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Original Research Article

Organic Matter Reduction by Adsorption: Comparative Studies with an Investigation on Affecting Parameters and Isotherms

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ABSTRACT

Organic matter removal from waste water is principle purpose behind treatment operations. Organic matter, if present in wastewater, reduces dissolved oxygen and forces the waster contaminants to undergo anaerobic decomposition. The treatment for organic matter removal can be carried out by various physical, chemical and biological methods, in combination or separately. The most important methods in biological and physic-chemical category are activated sludge process and adsorption. The adsorption with low cost adsorbents is feasible and economical method. In current research, three adsorbents namely, commercial activated carbon(AC), leaf litter derived adsorbent(LLDA)and wood charcoal derived adsorbent(WCDA) are used for studying their ability to removal organic matter measured as chemical oxygen demand(COD) and biological oxygen demand(BOD) from wastewater. The studies were carried out for parameters such as contact time, adsorbent dose and pH. With adsorbent dose and contact time, the adsorption increased for initial increase and then remained constant. The pH value of 6 provided best results for all three adsorbents.

Key words: Adsorbents, organic matter, contact time, concentration, isotherm, biological oxygen demand.

INTRODUCTION

Industrial effluent contains various organic and inorganic impurities. Chemical oxygen demand (COD, mg/l) is amount of oxygen required for chemical decomposition of organic matter present in wastewater. Biological oxygen demand (BOD, mg/l) is oxygen required for biological decomposition of organic impurities. COD to BOD ratio is important factor while deciding nature of treatment methods. High BOD indicates high biological organic matter. For industrial effluent maximum limit for COD is 250 mg/l as per regulatory norms. The dissolved oxygen depletion due to organic matter leads to adverse and fatal effects on aquatic life, unpleasant odour and bad taste. Effluent treatment plant normally contains primary, secondary and tertiary treatment methods. In primary methods, coarse solids are removal by screens or primary sedimentation. Secondary treatments are biological treatments. Many investigations are reported on parameter studies in suspended growth and activated sludge process for removal of organic matter from effluents. [1-7] Trickling filters are also used for wastewater treatments. Attached growth of the microorganism rather than suspended mechanism differentiates these from activated sludge processes. Membrane separation is also one of the important methods for desalination and water purification. [8-13] Other methods include mainly electro dialysis and chemical treatments. [14-17] Adsorption is one of the most important physico-chemical treatment methods. Investigations have been reported on removal of organic matter by using various low cost adsorbents. [18-21] These studies were aimed and studying affecting parameters and isotherms and kinetics. In current research, three adsorbents namely, commercial activated carbon(AC), leaf litter derived adsorbent(LLDA) and wood charcoal derived adsorbent(WCDA) are used for studying their ability to removal organic matter measured as chemical oxygen demand(COD) and biological oxygen demand(BOD) from wastewater.

The studies were carried out for parameters such as contact time, adsorbent dose and pH. The batch experimental data was also tested for isotherms.

MATERIALS AND METHODS

The waste water from nearby common effluent treatment plant was used for the investigation. The initial COD was determined by using potassium dichromate as oxidizing agent and COD digestion apparatus (spectralab-make). BOD_5 was also determined by using DO difference. The COD was adjusted by proper dilution to normalized values. The adsorbents were prepared by washing the raw material with distilled water. Then the material was washed with acid and again washed with water. Then it was thermally activated at 500 ^{o}C. The pH of samples was adjusted with dilute hydrochloric acid and dilutes sodium hydroxide when required. Then 50 ml of samples were agitated for required time in a conical flask, filtered and analyzed for COD and BOD.

RESULTS AND DISCUSSION

A. Effect of Contact Time

Fig.1 (A, B) indicates the chemical and biological oxygen demand at different time intervals for three adsorbents. It was observed that there is sharp drop in COD in initial period. It gradually becomes less steep and eventually after certain time, the effect of contact time diminishes. This may be due to saturation of adsorbents. The optimum contact times for these three adsorbents for initial COD of 5000 mg/l and 2 grams of adsorbent dose were observed to be 75, 90 and 105 minutes respectively with final COD values 500, 600 and 601 mg/l. This indicates that the new low cost adsorbents are comparable with commercial adsorbent in terms of contact time. Though there is 25- 40 percent rise in contact time, it can offset by cost and environmental factors.

