Treatment of Dairy Effluent By Trickling Filter By Using Ash Clay Ball

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ABSTRACT

Dairy industries have shown tremendous growth in size and number in most countries of the world. As for many other food processing operations, the main environmental impacts associated with all dairy processing activities are the high consumption of water and energy, the discharge of effluent which is characterized by high chemical oxygen demand, biological oxygen demand, nutrients, and organic and inorganic contents much higher than BIS permissible limits. In addition cleaning of plant results in caustic wastewater. Such wastewaters, if discharged without proper treatment, severely pollute receiving water bodies. This article discusses the methods to minimise the amount of both the organic and inorganic material in the wastewater, and methods of reusing the treated effluent in a beneficial manner rather than its disposal. Biological treatment appears to be the most promising technique, since diary effluents have low COD: BOD ratio. This study focuses on the treatment of dairy effluent using trickling filter. The lab scale trickling filter is being designed using NRC equation. In this study, filter is to run under different trials and the various parameters is being optimised. The treatability efficiency in different media like stone and ash clay ball media is being compared. The results obtained were promising showing significant reductions in COD of 83% and 92% with stone media and ash clay balls respectively which required a steady state period of 2 days. The study shows that the trickling filter can be effectively used as a treatment option with positive attributes of conceptual simplicity and lesser energy consumption.

INTRODUCTION

The dairies collect the milk from the producers and then either simply bottles it for marketing or produces different milk foods according to their capacities. Large quantity of waste water originates due to their different operations. As such, the dairy wastes though biodegradable are very strong in nature. The extensive use of chemical fertilisers containing high levels of nitrogen has resulted in pollution of the groundwater and surface waters in many countries. Nitrite in drinking water is known to be carcinogenic, and nitrite levels in drinking water that exceed 25–50 mg/l have been linked to cyanosis in newborn infants ('blue babies'). Compounds containing nitrogen and phosphorus, if discharged to surface water, can lead to excessive algal growth (eutrophication). This results in depleted dissolved oxygen levels in the water, thereby causing the death of fish and other aquatic species. In sensitive areas, therefore, the rate and manner of application of chemical fertilisers are critical.

Pretreatment of effluents consists of screening flow equalization, neutralization and air floatation**.** It is normally followed by biological treatment. If space is available, land treatment or pond system are potential treatments. Other possible biological treatment systems include trickling filters, rotating Biological contactors, activated sludge treatment.. The trickling filter reactors are widely recognized as an appropriate option for the treatment of domestic wastewater in tropical developing countries. The main advantages include simplicity, no mechanization, low sludge production and less energy consumption. Odor can be controlled by ventilation and scrubbing may be required where cheese is stored or melted. Fabric filters should be used to control dust from milk powder production to below 50 mg/Nm^3.

MATERIALS AND METHODS

ASH-CLAY BALLS

Commercially available clay (70% by weight) was thoroughly mixed with the ash (30% by weight). The ash-clay mixture was rolled into round balls of approximate 15 mm diameter. The balls were then baked in an incineration oven for 1.5 h at 600$_o$C, cooled down completely and used in the experimental procedures.

EXPERIMENTAL DESIGN

The laboratory scale unit of single stage trickling filter was fabricated with a size of 0. 30 m in diameter and 0.15 m in height, and a working volume of 0.011 m^3 filled with the manufactured ash clay balls of size 20 mm and riverstone media of size ranging from 20 to 40mm. Fixed perforated distribution system was provided at the surface of the trickling filter to ensure even distribution. The distribution system consists of PVC pipes, with downside holes, at the top face of the unit, arranged symmetrically and proportionally to ensure even distribution of influent. The influent was fed to the pipe system above the unit. The wastewater from the dosing tank allows influent to trickle through the distribution pipes over the filter media. This filtered water was collected through the control valve fitted at the bottom of the tank. The effluent was collected from Madurai Aavin. The effluent was stored at 4°C for further studies.

PROCESS MONITORING

The wastewater samples collected were analyzed for the following parameters:5-day Biochemical Oxygen Demand (BOD5), Chemical Oxygen Demand(COD), total solids, nitrates and pH. All samples were analyzed as per the procedure outlined in Standard Methods (APHA, 2005).

REUSE OF THE TRICKLING FILTER EFFLUENT

The effluent is to be characterised to evaluate its feasibility for irrigation and aquaculture rather than its disposal. Bioassy test is to be performed to determine the toxicity and lethal dosage.

