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Electrochemical Treatment of Biodigester Effluent (BDE) followed by Anaerobic Digestion

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Abstract: In this study an electrochemical treatment based on the principle of anodic oxidation was used to treat Biodigester effluent(BDE), where molasses is used as a raw material. The effect of Electrolysis duration , pH and current density on the rate of COD removal and improvement on biodegradability was studied using aluminum electrodes. The results showed the use of electrochemical treatment technique reduces the COD from an average value of 5760to896 mg/L. The BOD/COD ratio increased from 0.14 to 1.10 at optimal operating condition. A partially degraded pretreated Biodigester effluent was subjected to post anaerobic digestion. The performance of the digester was evaluated in terms of COD and BOD removal rate were at the end of 138 days of operating days the COD was reduced from 1536 to 240 mg/L meeting the discharge standards.
Keywords: Anodic oxidation, BDE, COD, Anaerobic digestion BOD/COD ratio, aluminum electrodes.

1. Introduction

Ethanol manufacture from Molasses generates large volumes of high strength wastewater that is of serious Environmental concern. India is the second largest producer of ethanol in Asia with around 319 distilleries producing 3.25 x 10^9 litres of alcohol and generating a large volume of effluent.For every litre of alcohol produces around 13-15 litres of effluent. The distillery effluent contains a dark brown pigment Melanoidin. This wastewater has very high concentration of carbohydrates, reducing sugars, dissolved lignin, proteins, alcohols, waxes etc impart high COD and BOD to the distillery wastewater.Due to the very stringent effluent discharge standards for COD and BOD,the BDE is to be treated further[1].

Biological methods and chemical precipitation methods are unable to degrade the coloring compounds and they induce secondary pollutants. Electrochemical treatment has been attracted great attention in treating industrial wastewater because of the versatility and its environmental compatibility. Electrochemical treatment is widely used to treat different industrial effluents such as pulp and paper[2-4] .

The present study focuses on the pretreatment of BDE for COD removal and increase in BOD/COD ratio. The operating parameters affecting the electrochemical degradation such as electrolysis duration, pH and current density are evaluated during this study. And the partially treated Biodigester effluent was then subjected to the anaerobic digestion to further reduce the BOD and COD to meet the stipulated standards.

2. Materials and methods

2.1 Source

Pre-treated Biodigester Effluent (BDE) was obtained from the outlet of anaerobic digester from a local alcohol distillery plant and the chemicals used for the analysis were of analytical grade. Standard methods was used to carry out analysis.

2.2 Experimental setup

Electrochemical treatment of BDE was carried out in an undivided bench-top parallel plate reactor in batch mode using two aluminum electrodes in dimensions of 5 cm×5 cm (active electrode surface dipped in wastewater). During the experiments, samples were drawn from the reactor at regular intervals and analysed. The COD and BOD/COD ratio were chosen as parameters in order to evaluate the progress of the oxidation and increase in biodegradability. All measurements and experimental studies were carried out at ambient temperature. The partially electrochemically degraded biodigester effluent was then subjected to post anaerobic digestion to achieve the COD and BOD of the BDE to meet the effluent discharge standards.

3. Results and discussion

3.1 Electrochemical Treatment

Electrochemical treatment of BDE was carried out under the various influencing parameters like pH (3, 5, 7, 9) and current density (0.01, 0.02 and 0.03 A/cm$^{2)}$. From Fig 1, 2 and 3 we observe, results 140 minutes of electrolysis duration was maintained with a constant pH of 7 at an applied current density of 0.03 A/cm^2 as optimum. For initial 70 minutes the COD removal was rapid and later on it was gradual The COD values reduced from initial concentration of 5760 to 896 mg/L .The rate of COD removal increases with increasing current density. This is consistent with Faraday's law[5] because of the increased production of chlorine/hypochlorite at higher current densities and also due to higher dissolution of electrode material occurs generating higher rate of formation of aluminum hydroxides results in the higher COD removal efficiency due to sweep coagulation and co-precipitation.

