CHAPTER IV

RESULTS AND DISCUSSION

In this experiment, sodium dodecyl sulfate $(CH_3(CH_2)_{11}SO_4^-Na^+)$ is an anionic surfactant used. It has a CMC of $8.3 * 10^{-3}$ M. in the absence of added electrolyte and forms roughly spherical micelles containing about 70 surfactant molecules. (Lionos et al., 1984)

4.1 TCE loading on virgin carbon

Figure 4.1 shows breakthrough curves for adsorption of model TCE on virgin carbon (no regeneration). The breakthrough curves are sharp and reproducable. The virgin carbon saturated at approximately 1400 mins. The equilibrium amount of TCE adsorbed is approximately 0.390 ± 0.01 grams of TCE /gram of activated carbon.
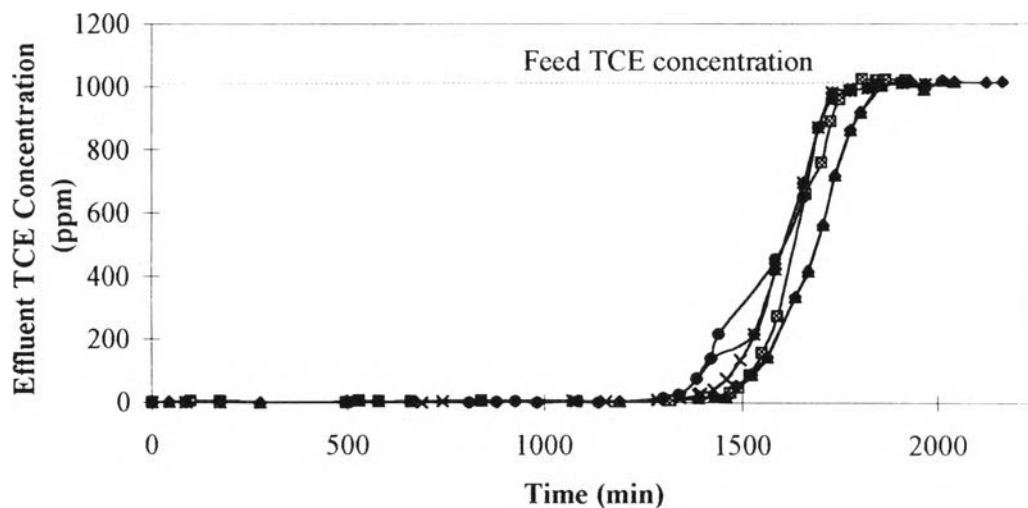

Figure 4.1 Breakthrough curves for TCE adsorption on virgin carbon.

