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Treatment of Dairy Cooling Unit Washing Wastewater using Modified Sequencing Batch Reactor (MSBR) with various Media

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Abstract

A bench scale modified sequencing batch reactor (MSBR) was employed for treatment of diary cooling unit wastewater. The reactor was constructed in cylindrical shape with outlet nozzle at the bottom using borosilicate glass with capacity of 10 L. The reactor was supplied with oxygen by bubble air diffuser at the aeration rate of 4 L/h. The aeration rate was optimized by doing series of trials for MSBR operation. The reactor was fed with dairy cooling unit wastewater under different operational conditions. For microbe feed, 10 g of cow dung was employed. For abundant growth of methanogenous bacteria present in cow dung, nutrients like phosphate buffer solution of 15 mL and 2 g of anhydrous glucose powder was supplied. As attached growth, media brickbats and wood chips were employed. The reactor was operated in continuous mode and maximum hydraulic retention time (HRT) of 6 h was given. The treatment efficiency was checked at every 1 h interval. At maximum HRT, the COD removal efficiency was found to be 70%, BOD removal was at 73%, pH was brought down to nearly neutral level (pH 6.79), transmittance was increased up to 81% and absorbance was reduced to 0.09. The other parameters of the wastewater were also reduced eventually which is clearly shown in this paper.

Keywords*: wastewater, dairy industry, treatment, batch reactor*

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INTRODUCTION

India is a large producer of milk and dairy products in the world with annual milk production crossing 85 million ton in the year 2002, and growing at the rate of 2.8% per annum. The dairy industry wastewaters are generated primarily from the cleaning and washing operations in the milk processing plants and are estimated to be 2.5 times the volume of the milk processed. Thus, some 200 million tons of wastewaters are generated annually from the Indian dairy industry. Dairy waste effluents consist of carbohydrates, proteins and fats originating from the milk. Moreover, dairy industry produces different products, such as milk, butter, yoghurt, ice cream, various types of desserts and cheese; thus, the characteristics of these effluents also vary greatly, depending on the type of system and the methods of operation used [9]. Since dairy waste streams contain high concentrations of organic matter, these effluents may cause serious problems, in terms of organic load on the local municipal sewage treatment systems. The treatment techniques may include physico-chemical and biological treatment methods. But, biological processes are generally preferred due to high chemical costs and the poor soluble COD removability in physico-chemical treatment processes. Among various biological treatment technologies available, anaerobic treatment is generally employed as this treatment can easily handle the varied inorganic loads and the temperature ranges encountered. The variable COD concentrations and warm and strong dairy effluents are ideal for anaerobic treatment. Furthermore, no requirement for aeration, low amount of excess sludge production and low area demand are additional

advantages of aerobic treatment processes [4]. The main advantages are easy operation, low cost, handling hydraulic fluctuation, no need for settling tank and sludge recycling as well as organic load without any significant variation in removal efficiency [5]. The sequencing batch reactor (SBR) system might be suitable to treat milk industry wastewater because of its ability to reduce nitrogen compounds by nitrification and de-nitrification, but the SBR system still has some disadvantages such as the high excess sludge produced and the high sludge volume index [8]. For overcoming this, the attached growth media like brickbats and wood chips were included for better efficiency and low sludge production. Biological processes based upon SBR are effective for organic carbon removal in domestic and industrial wastewater. In SBR operation, each reactor in the system has five basic operating modes or periods. The periods are the fill, react, settle, draw and idle [1]. The convention for SBR was made by introducing the attached growth media instead of suspended growth of microbes to make it as conventional MSBR.

STUDY AREA

Dairy cooling unit wastewater was collected from a nearby dairy cooling unit which produces 100 MLD per month. This cooling unit wastewater is produced only by washing the cooling sectors. These wastewaters are mainly characterized by their COD, BOD and odor. SBR was employed only for dairy processing unit wastewater, but in this study MSBR was employed for dairy cooling unit washing wastewater. The initial parameters of this cooling unit wastewater were analyzed in a standard laboratory using the analytical grade chemicals and the test results are listed in Table 1.

