CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The benzoxazine synthesis from phenol, formaldehyde and two types of amines, Diethylenetriamine (DETA) and Pentaethylenehexamine (PEHA), was successful and after curing at high temperature, polybenzoxazine were formed. The CO_2 adsorption capacities of impregnated adsorbents with both polybenzoxazines decreased when compared with the untreated activated carbon due to the pore blocking and the limitation of pore size and pore volume of the activated carbon. The impregnated adsorbents with PEHA-derived benzoxazine perform a higher CO_2 adsorption capacity than those impregnated adsorbents with DETA-derived benzoxazine at all operating temperatures (40 °C, 75 °C, and 140 °C) because the BET surface area and the amount of nitrogen content of the PEHA-derived benzoxazine are higher than the benzoxazine derived from DETA. The impregnated adsorbents with both polybenzoxazines can be regenerated completely at high temperatures (75 °C, and 140 °C) but cannot be completely regenerated at 40 °C because of the physisorption mechanism. However, polybenzoxazine as porous carbon has shown to be a potential adsorbent for CO_2 capture. The performance of the polybenzoxazine-derived activated carbon was better than the untreated activated carbon because of the-CO_2 and nitrogen bonding. The XPS results showed that all three carbonizing temperature (200 °C , 300 °C and 400 °C) could maintain the nitrogen functionalities of all polybenzoxazine-derived activated carbon. Carbonizing at 300 °C was the best condition that balanced between the BET surface area and the nitrogen functionalities remained in the sample. The results from this work show that the carbonization at 300 °C under N_2 atmosphere and following by activation at 800 °C by CO_2 could yield a porous carbon with a CO_2 adsorption capacity of 1.65 $mmol_{CO2}/g_{adsorbent}$ at 40 °C.

5.2 Recommendations

To increase the capacity of CO_2 adsorption in impregnated samples, it is suggested to use a support with bigger pore size and pore volume to avoid the pore blocking in activated carbon micropore. The higher portion of mesopore support is also recommended. Other solvent used to dissolve benzoxazine during impregnation method is a worth trial since chloroform is a very good solvent for benzoxazine. Other solvent such as methanol which is not as good as chloroform in term of solvent for benzoxazine may be used to dissolve benzoxazine in the impregnation step. A reduction of benzoxazine loading might be another way to improve the impregnation because this study may have varied the high concentration of benzoxazine loadings in a too high ranges (1wt%, 5wt%, and 10wt%). If varying lower concentration it may give better CO_2 adsorption performance.

Polybenzoxazine also can be derived from other preparation techniques to give polybenzoxazine-derived activated carbon with appropriate pore size and volume which will in turn improve the CO_2 adsorption performance. Other modification technique after carbonization and activation i.e. oxidation, nitrogen treatment, might be useful to improve the surface properties of the resulted activated carbon.