4.2   Effect of regenerant flow rate

From Figure. 4.2, the number of pore volumes required to reach a specified percentage recovery of TCE increases when the regenerant solution flow rate is increased from 5 to 40 mL/min. Since the number of pore volumes of regenerant solution required to attain a specified fractional TCE removal would be independent of flow rate if the regeneration were equilibrium limited, these results indicate substantial mass transfer resistance. Therefore, to minimize the volume regeneration solution needed, flow rate should be minimized.On the others hand, as shown in Figure 4.3, the lower the flow rate used, the longer the regeneration time required to remove TCE to specific levels.
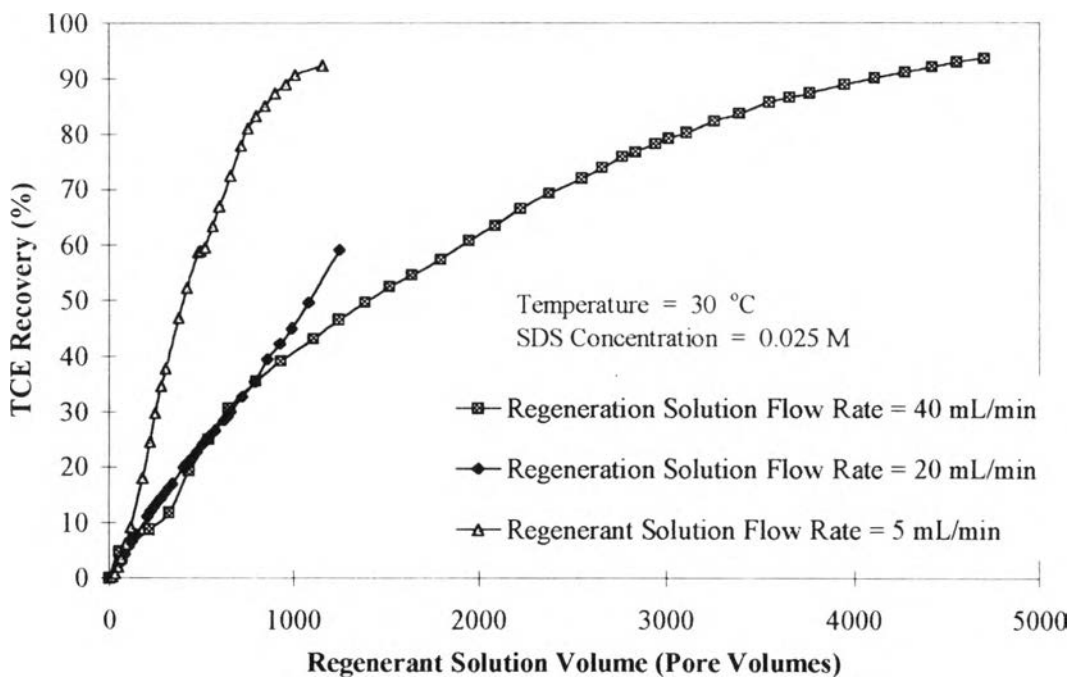

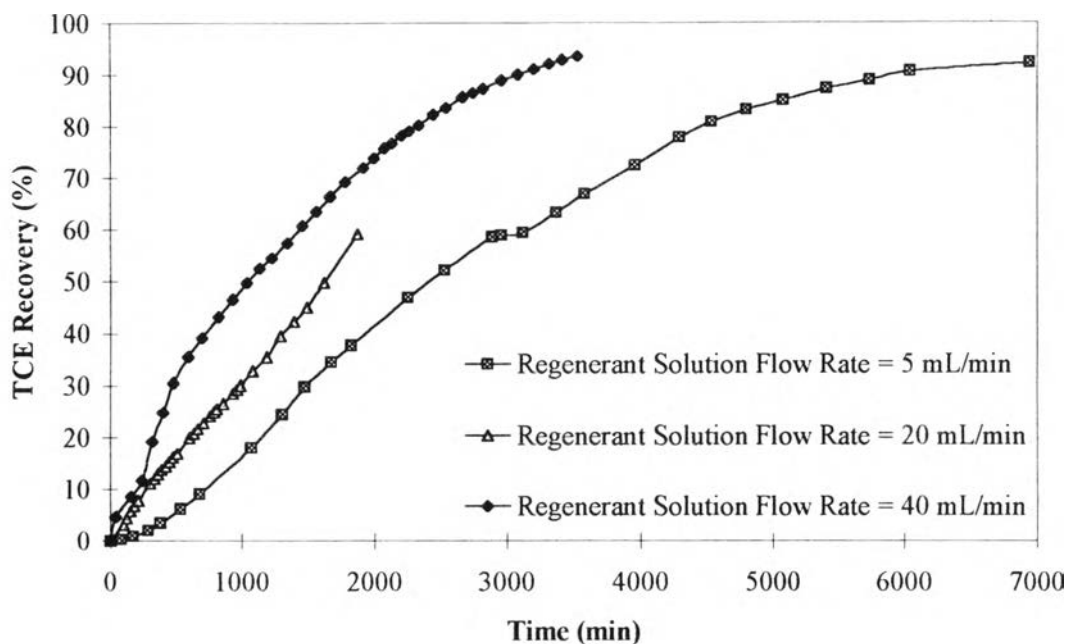**Figure 4.2** Effect of regenerant solution flow rate on TCE removal.

