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EFFECT OF HYDRAULIC LOADING RATES IN THE PERFORMANCE OF ROTATING BIOLOGICAL CONTACTORS FOR TREATING SUGAR AND DAIRY EFFLUENTS

D. Selvakumar and V. Nehru Kumar
Department of Civil Engineering, Annamalai University, Annamalai Nagar-608 002, T.N., India

ABSTRACT

A laboratory model of rotating biological contactor 10.125 litres of effective volume with three stages and a clarifier arrangement in the last stage was used. Synthetic effluent streams of sugar and dairy were used for treatability evaluation, in terms of COD removal under varying influent flow rate, influent COD and rotational speeds of the discs. The COD removal was found to vary from 72.93% to 91.66% under varying hydraulic loading rates of 0.039 to 0.133 m^3/m^2/day in the case of sugar effluent for the disc rotational speed of 6 rpm, and 67.95 to 87.57% under similar conditions for dairy effluent.

INTRODUCTION

Rotating Biological Contactor (RBC) is one of the most versatile aerobic treatment techniques that can process relatively higher organic content in the biodegradable industrial wastes (Weng 1972, Nehru Kumar 2000).

The rare and unique combination of suspended and attached growth systems of microorganisms, which are the integral parts of any RBC system, enable it to treat away the biodegradables at more than 90% through the oxidative pathway of microbial metabolism. The modified version of RBC with additional air supply systems, varying depth of disc submergence in the three stages and system flexibility to alter the rotational speed of the discs, got upgraded to treat biodegradable industrial wastes.

The RBC model was run for treating sugar and dairy industrial effluent streams. The effect of hydraulic loading rates under varying influent COD and rotational speed of discs were studied.

MATERIALS AND METHODS

Experimental setup

The experimental model is envisaged as modified RBC with increased reactor volume in each stage and with enhanced depth to support suspended growth system of microorganisms. The model is also incorporated with supplemental air supply to activate the aerobic biomass, both in suspended and attached form.

The laboratory model of RBC has 10.125 litres effective volume, having three stages of rotating discs and a clarifier system as fourth stage, in series.

The three stages of RBC have equal number of rotating discs, numbering 15, each with a diameter of 0.1 m. The effective surface area, offered by the discs with their affixed modular plastic sheets, is estimated to be 0.2368 m^2. The clarifier system is having 0.0225 sq. m as its overflow area. The three stages of RBC are supplied with air through a mini-aqua blower at 6 L/minute. The discs are placed at different depths of submergence *viz*., 60, 50 and 40% respectively for I, II and III stages of RBC.

The rotation of the discs is systemized with geared motor and pulley arrangement to vary the rotational speed of 6, 9 and 12 rpm. A peristaltic pump is used to regulate the influent flow rate and sustain the model for hydraulic stability. The schematic of the experimental model is presented in Fig. 1.

Experimental Methodology

The experiment was run using synthetic of sugar and dairy effluent streams. The real time sugar effluent was sampled from M/s Rajashri Sugar Mills, Mundiyampakkam, and the dairy effluent from Hatsun Agro Industries Limited, Salem. The characteristics were simulated to prepare synthetic sugar and dairy effluents.

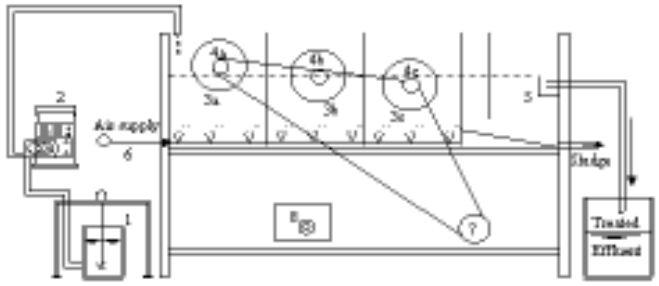
The experiment was conducted for three different influent flow rates, for varying influent COD and varying rotational speed of discs. The synthetic sugar effluent was experimented for varying influent COD (1494.48, 2445.96 and 4008.61 mg/L), varying influent flow rate (0.0094, 0.0126, 0.0188, 0.0251 and 0.0314 m^3/hr) and varying rotational speed of discs (6, 9 and 12 rpm).

The synthetic dairy effluent was experimented for varying influent COD (1489.08, 2457.10 and 3944.18 mg/L), varying influent flow rate (0.0094, 0.0126, 0.0188, 0.0251 and 0.0314 m^3/hr) and varying rotational speed of discs (6, 9 and 12 rpm).

RESULTS AND DISCUSSION

The % COD removal efficiency for treating sugar and dairy effluents under varying hydraulic loading rates for different rotational speeds of discs is presented in Figs. 2 and 3.

FIG. 1.1 EXPERIMENTAL SETUP



1. Synthetic wastewater mixing tank
2. Peristaltic pump; Miclins / pp 15 model
3. a, b, c – Stages of RBC
4. a, b, c – Rotating discs
5. Settling tank
6. Air blower assembly
7. Geared motor
8. Speed controller

Fig. 1 Schematics of the experimental setup.

