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APPRAISING THE AEROBIC HYBRID BIO-REACTOR INTENDED FOR DIMINISHING THE POLLUTANTS IN THE SUGAR INDUSTRY WASTEWATER

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Key words: *Aerobic Hybrid Bio-Reactor, Chemical Oxygen Demand, Hydraulic Retention Time, Industrial wastewater, and Organic Loading Rate.*

Abstract– The effective treatment of sugar industry wastewater is a tricky mission. In the current study, an effort was made for the management of sugar industry wastewater. The synthetic sugar wastewater is primed in the laboratory and used for the experimentation. A laboratory scale Aerobic Hybrid Bio-Reactor was planned and fabricated for the treatment of Industrial wastewater to observe the intensity changes of Chemical Oxygen Demand, Turbidity, pH and Dissolved Oxygen. The Aerobic Hybrid Bio-Reactor was accomplished with both suspended as well as an attached growth process. The effect of OLR on the recital of an AHBR reactor depends on an integer factor which sometimes have a tricky outcome, mostly conflicting, on the performance of AHBR reactor. Researchers have accounted an increase in the effectiveness of high rate aerobic reactors with mounting OLR. The COD reduction was conquered at less in the early stage and increased and achieved a steady state. The utmost COD deduction effectiveness was attained at 91.42% with an organic loading rate of 1.591 Kg COD/m^3.day. Apart from the different technologies the Aerobic Hybrid Bio-reactor proves the healthier one for treating industrial wastewater which can be considered as a trustworthy, secure and cost efficient method in favor of the treatment of sugar industry wastewater.

INTRODUCTION

India's long-standing agrarian economy is gradually evolving into an industrial one, making it one of the world's greatest economies (Chatterjee, 2008). While this change has had noteworthy optimistic monetary effects in terms of job creation, raising living standards, per capita income, etc., it has also been associated to having significant negative social and environmental effects, mainly in the crate of water pollution (Abhilash and Singh, 2009; Chandra, 2003, Rajaram and Das, 2008; Khan and Ansari, 2005). For the discharge of wastewater from food processing companies, India's environmental constitutional bodies have established strict policy and rules. But because these acts are getting more serious, a comprehensive waste management strategy is urgently needed to effectively clean and use the waste water from the food processing and agro-based industries (Rajagopal *et al.,* 2013). Nevertheless, in budding economies like India, lack of rigorous implementation of aerobic treatment skills on agro-based industrial effluent (Dasgupta, 2000), combined with lack of wakefulness and monetary limits for manufacturing, recurrently leads to the espousal of less effectual waste water management systems (Murty and Kumar, 2002; Afsah *et al.,* 1996).

For usage in the agro processing sectors, a variety of wastewater management systems (physical, chemical, biological, and hybrid), both aerobic and anaerobic, are commercially accessible (Klemes *et al*., 2008). These technologies each have inimitable benefits and drawbacks (Bolzonella *et al*., 2007). Excluding the choice of wastewater treatment technology for any industrialized division often depends on various factors (Metcalf *et al*., 2010). Treatment strategies using biological rather than physico-chemical means are becoming more popular. On account of microbial action, biological

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processes yield straight forward and safe final products. Anaerobic and aerobic processes can both be used to crumble recyclable organic waste. Owe to the lofty concentration of nutrients and organic contaminants in the effluent from these sectors, which favours effective microbial degradation, biological treatment expertise have become well-known in the field of wastewater management. In the present research, a laboratory scale of Aerobic Hybrid Biological treatment technology was conducted to assess its applicability to the effluent from the sugar sector in light of its requirements and constraints. The suspended growth process and the attached growth process have been accomplished in a single reactor as an innovation from the existing system. The main intention of this research is to eradicate the organic pollutants like COD, BOD, Turbidity, from the sugar industry wastewater by the performance evaluation of an AHBR. In this juncture, the synthetic wastewater of sugar industry effluent has been geared up in the laboratory and used for the experimental investigation of Aerobic Hybrid Bio-reactor.

MATERIALS AND METHODS

Reactor Fabrication

A working volume of 13.30 litres with the Plexiglass was used to create the experimental model. The suspended growth process and the attached growth process were successfully placed in a single reactor by making the appropriate separations. A suspended growth process is used to complete the first half of the reactor, and an attached growth process is used to complete the second half. The Bio carriers were sporadically filled in the subsequent half of the reactor to confess the attached growing process. In Figure 1, you can see he photographic outlook of an experimental setup. The carrier was 15 x 22 mm in size and had a black finish. The carrier's specific surface area was 400 sqm/cum and its specific gravity ranged from 0.90 to 95 gms/sqcm.