Figure 4.3 Effect of regenerant solution flow rate on TCE removal.

4.3 Effect of surfactant concentration in regenerant solution

As seen in Figure 4.4, the surfactant concentration has little effect on the removal of TCE for a given volume of regenerant solution. If the regeneration were equilibrium limited, the fractional TCE removal would be approximately proportional to the concentration of surfactant in micellar form passed through the column. The lack of surfactant concentration effect also is consistent with the regeneration step being mass transfer limited.
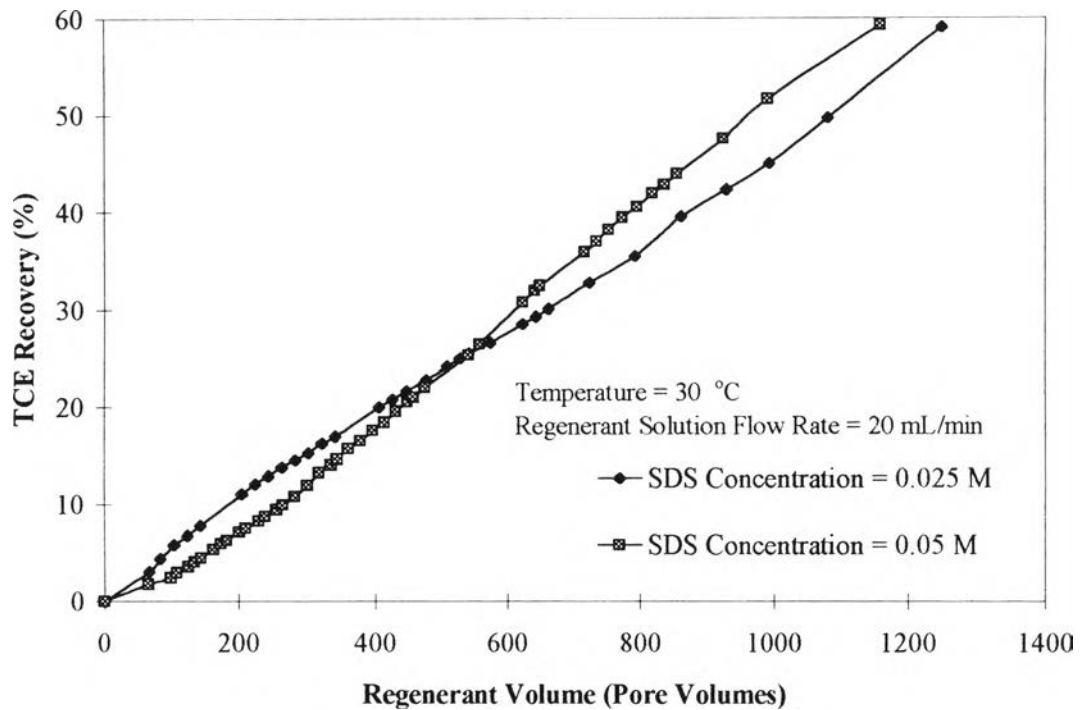
Figure 4.4 Effect of regenerant solution surfactant concentration on TCE removal.

