CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

A summary from the flash vacuum stripping study of toluene in coacervate phase solution using t-Octylphenolpolyethoxylate (Triton X-114) or $OP(EO)_7$ as nonionic surfactant is as follows:

1. *Henry's law constants and partition coefficient determination*
   - Henry's law constant of toluene in water system at 30°C (Vane and Giroux, 2000)

     $$H_{Tr} = 6.8\times10^{-5} \text{ atm/ppm}$$

   - Henry's law constant of toluene in surfactant solution system with initial $[OP(EO)_7]$ 300 mM, at 30°C

     $$H_{App} = 3.0\times10^{-6} \text{ atm/ppm}$$

   - Partition coefficient of toluene and water in coacervate phase solution
     with initial $[OP(EO)_7]$ 300 mM, at 30°C in vacuum system

     $$K_{Toluene} = 262.8$$

     $$K_{Water} = 1.0734$$

   The dramatic decreasing of Henry's law constant of toluene in surfactant system is due to partitioning of toluene into surfactant micelles. This partitioning significantly affects the apparent vapor liquid equilibrium of toluene in surfactant solution and complicates the removal of toluene from surfactant solution by standard separation processes.

2. *The co-current flash vacuum stripping operation*

   The co-current mode of vacuum stripping operation eliminates the foaming of coacervate phase solution. No plugging and flooding are observed. The equipment is successful in continuous operation. However, a little foam is observed at the liquid distributor, while foaming at the other parts of the packed column is not noticed.

Moderate pressure drop (0-78 torr/m) is observed across the packed column, probably because of the relatively high viscosity of liquid phase.

3. Effect of liquid flow rate on the overall volumetric mass transfer coefficient (K_xa), number of transfer unit (NTU), and height of transfer unit (HTU)

At liquid flow rate lower than 13 ml/min, channeling is occurred, and causes the K_xa of toluene drop with an increasing in liquid flow rate. However, beyond this liquid flow rate, channeling is eliminated, as a result, the effective contacting area is increased, leading to higher K_xa.

At higher liquid flow rate, the efficiency of the packed column should be less than at lower liquid flow rate. Therefore, NTU is expected to be decreased while HTU is increased. However, the NTU and HTU are relatively constant with the liquid flow rate since the effective contacting area is increased, therefore the efficiency of the column is unchanged.

4. Effect of liquid flow rate on surfactant concentration in product stream

The surfactant concentration in effluent stream remained relatively constant even with changes in liquid flow rate.

5. Effect of pressure on overall volumetric mass transfer coefficient (K_xa), number of transfer unit (NTU), and height of transfer unit (HTU)

K_xa of toluene increases with decreasing pressure. At pressure above 100 torr, the effect of pressure on K_xa is not significant. However, if the pressure is lower, the K_xa is significantly increased.

In the same way of K_xa, NTU is significantly increased while HTU is considerably decreased when pressure below 100 torr.

6. Effect of pressure on surfactant concentration in product stream

The surfactant concentration in effluent stream is relatively constant even though the pressure is changed.

5.2 Recommendations

Based on the studies done in this work, the following recommendations are given for future research.

1. Liquid distributor should be redesigned and installed for better feed distribution and better effective contacting area between liquid and gas phase. In addition, liquid redistributor, wall wiper, and height of column should be added to improve the separation efficiency.

2. Find the vapor-liquid equilibrium variables which are the solubilization constant, the apparent Henry's law constant, and the vapor-liquid equilibrium partition coefficient of solute and water to investigate the effect of temperature on mass transfer of solute between liquid and gas phase.

3. Increasing the operating temperature in the packed column should increase the separation efficiency.

4. Take and analyze samples at different heights and calculate the mass transfer in each section, this would help in getting a better estimation of the mass transfer coefficient.