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EFFECT OF HYDRAULIC RETENTION TIME FOR TREATING DISTILLERY EFFLUENT IN DIPHASIC ANAEROBIC DIGESTER

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ABSTRACT

Diphasic anaerobic digesters have inherent advantages of exclusive process controls on the growth of microorganisms independently in acidogenic and methonogenic phases. A laboratory model of 15.0L effective volume with 2.5L of acidogenic reactor and 13.5L of methonogenic reactor was used to evaluate the treatability of distillery wastewater stream. The model was run for varying concentrations of COD and influent rates to study the effect of hydraulic retention time in reducing the COD into unharmful end products. The COD removal efficiency is found to vary from 17.67 to 26.19 % for the acidogenic reactor under the varying HRT of 0.96 to 2.89 days and 59.51 to 77.42% with varying HRT conditions from5.21 to 15.63 days for the methanogenic reactor. The overall COD removal of the system is observed at an efficiency of 82.30% for the system HRT of 18.52 days.

INTRODUCTION

The diphasic anaerobic processes are the most appropriate for high - strength distillery wastewater because of its widely reported advantages such as the possibility of maintaining optimal environmental conditions for the acid and methane forming organisms, alternation of imbalances between organic acid production and consumption, stable performance, and high biogas yield (Cohen *et al*. 1980). Pohland and Ghosh (1971) proposed the separation of the two main groups of microorganisms physically into serial reactors to make use of the differences in their growth kinetics. An advantage of diphasic digester is that their operating conditions may be selectively determined in order to maximize not only acid but also methane forming bacterial growth.

The introduction of an acidogenic phase should enable optimization of the conditions required for many of complex organic compounds present in the wastewater to be converted in to short - chain Volatile Fatty Acids (VFA) and other simple compounds. This, in turn, buffers the slow-growing methanogens, predominantly present in methanogenic reactor, from possible toxins or inhibitors and ensures a uniform feed stock for the methanogens. Massey and Pohland (1978) suggested that the process could be applied to complicated as well as simple substrates, and equation were derived describing the growth of bacteria during substrate utilization in the dual - phased treatment system. Ince (1998) achieved good separation of acid and methane phases with low and high methane yields in the first and second phases. Solera et.al.,(2002) observed the variations in auto fluorescent methanogens and non-methanogenic bacteria at differing rates of HRT and OLR.

The phased anaerobic treatment process is gaining momentum in industrial wastewater treatment plants. The wastewater-specific design of diphasic process is invariably important for desired performance of the treatment plant. A laboratory model of diphasic digester was evaluated to characterize its performance for treating distillery wastewater.

EXPERIMENTAL SETUP

A diphasic, two-reactor configuration has been used to investigate treatability in terms of COD reduction in acidogenesis and methanogenesis independently and collectively under different streams of distillery spent wash. The phased digesters are defined in the recommended ratio of volume of 1:5 Viz., Acidogenic reactor (AR) verses Methanogenic reactor (MR). Both experimental reactors were made up of Plexiglass and had working volumes of 2.5 and 13.5 liters. The two reactors were hermetically sealed to avoid any air entrapment. The acidogenic reactor is fed with diluted distillery spent wash from the influent tank by means of a Peristaltic pump. The methanogenic reactor is respectively and continuously fed with the acidogenic effluent. The % COD reduction and gas production are continuously measured for both the reactors. The schematics of the experimental setup on diphasic digester is shown in Fig. 1

EXPERIMENTAL METHODOLOGY

Wastewater source and its characteristics

The distillery spent wash used in this study was collected from the molasses based distillery industry M/s EID parry India Ltd, Nellikuppam, Cuddalore District, Tamil Nadu. The important characteristics of the distillery-spent wash samples are analyzed and the average value is presented in Table 1. All analysis was carried out in accordance with Standard methods (1992).

Acclimation and processes stability

Table 1. Characteristics of distillery- spent wash

Parameters	Concentration
Colour	Dark brown
pH	4.5
BOD_5, mg/L	54000
COD, mg/L	92000
Total solids, mg/L	72000
Volatile solids, mg/L	54000
Suspended solids, mg/L	3800
Total Nitrogen, mg/L	1600
Total phosphate, mg/L	800
Sodium as Na, mg/L	2200
Potassium, mg/L	8000
Calcium, mg/L	2200
Sulphate, mg/L	2400