4.4 Surfactant removal in water flushing step

As seen in Figure 4.5, about half of the residual of SDS is removed in the water flushing step after about 1000 pore volumes of flush solution. The flow rate has litlle effect on the number of pore volumes required to flush the surfactant from the carbon following the regeneration step, indicating that this step is also mass transfer limited.
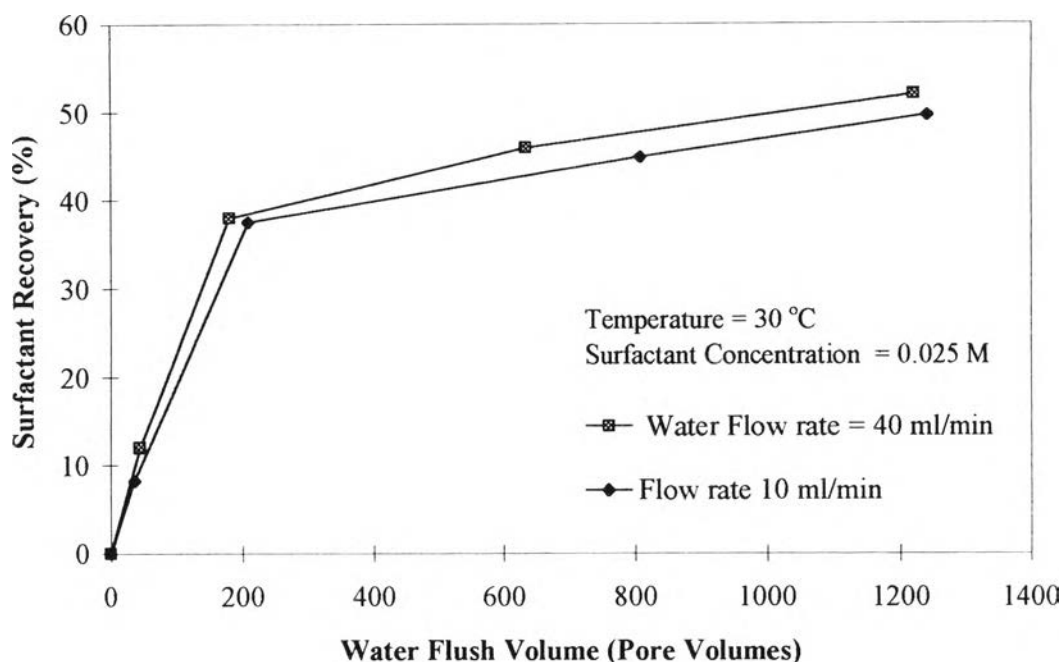
Figure 4.5 Effect of water flush flow rate on SDS removal.

4.5 Desorption breakthrough curves on regenerated carbon

Figure 4.6 illustrates the adsorption capacity of carbon, after regenerated with 4700 pore volumes of 0.025 M SDS at 40 mL/min, washed with 1400 pore volumes water and dried for 24 hours. In this experiment, approximately 95% of TCE can be removed from the carbon bed, but the heel of adsorbed solute is very difficult to remove. And nearly half of surfactant still remain in the carbon bed. However, The equilibrium adsorption efficiency decreases 5% from 0.375 grams of TCE/gram of carbon to 0.356 grams of TCE/gram of carbon after regeneration.

Arbitrarily setting an acceptable effluent TCE concentration at 5% of the feed concentration (50 ppm based on a feed of 1000 ppm), the effective adsorption capacity of the regenerated carbon is 95 % of the capacity of the virgin carbon. This modest reduction in adsorption capacity is remarkable

because approximately half of the surfactant remains on the carbon after the water flush. In contrast, in liquid phase adsorption of phenol (Bhummasobhana et.al,1995), the residual surfactant on the carbon resulted in the regenerated carbon only having 55 % to 75 % percent of the capacity of virgin carbon. The residual surfactant in the vapor phase application may became precipitate crystals during drying while remaining as adsorbed molecules in the liquid phase application. In the former case, the surfactant precipitate has a modest effect on adsorption capacity of the activated carbon while the adsorbed surfactant layer substancially reduces the equilibrium solute adsorption capacity of the carbon and / or sets up diffusional barriers to solute adsorption, resulting in a reduction in effective adsorption capacity. From a practical point of view, application of SECR to vapor phase activated carbon appears to be more promising than liquid phase application.

