Experimental Studies of Bagasse Flyash Adsorption on Chemical Oxygen Demand and Dissolved Oxygen of the Distillery Waste

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Abstract: The sugar industries are the backbone of our agro-economy. At the same time they emit effluent with high organic matter and very less dissolved oxygen content. In the present work attempt is done to remove organic matter from the effluent after secondary treatment by using baggase flyash as adsorbent. The studies are carried out in batch experiments to optimize the parameters like adsorbent dose, pH, initial concentration and contact time. Also the dissolved oxygen content is measured along with COD. It was observed that with increase in adsorbent dose, COD decreases steeply up to 3 grams and the rate of COD decrease drops after 3 grams/l. Similarly other parameters were optimized. The optimum pH, contact time and initial concentrations were found to be 6, 2.5 hr and 6000 mg/l respectively. The dissolved oxygen of the diluted effluent (1% concentration) was found to increase from 3 to 8.5 during the experiments. The behaviour of dissolved oxygen of diluted effluent(1%concentration) is also studied along with COD as dissolved oxygen content is very important for the aquatic life.

Index Terms— Batch, Adsorption, flyash, Effluent, dissolved oxygen

I. INTRODUCTION

The treatment of the effluent for removal of organic matter can be carried out by various chemical and biological methods. Still there is potential for adoption as a important method for it. Activated carbon adsorption can be considered as one alternative. But 10-20 % loss during regeneration is a limitation to this method considering huge size of effluent treatment plants and the quantity of the effluent. The limit for disposing off the effluent to the river and inland water is 250 mg/l. The DO of the effluent ranges from zero to 4 for the distillery effluent. The removal of organic matter from distillery effluent was studied by Mall and Kumar [1].Mall and Mishra have studied the removal of organic matter from sugar mill effluent using bagasse flyash [2].The role of dissoled oxygen on adsorption capacity of activated carbon was studied by Vldc and suldan [3].Color and COD removal from wastewater containing Reactive Black 5 using Fenton’s oxidation process was studied by Meric et al [4]. The adsorption operation exploits the ability of certain solid to preferentially concentrate specific substance from solution onto their surfaces. In this manner, the component of either gases or liquid solutions can be separated from each other. The scale of operations range from the use of a few grams of adsorbents in the laboratory to industrial plants with an adsorbent inventory exceeding 35000 kg. The principle of adsorption, types of adsorption and its the isotherms are described by Treybal [5].

Adsorption is a low cost and important physical process for the treatment and renovation of wastewater. Activated carbon is a highly effective low cost adsorbent and shows 10 – 15 % carbon loss during regeneration. Various non-conventional adsorbents, like saw dust, baggase pith, rice husk ash, activated coconut shell powder controlled burnt wood charcoal , flyash, peat, wood , jute fibers , have been tried,[6,7].The chemical oxygen demand (COD) is the amount of oxygen consumed for oxidizing the organic matter. In the present study the oxidizing agent used is potassium dichromate.

The dissolved oxygen (DO) content of the water should be minimum 5 mg/l. The dissolved oxygen is very significant characteristic of the effluent. The effluent containing very low DO is harmful for aquatic life because it affects adversely the DO of the reservoir or river in which it is disposed. The maximum DO that water can have is called saturation DO. Saturation DO is 9.1 at 20°C. The DO is inversely proportional to temperature. The factors affecting the dissolved oxygen are: reaeration, deoxygenating, respiration and photosynthesis [8, 9]. If the DO of the water is less than saturation DO then the mass transfer of atmospheric oxygen into the water takes place. Deoxygenation is due to utilization of dissolved oxygen by the organic matter in the wastewater. Respiration is the oxygen consumption by fishes and other aquatic life. Photosynthesis is carried out by the plant in the process of utilizing food to synthesize energy. In this process oxygen is evolved. [10].

II. EXPERIMENTAL WORK

The following parameters were optimized during the study: adsorbent dosage, pH, Contact time and initial COD. For all the above parameters 100 ml of distillery effluent was taken into 500 ml conical flasks and adsorbent was added. The flasks were kept on shaker and the samples were filtered and collected for analysis. The COD of the effluent and DO of the diluted effluent (1% concentration) were measured for each run.
The dissolved oxygen was measured by using soil and water analysis kit by inserting the electrode probe into the wastewater. For the measurement of COD, the wastewater containing known amount of potassium dichromate with known normality was kept at 150°C on COD digestion apparatus (make-spectralab) for 2 hours. From the literature and the available data, two hours are sufficient for the organic matter to decompose. The blank containing distilled water instead of wastewater in the sample tube is also kept at same temperature and for same duration. Silver sulphate and mercuric sulphate are used to fasten the process of decomposition. After two hours the samples were cooled and titrated with Mohr’s salt (Ferrous ammonium sulphate) of known concentration using ferroin indicator. The difference in the burette reading for blank and the sample is indicator of the difference in potassium dichromate concentration. The COD is estimated by calculating the equivalent concentration of organic matter required for the consumption of potassium dichromate.

