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Experimental Study of an Up-Flow In Anaerobic Sludge Blanket Reactor In The Treatment Of Slaughter Wastewater

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ABSTRACT
The wastewater discharged by slaughterhouse was characterized mainly by the high BOD, high suspended solids and complex mixture of fats proteins are requiring systematic treatment before the disposal. This study was carried out to examine lab-scale of up-flow in anaerobic sludge blanket reactor performance to treat slaughter wastewater under the 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 a varying OLR (0.025) and HRT (7.00, 11.00, 15.00, 19.00, 23.00 hrs) at the temperature of (29-35°C). The maximum total demand for the COD removal efficiency is 82.83% was achieved at an OLR of 0.015 kg/COD/m^2/day and at the HRT of 23 hours.
KEYWORDS*: Slaughterhouse wastewater, UASB Reactor, COD, OLR, and HRT,*

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I. INTRODUCTION

Slaughterhouse wastewater was considered by the different European legislation as 'very contaminating' (Tritt & Schuchardt, 1992) due to their composition , characterized mainly by complex mixture of fats and proteins. Processing of a chicken for human consumption requires 10 – 12 l of water, so overall the water consumption for a 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, BOD between 4500 and 12,000mg/l, and the 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 process through run-off.

In most slaughterhouses in the Tamil Nadu, useful blood collection, separation of the manure, or effluent treatment methods was not practiced, and incredibly complex effluents are been discharged into land or to water. Surface and groundwater pollution, in addition to odor, fly, and mosquito nuisances, are posed by these practices. Most of this wastewater is treated by physicochemical, this requires large quantities of the chemicals and the energy to dry the affluent and generating 20g of the 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 biosolids might be the anaerobic digestion using of up-flow anaerobic sludge blanket reactors (UASB) (Speece, 1983; Young and Dahab, 1983; Young, 1991).

In USAB process, the anaerobic bacteria convert the organic material into methane, carbon dioxide, and biomass while purifying in the wastewater (Del Nery et al., 2001). USAB systems were known for their high volumetric treatment rates, good CH_4 productivity, and low sludge production, making their process economically and technologically attractive.(Del Pozo et al., 2000).

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

RELATED WORK

A wide range of the organic loading rates and the HRT have been reported in literature for UASB reactors, depending on their substance used and their 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 HRT was investigated; removal efficiency was optimum at the high retention time. The decrease in the efficiency of reducing the HRT, 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 been utilized.

EXPERIMENTAL SET-UP

A bench-scale continuous of up-flow in the Anaerobic Sludge Blanket (UASB) reactor made of fiberglass was used in this study. The reactor had an internal diameter of 11.5 cm and a total height of 98 cm resulting in total volume of 10lit and a the working of 5.4lit with a gas headspace of 1lit. The reactors was 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. The experimental setup of the UASB reactor was shown below.

