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Treatment Efficiency of Uasbr in Slaughter Wastewater

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ABSTRACT:
The wastewater discharged by slaughterhouse is characterized mainly by high biochemical oxygen demand, high suspended solids and complex mixture of fats, proteins and fibers requiring systematic treatment prior to disposal. This study was carried out to examine a lab-scale up flow anaerobic sludge blanket reactor performance for treatment of 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 run at varying OLR (0.025) and HRT (7.00, 11.00, 15.00, 19.00, 23.00 hrs) at temperature of (29-35°C). The maximum total chemical oxygen demand removal efficiency of 82.68% was achieved at an organic loading rate of 0.013 kg/COD/m^2/day and at a hydraulic retention time of 23 hrs. A post treatment of the effluent was however found necessary to achieve land or inland water discharge standard.

KEYWORDS: Slaughter wastewater, UASB Reactor, COD, OLR, HRT

I. INTRODUCTION

Slaughterhouse wastewaters are considered by the different European legislations as 'very contaminating' (Tritt & Schuchardt, 1992) due to their composition, characterized mainly by a complex mixture of fats, proteins and fibers. Processing a chicken for human consumption requires 10–12 l of water so the overall water consumption in a poultry processing plant is considerable. Sixty percent of the water is converted into wastewater with 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 blood (more than 40% in volume), with a high fat content (Mercado, 1995). The rest of the wastewater is lost in the process through run-off.

Most of the slaughterhouses in Tamil Nadu effective collection of blood, separation of manure or effluent treatment methods are not practiced and extremely complex effluents are discharged into land or water. Surface and ground water pollution in addition to the odour, 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 effluent and generating 20g of sludge per liter of water. Deposition of the sludge is difficult, thus limiting the use of this technique. A better option to reduce the generated biosolids might be an anaerobic digestion using up-flow anaerobic sludge blanket reactors (UASB) (Speece, 1983; Young and Dahab, 1983; Young, 1991).

In the USAB process, anaerobic bacteria convert organic material into methane, carbon dioxide, and biomass while purifying the wastewater (Del Nery et al., 2001). USAB systems are known for their high

volumetric treatment rates, good CH_4 productivity, and low sludge production, which makes the process economically and technologically attractive (Del Pozo et al., 2000).

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

II. RELATED WORK

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

The effect of varying HRT was investigated; removal efficiency was optimum at high retention time. The reason for decrease in efficiency while reducing the HRT, in spite of increasing the turbulence in the reactor, is that the contact time of wastewater with sludge granules will be decreased, so less organic matters are utilized.

III. EXPERIMENTAL SET-UP

Bench scale continuous up flow Anaerobic Sludge Blanket (UASB) reactor made of fibre glass was used in this study. The reactor had an internal diameter of 11.5 cm and total height of 98 cm resulting in total volume of 10 l and working volume of 5.4 l with a gas head space of 1l. The reactors were fed with substrate using peristaltic pump (Model: PP-30, Miclins). The peristaltic pump can maintain constant flow rate in the range of 2 ml/h to 10 l/h, available with timer and LED display for flow rate of function and time. Five sampling ports were installed along the length of the reactor. Biogas produced from the reactor was collected by water displacement method using Mariotte bottle. The operating temperature of the reactors was in the mesophilic range (29-35°C). The experimental setup of an UASB reactor was shown below.

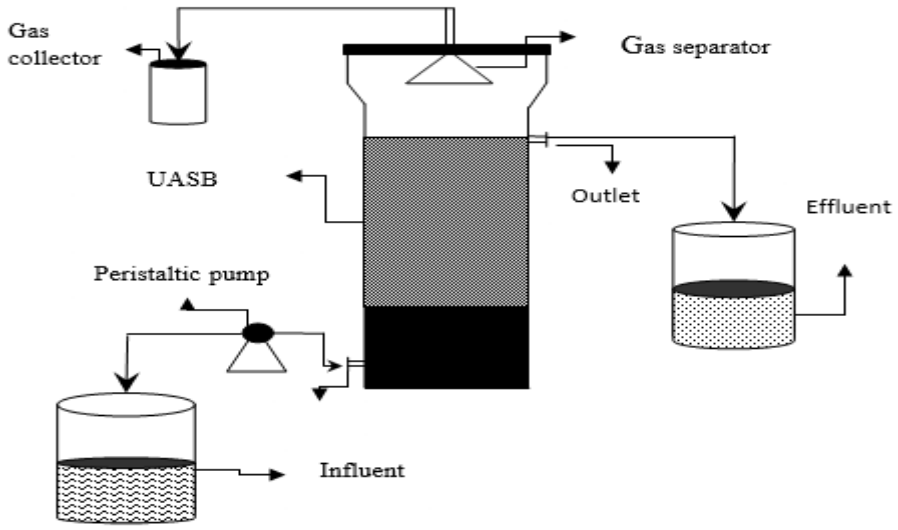

Fig.1 Experimental Setup of UASB System

INFLUENT WASTEWATER

For this study, the main source of wastewater was collected from local slaughterhouse in market on two different locations, in Trichy. Wastewater consisted of effluent from a combination of several stages. It included blood from killing operations, wash waters from stomach and intestines. Addition of nutrients was not deemed necessary since wastewater characteristics indicated an adequate concentration of essential proteins and trace elements. No dilution or recycling of feed was made in the beginning or at any of the phases of the study.

