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A Comparative Study on Aerobic Treatment of Dairy Waste Water in Presence of PVC and Aluminium as Media

R. Gobinath, Eldho Issac Dias*, Riju Saji, E. Jeevanantham, S. Krishnaviraj, N. Dhanalakshmi
Department of Civil engineering, Jay Shriram Group of Institutions, Tirupur (Tamil Nadu), India

Abstract

The dairy industry handles large volumes of milk, and the major waste material from processing is the water. The water removed from the milk can contain considerable amounts of organic milk products and minerals. This article discusses the efficiency of MSBR in treatment of dairy waste water in presence of two different media to minimize the amount of organic material in the dairy wastewater. In this work a bench scale modified sequential batch reactor (MSBR) having two aeration chambers were established. The chambers consisted of separate inlet and outlet in which the inlets were connected to the feed pumps having discharge capacities of 2L/h and the outlets were connected to the collection tank. The continuous aeration was supplied inside the chambers to create an aerobic medium. The efficiency in removal of COD, BOD, and other parameters were checked for 24, 48 and 72 h respectively. The ammonia removal efficiency of MSBR in presence of PVC rings and aluminium caps was 75 and 65%. The BOD removal efficiency of MSBR was found as 71 and 65% and the COD removal efficiency clocks 68 and 58%. This work indicates the application of PVC ring and aluminium caps media in SBR increases the efficiency in treatment of dairy waste water, where PVC ring media gives more efficiency in dairy wastewater treatment.

Keywords: *Dairy waste, MSBR, COD, BOD, PVC ring media, aluminium caps*

****Author for Correspondence:*** *Email ID: eldho.dias17@gmail.com*

INTRODUCTION

Aerobic biological treatment involves microbial degradation and oxidation of waste in the presence of oxygen. Processes included in traditional treatment of dairy wastewater by aerobic processes are trickling filters, aerated lagoons, activated sludge, or their combination. Except protein and fats which are not easily degraded, all compounds of dairy wastewater are biodegradable. Amongst the various aerobic technologies, modified sequential batch reactor (MSBR) seems to be the most likely technology for treatment of dairy wastewater. It is a fill-and draw-activated sludge system. In this system, firstly wastewater is added to a single batch reactor then treated to eliminate unwanted components and after that gets discharged. Using a single-batch reactor equalization, aeration, and clarification can all be attained. Hence, by elimination of clarifiers and other equipment, savings on the total cost are obtained.

The treatment efficiency of MSBR depends on the operating parameters such as phase duration, hydraulic retention time (HRT) and organic loading, temperature, pH, dissolved-oxygen concentration, and the strength of the wastewater. The key parameters are biochemical oxygen demand (BOD), with an average ranging from 0.8 to 2.5 kg per metric ton (kg/t) of

milk in the untreated effluent; chemical oxygen demand (COD), which is normally about 1.5 times the BOD level. More than 90% COD removal efficiency was achieved when COD concentration varied from 400 to 2500 mg/l when a bench scale aerobic MSBR was used to treat milk factory wastewater. The peak dissolved oxygen in the reactor was 2 to 3 mg/l. Nitrogen and phosphorus removal were found to be 96 and 80%, respectively; whereas BOD removal was found to be in the range of 97–98%. In comparison to SBR, MSBR performed well even at higher organic loadings. The main source of eutrophication is Nitrogen. In this regard, the whole oxidation of ammonia throughout the treatment is favorable. MSBR operation can be adjusted to accomplish biological phosphorus removal[1–3], filament control[4–8] as well as the removal of specific organics in industrial wastes[9], and the destruction of hazardous waste[10–13]. All usual treatment approaches used for the treatment of dairy waste are related with their own inherent problems. Aerated lagoons and steadying ponds can be provided only where land price is low, where the system can be connected some distance away from housing areas and climatic conditions are low. True batch reactor technology now provided by Modified sequencing batch reactor with all phases of treatment accomplished in a single reactor. All components are effortlessly accessible and best quality effluent withdrawal is confirmed by the advanced decant system.

