CHAPTER 7

CONCLUSIONS AND FUTURE SCOPE OF WORK

7.1 Conclusions

Both experimental and theoretical studies have been carried out for the dynamic adsorption of the removal of toluene and xylene separately on granular activated carbon. The experiments were carried out under various inlet concentrations and varying bed heights. Following conclusions have been drawn based upon the experimental studies:

- The experimental studies revealed that granular activated carbon is a potential adsorbent for capturing both toluene and xylene at low concentration levels, due to its high BET surface area.
- The breakthrough time during adsorption was observed to considerably decrease with increase in the inlet concentration levels suggesting utility of the adsorption method for controlling VOC from gaseous effluent at low concentration levels.
- The breakthrough time during adsorption was found to be increasing with increase in bed height suggesting greater utilization of bed at greater bed heights.

A mathematical model for predicting the behavior of breakthrough curves in a fixed bed adsorption column was also developed and it was based on two governing equations: (1) the species balance of the component in the bulk phase, and (2) species balance inside the pores of the adsorbent. The mathematical model has been found to be robust in predicting the behavior of breakthrough curves under varying operating conditions such as flow rate, inlet concentration, bed height, particle diameter and effective diffusivity. The Langmuir isotherm was found appropriate in explaining adsorption behavior of toluene and xylene on granular activated carbon. Following conclusions have been drawn based on the simulation studies:

- The experimental and model predicted results were found to be in good agreement with each other.
From sensitivity analysis flow rate was found to be most sensitive parameter with respect to breakthrough time suggesting the process to be externally mass transfer controlled under experimental conditions for both toluene and xylene.

Effect of pore diffusivity on adsorption rate was found to be significant at high flow rates implying adsorption process is limited by pore diffusion whereas the effect of pore diffusivity on adsorption rate was found to be insignificant at lower flow rates implying adsorption process to be external mass transfer controlled.

The breakthrough time was found to be increasing with the decrease in particle radius and steeper breakthrough curves were obtained following breakthrough suggesting the use of adsorbent with smaller diameter which also increase the length of bed utilized up to breakthrough and efficiency of the adsorbent.

Concentration of solute in the pores along the radial direction for the adsorbent particle and along the axial direction of the length of the column as a function of time was also predicted with the help of a developed mathematical model for better understanding of the adsorption process within the pores of the adsorbent. Similarly the concentration of solute in the bulk phase along the axial direction of the column has been predicted as a function of time from where the movement of the mass transfer zone can be seen.

Finally breakthrough curves were drawn for both xylene and toluene for the same set of parameters over granular activated carbon and breakthrough time of xylene was found to be more in comparison to breakthrough time of toluene suggesting the better performance of granular activated carbon in adsorbing higher molecular weight solutes.

7.2 Future Scope of Work

The following recommendations are made to carry out further studies:

Studies on the removal of mixtures of VOCs may be carried out on granular activated carbon or with other types of adsorbent materials like zeolite, activated carbon fiber etc.

Other major area which can be studied is desorption.

Experimental studies can also be done for finding the effect of particle diameter, pore size and flow rate on breakthrough curve.

Present mathematical model can be further modified by introducing velocity variation term.