Treatment Effciency of Sugar Effluent using Membrane Bioreactor

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Abstract **- An integrated laboratory-scale aerobic membrane bioreactor was used to treat sugar effluent at different HRTs. The MBR is designed to have 108 litres of effective volume. The membrane package is submerged which allows the retention of MLSS to an average of 8000-9000 mg/l. The reactor was run at varying OLR (0.012 to 0.039 kg/COD/m^2/day) and HRT (7, 11, 15, 19, and 23 hrs) at temperature of (29-35°C). The treatment efficiency was found to vary between 73.53 to 95.89 %, which could be rated as the best among the available technologies in practice in India. Hence the models of First Order Model and Stover Kincannon were considered in this work for evaluating bio kinetics coefficients using the experimental data of this work.**

Keywords: MBR, MLSS, COD, OLR and HRT.

I. INTRODUCTION

In recent years, purification of wastewater from various industrial processes has been of prime importance due to limited amounts of water available for direct use. Maintaining drinking water quality is essential to public health. Although wastewater treatment is a common practice for supplying good quality of water from a source of water, the high price of purification, necessity of utilizing the waste products, and maintaining an adequate supply of good quality water have been the major issues. 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 sugar effluent.

II. EXPERIMENTAL SETUP

An experimental model of MBR, having an effective reactor volume of 108 lit, was used for the study to evaluate the treatment performance. The reactors were fed with substrate using peristaltic pump (Model: PP-30, Miclins). The peristaltic pump a 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 the water displacement method using Mariotte bottle. The operating temperature of the reactors was in the mesospheric range (29-35°C). The experimental setup of an UASB reactor was shown in **figure.1.**

As a case study, effluent samples were drawn on two occasions from an Integrated Milk Plant and analyzed for primary parameters for characterizing the effluent.

The average values of the biochemical characteristics of the sugar mill effluent are listed in **Table 1.1.** 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) (3).

Fig.1 Experimental Setup of UASB System

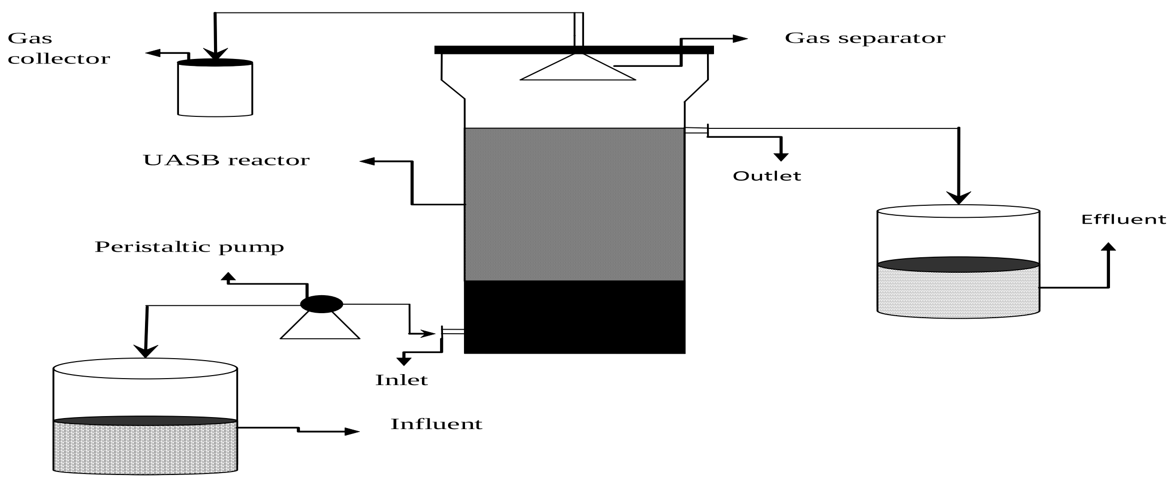

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Table1.1; Characteristics of Sugar Effluent

Sl.no	Parameters	Concentration
1	pH	6.50
2	TSS, mg/l	400
3	TDS, mg/l	2500
4	TS, mg//l	2950
5	$BOD_{5,}$ mg/l	1850
6	COD, mg/l	2650
7	Total Nitrogen, mg/l	16..35
8	Total Phosphorus, mg/l	6.75

III. EXPERIMENTAL METHODOLOGY

The experiment was conducted using synthetic effluent stimulating the real time characteristics of the sugar effluent. A peristaltic pump was used to conduct the experiment for six different flow conditions viz., 3, 5, 8, 10, 12 and 16 lit/hr. The corresponding Hydraulic Retention Times (HRT) is7, 11, 15, 19, and 23 hrs.

The 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 2126, 2780 and 3375 mg/l for varied HRT (7, 11, 15, 19, and 23 hrs) and OLR 0.012 to 0.039 kg/COD/m^2/day. Under each operating condition, influent and effluent COD and amount of gas were observed. Using Standard Method of Analysis.

