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Performance of an Up-Flow Anaerobic Sludge Blanket Reactor in the Treatment of Slaughter Wastewater

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Abstract: ***The wastewater discharged by the slaughterhouse was characterized mainly by the high biochemical oxygen demand, high suspended solids, and complex mixture of fats, proteins are requiring systematic treatment before disposal. This study was carried out to examine a lab-scale up-flow anaerobic sludge blanket reactor performance to treat slaughter wastewater under varying operating conditions. (pH) 7.1-7.8, total suspended solids (TSS) 900-1500 mg/l, total dissolved solids (TDS) 1600-3000 mg/l, chemical oxygen demand (COD) 3000-5000 mg/l). The reactor was running at varying OLR (0.025) and HRT (7.00, 11.00, 15.00, 19.00, 23.00 hrs.) at a temperature of (29-35°C). The maximum total demand for the chemical oxygen removal efficiency of 82.83% was achieved at an organic loading rate of 0.015 kg/COD/m^2/day and at the hydraulic retention time of 23hours.***

Keywords: Slaughter wastewater, UASB Reactor, COD, OLR, and HRT

1. Introduction

Slaughterhouse wastewaters were considered by different European legislation as 'very contaminating' (Tritt & Schuchardt, 1992) due to their composition, characterized mainly by the complex mixture of fats, proteins. Processing a chicken for human consumption requires 10 – 12 l of water, so overall water consumption for the poultry processing plant is considerable. Sixty percent of the water is converted into wastewater with a value of pH between 6.1 and 7.1, a biological oxygen demand (BOD) between 4500 and 12,000mg/l, and a large percentage of solids, mostly clotted of blood (more than 40% in volume), with the high-fat content (Mercado, 1995). The rest of the wastewater is lost in the process throughrun-off.
In most slaughterhouses in Tamil Nadu, useful blood collection, separation of manure, or effluent treatment methods were not practiced, and incredibly complex effluents are discharged Into land or water. Surface and groundwater pollution, in addition to odor, fly, and mosquito nuisances, are posed by these practices. Most of this wastewater is treated physicochemical, requiring large quantities of chemicals and energy to dry the affluent and generating 20g of sludge per liter of water. The deposition of the sludge is difficult, thus limiting the use of this technique. A better option to reduce the generated bio solids might be anaerobic digestion using up-flow anaerobic sludge blanket reactors (UASB) (Speece, 1983; Young and Dahab, 1983; Young, 1991).

In the USAB process, the anaerobic bacteria convert organic material into methane, carbon dioxide, and biomass while purifying the wastewater (Del Nery et al., 2001). USAB systems were known for their high volumetric treatment rates, good CH4 productivity, and low sludge production, making their process economically and technologically attractive. (Del Pozo et al., 2000).

As mentioned before, this study's objective was to evaluate the performance of the up-flow of anaerobic sludge blanket reactor in the treatment of slaughterhouse wastewater. The experiments were carried out in a UASB reactor were processed to study their influence on the organic loading rate (OLR) and hydraulic retention time (HRT) in slaughterhouse treatment of wastewater.

2. Related Work

A wide range of the organic loading rates and Hydraulic retention times have been reported in the literature for UASB reactors, depending on their substrate used and the microbial community's quality. In this study, the removal efficiency of COD for varying OLR (0.013, 0.023, 0.037 kg/COD/m^2/day) was studied. Initial reduction with the increased OLR was moderate, and it tends to increase with the decrease in OLR.

The effect of varying H.R.Twas investigated; removal efficiency was optimum at the high retention time. The decrease in the efficiency of reducing the H.R.T., despite increasing the turbulence of reactor, is that contact time of the wastewater with the sludge granules will be decreased, so less organic matters was utilized.

3. Experimental Set-Up

A bench-scale continuous of up-flow in Anaerobic Sludge Blanket (UASB) reactor made of fiber glass was used in this study. The reactor had an internal diameter of 11.5cm and a total height of the 98 cm resulting in a total volume of 10 l and a working of 5.4 l with a gas headspace of 1 l. The reactors were fed with the substrate using the peristaltic pump (Model: PP- 30, Miclins). A peristaltic pump can maintain the straight flow of rate in a range of 2 ml/h to 10 l/h, present with the timer and L.E.D. Display for the flow rate of the function and time. Five sampling ports were installed along with the length of the reactor. Biogas produced from the reactor was collected by the water displacement method using a Mariotte bottle. The operating temperature of reactors was in the mesophilic range of (29-

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35°C). The experimental setup of the UASB reactor was shown below.