Table 1: *Initial Parameters.*

S. No.	Parameter	Initial concentration
1	pH	4.53
2	TDS	1.60 ppt
3	Absorbance	1.42
4	Transmittance	20%
5	Turbidity	107.6 NTU
6	Sulfate	47.19 mg/L
7	Sulfide	22.3 mg/L
8	Ammonia	6.05 mg/L
9	BOD	440 mg/L
10	COD	613.3 mg/L
11	Odor	Objectionable
12	Color	Greyish white

SAMPLING

Sampling of waste water was done at the main collection sump of effluent treatment plant from dairy cooling unit using grab sampling method. The sampling bottles were of 40 L capacity which were cleaned several times with tap water, then with distilled water and rinsed fully with 1N HNO_3 for removal of living micro-organisms, pathogens and odor of the sampling bottles. The sample was brought to the laboratory and immediately the initial parameters were analyzed.

MATERIALS AND METHODS

Two lab-scale modified sequential batch reactors with continuous operation and fill and draw method were constructed using borosilicate glass with fine nozzle at the bottom. These were constructed in cylindrical shape with 10 L capacity. The reactor was fed with wastewater using feeding pump. After filling the reactor with wastewater 10 g of cow dung was added to it as microbe feed to the reactor. For the effective growth of methanogeneous bacteria present in cow dung, nutrients like 20 mL of phosphate buffer solution and 2 g of anhydrous glucose powder was added.

For attached growth of microbes, media like brickbats and wood chips were added in each reactor to know the difference in growth of microbes in each medium and also to find the removal efficiency in each reactor. Oxygen supply was given to the reactor using fine bubble air diffuser at the rate of 4 L/h. The sample was drawn at every 1 h interval and the parameters were analyzed to optimize the reactor time. Total hydraulic retention (HRT) time of 8 h was given to the reactor. The reactor was operated at room temperature.

RESULTS AND DISCUSSION

After setting the needed amenities for the operation of the reactor, it was operated in continuous mode with maximum hydraulic retention time of 8 h. The wastewater was drawn from the reactor at 1 h interval and the change in parameters from its initial concentration was analyzed. Table 1 shows the variation of parameters from its initial concentration in brickbat medium. Table 1 shows the variation of parameters from its initial concentration in woodchip medium. Figures 1 and 2 represent the change in pH value with varying HRT for brickbats and woodchip media respectively. Figures 3 and 4 represent the change in turbidity with varying HRT for brickbats and wood chip media respectively. Figures 5 and 6 show the change in transmittance with change in HRT for brickbats and woodchip media respectively. Figures 7 and 8 represent the change in COD for brickbats and woodchip media. Figures 9 and 10 show the change in BOD for brickbats and woodchip media. Figures 11 and 12 show the change in sulfate for brickbats and woodchip media respectively.

