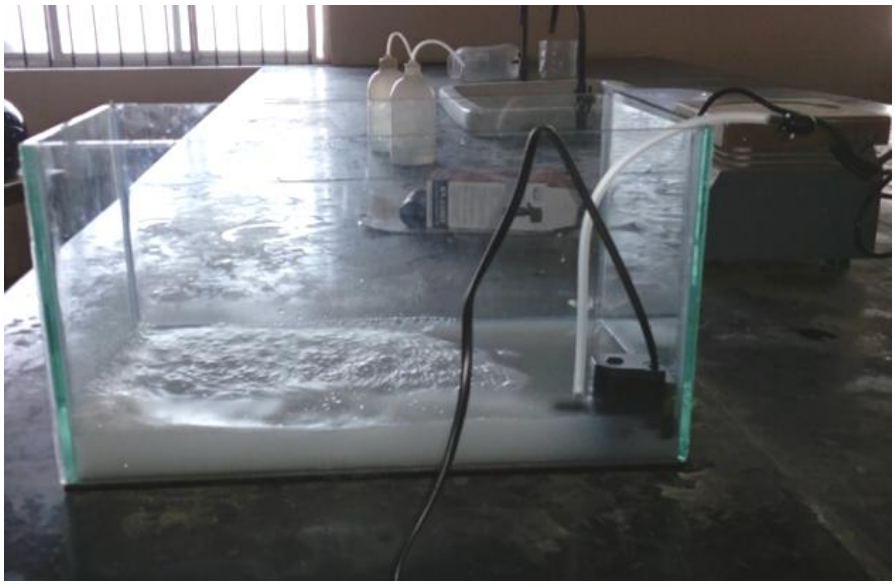

FIG. 1 EXPERIMENTAL SETUP OF AERATION PROCESS

The dairy wastewater was characterized before and after the treatment process. The parameters like chemical oxygen demand (COD), bio-chemical oxygen demand (BOD), pH, suspended solids (SS) were estimated using standard methods for the examination of water and wastewater.

3.2 Characterization of dairy wastewater

Dairy wastewater was characterized for various parameters and furnished in table.1 more than 3 levels of headings should be used. All headings must be in 10pt font. Every word in a heading must be capitalized except for short minor words as listed in Section III-B. The characteristics of dairy waste water before treatment.

TABLE 1
CHARACTERISTICS OF DAIRY WASTEWATER

S.No	Parameter	Raw wastewater Concentration	Existing aerated water concentration	CPCB Standards
1.	pH	8.98	7.32	5.5-9.0
2.	COD	3075	1872	250
3.	BOD	1020	624	30
4.	TSS	324	420	100
5.	TDS	858	663	
6.	Oil & grease	135	8	10

IV. RESULTS AND DISCUSSION

The wastewater sample was collected from the equalization tank daily at the effluent treatment plant and ASP process was conducted. The treated water collected from ASP tank and characteristics like COD, BOD, TDS and TSS. By using the ASP process, dairy wastewater sample was treated for time of 2 hrs for consequent days. The process was conducted for 3 times. Each cycle began with fill phase that was an anaerobic stage about 3.75 min (the reactor was stirred but not aerated). After the anaerobic stage there was an aerobic stage of 1.5 hrs, with stirring and aeration, for nitrification. The next phase of 7.5 min was anoxic for de-nitrification, with stirring but no aeration. The cycle should have finished at the following stages of settling and decant phase of 15 min & 3.75 min respectively. The treated water was collected from the SBR tank and the following parameters like COD, BOD, TDS and TSS were estimated from all the samples.

TABLE 2
EFFECT OF 2HR ASP'S HRT ON REMOVAL OF BOD, AND COD

Parameter	Raw effluent concentration*	Treated effluent concentration*				% of removal	CPCB standards
		S_1	S_2	S_3	Mean		
Ph	8.5	7.1	7.3	7.0	7.1	-	5.5-9.0
COD	3350	395	360	380	378	88.7	250
BOD	1700	55	48	45	49	97.1	30
TSS	1150	145	110	130	128	88.9	100
TDS	858	229	230	225	228		195

(Note: All the parameters are in mg/L except pH)

Comparing to the existing treatment method, ASP process was removed more amount COD, BOD from the dairy wastewater. % of removal was from 60 to 75 %.The Effect of 2 hrs, 4 hrs and 6 hrs ASP's HRT on removal of BOD and COD is shown in table 2, 3, 4.