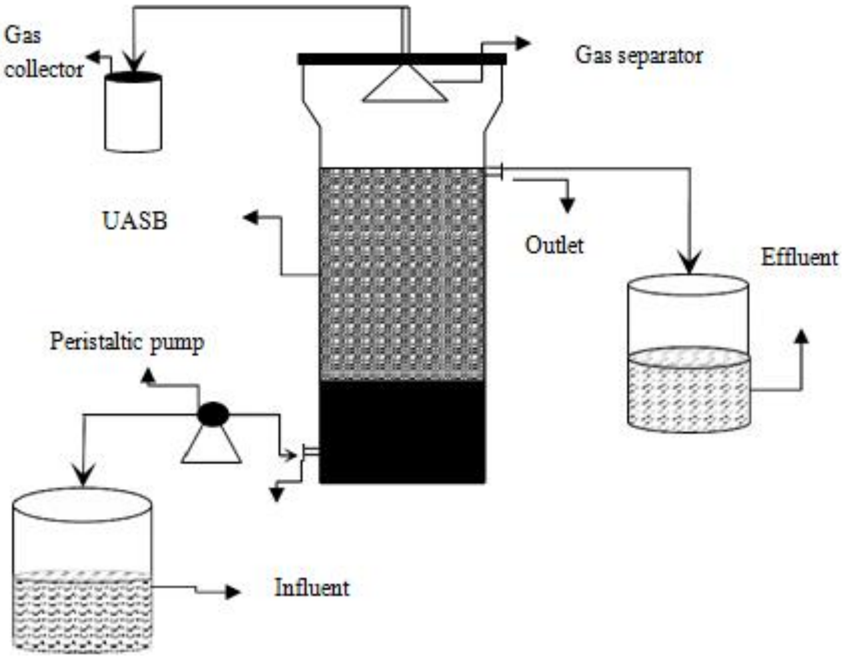

Figure 1: Experimental Setup of UASB System

Influent Wastewater

For this study, the primary source of the wastewater was collected from the local slaughterhouse in the market in two different locations, Chidambaram, Cuddalore, and Tamilnadu. Wastewater was consisted of effluent from the combination of several stages. It included blood from the killing operations, wash waters from the stomach and the intestines. The addition of nutrients were not deemed necessary since the wastewater characteristics indicatedan adequate concentration of the essential proteins and trace elements. No dilution or recycling feed was made in the beginning or at any of the study phases.

Chemical analyses such as pH, BOD, TSS, VSS, TDS, and COD to determine the wastewater quality parameters, were conducted according to Standard Methods (APHA, 2005).

4. Experimental Methodology

For the start-up, the bottom of the reactor was filled with the anaerobic sludge taken from the wastewater treatment facilities of Annamalai University and then fed continuously with the screened domestic wastewater and are allowed to stand for 15 days. Throughout the study, the reactor was operated at a room temperature of 30±2°C.

After stabilization, synthetic wastewater was used for a experimental study to standardize the experiment. The synthetic wastewater was prepared by using the **Dry FishPowder.**

The synthetic wastewater were fed into the reactor, and it was studied for COD removal, as % of COD removal efficiency under varied organic loading rates (OLR) and hydraulic retention time (HRT).The averaged influent of COD applied over system was 5741.6, 6354, and 6818 mg/lforthevariedHRT(7.00,11.00,15.00,19.00,23.00hrs)and OLR(0.013,0.023,0.037 Kg/COD/m2/day). Under each operating condition, influent and effluent of COD and amount of gas were observed using the Standard Method of Analysis.

The average values of biochemical characteristics of slaughter wastewater effluent are listed in

Table 1: Typical characteristic of slaughter wastewater

S. No	Parameters	Concentration (mg/l)
1	pH	7.4
2	COD	3850
3	Total Solids	3072
4	Total Suspended Solids	979
5	Total Dissolved Solids	2093
6	Total Nitrogen	127
7	Sulfate Concentration	110

5. Results and Discussion

After the UASB reactor was stabilized, synthetic wastewater was prepared and the used for the experimental study. The experiment was conducted to evaluate the UASB system in the terms of COD removal. The reactor ran continuously for 45days.

The average influent of COD was prepared 5741.6, 6354, and 6818 mg/l. Initially, COD removal efficiency were poor, after some period of the reactor reached the steady-state condition and removal condition efficiency was improved 82.68%. The graphical representations to the assess reactor performance for different operating conditions was drawn, using the observed values. COD removal of efficiency for varying OLR (**0.013, 0.023, 0.037 kg/COD/m^2/day**) was shown in **Fig 2**. And COD removal of efficiency for varying HRT (7.00, 11.00, 15.00, 19.00, 23.00 hrs) was shown in **Fig 3.**

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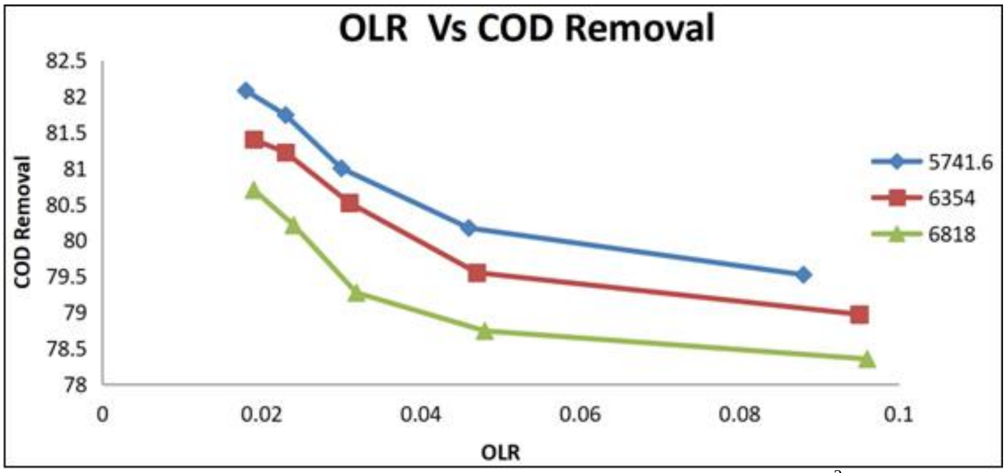