The wastewaters generated from milk processing can be separated into two groups; the first group comprises wastewater having high flow rates and the second comprises the effluents produced in small milk-transformation units[14]. The discharge of the polluted water is the most significant contributor to the pollution of environment from the dairy industry in terms of both quality and quantity; contamination by the solid waste and waste gases are less serious[15]. Dairy waste effluents are concentrated in nature, and the main contributors of organic load to these effluents are carbohydrates, proteins and fats originating from the milk[16].

In aerobic wastewater treatment systems, aerobic biomass in the presence of oxygen converts organics in the wastewater into carbon dioxide and new biomass. Many researchers reported that the biological process could be applied for treating the wastewater containing both organic and inorganic matters[17]. SBRs are used all over the world and have been around since the 1920s. With their growing popularity in Europe and China as well as the United States, they are being used successfully to treat both municipal and industrial wastewaters, particularly in areas characterized by low or varying flow patterns. Municipalities, resorts, casinos, and a number of industries, including dairy, pulp and paper, tanneries and textiles, are using SBRs as practical wastewater treatment alternatives. Sequencing batch reactor (SBR) and granular activated sludge-SBR (GAC-SBR) systems could be used to treat the wastewater containing heavy metals due to their high mixed liquor suspended solids (MLSS) operation and resistance to the shock load and toxic substance[18]. The selection of wastewater treatment process is based on the qualities of effluent and influent volume and type of influent, investment and operating costs and so on. Water that is being received can be affected by various ways:

1. Due to increased rate of dissolved oxygen, depletion diary wastewater gets affected.
2. During fermentation process lactose gets converted in to lactic acid by which there is a decrease in the pH level.
3. Due to acidic pH there is an increase of casein bed deposit and also increase in fungal growth.

4. Due to the access of cleansers and detergents from the cleaning process there is a destruction of marine life.

Therefore owing to the vast dispersal of the dairy industry across the country of India, a step must be taken towards treatment of the produced waste to prevent pollution from damaging our living environment[19].

EXPERIMENTAL PROGRAM

Materials and Methods

Sample Collection

The waste water has been obtained from ASM dairy, which is located at Kangayam, Tirupur district in Tamil Nadu. The waste water has high amount of COD, BOD and turbidity with acidic waste water lines. Some of the important waste water characteristics are given in Table 1.

Sampling

Sampling of waste water is done at the main collecting tank using grab sampling method, the sample bottles are of 50 L capacity which are cleaned three times with tap water then with distilled water and rinsed fully with 6N HNO3 for removal of every sign of pathogens or odour. Samples collected are used immediately for the study. Before conducting the study, the initial parameters are noted.