III. RESULTS AND DISCUSSION

1) Effect of adsorbent dosage

Fig.1 presents the variation of chemical oxygen demand and dissolved oxygen with variation in adsorption dosages. The effect of adsorbent dosage was studied by keeping the initial concentration, pH and contact time constant. It was observed that an increase in adsorbent dose favors the COD removal. This dependence becomes more insignificant at higher doses of adsorbents. This may be because of inability of the adsorbate to utilize the adsorbent, and at very high concentration all the organic matter may not have reached to the entire adsorbent surface. The optimum adsorbent dose was found to be 3 grams for 100 ml of effluent. The DO of the diluted effluent (1% concentration) increases from 3 mg/l to 8.5 mg/l, after the adsorbent dosage of 3 mg/l, the DO rise becomes insignificant.

2) Effect of pH

Fig. 2 depicts the variation of Chemical oxygen demand and dissolved oxygen with pH. The effect of pH on the COD removal and DO of the diluted effluent (1% concentration) was observed by keeping other parameters constant. Adsorption phenomenon is analogous to ion exchange process. The pH of the aqueous solution has significant effect on organic matter adsorption by the adsorbent; pH of the solution also influences the active sites and therefore, solution chemistry. Effect of variation of pH on removal of COD is presented in Fig. 2. It is observed from Figure that COD removal increases with increase in pH up to 6 and decreases further with increase in pH. The removal rate of organic matter is observed to be increasing from pH 3 to 6. Further increase in pH doesn’t favor the adsorption. It is also seen from present study that the removal of organic matter observed to be maximum at corresponding pH value of 6. The dissolved oxygen content goes on increasing in between pH of 6 and 7. Further it drops to 5 at the pH of 10. The value of optimum DO was observed to pH is found to be 6 to 7.

3) Effect of contact time

Fig. 3 indicates the variation of Chemical oxygen demand and dissolved oxygen with contact time. The effect of contact time on COD of the effluent on DO of the diluted effluent (1% concentration) was studied by keeping the adsorbent dose and pH at optimum level i.e. 3 grams and 6 respectively. As contact time was increased the COD removal was found to increase up to 150 minutes. There after the adsorbent saturates and further increase in contact time has no effect on the COD removal. Also DO level increases from 3 mg/l to 8.5 mg/l. The optimum contact time was observed to be 150 minutes.
4) Effect of initial COD

Fig. 4 shows the variation of % COD removal and % DO increase with initial COD. The effect of initial COD i.e. organic matter concentration on COD removal and DO of the diluted effluent (1% concentration) was studied. The samples of various COD concentration were obtained by diluting the effluent. The % COD removal is high at high initial COD. This is because of high concentration difference. Excessively high initial concentration is not desirable.

The optimum initial concentration depends on the capacity of the adsorbent to adsorb the adsorbate. In the present case the initial COD concentration of 6000 mg/l found to be the optimum for maximum COD removal of 78%. The increase in DO is found to be 166%. With decrease in the initial COD from 6000 mg/l to 500 mg/l, the % COD removal decreases from 78% to 25%.

5) Adsorption isotherm

Fig. 5 shows the equilibrium data for Freundlich isotherms. At initial concentration of 6000 mg/l the effluent was treated with different amount of adsorbents (M). The equilibrium concentration (C*) was determined by allowing sufficient time to attain the equilibrium concentration C* and same was plotted against X/M. The amount of adsorbate adsorbed, X is the difference between initial concentration (C₀) and C*, the equilibrium concentration.

It is observed from Fig. 5 that adsorption process for present study reasonably follows the first order kinetics and Freundlich adsorption pattern.

![Fig. 5. Freundlich isotherms](image)

IV. CONCLUSION

The bagasse flyash is found to be effective adsorbent. The % COD removal obtained was 78 to 85 %. The adsorbent dosage, pH, contact time and initial concentration of organic matter have significant effect on the COD removal and dissolved oxygen. The dissolved oxygen content of the wastewater is the indicator of organic matter content of wastewater.

1. More the COD less is the DO because the DO is consumed by organic matter. If COD is less then DO is higher.
2. Also it is found that there is the limit for increasing the adsorbent dose for given amount of effluent. This should be carefully determined. Excess use can make the process uneconomical. Initial concentration plays important role. By carrying out studies on known initial concentration, optimum initial concentration is determined.
3. The adsorption is found to favor acidic conditions. The data obtained from the batch experiment can be very useful for column operation in deciding length of the column, initial concentration, residence time and flow rate.
4. The flyash can be regenerated by thermal regeneration in multi hearth or rotary furnace in presence of steam to volatize and carbonize organic matter. Other methods like chemical and biological are also available. Regeneration and disposal depends on the amount and the availability of the adsorbent.

5. At present flyash is disposed in the form of slurry. The efforts are being made to utilize fly ash as in productive methods as pozzolana in cement making, raw material for brick making, fire resistant material, insulation material, raw material for glass material.

V. REFERENCES