Moreover, from BET surface area report, its pore size distribution was shown that majority of its pores concentrated in the micropore region (pores less than 100 Angstroms in diameter). And the rest portion belong to macropores. These micro pores provide a good retention of the adsorbed molecules and adsorbates mobiling easily while regeneration step. Moreover, macropores(pores larger than 1000 Angstroms in diameter) will provide large paths for the rapid diffusion of gases to and from the micro pore surfaces. These range of pore size resulted in the enhance both adsorption and regeneration step.

But for standard liquid phase activated carbon, there is a wider range of pore size. So residuals surfactant resulted in blocking paths for subsequent adsorption step. Then a reduction of adsorption capacity occured for liquid phase application.

This result is consistent with the previous work by Roberts et al. (1989) in which amyl acetate (molecular weight of 130) was shown to be regenerated using SECR with a significant mass transfer limitation. Since TCE (molecular weight 131) has similar size and diffusivity, it is reasonable that the two molecules would behave similarly during regeneration..
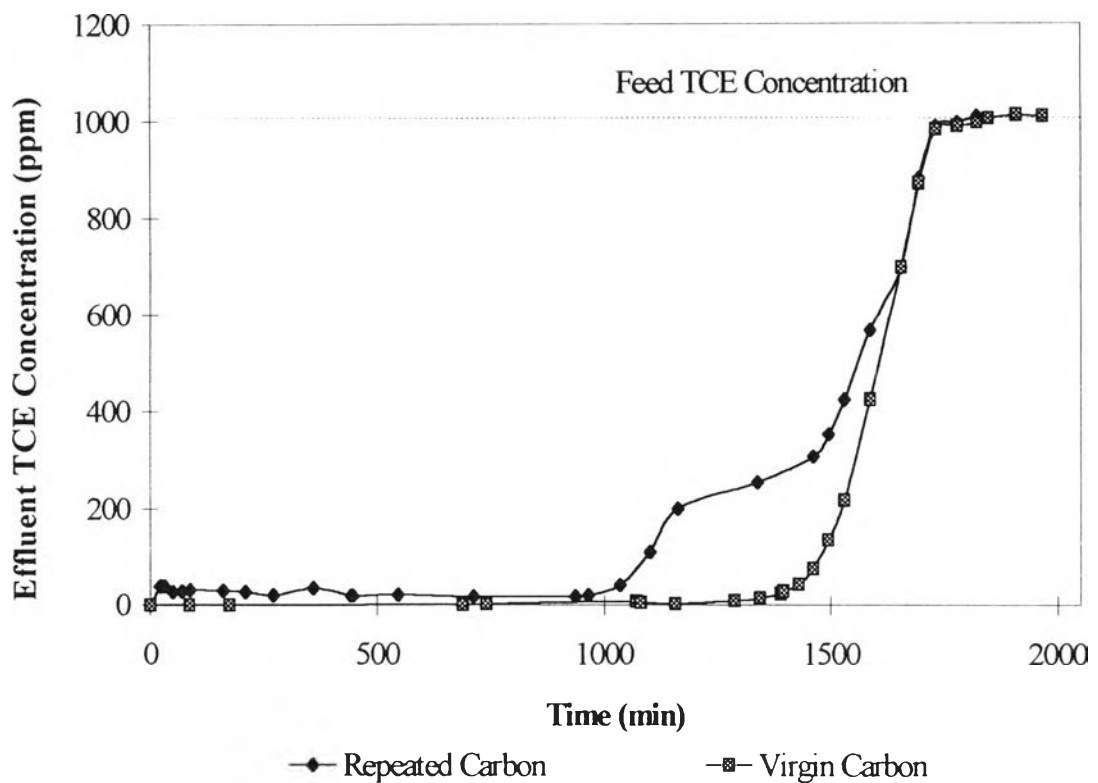

Figure 4.6 Breakthrough curve for TCE adsorption on virgin carbon and regenerated carbon.