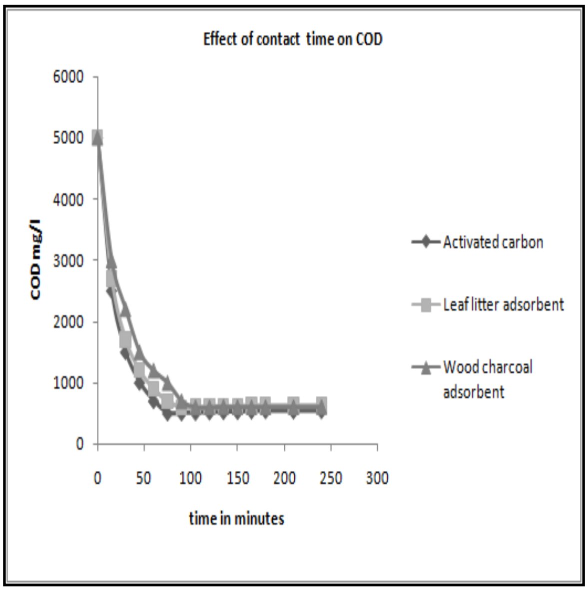

Fig 1A: effect of contact time for COD

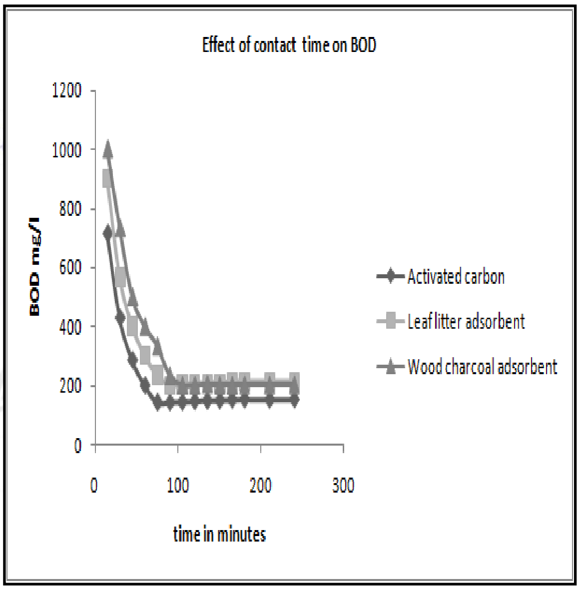

Fig 1B: effect of contact time for BOD

B. Effect of Adsorbent Dose

Fig.2 (A, B) indicated the chemical and biological oxygen demand at different adsorbent dosage for three adsorbents. It was observed that there is sharp drop in COD for initial rise in adsorbent dosage. It gradually becomes less steep and eventually after certain dosage, the effect of adsorbent dose diminishes. The optimum adsorbent dosage for these three adsorbents for initial COD of 5000 mg/l and optimum contact time were observed to be 2.5, 2.5 and 3 grams respectively with final COD values 400, 700 and 809 mg/l. This indicates that the new low cost adsorbents are comparable with commercial adsorbent in terms of adsorbent requirement. Though there is 25-30 percent rise in adsorbent dose for LLDA, it can offset by cost and environmental factors.

