CHAPTER VIII
CONCLUSIONS AND RECOMMEDATIONS FOR FUTURE WORK

8.1 Conclusions

Sodium A (NaA) zeolite membranes were successfully synthesized using silica (SiO_2) and alumina (Al_2O_3) as precursors via microwave, autoclave, and electrophoretic techniques, using pervaporation process for the separation of water from an water-ethanol mixture. A high purity of ethanol (99.5 %) was obtained using those membranes under recycle-continuous mode of water-ethanol separation. Total water flux ($kg/m^2/h$) for the recycle-continuous pervaporation process for water-ethanol separation was found to be higher than 1.0 $kg/m^2/h$ and higher than 2.0 $kg/m^2/h$ when the membrane thickness decreased. The separation factor (and time-dependence separation factor) for this system was higher than 10,000. All membranes showed good performance for use in the pervaporation process of the water-ethanol separation and also appeared to have good selectivity and stability.

Furthermore, from a techno-economics analysis, a hybrid process system, consisting of distillation column, followed by pervaporation system using homemade NaA zeolite membrane, was more economically attractive than the azeotropic distillation process system, consisting of distillation column, followed by practical azeotropic distillation. It not only saved significant energy required for producing 99.5 %wt of ethanol, but also was an environmentally friendly process.

8.2 Recommendations for Future Work

Possible directions for future works in the area of the membrane application are as follows;

1. A preparation of large-scale NaA zeolite membranes and large-scale pervaporation system should be studied to make them more efficiency and capability for industrial use.

2. Stability testing of NaA zeolite membrane in the pervaporation system should be studied for long-term stability testing from 1 week to 1 month to confirm the stability of NaA zeolite membrane.