RESULTS AND DISCUSSION

Table 1 Raw wastewater characteristics

S.No	Parameters	Values(mg/L)
1	TS	3888
2	pH	7
3	DO	1.8
4	COD	1280

Experiments were carried out in the trickling filter and were operated for a period of 5days.. Table 1 to Table 10 presents the influent concentration to the trickling filter and effluent concentration COD through trickling filter. Based on influent/effluent concentrations to each unit, removal efficiencies of each unit operation and overall removal efficiencies have been calculated and are presented in respective tables. The excellent performance in terms of organic matter can be readily seen from the experimental results. It has been seen that steady state period has been achieved within 2 days and there had been no significant change in nitrates and total solids concentrations.

SAMPLE COLLECTION

The effluent was collected from Madurai Aavin.

INFLUENT CHARACTERISTICS

Influent characteristics of the raw wastewater had been determined and tabulated below

DESIGN

ASSUMPTIONS

- Flow = 40 l/hr.
- Efficiency = 83%
- Conversion factor (f) = 0.9
- Recirculation ratio (R) = 1.5

NRC EQUATION

$$E_1 = \frac{100}{1+0.44(F_{1.BOD}/V_1.Rf_1)^{1/2}}$$

DIMENSIONS

- Volume = 0.011 m3
- Diameter = 0.3 m
- Depth = 0.15 m

RECIRCULATION ARRANGEMENTS

It is often preferred to recirculate wastewater that has already passed through a clarifier.

- This reduces the chances of solids clogging the filter media.
- Most solids in the trickling filter effluent will have settled in the clarifier.
- A drawback, however, can be hydraulically overloading the clarifier.

Final clarifier effluent was re-circulated to the trickling filter influent.

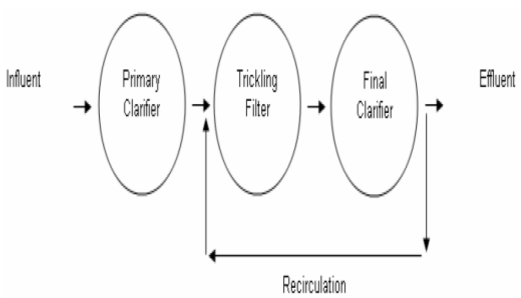

Figure 1 : Single Stage Trickling Filter with Final Clarifier Effluent Recirculation

Table 2 Effluent concentrations collected during first day with stone media

S.No	Time(hrs)	COD(mg/L)	Efficiency(%)
1	**1**	**2080**	**26.14**
2	**2**	**1472**	**47.73**
3	**3**	**1952**	**30.68**
4	**4**	**1632**	**42.05**
5	**5**	**1408**	**50**

Table 3 Effluent concentrations collected during second day with stone media

S.No	Time(hrs)	COD(mg/L)	Efficiency(%)
1	1	269	78.98
2	2	247	80.68
3	3	204	84.09
4	4	201	84.32
5	5	197	84.65
6	6	145	88.64

Table 4 Effluent concentrations collected during third day with stone media

S.No	Time(hrs)	COD(mg/L)	Efficiency(%)
1	1	182	85.79
2	2	160	87.5
3	3	138	89.2
4	4	124	90.3
5	5	109	91.47
6	6	73	94.32