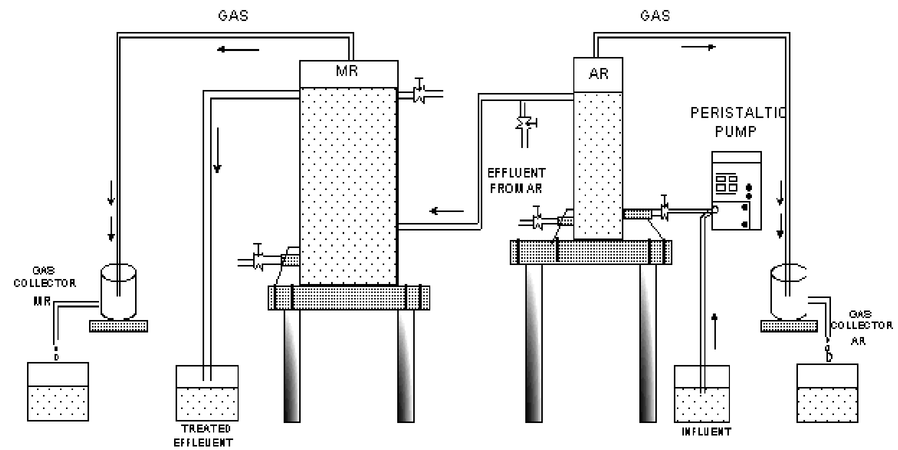

Fig. 1 Experimental setup of diphasic digester

The digesters were seeded with anaerobic digesting distillery sludge, which was collected from a return sludge line of wastewater treatment plant of M/s EID Parry India Ltd. In continuous- flow systems, acclimation is a time - dependent process and it can be influenced by the type of seed used, the characteristics of feed, and the chosen plant operational and environmental conditions (Ghosh *et al*. 1971).

The process stability of the model was assessed with uniform COD reduction at 21 to 22% in acidogenic reactor and 62 to 65 % in methanogenic reactor after 27 days from the date of experimental start up. Five different COD concentrations (8360, 10000, 14240, 20280 and 40040mg/L) of spent wash treated for five different HRT (18.52, 12.35,9.26,7.41 and 6.17 days) conditions were investigated which allowed the maximum COD removal efficiency and significant biogas yield. The HRT was varied from 0.96 to 2.89 days in acidogenic reactor and correspondingly methanogenic reactor was operated

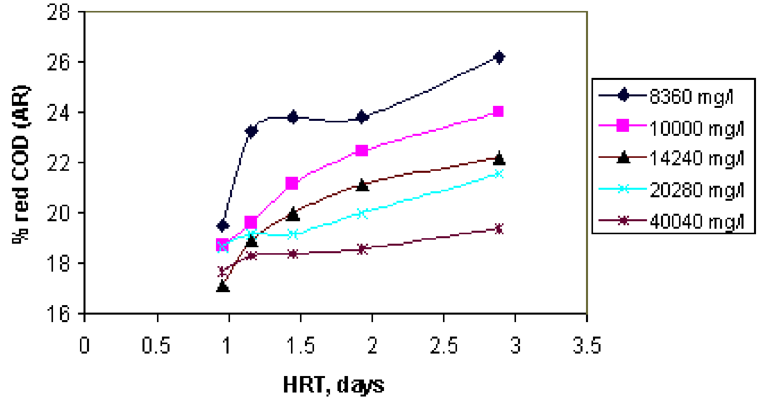

Fig. 2 HRT Vs % red COD (AR)

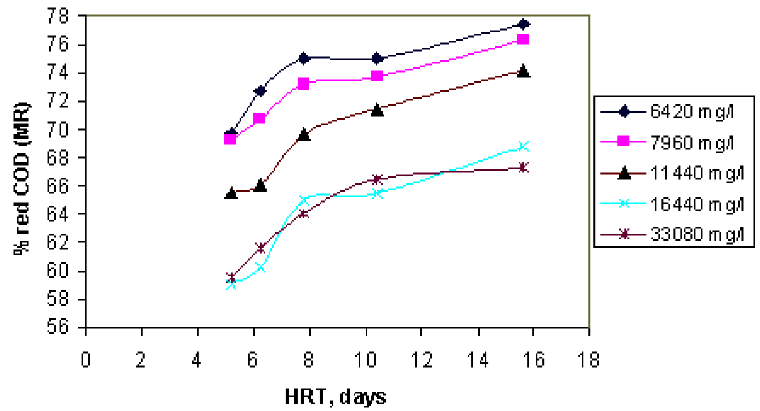

Fig 3. HRT Vs % red COD (MR)

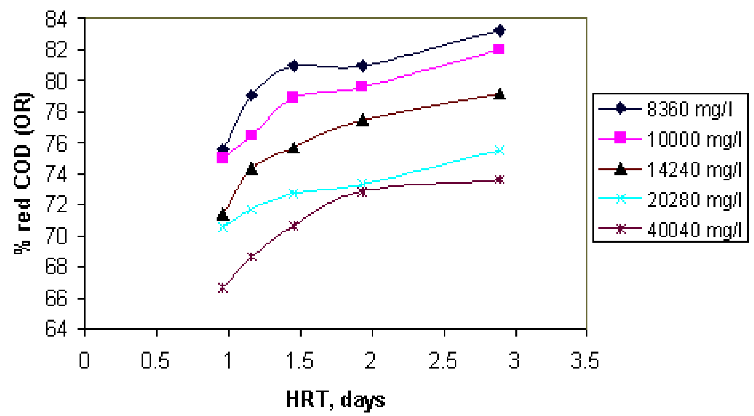

Fig. 4. HRT Vs % red COD (OR)

from 5.21 to 15.63 days.

