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Original Research Article

An Investigation on Factors affecting Breakthrough Curve for Low Cost Adsorbent

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ABSTRACT

Adsorption using low cost adsorbent is effective method for organic matter removal from wastewater. For treatment of organic matter, generally packed beds are used. Other contacting patterns like fluidized beds are also investigated. Removal of various pollutants from effluent using packed beds is widely used treatment method. Bed height and flow rate are two key factors affecting column operation. Though the column is often designed based on batch experimental data, it is important to know the behavior of the adsorption phenomenon with respect to flow rate and bed height variations. In present investigation effect of flow rates and bed height on the nature of break through curve is studied for three adsorbents namely activated carbon, leaf litter adsorbent and wood charcoal adsorbent.

Key words: Adsorbate, adsorbent, height, flow rate, breakthrough curve.

INTRODUCTION

Adsorption for removal of various pollutants is very efficient and adoptable method for liquid effluent. Investigations are reported from removal of organic matter (COD) in packed bed by various investigators. [1-5] Most of the investigations are aimed at studying effects of parameters like flow rate and bed height on the removal efficiency and breakthrough curves. The studies are reported on packed bed removal of phenolic compounds from wastewater. [6-10] Also heavy metal removal in packed bed has also been reported. [11,12] The modeling for breakthrough curves is important aspect in packed bed studies. Various investigators have reported studies on model fitting for Thomas and Yoon Nelson models. [13,14] Use of low cost adsorbent is being explored to minimize cost. In current research, effect of flow rate and bed height for three low cost adsorbents is reported.

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^oC. Packed column with 60 cm height and 4.5 dia. was used. The flow rates were adjusted by using needle valve. The column was having a sprinkler at the top inlet and wire mesh at the bottom. Flow rate was measured by rotameter. The sample was collected after every half hour interval. The experiments were carried out at different bed heights and flow rates.

RESULTS AND DISCUSSION

Initial studies were carried out with 35 cm bed height and 50 ml per minute flow rate to have rough estimates of the COD removal. It was observed that activated carbon reached the break through point in 25 minutes. The break through times for other two adsorbent were slightly more. Activated carbon was best adsorbent with almost 88 percent removal. Wood charcoal showed 84 percent removal. Leaf litter showed 85-87 percent removal. It can be said that the ability of the new adsorbent is

comparable with the conventional adsorbent. Exhaustion time was maximum for wood charcoal adsorbent and minimum for activated carbon. The break through time was time required for the outlet concentration to reach 10 percent of initial concentration. The exhaustion time is considered as time required for exhaustion of bed capacity to adsorb the adsorbate.

Fig.1 shows the COD behavior at various time intervals for these three adsorbents. Fig. 2, 3 and 4 indicates effect of flow rate on break through curves. It was observed that as flow rate is increased, the break through time reduces. Also exhaustion time decreases. For all three adsorbents this behavior was observed. This may be due to rapid availability of adsorbate. Figure 5,6 and 7 indicates the effect of bed height on breakthrough curves. It was observed that the break through is delayed with increase in the adsoption column heights. Table 1 to 3 summarizes results for bed height and adsorption column height. Break through time (tb) and exhaustion time (t_e) are shown at various value of these parameters in the table.

Table1: Activated carbon column studies

Flow rate ml/min	**25**	**50**	**75**
Break through time, minutes	25	20	17
Exhaustion time, minutes	240	240	210
Bed height,cm	**35**	**45**	**55**
Break through time, minutes	20	24	29
Exhaustion time, minutes	235	240	240

Table2: Leaf litter column studies

Flow rate,ml/min	25	50	75
Break through time	27	22	20
Exhaustion time,minutes	240	210	210
Bed height,cm	35	45	55
Break through time, minutes	22	26	33
Exhaustion time, minutes	250	250	250

Table3: Wood charcoal column studies

Flow rate	**25 .ml/min**	**50 ml/min**	**75 ml/min**
Break through time	30	25	22
Exhaustion time	255	225	200
Bed height	35 cm	45 cm	55 cm
Break through time, minutes	24	30	39
Exhaustion time, minutes	250	240	240