Table 5 Effluent concentrations collected during fourth day with stone media

S.No	Time(hrs)	COD(mg/L)	Efficiency(%)
1	1	218	82.95

Table 6 Effluent concentrations collected during fifth day with stone media

S.No	Time(hrs)	COD(mg/L)	Efficiency(%)
1	1	218	82.95

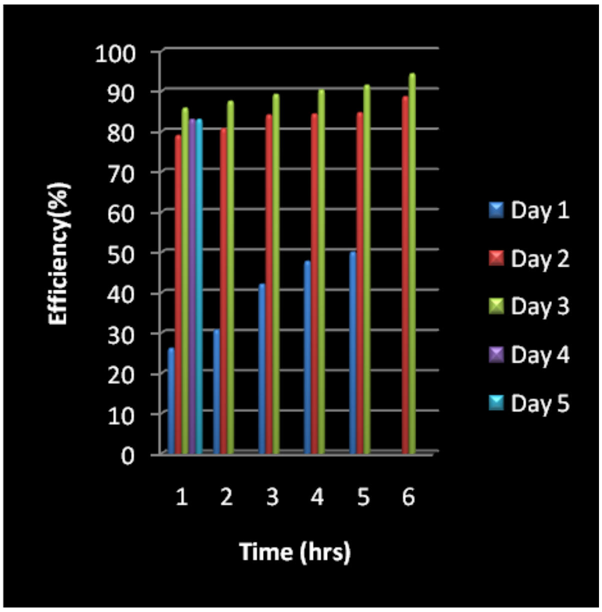

Fig 2: COD removal in the riverstone media filled trickling filter

Figure 2 illustrates the chemical oxygen demand (COD) reduction efficiency of the trickling filter. The trickling filter was fed at an organic load range of 1280 mg/ L COD concentration. A maximum COD removal of 83% was achieved in the trickling filter with riverstone as the packing medium in the first hour without recirculation. Typically the final concentration leaving the trickling filter was 218 mg/l.

Table 7 Effluent concentrations collected during first day with ash clay balls media

S.No	Time(hrs)	COD(mg/L)	Efficiency(%)
1	1	845	34
2	2	743	42
3	3	474	63

Table 8 Effluent concentrations collected during second day with ash clay balls media

S.No	Time(hrs)	COD(mg/L)	Efficiency(%)
1	1	256	80
2	2	230	82
3	3	180	86
4	4	128	90
5	5	102	92

Table 9 Effluent concentrations collected during fifth day with ash clay balls media

S.No	Time(hrs)	COD(mg/L)	Efficiency(%)
1	1	102	92
2	2	77	94
3	3	77	94
4	4	77	94
5	5	77	94

Table 10 Effluent concentrations collected during fifth day with ash clay balls media

S.No	Time(hrs)	COD(mg/L)	Efficiency(%)
1	1	102	92

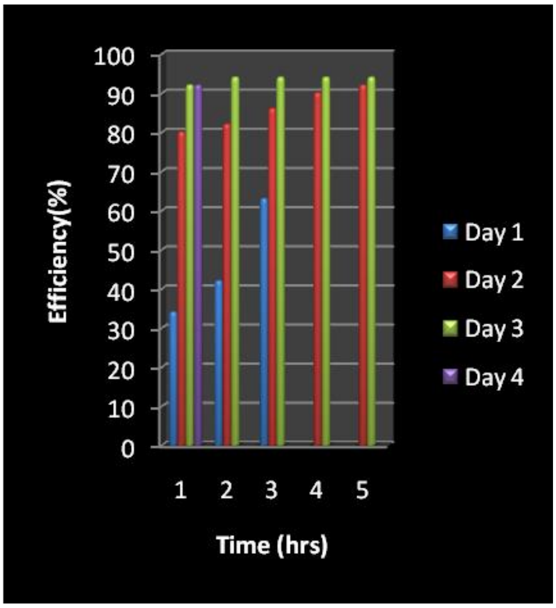

Fig 3: COD removal in the riverstone media filled trickling filter

Figure 3 illustrates the chemical oxygen demand (COD) reduction efficiency of the trickling filter. The trickling filter was fed at an organic load range of 1280 mg/ L COD concentration. A maximum COD removal of 92% was achieved in the trickling filter with ash clay balls as the packing medium in the first hour without any recirculation. Typically the final concentration leaving the trickling filter was 102 mg/l.

CONCLUSION

In conclusion it may be stated that effluent treatment need to be done chiefly due to this reason

1. To avoid the ill effect of discharged untreated effluent into the environment.
2. To satisfy the statutory requirements of the state pollution control board and central pollution control board.
3. In realization of our commitment to the future generations to provide clean pollution free environment.

A mixture of ash and clay were used to produce a light weight ball with a large surface area for microbial attachment. These ash-clay balls were used as a package medium in a laboratory-scale trickling filter. The trickling filter was operated and monitored over an experimental period of 5 days. The results obtained were promising showing significant reductions in COD of 92%. More research is however needed to optimize this innovative idea, which could result in a novel method of ash re-use and an alternative and cheap medium for trickling filters. Due to its simple design, in actual operation the trickling filter is one of the most trouble-free types of secondary treatment processes. It requires much less operating attention and process control than the activated sludge system, but some problems do exist. Additional treatment may be needed for the effluent to meet strict discharge standards. Therefore the effluent is to be characterised to evaluate its feasibility for irrigation and aquaculture rather than its disposal.

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