

## CHAPTER VIII

### CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

#### 8.1 Conclusions

The present work demonstrated the successfully synthesized polybenzoxazine membranes, using various types of diamines through “quasi-solventless” method. Polybenzoxazine membranes were examined their activity for separating ethanol from an ethanol–water mixture with low ethanol concentration via pervaporation process. The membrane derived from poly(BA-hda) showed the longest service time when compared with those prepared from poly(BA-teta) and poly(BA-tepa). The membrane thickness, the feed temperature, and the feed concentration affected the separation performance. The permeation flux increased with an increase in the feed temperature and with a decrease in the membrane thickness. The best temperature of the feed solution and the thickness of the polybenzoxazine membranes for 10:90 ethanol:water were at 70 °C and 200 μm, respectively. Additionally, poly(BA-eda) membrane can be used for 20:80 ethanol:water separation. Polybenzoxazine was also successfully used to make mixed matrix membranes with ZSM–5 for CO<sub>2</sub>/CH<sub>4</sub> gas separation. The 5 wt.% of ZSM–5 loading showed the highest CO<sub>2</sub>/CH<sub>4</sub> selectivity and great CO<sub>2</sub> and CH<sub>4</sub> permeability when compared with those prepared with higher percent of ZSM–5 loading content. Increase of zeolite loading in polybenzoxazine membrane did not significantly improve either gas permeability or CO<sub>2</sub>/CH<sub>4</sub> selectivity. Sol–gel transition, molecular weight, radius of gyration and hydrodynamic radius with time of poly(BA-hda) were determined using static and dynamic light scattering (SLS and DLS, respectively). Molecular weight was increased with time whereas radius of gyration and hydrodynamic radius were slightly decreased.

#### 8.2 Recommendations for Future Work

Possible directions for future work should be in the area of synthesis and applications of polybenzoxazine, as follows:

1. Polybenzoxazine membrane can be modified using different diamines and diphenols to improve the properties of the membranes for separating another mixtures, such as acetone, isopropanol, methanol etc., via pervaporation process.
2. Different MMMs using polybenzoxazine and other metal oxides should be further studied to achieve a better gas separation.