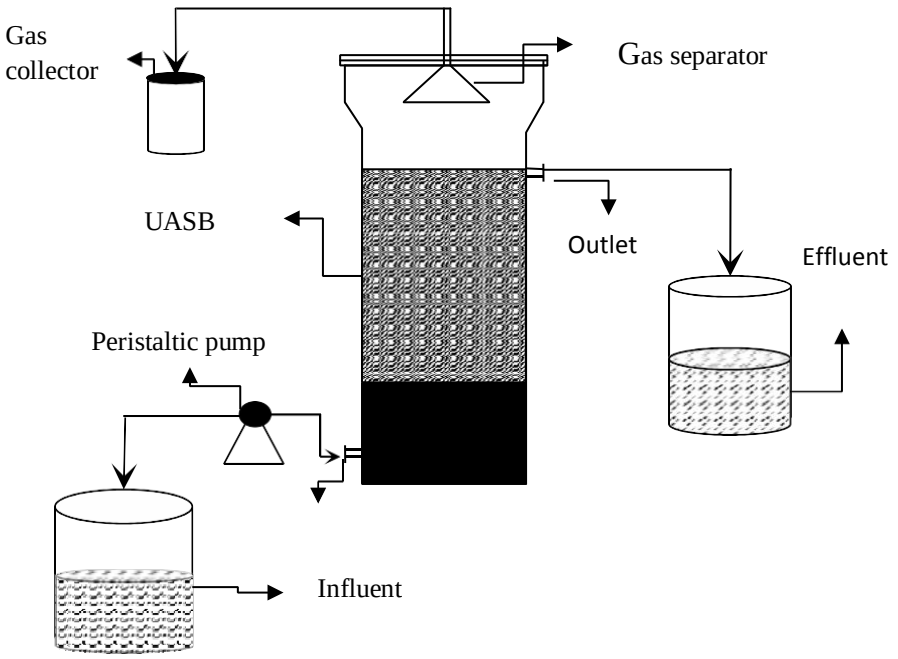

Fig.1 Experimental Setup of UASB System

INFLUENT WASTEWATER

For this study, the primary source of wastewater were collected from the local slaughterhouse in the market of two different locations, Chidambaram and Cuddalore, in Tamilnadu. Wastewater was consisted of the effluent from the combination of several stages. It included blood from the killing operations, wash waters from stomach and the intestines. The addition of nutrients were not deemed necessary since the wastewater characteristics indicated 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 ,was conducted according to the Standard Methods (APHA, 2005).

EXPERIMENTAL METHODOLOGY

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

After stabilization, synthetic wastewater was used for a experimental study to standardize the experiment. The synthetic wastewater were fed into reactor, and it was studied for the C.O.D. 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 2789.4 , 3770 and 4738.8 mg/l for varied HRT (7.00, 11.00, 15.00, 19.00, 23.00 hrs) and OLR (0.013, 0.023, 0.037 kg/COD/m^2/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.

Sl.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

Table.1 Typical characteristic of slaughter wastewater RESULTS AND DISCUSSION

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

The average influent of COD was prepared 2789.4, 3770, and 4738.8 mg/l. Initially, COD removal efficiency was poor, after some period of 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.**

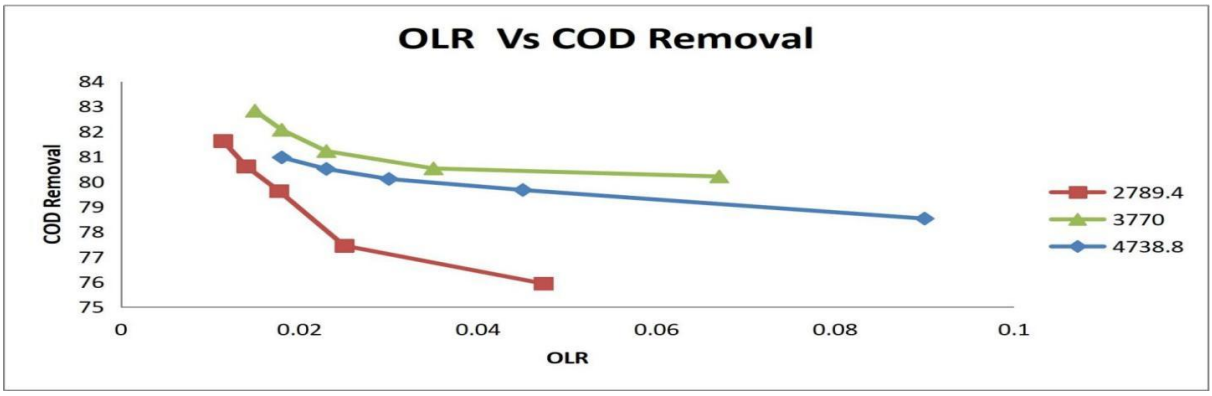

Fig.2 Average Influent COD mg/l Vs varying OLR kg/COD/m^2 day

It shows the treatment of the 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.