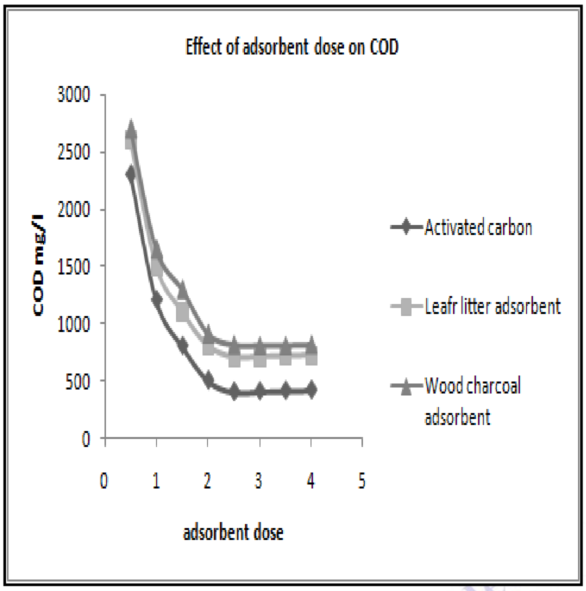

Fig 2A: Effect of adsorbent for COD

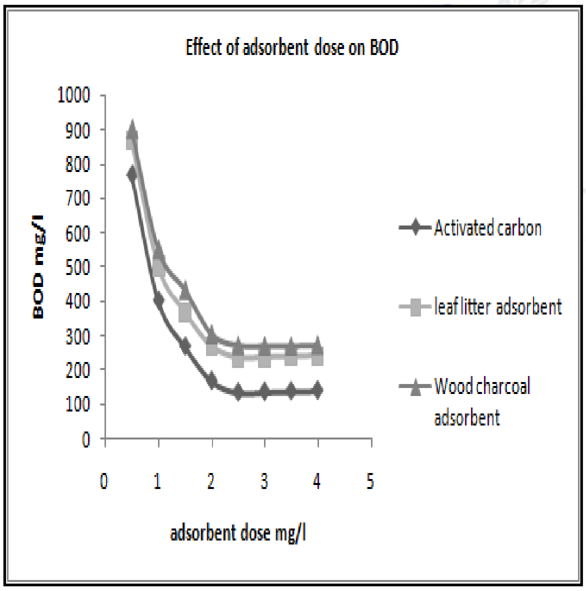

Fig 2B: Effect of adsorbent dose for BOD

C. Effect of pH

Fig.3 (A, B) indicated the chemical and biological oxygen demand at pH for three adsorbents. It was observed that there is sharp drop in COD for initial rise in pH. It gradually becomes less steep and eventually after certain pH, the effect of pH diminishes. With rise in pH above 6, the removal of COD is adversely affected. The pH for these three adsorbent was 6 with final COD values 500, 700 and 600 mg/l respectively. This indicates that the new low cost adsorbents are comparable with commercial adsorbent in terms of adsorbent requirement.

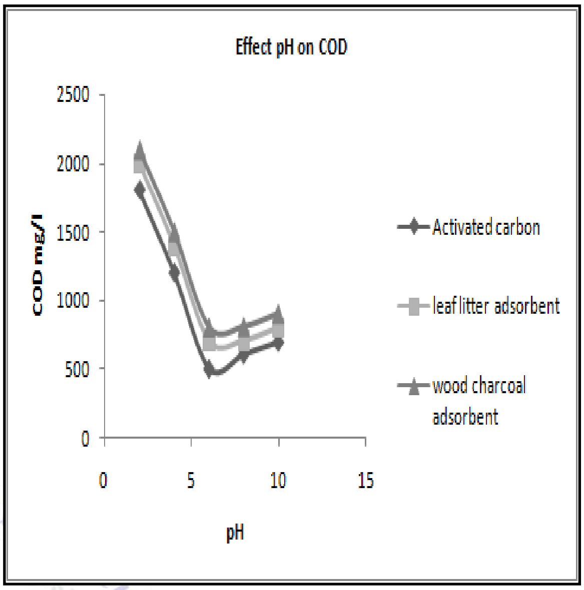

Fig 3A: effect of pH for COD

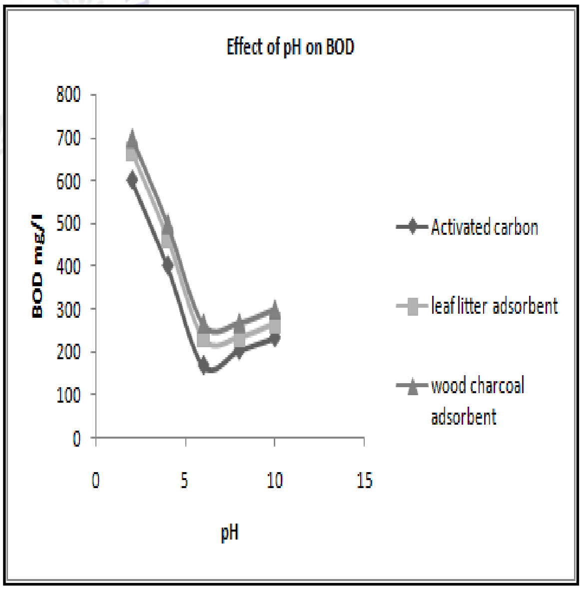

Fig 3B: Effect of pH for BOD

ADSORPTION ISOTHERMS

The Freundlich isotherm was plotted as ln X/M verses ln C*, where C* is equilibrium concentration, X, amount adsorbed of adsorbate and M, mass of adsorbent. Langmuir plot was plotted as 1/X/M verses 1/C*. The adsorption by activated carbon follows Langmuir isotherm with R^2 value of 0.988. It agrees with Freudlich equation with R^2 value of 0.88. This shows physic-chemical nature of removal mechanism. The isotherms for activated carbon are shown in figure 4.1A and B). For other two adsorbents also freundlich equation is satisfied by the experimental data reasonably well. The Langmuir equation indicated better fit for the batch experimental data than Freundlich equation.