Figure 2: Average Influent COD mg/l Vs varying OLR kg/COD/m^2 day

It shows the treatment of performance of reactor as % removal under the varying OLR, kg/COD/m^2/day. And it depicted the understanding of the all different influent COD concentration.

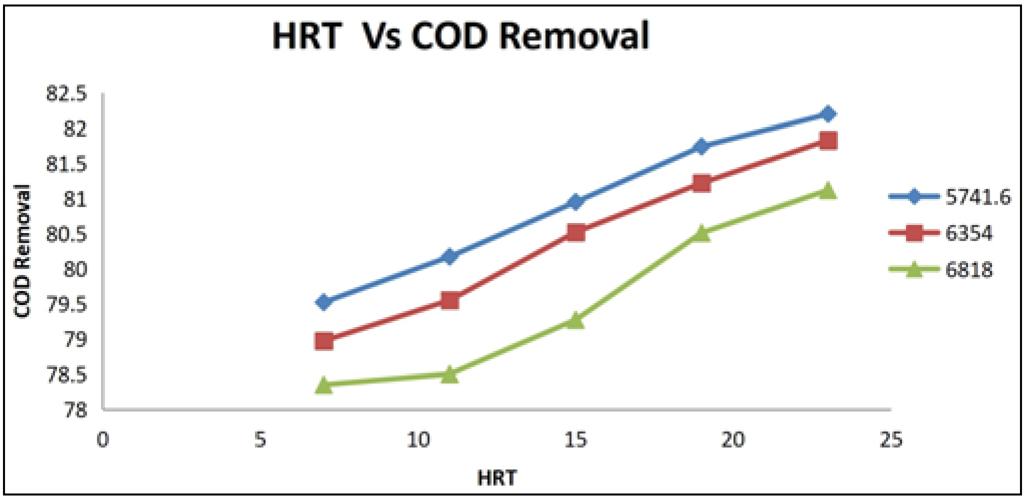

Figure 3: Average Influent COD mg/l Vs. varying HRT hrs

It was drawn on reactor's performance in the terms of % COD removal under varying Hydraulic Loading Rates, hrs.

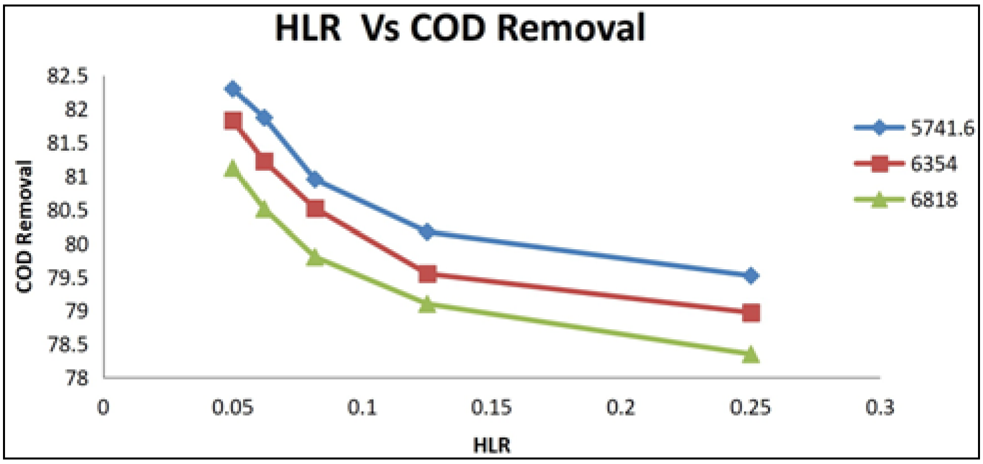

Figure 4: Average Influent COD mg/l Vs. varying HLR hrs

The COD removal of efficiency for varying HLR (0.25, 0.125, 0.082, 0.062, 0.05 m3 /m2 /day) was shown in above **fig.4.**

6. Conclusion

The UASBR is the experimentally concluded to offer the maximum demand of chemical oxygen removal for

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efficiency of 82.83% was achieved at the organic loading rate (OLR) of 0.015 kg/COD/m^2/day and at the hydraulic retention time (HRT) of 23h. Hence, it can be studied that UASBR is the credible alternative to reach the reusable standards for treating the slaughter wastewater effluent streams.

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