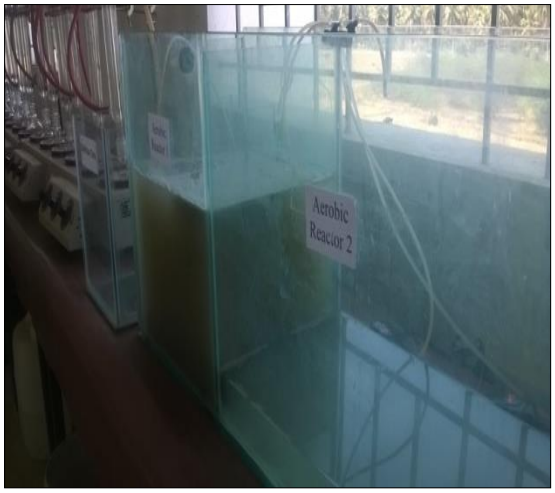

Fig. 1: *Aeration Chambers.*

Fig. 2: *Feed Pump (2L/h).*

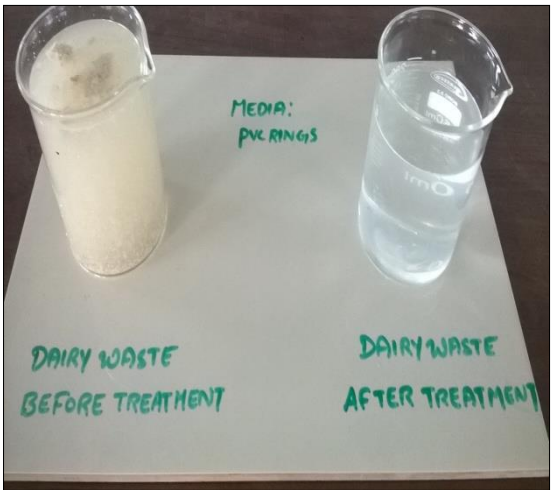

Fig. 3: *Sample Before and After Treatment (Using PVC Ring Media).*

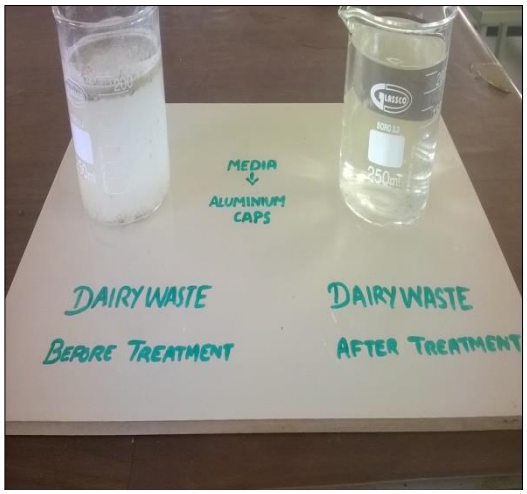

Fig. 4: *Sample Before and After Treatment (Using Aluminium Caps*

MSBR SETUP

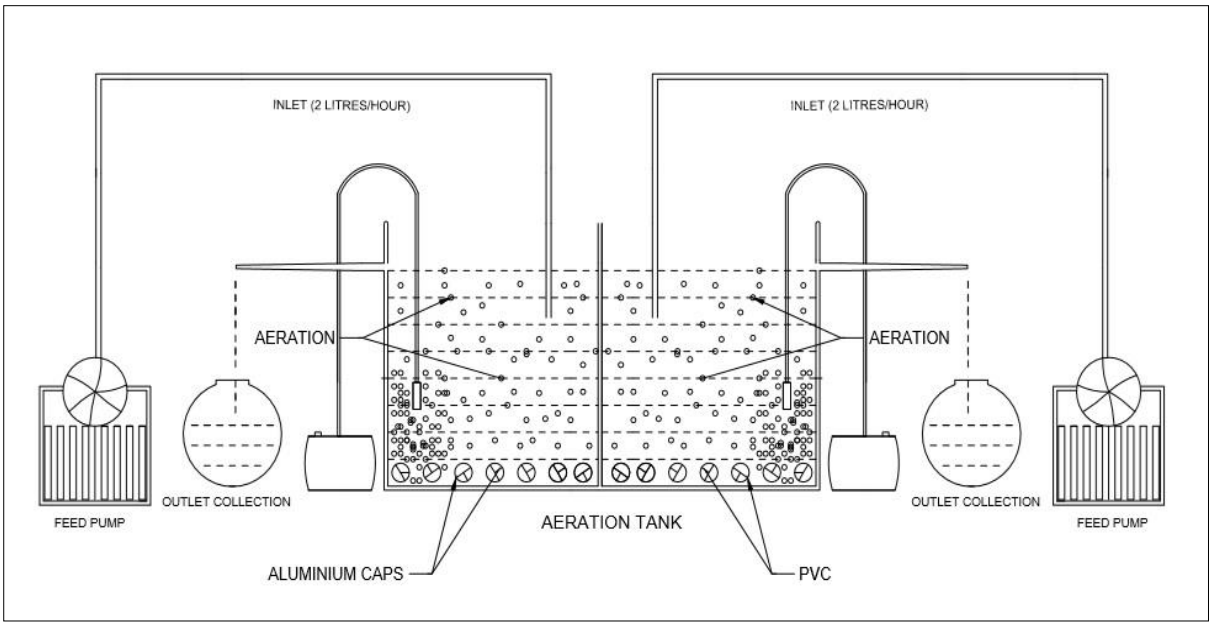

Fig. 5: *Modified Sequential Batch Reactor with PVC Ring Media.*

RESULTS AND DISCUSSIONS

Table 1: *Dairy Waste Characteristic Variation during Aeration in Presence of PVC Media.*

