

## CHAPTER V

### CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Conclusions

In this study we studied the adsorption of two single surfactants and a binary mixture of the two, using the cationic surfactant CTAB and the nonionic surfactant Triton X-100, at three different pH values (3, 5 and 8) on precipitated silica. We then examined the adsolubilization of three organic compounds, benzene, toluene, and ethylbenzene, into the adsorbed surfactant aggregates in each surfactant system. From the adsorption studies, it can be seen that CTAB and mixed CTAB/Triton adsorption on Hi-Sil<sup>®</sup>255 silica at pH 8 is higher than those at pH 5 and pH 3 at every equilibrium concentration, whereas the effect of pH is not significant in Triton adsorption. The observed effect of pH can be attributed to the increase in the surface charge of silica as pH increases, thus leading to a higher adsorbed amount and more tightly packing of the surfactant on the silica surface as well as a higher polarity of the surface. In addition, the results indicate that the adsorption of CTAB on Hi-Sil<sup>®</sup>255 is much higher than that of Triton X and mixed CTAB/Triton. This is attributed to the preferential adsorption via electrostatic interaction between CTAB and silica surface more than the hydrogen bonding between Triton X and silica surface leading to the tighter packing of CTAB molecules. The presence of Triton-X 100 in mixed CTAB/Triton system causes lowered adsorbed amount of surfactant as well as a reduction in CMC of the mixed surfactant system when compared to the pure CTAB system. A possible explanation is that the ionic head groups of CTAB molecules are separated from each other by the nonionic surfactant head groups, thus causing in the reduction in electrostatic repulsion of the head groups

From the adsolubilization studies, the results show that the adsolubilization of three organic compounds, benzene, toluene, and ethylbenzene, are found to depend on the amount of surfactant adsorbed on silica as well as the packing of the surfactant molecules and the polarity of the solute. The adsolubilization of three organic solutes is highest in the CTAB system, whereas the lower adsorption is

observed in the Triton and mixed CTAB/Triton systems. This is attributed to the tighter packing of CTAB molecules from the highest CTAB adsorption on silica surface. Moreover, benzene is the only solute which solubilized more in the mixed CTAB/Triton system than in the pure Triton system. This may be due to the differences in polarity and structure of the three solutes. Benzene has no attached branching whereas toluene and ethylbenzene has methyl and ethyl groups, respectively. The effect of pH is clearly observed in CTAB system, that is, the adsolubilization of three organic solutes at pH 8 is higher than those at pH 5 and pH 3, respectively. This is possibly due to (1) the increase in polarity of the surface at pH farther from the point of zero charge causes polar organic solute (benzene and toluene) to adsolubilize more near the lower part of the admicelle, (2) tighter packing of admicelle as pH increases, thus preventing the penetration of water molecules into the palisade region of the admicelle. Consequently, this increases the core volume allows more of the more non-polar organic solute (ethylbenzene) to adsolubilize. The partition coefficient (K) obtained from the adsolubilization data indicates that the location of benzene is in both head and palisade regions, whereas toluene is adsolubilized in palisade and core regions. In contrast to benzene, ethylbenzene is mostly in the core region. This is consistent with the difference in polarities between the three solutes.

## 5.2 Recommendations

Upon the completion of this study, effect of pH on adsolubilization of organic compounds in mixed cationic-nonionic surfactant admicelles has been examined. It would be interesting to further study both adsorption and adsolubilization in a binary system of anionic-nonionic surfactants to compare with the mixture of cationic-nonionic surfactants. In addition, the adsolubilization by admicelles of surfactant mixtures should be investigated in more details using relevant techniques such as atomic force microscopy (AFM).