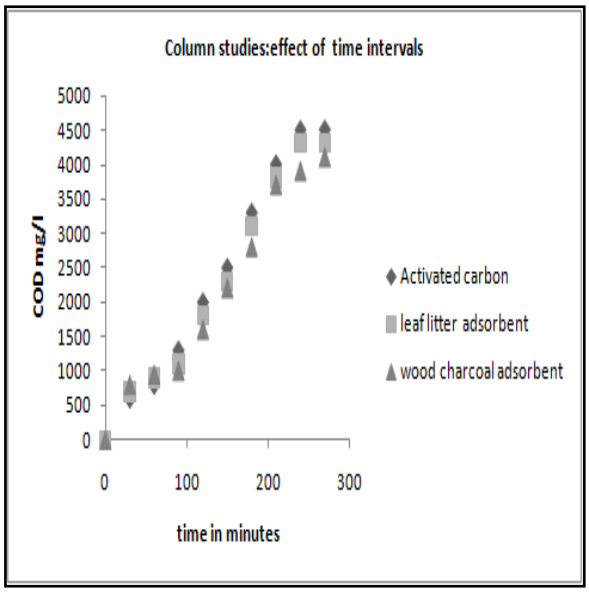

Fig1: Column studies for different adsorbents

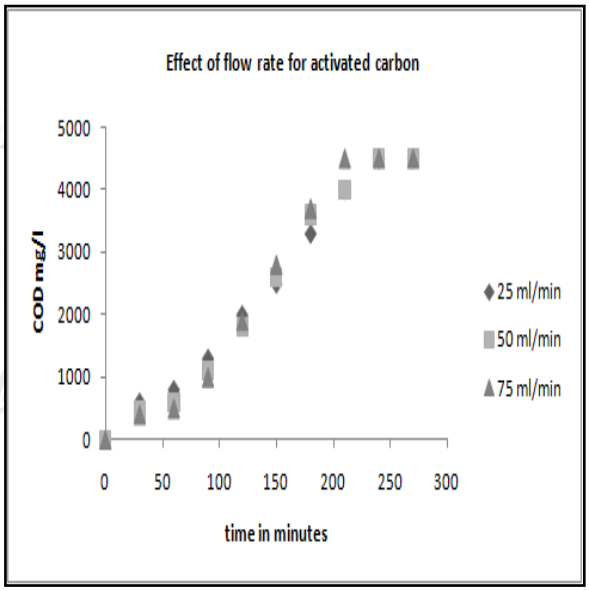

Fig2: Effect of flow rate for activated carbon

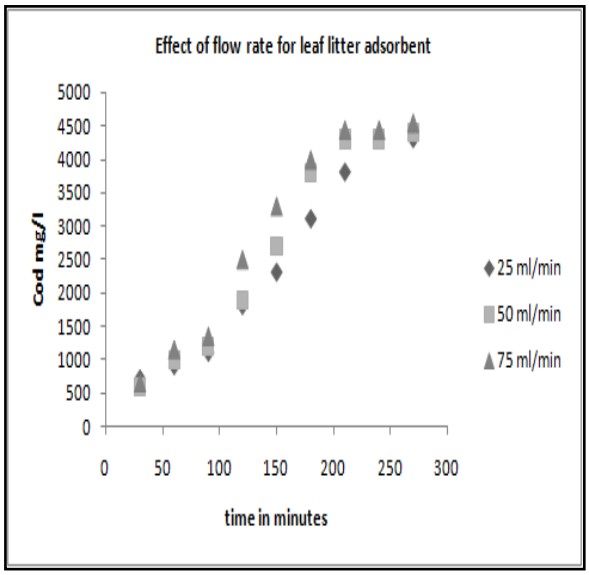

Fig3: Effect of flow rate for leaf litter adsorbent

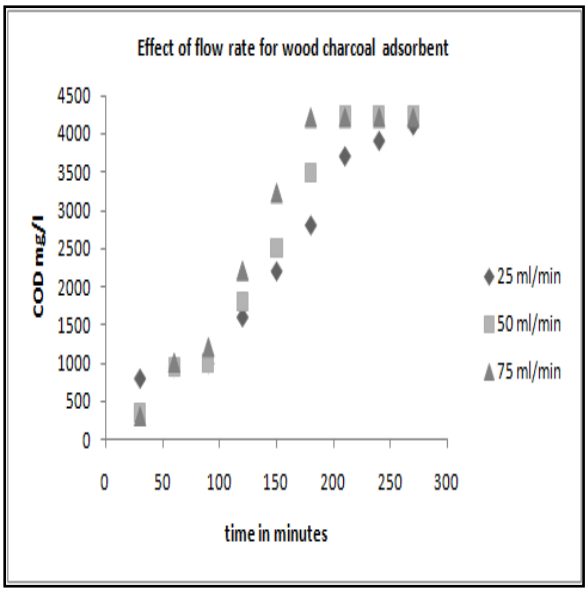

Fig4: Effect of flow rate for wood charcoal adsorbent

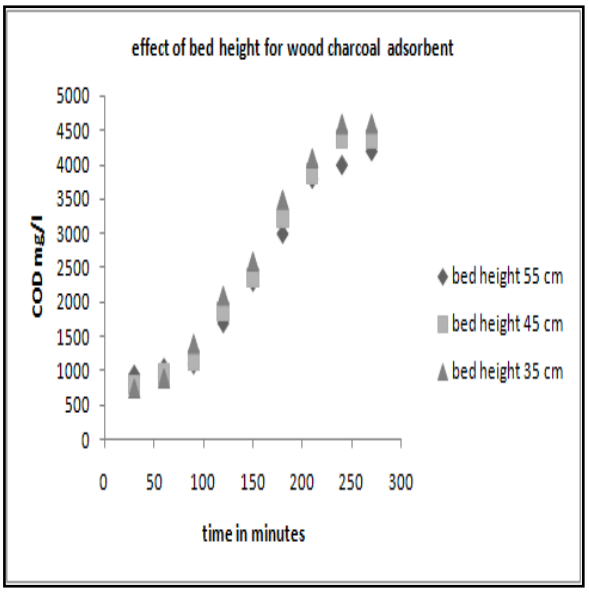

Fig7: Effect bed height for wood charcoal adsorbent

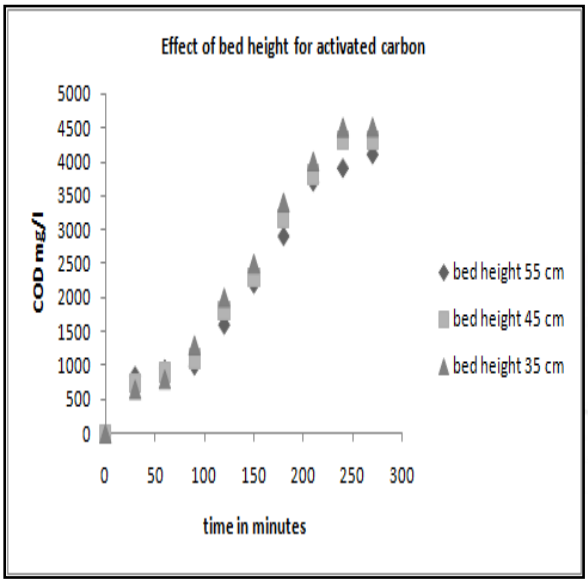

Fig5: Effect bed height for activated carbon

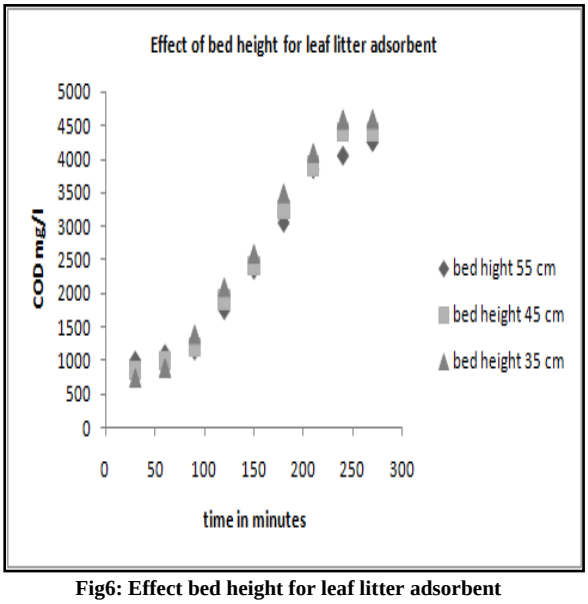

Fig6: Effect bed height for leaf litter adsorbent

CONCLUSION

In present investigation effect of flow rates and bed a height on the nature of break through curve is studied for three adsorbents namely activated carbon, leaf litter adsorbent and wood charcoal adsorbent. It was observed that activated carbon reached the break through point in 25 minutes. The break through times for other two adsorbent were slightly more. Activated carbon was best adsorbent with almost 88 percent removal. Wood charcoal showed 84 percent removal. Leaf litter showed 85-87 percent removal. It was observed that as flow rate is increased, the break through time reduces. For all three adsorbents this behavior was observed.

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