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

IV. EXPERIMENTAL METHODOLOGY

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

After stabilization, synthetic wastewater was used for experimental study in order to standardize the experiment. The synthetic wastewater was prepared by using **Dry Fish Powder.**

The synthetic wastewater was fed into the reactor and it was studied for COD removal, as % COD removal efficiency under varied organic loading rates (OLR) and hydraulic retention time (HRT). The varied influent COD applied over system were 2121, 2789 and 3363 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 conditions, influent and effluent COD and amount of gas were observed using Standard Method of Analysis.

The average values of the biochemical characteristics of the 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	Sulphate Concentration	110

Table.1 Typical characteristics of slaughter wastewater

V. RESULTS AND DISCUSSION

After UASB reactor was stabilized, synthetic wastewater was prepared and used for experimental study. Experiment was conducted for evaluating UASB system in terms of COD removal. Reactor ran on continuous basis of 45 days.

Average influent COD prepared were 2121, 2789 and 3363 mg/l. Initially, COD removal efficiency was poor, after some period of reactor reached to steady state condition and removal efficiency was

improved to 82.68%. The graphical representations to assess the reactor performance for different operating conditions were drawn, using observed values. The COD removal efficiency for varying OLR (0.013, 0.023, 0.037 kg/COD/m^2/day) was shown in **Fig 2**. And COD removal efficiency for varying HRT (7.00, 11.00, 15.00, 19.00, 23.00 hrs) was shown in **Fig 3.**