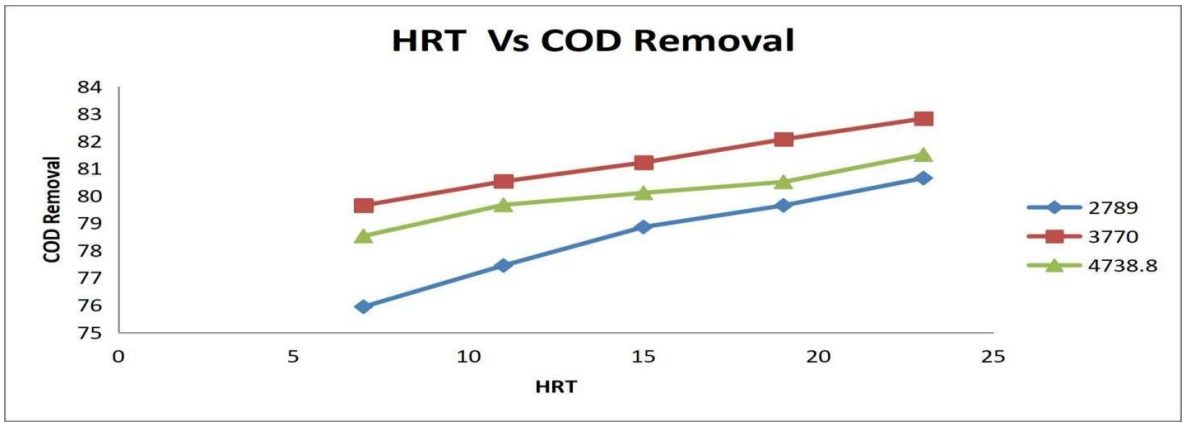

Fig.3 Average Influent COD mg/l Vs. varying HRT hrs

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

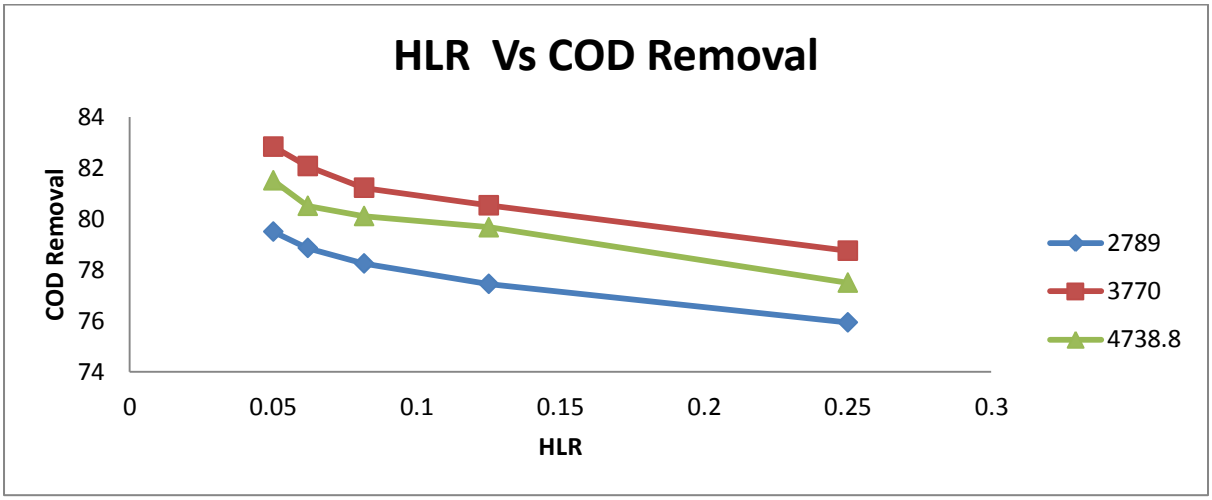

Fig.4 Average Influent COD mg/l Vs. varying HLR hrs

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.**

II. CONCLUSION

The UASBR is the experimentally concluded to the offer the maximum demand of the COD for 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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