S. No.	Parameters	Initial Concentration	24 h Aeration	48 h Aeration	72 h Aeration
1	pH	5.6	5.8	6.3	6.7
2	Conductivity (mS)	6.92	5.60	4.83	3.9
3	TDS (ppm)	0.46 x 10000	0.62 x 10000	0.7 x 10000	0.82 x 10000
4	Turbidity (NTU)	190.2	132.6	68.2	42.3
5	Ammonia (mg/l)	3.2	2.6	1.9	0.8
6	BOD (mg/l)	520	430	260	160
7	COD (mg/l)	800	666.3	450	250
8	TS (mg/l)	4500	900	500	200
9	TSS (mg/l)	2400	1800	1100	700
10	Odour	Objectionable	Decreased	Nil	Nil
11	Colour	Greyish white	Greyish white	Partially white	Colour less
12	Oil and grease (mg/l)	60.3	48	35.4	22.5

Table 2: *Dairy Waste Characteristic Variation during Aeration in Presence of Aluminium Caps Media.*

S. No.	Parameters	Initial Concentration	24 h Aeration	48 h Aeration	72 h Aeration
1	pH	5.9	6	6.2	6.6
2	Conductivity (mS)	5.02	4.9	4.7	4.5
3	TDS (ppm)	0.59 x 10000	0.7 x 10000	0.78 x 10000	0.85 x 10000
4	Turbidity (NTU)	172.8	127.3	53.8	39.7
5	Ammonia (mg/l)	2.5	2.2	1.6	0.9
6	BOD (mg/l)	460	360	240	150
7	COD (mg/l)	666.67	600	433.3	280
8	TS (mg/l)	4000	800	400	200
9	TSS (mg/l)	2500	2000	1300	800
10	Odour	Objectionable	Decreased	Nil	Nil
11	Colour	Greyish white	Greyish white	Partially white	Colour less
12	Oil and grease (mg/l)	44.5	37	28	20

Table 1 represents the aeration results in presence of PVC media which clearly shows the changes occurred in different parameters due to the continuous aeration. The SBR setup was placed in optimum operational conditions to get optimum result achievement. Almost all the parameters are reaching to the limited value. A pH value 6.7 is obtained from the third day of aeration. This indicates that treatment is efficient.

The key parameters such as BOD, COD are reduced, the value of BOD is reduced from 560 to 160 mg/L with a removal efficiency of 71% and the COD is minimized from 800 to 250 mg/L with a removal efficiency of 68%. Other parameters such as ammonia, oil and grease were reduced with the efficiency of 75 and 62%. Total suspended solids present in the dairy waste water reduced from 2400 to 700 mg/L with a removal rate of 70%, while the total dissolved solids varied from 0.59 × 10000 to 0.85 × 10000 ppm. Turbidity was ranging from 190.2 to 42.3.

Table 2 represents the aeration results in presence of aluminium caps, media also satisfies the quality of treatment and the pollutants present in the waste water are reduced to a minimum. The pH value reaches to 6.6, main parameters such as BOD; COD are reduced upto 65 and 58%. Other parameters such as ammonia, oil and grease were reduced with the efficiency of 64 and 55%. The total suspended solids present in the dairy wastewater were reduced from 2500 to 800 mg/L with 68% of removal efficiency.

This work shows that both the PVC and aluminium are good media in MSBR, but on comparing PVC media poses more efficiency in treatment of dairy waste water.

CONCLUSIONS

Aerobic treatment has received great attention over the past decades due to their numerous advantages such as low energy consumption, low chemical consumption, low sludge production, vast potential of resource recovery, less equipment required and high operational simplicity. The comparative study of aerobic treatment with two different media has been done. The variation in the parameters due to aeration is obtained. The major pollutant parameters present in wastewater were reduced to the satisfactory level. Aerobic treatment is more economical than other conventional treatment methods. Efficiency in treatment of wastewater was good and less maintenance is required. The COD removal efficiency in presence of PVC rings and aluminium caps media was about 68 and 58%. BOD removal efficiency is 71 and 65%, ammonia is reduced upto 75 and 62%. The other parameters of the wastewater were also reduced eventually which concludes that using PVC rings and aluminium caps as media is an effective solution for treating diary waste water. On comparing both media, we obtain more treatment efficiency in MSBR in the presence of PVC ring media, so PVC media is more effective than aluminium caps media for the treatment of dairy waste water in MSBR. By using MSBR system we obtain a good efficient treatment with a maximum removal of pollutants.

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