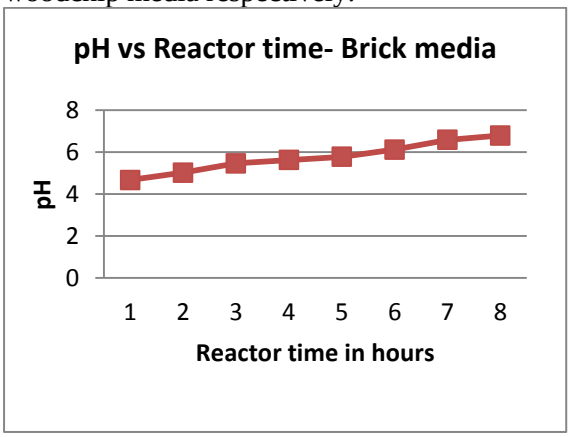

Fig. 1: *pH vs. Reactor Time – Brickbat Medium.*

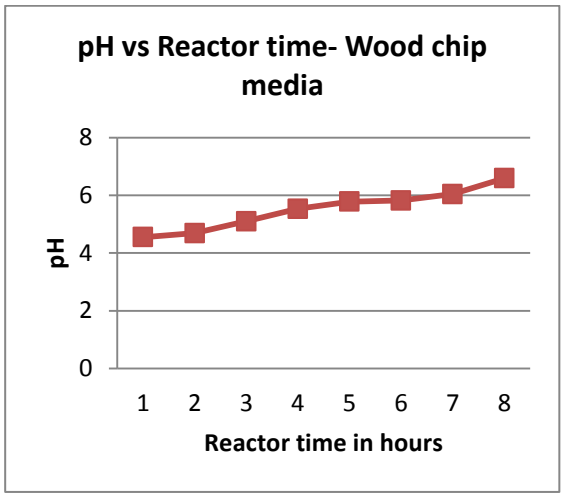

Fig. 2: *pH vs. Reactor Time – Wood Chip Medium.*

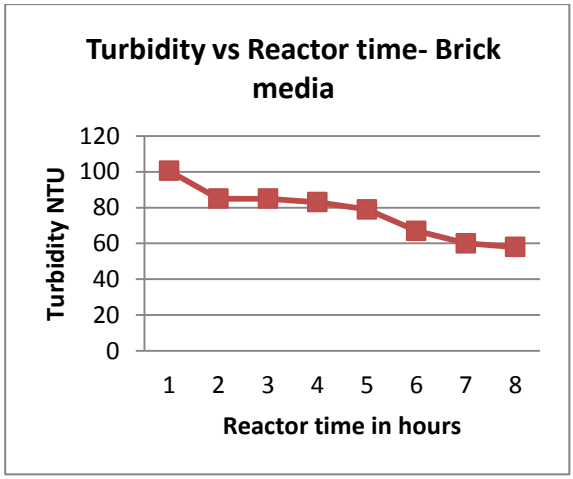

Fig. 3: *Turbidity vs. Reactor Time – Brickbat Medium.*

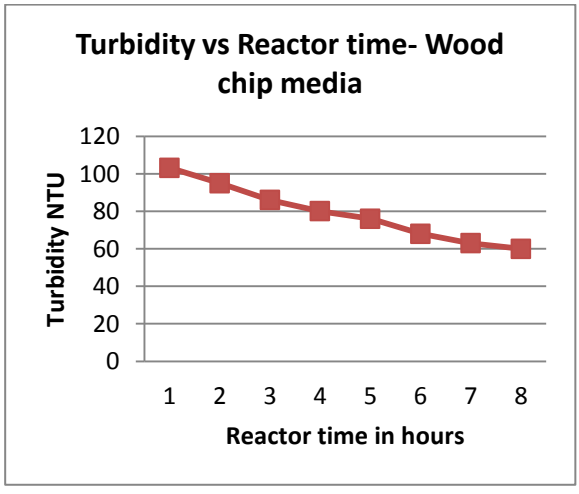

Fig. 4: *Turbidity vs. Reactor Time – Wood Chip Medium.*

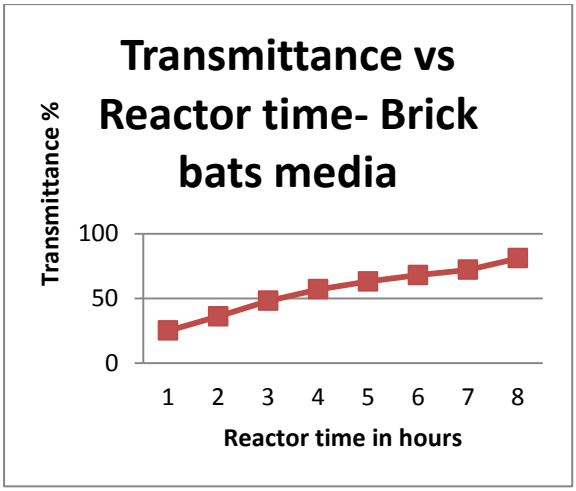

Fig. 5: *Transmittance vs. Reactor Time – Brickbats Medium.*

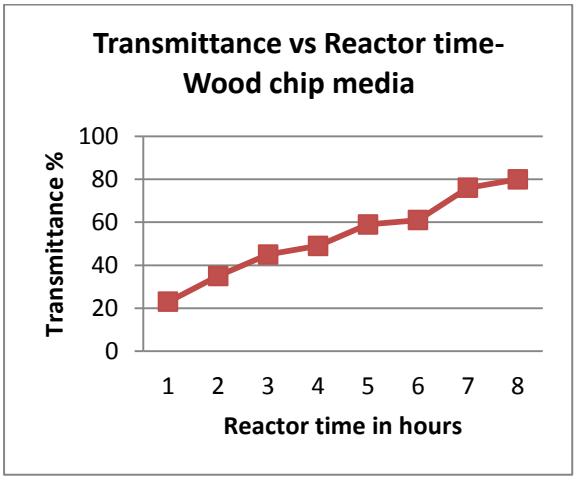

Fig. 6: *Transmittance vs. Reactor Time – Wood Chip Medium.*

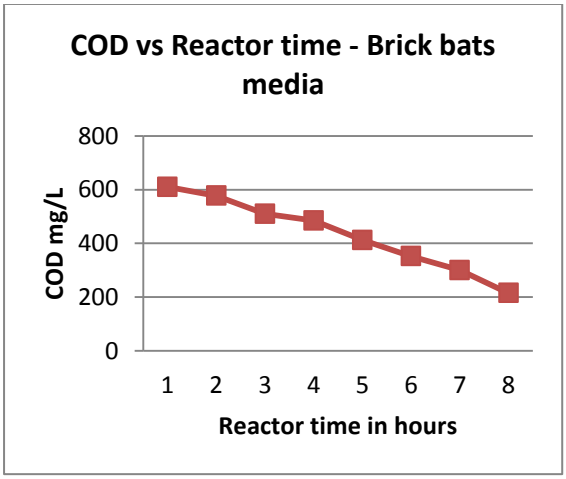