RESULTS AND DISCUSSION

It is found that the COD reduction rate is largely affected by the changes in HRT, reaching its maximum value 26.19% at 2.89 days in acidogenic reactor

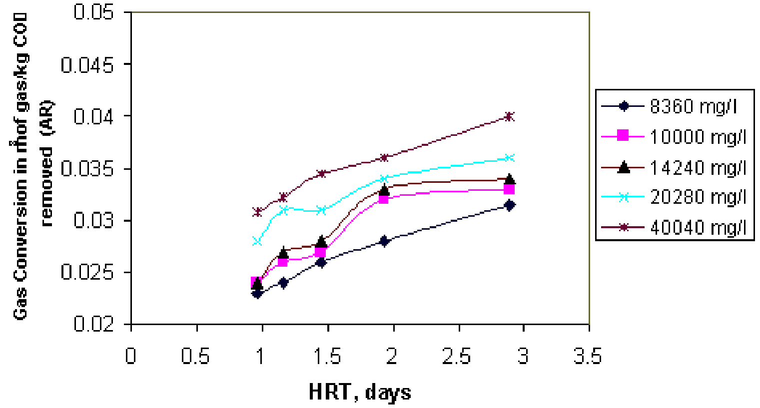

Fig. 5 HRT Vs Gas Conversion in m^3 of gas/kg COD removal (AR)

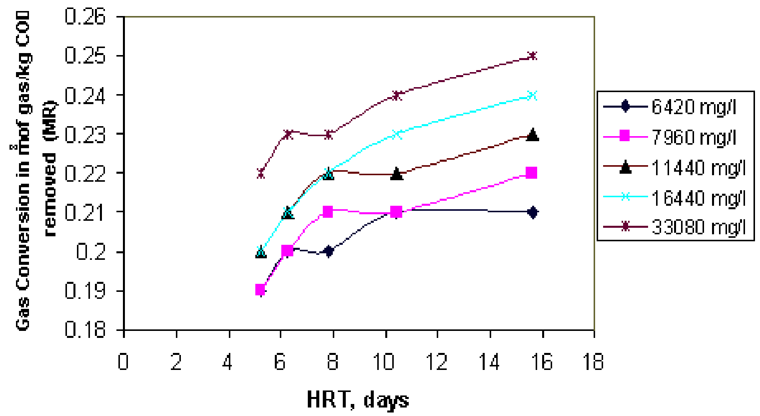

Fig. 6 HRT Vs Gas Conversion in m^3 of gas/kg COD removal (MR)

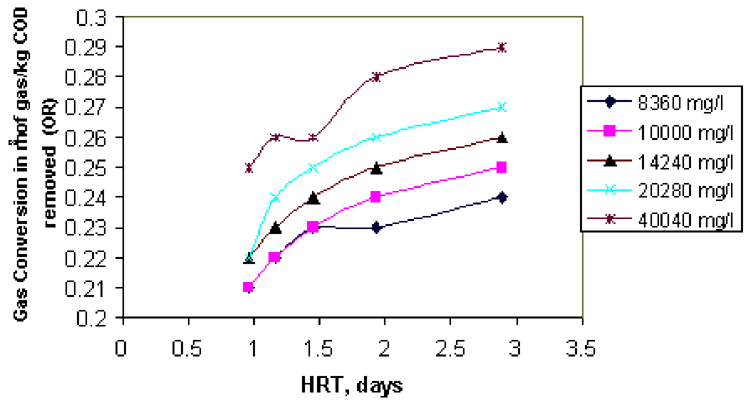

Fig. 7 HRT Vs Gas Conversion in m^3 of gas/kg COD removal (OR)

and 77.42 % at 15.63 days in methanogenic reactor. The respective observations are used to draw characteristic curves are presented in Figure 1.1 and Figure 1.2. The biogas collection from acidogenic reactor is found insignificant. The biogas collection from the methonogenic rector is found to range from 0.19

to 0.25 m^3 of gas/kg COD removed. From the Figure 1.4 to 1.6, it could be seen that increase in HRT increases the biogas conversion for a specific COD loading.

The acidogenic reactor was operated for a maximum OLR of 41.06 kg COD/m^3.d with a HRT of 0.96 days and correspondingly the methanogenic reactor for a maximum OLR of 6.317 kg COD/m^3.d with a HRT of 5.2l days. The maximum COD conversion rate of 26.19% was achieved in 2.89 days of HRT in the acidogenic reactor and 77.42% was achieved in 15.63 days in methanogenic reactor. The diphasic digester model is found to offer an overall COD reduction of 82.3% in treating distillery spent wash (Figure 1.3).

CONCLUSION

The effect of hydraulic retention time is found significantly affect to the performance of the diaphasic digester. It can be concluded from the result of the experiment that the 2.89 days of HRT for acidogenic reactor and 15.63 days for methanogenic reactor are found very optimal and feasible as they collectively offer the system performance of overall COD removal at 82.30% at the system HRT of 18.52 days.

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