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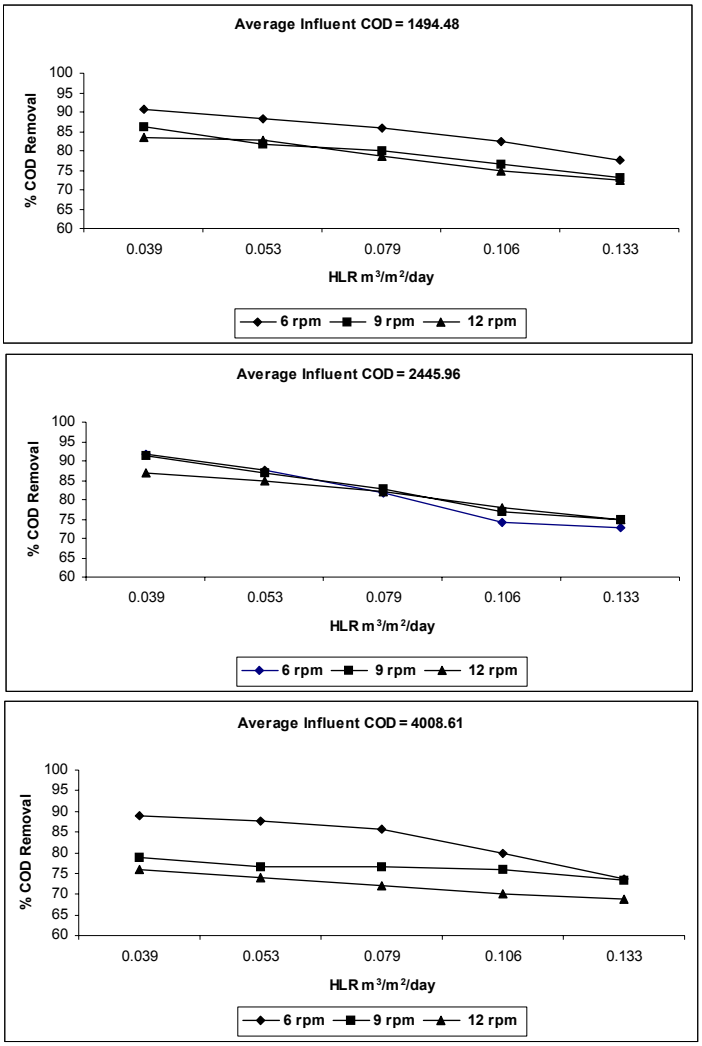

Fig. 1: % COD removal efficiency versus HLR for varying rotational speeds of discs (sugar effluent).

The COD removal efficiency was observed to be 72.93% to 91.66% for varying hydraulic loading rates of 0.039, 0.053, 0.079, 0.106, 0.133 m^3/m^2/day in the case of sugar effluent while it was 67.95% to 87.57% for the same hydraulic loading rates of in case of dairy effluent.

The rotational speed of discs was found to influence % COD removal efficiency with 6 rpm as to offer the maximum performance. Any increase in rotational speed was found to decrease the performance of the system.

CONCLUSION

The RBC was found to offer the maximum COD removal of 91.66% for a hydraulic loading rate of 0.039 m^3/m^2/day at the rotating disc speed of 6 rpm, for treating sugar effluent. However, it was 87.57% for dairy effluent for the same operating conditions.

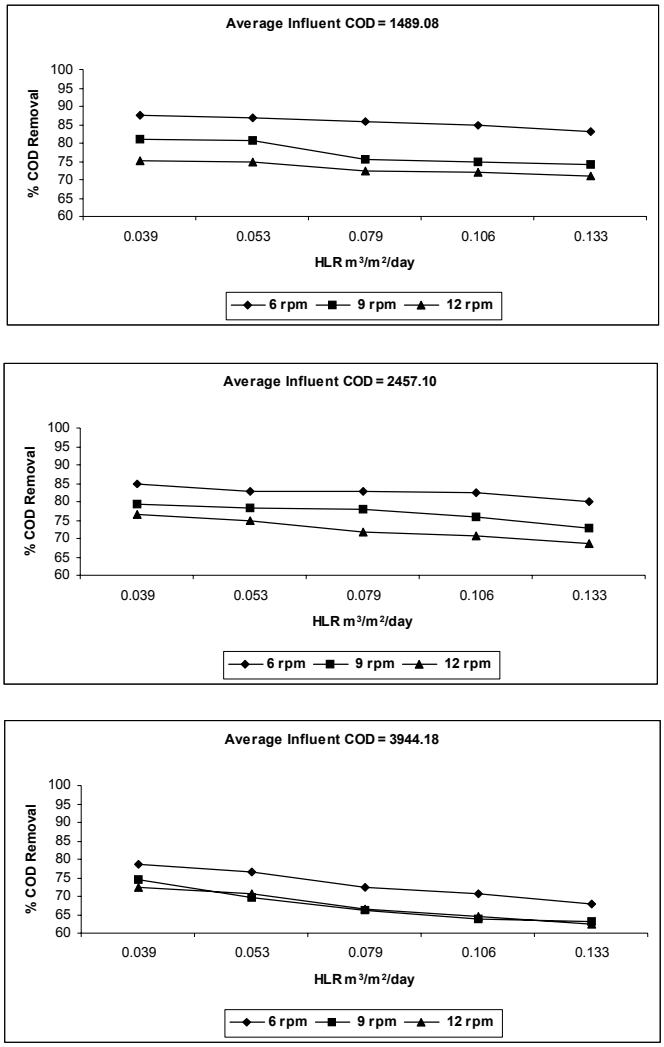

Fig. 2; % COD removal efficiency versus HLR for varying rotational speeds of discs (dairy effluent).

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