IV. MATHEMATICAL MODELING

Mathematical modeling is an important preliminary step for implementing the wastewater treatment processes guiding systems.

A.FIRST ORDER MODEL

The rate of change in substrate concentration in a complete mixed system, considering first-order degradation kinetic and substrate concentration (S) dependence can be expressed as:

$$\frac{dS}{dt} = \frac{Q}{V} \times S_o - \frac{Q}{V} \times S - k_i S$$

Under steady state conditions, the rate of change in substrate concentration (*-dS/dt)* is negligible, then Equation reduces to:

$$\frac{So - S}{\theta H} = k_i S$$

The value of the first-order kinetic constant can be obtained by plotting *(So-S)/θ_H* versus *S*, according to Equation. The value of k_i is obtained from the slope of the straight line.

B.MODIFIED STOVER-KINCANNON MODEL

It is one of the most widely used mathematical models for determining the kinetic constants.The effective volume of reactor is used for the Modified Stover-Kincannon model. This model is expressed as:

$$\frac{dS}{dt} = \frac{\text{Umax} \times (Q \times \frac{So}{V})}{\text{kB} + (Q \times \frac{So}{V})}$$

here the substrate consumption rate *dS/dt* is expressed as:

$$\frac{dS}{dt} = \frac{Q}{V} \times (S_o - S)$$

Equation (5) is obtained from the arrangement and linearizing of Equation (3)

$$\frac{V}{Q \times (So - S)} = \frac{\text{kB}}{\text{Umax}} \frac{V}{Q \times So} + \frac{1}{\text{Umax}}$$

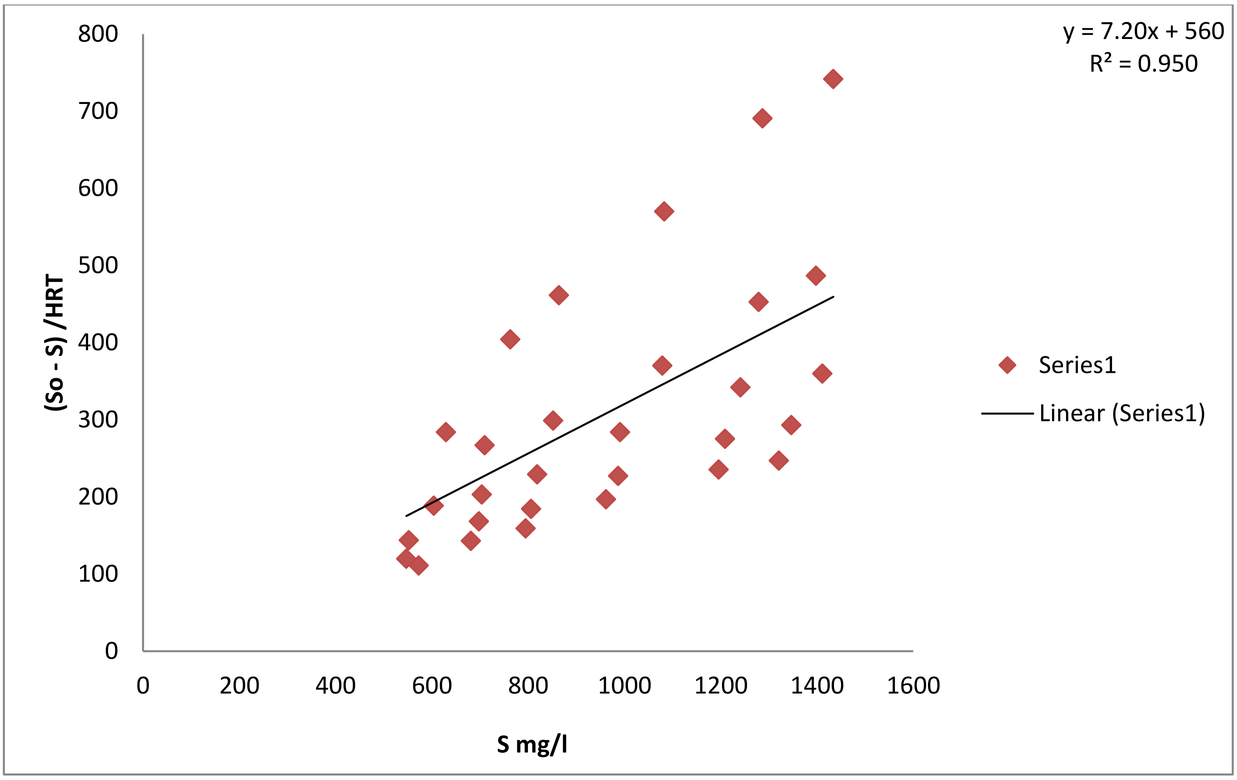
The value of the Stover- Kincannon kinetic constants can be obtained by plotting V /Q (So -S) versus V /Q So, according to Equation. The value of K_s and U_{max} is obtained from the slope of the straight line.