Wastewater Characteristics

The influent chemical oxygen demand (COD) range from 2800 to 3720 mg/l. Commercially obtainable edible glucose, sugar powder, urea, KH_2PO_4 and K_2HPO_4 were used to create this synthetic wastewater. The pH of the inlet wastewater is maintained in the neutral array of 7-8 to provide the best circumstances for bacterial growth. To facilitate supply the necessary nutrients for biological intensification, edible sugar was added to around 30% of the inflow COD in all different organic loads. The complete operation was conceded out in the room temperature.

Fig. 1. Photographic outlook of the Reactor

Composition and Analysis of Wastewater

The components recommended by Guiot and Berg (1984) were used to create artificial sugar industry wastewater, which was then used in this study. Periodically, samples taken from the feednosh tank and from the reactor's outlet were examined using the procedures outlined in Standard techniques by the American Public Health Association and the American Water Works Association (Standard Methods for Examination of Water and Wastewater, 2017).

Experimental Conditions

Throughout the study period, the average room temperature ranged from 29 to 37 °C. Daily records were kept of the flow rate, the pH of the influent and effluent, and the MLSS and DO in the reactor. Initial flow rate settings were made to achieve a HRT of 42 hours, and they were let to stabilize. When there was little to no distinction between two consecutive COD levels, HRT was altered (i.e. after attaining steady state).

RESULTS AND DISCUSSION

Initially, the wastewater from the Chidambaram Municipality was combined with seeding sludge from the M R K Sugar Mill in Sethiathoppe, Cuddalore, Tamil Nadu used for the start-up process. Cow dung was mingled with water to speed up startup time, and the resulting filtrate was

deployed as the reactor's seed after being sieved to eliminate big debris. Microorganisms received the bare minimum in the way of nutrients and carbon sources. The technology was used for a week in batch mode to adjust the microbes. In order to accomplish this, the ventilation was stopped up each 8 hours, and set of time offered for the sludge to settle- roughly 1 hour. The reactor was decanted to about half its contents and nosh with synthetic wastewater. Owing to the development of biofilm resting on the carriers, the procedure changed from batch mode to continuous mode after that. Peristaltic pump was used in this stage to feed the structure, and the sludge was beginning to settle. The biofilm was readily visible after a month, and the experiments then proceeded. However, the reactor's treatment time was just 15 days long, making it practically impossible to apply the reactor in the field. The original measurement of the MLSS was 2100 mg/l. Although there was little raise in MLSS concentration over the earliest various days, there was a progressive rise in concentration that was eventually documented, reaching 3700 mg/l.

Throughout the first two days of the reactor start-up, merely frothing was viewed on the facade of the wastewater body. This may designate a few respiratory activities inside the reactor, but it did not consequence in perceptible COD reduction. Based on the treatment situation and the modification of effluent standard of wastewater there is an inclination and declination in the parameters. The reactor has been incessantly operated at mesosphilic series with an organic load pace of 0.735 kg COD/m^3.day. The outcome evidenced that the aerobic bio-reactor conquered a steady state from 15^{th} to 18^{th} day. All through the start up episode the pH plays an imperative responsibility for the putrefaction of unrefined essence in the reactor. The COD diminution was arrived at 7% in the preliminary stage and was augmented upto 12^{th} day and turn down from 12^{th} to 15^{th} day and then reached a steady state from 15^{th} to 18^{th} day. The maximum COD deduction effectiveness was achieved at 96.45% at a hydraulic retention time of 24 hours amid organic loading rate of 0.735 kg COD/m^3 day.

The reactor was functioned with enhanced OLR after reaching steady-state during the startup procedure so as to obtain the maximum positive loading rate possible. In this investigation, three sets of synthetically prepared sugar wastewater with Influent COD values of 2800, 3400, and 3720 mg/l were used. Acclimatization is required for biological treatment if the BOD/COD proportion of the sugar wastewater is superior than 0.6; otherwise, biological treatment may not be required. If the ratio is between 0.3 and less than 0.3, acclimatization is not required. The BOD/COD ratio for synthesized sugar wastewater is 0.57, thus acclimation is required for biological treatment.