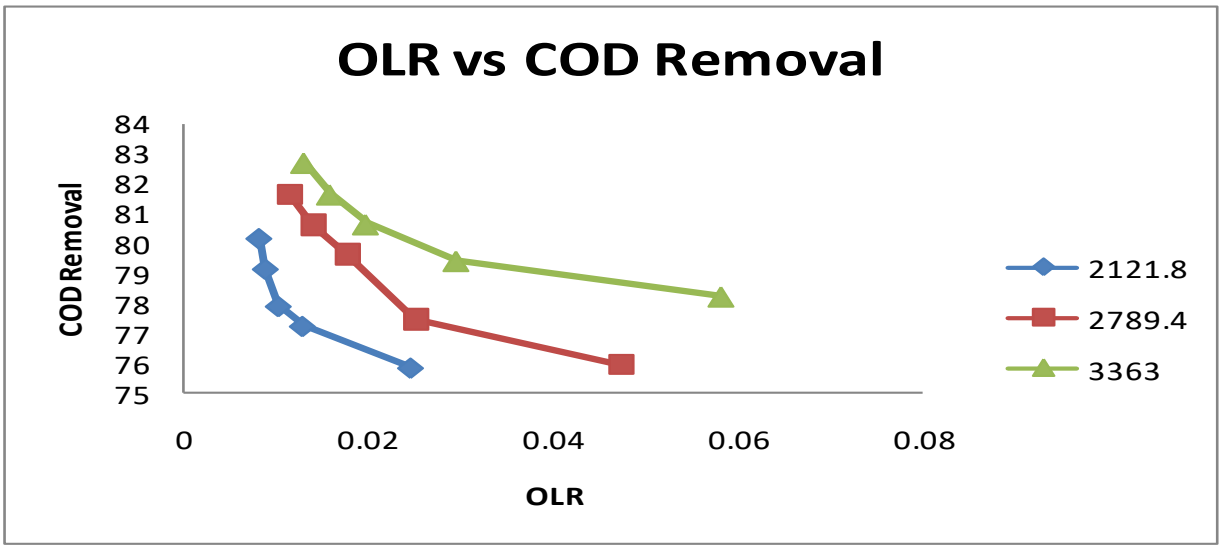

Fig.2 Average Influent COD mg/l Vs varying OLR kg/COD/m^2 day

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

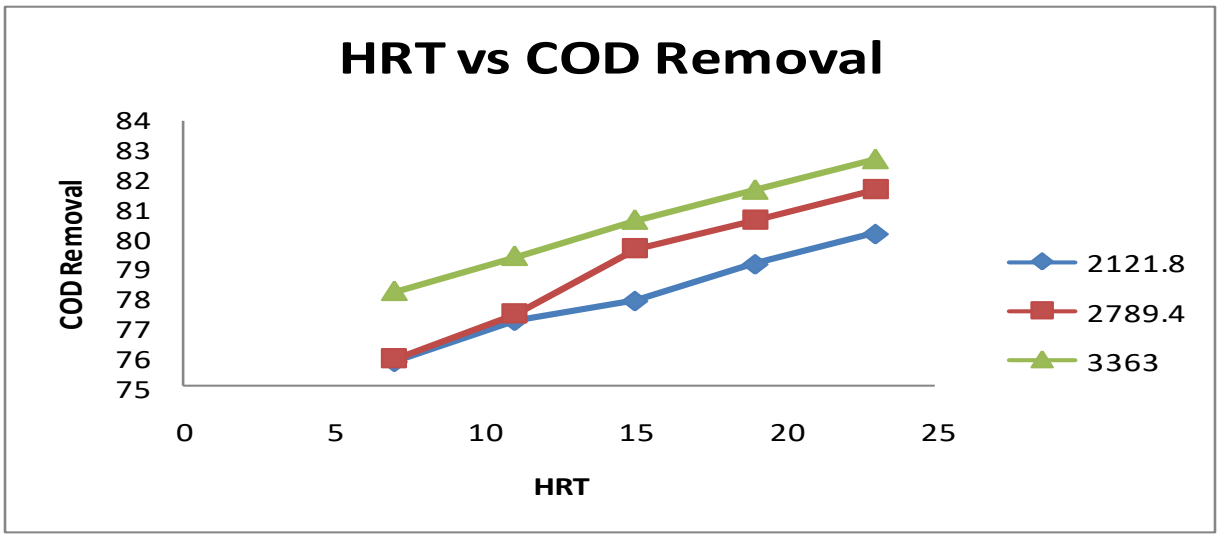

Fig.3 Average Influent COD mg/l Vs varying HRT hrs

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

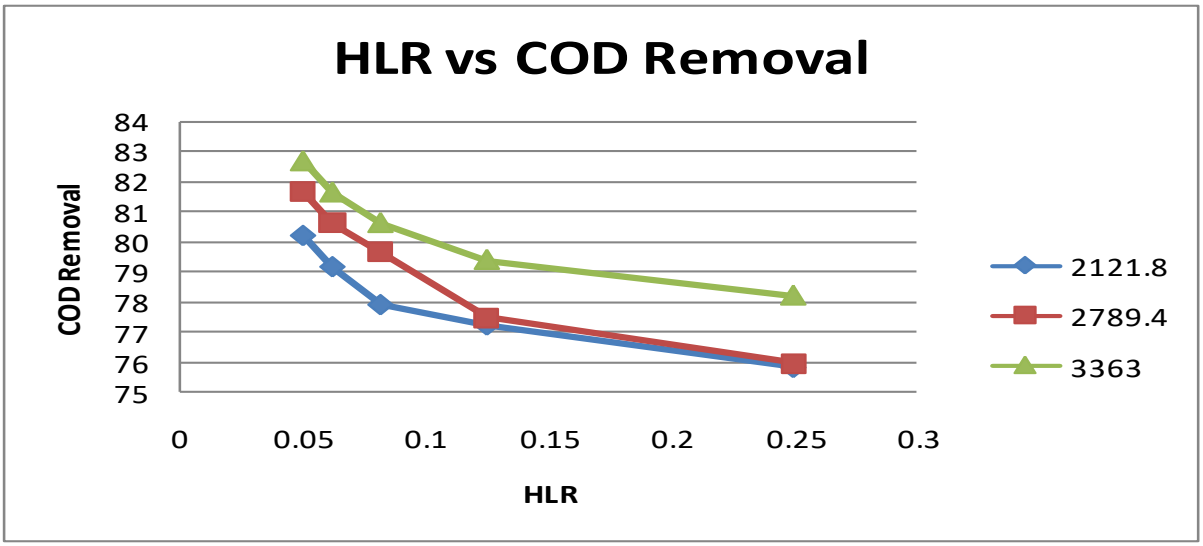

Fig.4 Average Influent COD mg/l Vs varying HLR $m^3/m^2/day$

The COD removal efficiency for varying HLR (0.25, 0.125, 0.082, 0.062, 0.05 $m^3/m^2/day$) was shown in above fig.

VI. CONCLUSION

The UASBR is experimentally found to offer a maximum chemical oxygen demand removal efficiency of 82.68% was achieved at an organic loading rate (OLR) of 0.013 kg/COD/m^2/day and at a hydraulic retention time (HRT) of 23h. Hence, it can be concluded that UASBR is a credible alternative to reach the reusable standards for treating slaughter wastewater effluent streams.

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