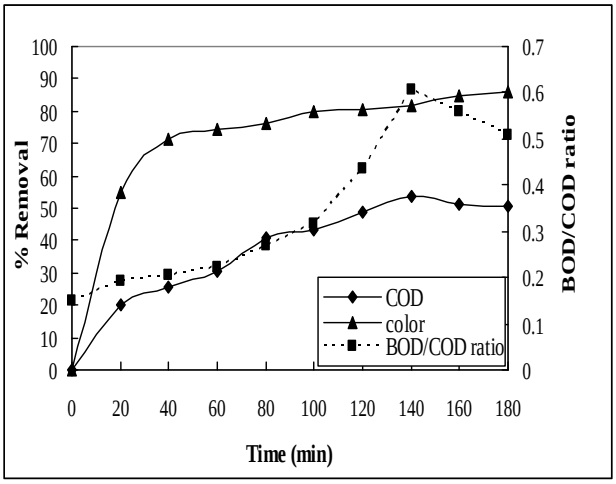

Fig. 1 Variation of COD and Color removal efficiency and BOD_3/ COD ratio as a function of electrolysis duration

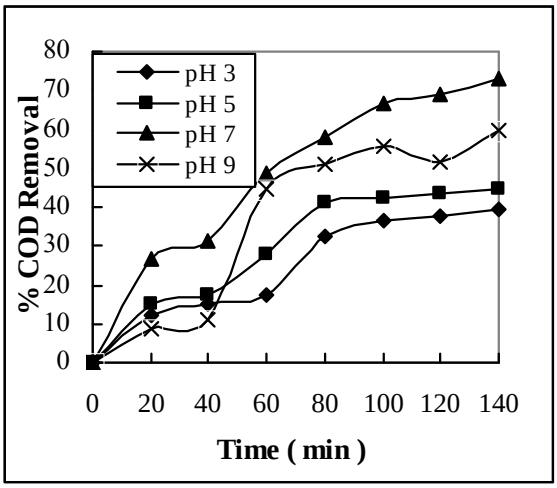

Fig 2 Effect of pH on COD removal

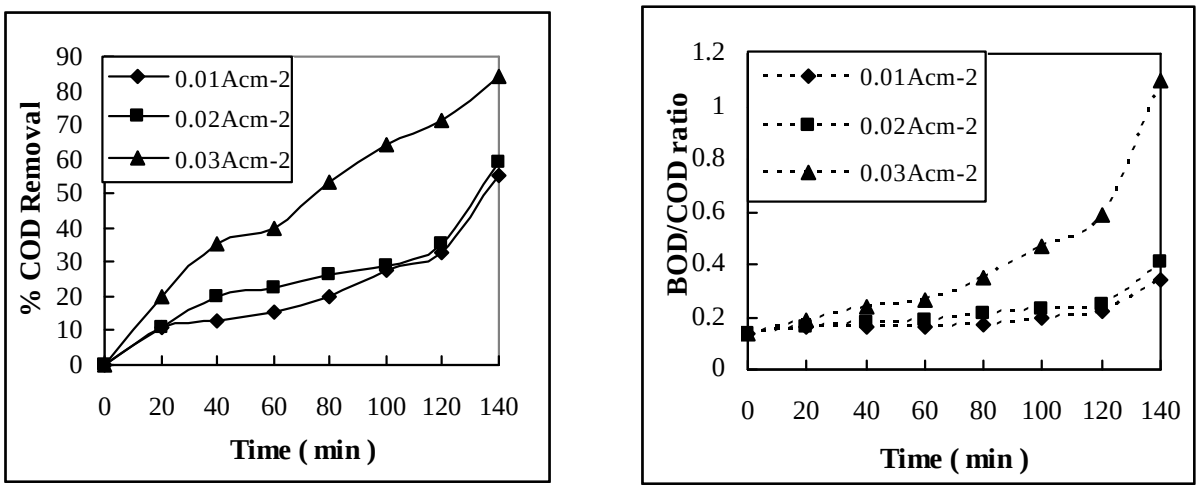

Fig. 3 COD and BOD_3/ COD ratio as a function of electrolysis duration

The BOD_3/COD ratio was increased from 0.15 to 1.10 and it was noticed that the percentage color removal at higher current density was found to be 93.25%. Since the BOD/COD ratio after EC treatment was found to be a > 0.5, thus indicating that the effluent can be further biologically treated. Anaerobic digester feed with electrochemically treated BDE was studied in batch process. Initial Organic Loading Rate (OLR) of 1536 mg/L COD at a zeroth day of the reactor set up was fed. The performance of the reactor was studied for 138 days. At the end of 138 operating days, COD was reduced from 1536 to 240 mg/L and the BOD was reduced from 873 to 36 mg/L respectively thus their concentrations are within the disposable limits.

4. Conclusion

Electrochemical treatment with aluminum found to be successful for the pretreatment of BDE. Optimum working conditions determined are as follows: current density of 0.03 A/cm^2, pH 7 at 140min the COD removal was 85% and BOD_3/COD ratio was 1.10 for electrochemical treatment. Anaerobic digestion was found to be the most successful one resulting in COD and BOD reduction from 1536 to 240 mg/L and 873 to 36 mg/L respectively.

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