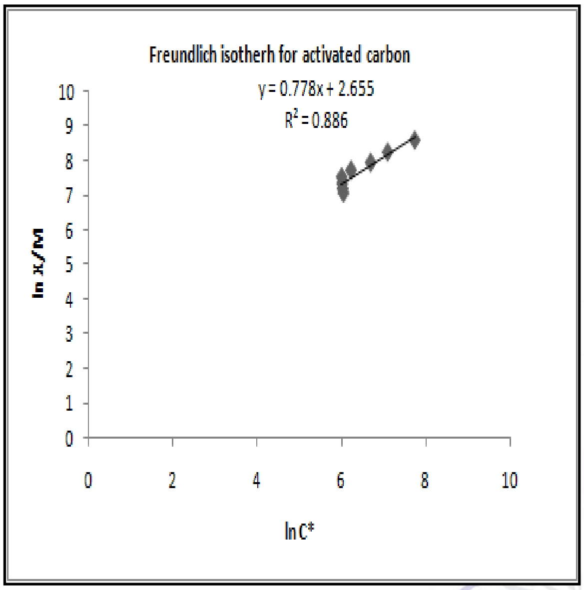

Fig.4.1A: Freundlich isotherm for AC

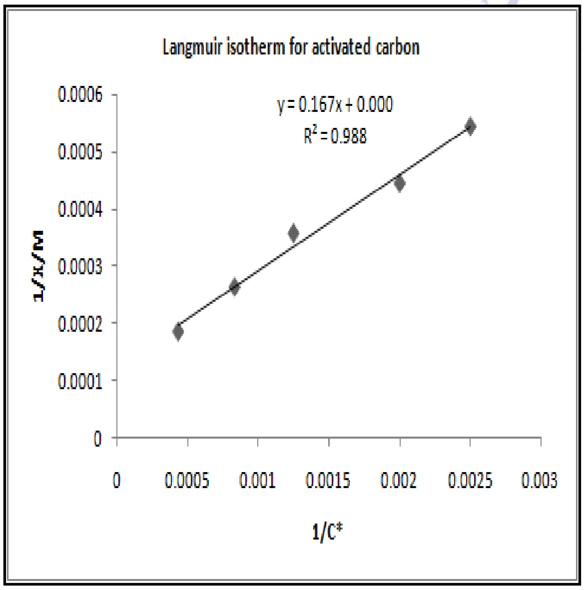

Fig.4.1B: Langmuir isotherm for AC

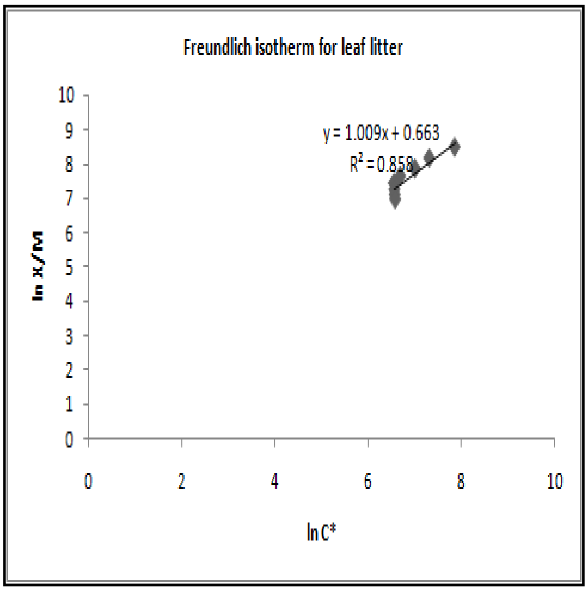

Fig.4.2A: Freundlich isotherm for leaf litter adsorbent

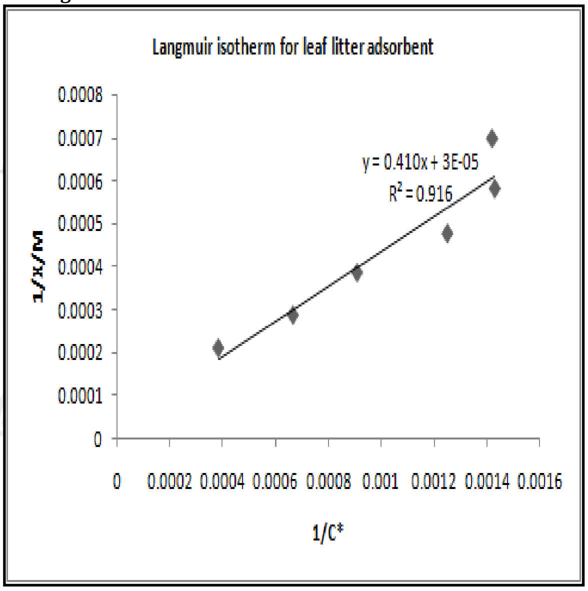

Fig.4.2B: Langmuir isotherm for leaf litter adsorbent

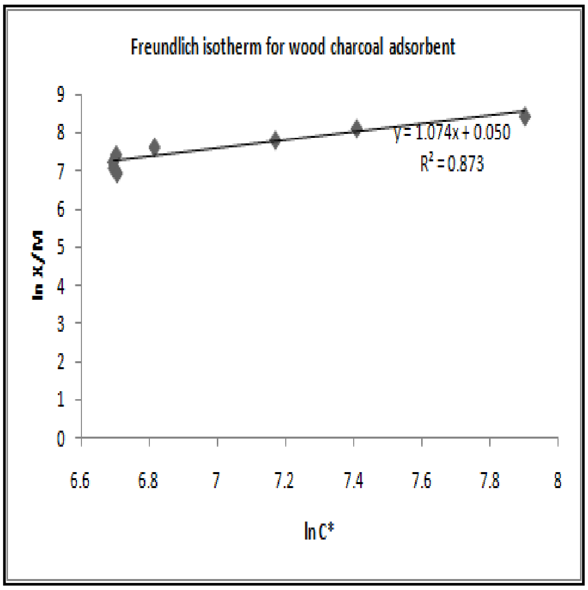

Fig.4.3A: Freundlich isotherm wood charcoal adsorbent

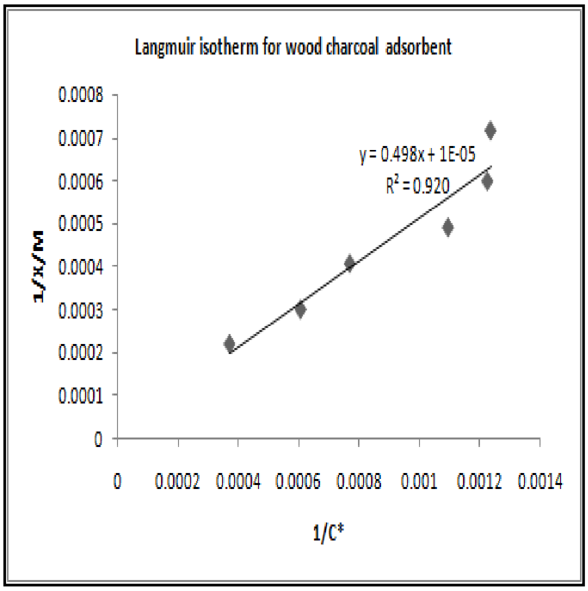

Fig.4.3B: Langmuir isotherm wood charcoal adsorbent

CONCLUSION

It was observed that there is sharp drop in COD in initial period. It gradually becomes less steep and eventually after certain time, the effect of contact time diminishes. The optimum contact times for these three adsorbents for initial COD of 5000 mg/l and 2 grams of adsorbent dose were observed to be 75, 90 and 105 minutes respectively with final COD values 500, 600 and 601 mg/l. The optimum adsorbent dosage for these three adsorbents for initial COD of 5000 mg/l and optimum contact time were observed to be 2.5, 2.5 and 3 grams respectively with final COD values 400, 700 and 809 mg/l. The pH for these three adsorbent was 6 with final COD values 500, 700 and 600 mg/l respectively. The Langmuir equation indicated better fit for the batch experimental data than Freundlich equation.

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