Graphic representation of experimental data was made according to linearized form of first-order model and Modified Stover-Kincannon model.

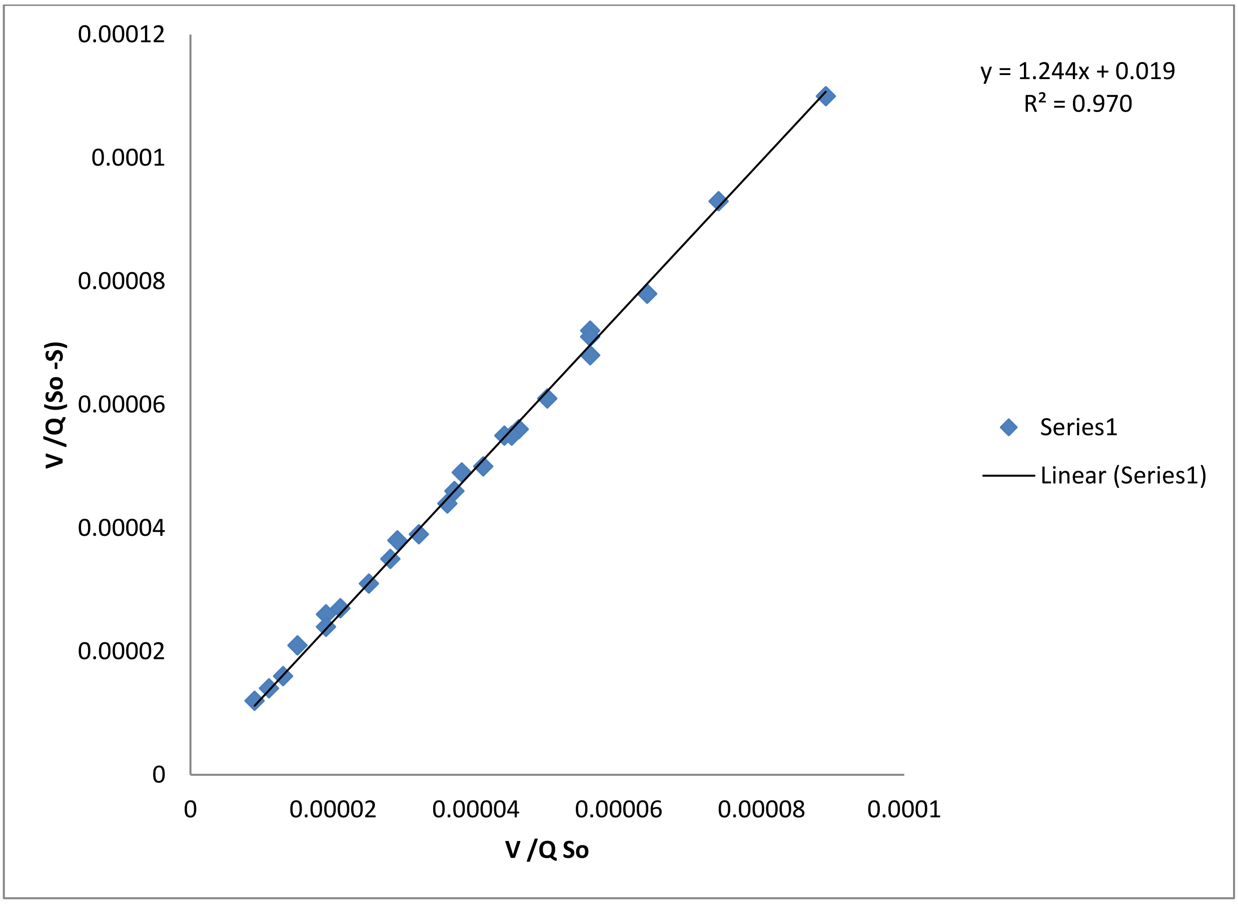
V. RESULTS AND DISCUSSION

After the UASB reactor was stabilized, synthetic wastewater was prepared and used for experimental study.An experiment was conducted for evaluating the UASB system in terms of COD removal. Reactor ran on a continuous basis for 45 days. Influent COD prepared were 2126, 2780 and 3375 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 (0.012 to 0.039 kg/COD/m^2/day).

FIRST ORDER MODEL



MODIFIED STOVER-KINCANNON MODEL



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 g/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 sugar wastewater streams. The correlation coefficient r^2 was chosen as the criterion for choosing the most suitable model to represent organic matter removal kinetics. Considering this criterion, the modified Stover-Kincannon was more suitable than the first-order model.

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