CHAPTER VI
CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This work demonstrates that the designed co-current packed column can successfully remove over 87% of the VOCs from the coacervate solution. Due to co-current flow, the viscous coacervate solution can flow passing the packing materials without plugging in the packed column. Moreover, although surfactant solution has notorious in causing foam, the column still can be operated without significant foaming that could lead to flooding.

From the batch experiment, the presence of surfactants substantially reduces the Henry's law constants of the VOCs due to solubilization. The VOC Henry's law constant is decreased with increasing $OP(EO)_7$ concentration and VOCs' hydrophobicity, but is increased with increasing temperature.

In continuous operation, it was found that if the feed flow rate is decreased from 9.8 to 1.1 mL/min, the toluene removal is increased by 34%. By reducing the column pressure from 70 to 38 Torr, the toluene removal is increased by 28%. The toluene removal increases by 22% when increasing the number of holes in the liquid distributor plate from one to five.

Moreover, if the $OP(EO)_7$ concentration increases from 300 to 630 mM, the toluene removal is dramatically reduced by 32%. Moreover, if the operating temperature increases from 30 to 50°C, the toluene removal is substantially increased by 70%.

Furthermore, it was also observed that a significant amount of foam is generated when the feed flow rate is higher than 7.0 mL/min; but, without adding antifoams, foam generation can be avoided if the feed flow rate is less than 5.0 mL/min. In addition, the significant amount of foam is also observed in the packed column, especially at high $OP(EO)_7$ concentration (500–630 mM). Foaming and viscosity of the coacervate solution are markedly reduced at operating temperature of

40–50°C. This observation allows the stripping column to operate at higher feed flow rate, leading to higher process capacity.

Moreover, based on the VOC types, the VOCs that are more hydrophobic are more solubilized into the $OP(EO)_7$ coacervate phase solution, leading to lower stripping process efficiency. The results are also reported in terms of an overall liquid phase volumetric mass transfer coefficient, which can be used in design of a larger scale stripping unit.

6.2 Recommendations

The VOC removal efficiency can be improved by increasing operating temperature. Moreover, the increase in temperature also reduces foam and viscosity of coacervate solution. This enhances the coacervate solution to flow and spread easier on the packing surface. Thus, it is interesting to increase the liquid loading rate in the packed column at high operating temperature range, especially at 40–50°C, in order to gain higher vacuum stripping capacity. In addition, since the surfactant structure is one of the crucial factors in CPE process, it is challenge to study this effect on the vacuum stripping efficiency. Furthermore, the foaming condition is also interested to observe for the advantage of the stripping process design.