TABLE 3
EFFECT OF 4HR ASP'S HRT ON REMOVAL OF BOD, AND COD

Parameters	Raw effluent concentration*	Treated effluent concentration*				% of removal	CPCB standards
		S_1	S_2	S_3	Mean		
pH	8.5	7.1	7.3	7.0	7.1	-	5.5-9.0
COD	3350	305	325	290	307	90.8	250
BOD	1700	45	35	30	37	97.8	30
TSS	1150	105	95	80	93	91.9	100
TDS	858	194	197	197	196		195

(Note: All the parameters are in mg/L except pH)

TABLE 4
EFFECT OF 6HR ASP'S HRT ON REMOVAL OF BOD, AND COD

Parameter	Raw effluent concentration	Treated effluent concentration*				% of removal	CPCB standards*
		S_1	S_2	S_3	Mean		
Ph	8.5	7.1	7.3	7.0	7.1	-	5.5-9.0
COD	3350	240	265	230	245	92.7	250
BOD	1700	25	28	20	24	98.6	30
TSS	1150	95	89	86	90	92.2	100
TDS	858	187	189	191	189	78	195

By comparing the various HRT in ASP process, the HRT of 8 hrs was found to be more efficient than the other HRT of 2 and 4 hrs. COD, BOD, TSS removal also achieved in the time of 6hrs. The organic matter removal efficiency for the HRT of 6 hrs was in the range of 93 to 99 %. So the HRT of 6hrs was found to be more efficient and better than the other 2 HRT. Effects of HRT on organic matter removal are shown in fig 2, 3 and 4.

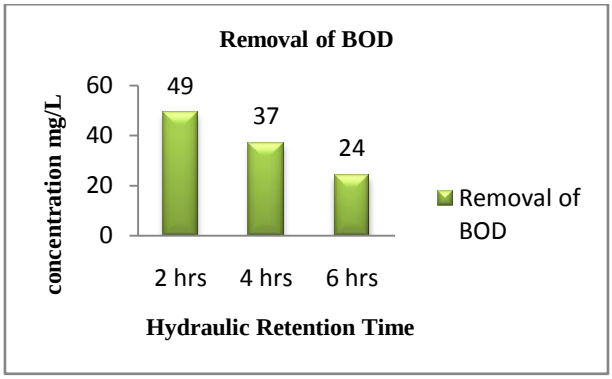

FIG. 2: EFFECTS OF VARIOUS HRT ON REMOVAL OF BOD

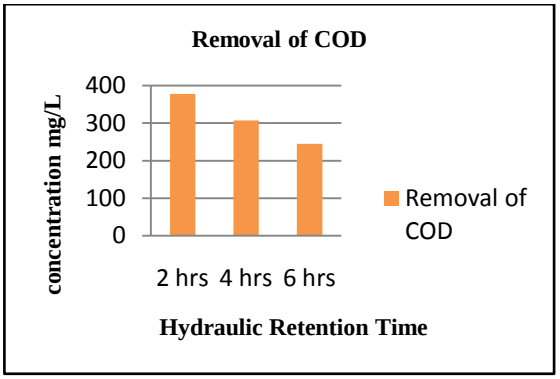

FIG. 3: EFFECTS OF VARIOUS HRT ON REMOVAL OF COD

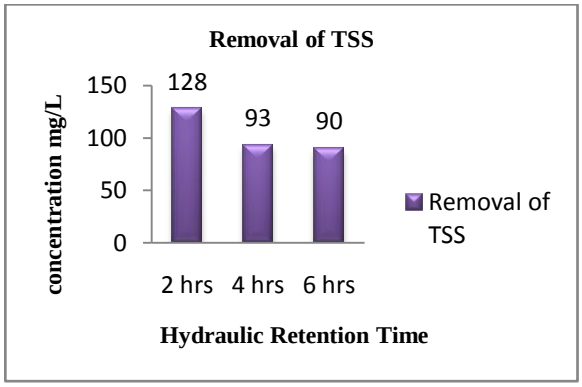

FIG. 4: EFFECTS OF VARIOUS HRT ON REMOVAL OF TSS

V. CONCLUSION

The enhancement of COD, BOD removal from the dairy effluent by the ASP process was found feasible and was in the range of 80 to 96 % and the HRT of 6 hrs was found to be more efficient. The process of acclimatization was found to be more feasible in the development of bacteria in this study.

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