Behind achieving a firm state, the synthetic sugar wastewater was feeded to the reactor gradually at the pace of 20%, 40%, 60%, 80% and 100%. After allowing 100% concentration of unreal sugar wastewater, the COD exclusion is monitored to achieve a stabilized removal of COD. The reactor have been incessantly operated at mesosphilic range with the Hydraulic Retention Time of 11, 14, 17, 21, 28, 42, 84, 141 hours. The initial loading rates were kept modest in sort to ensure the success of the AHBR reactor. Because it promotes the development of aerobic active sludge and the stumpy organic loading rate that ultimately led to the low up-flow velocity. Fig. 2 shows the effectiveness of HRT and HRT in terms of % COD elimination efficiency. Fig. 3 shows the routine of HRT and HRT in relation to pH. Due to biomass edition to the environment, the deduction efficiency was poor at the beginning of the operation.

In aerobic reactors, MLSS and DO continue to be a key controlling component during the whole process. Additionally, a key factor in the digesting process is pH. The MLSS must be between 2000 to 2500 mg/l as well as the DO must be between 4 to 5 mg/l for aerobic microbes to thrive. The scenario showed an abrupt rise in MLSS concentration, with the beginning attentiveness of 2000 mg/l and a peak attentiveness of 4800 mg/l. This was the reason the reactor was capable to remove such a high percentage of COD (Mise and Biradar, 1997). Due to its unique characteristics, an aerobic approach is used for wastewater management in the Indian industrial sector (Yeole and Gadre, 1996) and maximum MLSS concentration of 5000 mg/l was allegedly reached. This shows a considerable rise in the microbial population in the tank, which in turn led to a notable decrease in BOD/COD (Schmidt and Ahring, 1977, Sutton and Mishra, 1997). An ideal pH series in effluent is between 7.12 and 8.75, which aids in the breakdown of organic contaminants. The COD deletion effectiveness of experiment was achieved 91.42% with an Influent COD of 2800 mg/l decreased to 240 mg/l. The highest COD deduction effectiveness of 91.42% was reached in 42 hours at an OLR of 1.591 Kg COD/m^3 day and a pH of 7.45.

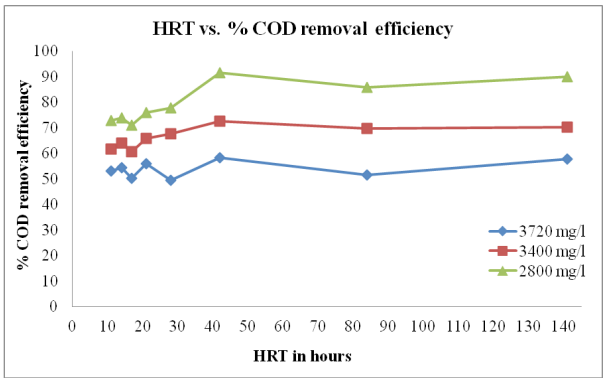

Fig. 2. HRT (hours) relating to % COD removal efficiency through an average influent COD of 3720, 3400 and 2800 mg/l

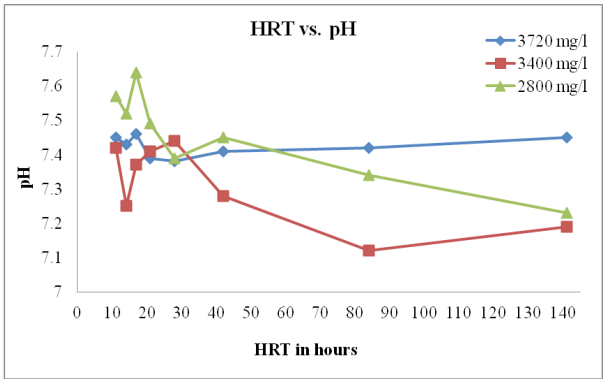

Fig. 3. HRT (hours) relating to Effluent pH through an average influent COD of 3720, 3400 and 2800 mg/l

CONCLUSION

The study finds that the AHBR, with its great performance, can manage any kind of high strength wastewater and was able to handle the high organic load. Within 15 to 18 days following the day's instigation, the reactor reached steady-state conditions. The sample of wastewater containing synthetic sugar was prepared and scrutinized in the laboratory. Within a short start-up time, the AHBR reactor was effectively used to achieve high COD removal efficiency. The optimal operating settings formed an utmost COD removal of 91.42% in 42 hours at an OLR of 1.591 Kg COD/m^3.day, according to the assessment data. At the top COD reduction, the pH was 7.45. As a result, it may be claimed that this approach emerges to be a doable alternate for treating wastewater from the sugar industry. As a result, it is a rapid, easy, and economical process for treating effluent from the sugar industry that uses little space and equipment.

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