CHAPTER 5: Conclusion

5.1 Conclusion

Both new protic ionic liquids were successfully synthesized to cater the initial criteria which it is made to be moderately hydrophobic. These new moderate hydrophobic protic ionic liquids were one step closer in making sure ternary mixures prepared exhibit upper critical solution temperature (UCST) or lower critical solution temperature (LCST). Since protic ionic liquids have proton(s) able to do back donation, any chemical activities during phase separation and phase miscibility were studied. On the other hands, since there separation happened, further studies on the composition for each component during phase separation were determined to see the efficiency of these two protic ionic liquids to extract isopropanol from water.

Both ternary mixtures *i.e.* BEHA tosylate/ water/ isopropanol and TEHA tosylate/ water/ isopropanol were thermoresponsive, where, both mixtures separated into two layers when the mixture were exposed to lower temperatures than the temperature it formed as a homogeneous mixture. This responsive behaviour towards temperature is an advantage to most separation or extraction application in the aspect of controlling the process. However, based on the reported findings in chapter 4, a few degrees different of temperatures were needed for the mixtures to be separated. In this case, it is verified that the chemical structures of both protic ionic liquid plays an important role in efficiency of separation process of isopropanol from water.

One of the objectives for this study was not only to look at the physical changes in both mixtures. The protic behaviour in designing the ionic liquids was to study the chemical activities during phase miscibility and phase separation for both ternary systems. The hydrogen(s) that are attached to nitrogen from protic ionic liquids' cation were observed for any changes. For a system consist of BEHA tosylate as an ionic liquid, the transition of N-H proton to acid and reverse was really rapid compared to TEHA tosylate system. However, both systems show that the separation was driven by the loss of N-H proton.

Determining each component composition was a crucial step of this study in order to look at the efficiency of both protic ionic liquid. The results that were collected were similar and closely related to above two studies. As predicted, the less hindered BEHA tosylate have better capabilities to extract isopropanol from water compared to TEHA tosylate. From this composition study, we can say that the acid that accepted the N-H proton were most probably the isopropanol, just for a simple reason because most of the isopropanol's volume will remain in ionic liquid – rich phase at all temperatures studied. Based on the composition data, it shows that both protic ionic liquids have the abilities to extract isopropanol from water, however, none of this two protic ionic liquid were able to extract 100% isopropanol from water.

As an overall, all objectives that were mentioned in chapter 1 of this thesis were answered and proved from conducted studies;

i) Both system shows that the separation was driven by the loss and of N-H proton.

ii) Higher molecular protic ionic liquid *i.e.* tris-(2-ethylhexyl) ammonium tosylate formed miscibility with isopropanol and water at higher temperature, 333 K, compared to lower molecular weight protic ionic liquid i.e. bis-(2-ethylhexyl) ammonium tosylate at 313 K.

iii) On the other hand, despite of less percentage of isopropanol extracted these studies shows that both protic ionic liquids have the potential to be used in aqueous isopropanol extraction. From the data collected, BEHA tosylate extracted out 60.97 % of isopropanol and TEHA tosylate extracted 47.92 % of isopropanol.

5.2 Future studies

This thermoresponsive consist of ionic liquid mixture studies are still new in research world, hence, different type of ionic liquid can be used in order to get 100 % percent extraction of isopropanol from water. In addition, phase diagrams can also be constructed for these particular systems. However, a study on various concentrations will be needed in order to do so.