Fig. 7: *COD vs. Reactor Time – Brickbats Medium.*

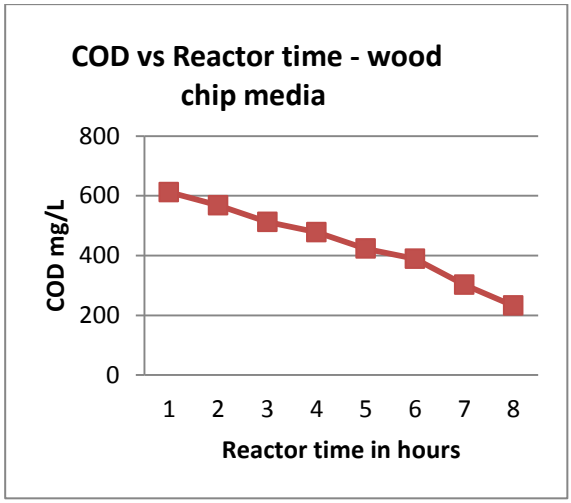

Fig. 8: *COD vs. Reactor Time – Wood Chip Medium.*

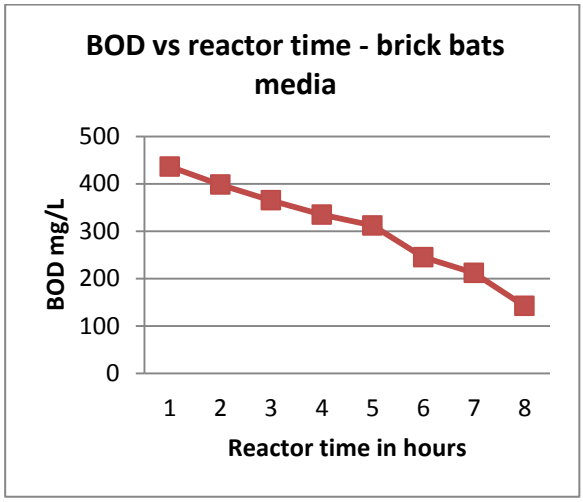

Fig. 9: *BOD vs. Reactor Time – Brickbats Medium.*

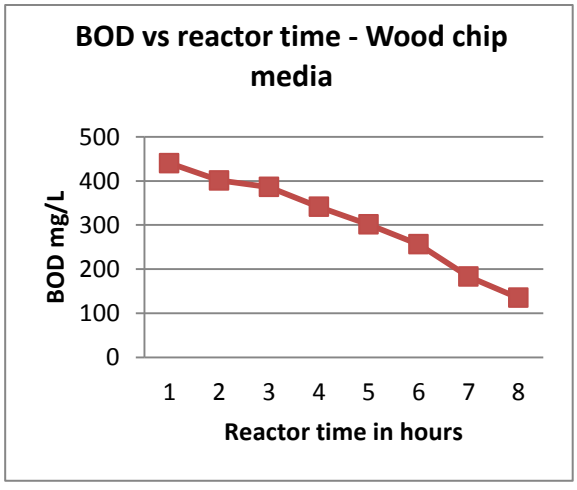

Fig. 10: *BOD vs. Reactor Time – Wood Chip Medium.*

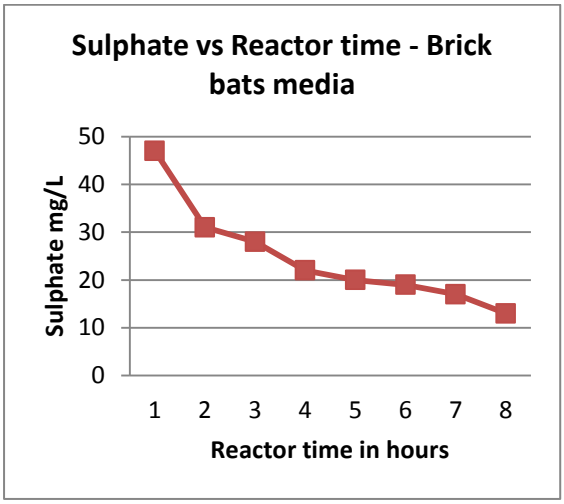

Fig. 11: *Sulfate vs. Reactor Time – Brick Bats Medium.*

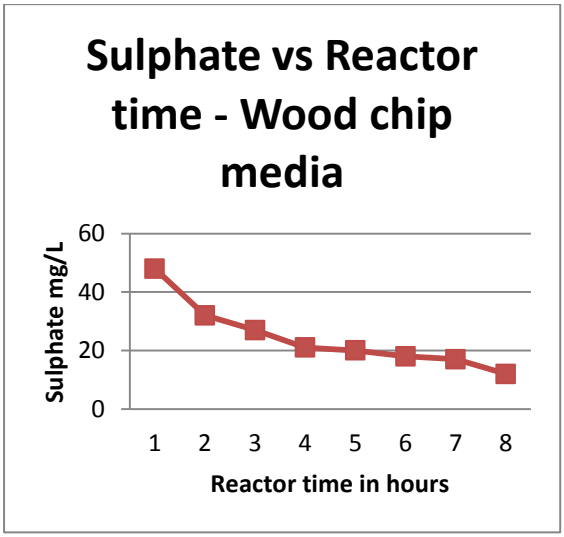

Fig. 12: *Sulfate vs. Reactor Time – Wood Chip Medium.*

CONCLUSIONS

In this study, it was found that the pollutant parameters of dairy cooling unit washing wastewater were significantly reduced using MSBR with the help of brickbats medium and woodchip medium. By analyzing the parameters at maximum HRT, it was found that pH was nearly brought to a neutral level (pH 6.79). Turbidity was reduced to 58 NTU (68% reduction). Absorbance was reduced to 0.09 and transmittance was increased up to 81%. BOD was reduced to 135 mg/L (73% reduction) and COD was reduced up to 215 mg/L (70% reduction). Thus, it was concluded that MSBR can be employed for the treatment of dairy cooling unit washing wastewater in a cost-effective and environmental protective manner.

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