CHAPTER VI

CONCLUSION AND RECOMMENDATION

6.1 Conclusions

Carbon nanoparticles, including multi-walled carbon nanotubes (MWCNTs) and multi-shell carbon nanocapsules (CNCs), which are synthesized by co-pyrolysis of glycerol and ferrocene mixture with molar ratio of 5:1 at 900 °C have been utilized for Methylene blue, Reactive Black5 and Reactive Red31 removal. The main purpose of the research is to investigate the dye adsorption performance on synthesized CNPs. From the results, it can be concluded as follows:

6.1.1 Morphology and structure of CNPs

The obtained CNPs consist of multi-walled carbon nanotubes with diameters of 40-80 nm and multi-shell carbon nanocapsules. Moreover, the obtained products are multi-walled carbon nanotubes (MWCNTs) with iron particles filled in the tubes and at the tube tip and multi-shell carbon nanocapsules with iron particles which were encapsulated in the core. The BET specific surface area, total pore volume and average pore diameter were 73.85 m^2/g, 0.2668 cm^3/g and 18.453 nm, respectively.

6.1.2 Dye adsorption performance

This study investigated the removal of B5, R31 and MB from aqueous solution by synthesized CNPs. It takes only 60 minutes to reach the equilibrium. The amount of dye adsorbed per unit adsorbent mass increased with increases in the initial dye concentration but decreases as the increasing of adsorbent dose and initial pH value. R_L lied between zero and unity, suggesting that the adsorption of B5, R31 and MB on CNPs were favorable. The experiment data of B5 and MB well fitted with Freundlich model and the experiment data of R31 well correlated with the Langmuir

model. All values of $1/n$ less than 0.45, suggesting that the adsorption of three typical dyes in this study on CNPs is physical. Base on the regression of kinetic model, suggesting that the adsorption of B5, R31 and MB was best represented with the pseudo second-order model. Moreover, the results of kinetic analyses suggesting that the adsorption relate with intra-particle diffusion; however, that was not the only rate-controlling step. From the desorption experiment, It was observed that desorption efficiency of B5 and R31 increased when increasing pH of solvent. Over three adsorpton/desorption cycles, the re-adsorption efficiency result was found that the loss in the sorption capacity between the first cycle and the last cycle was 33.07%, 48.99% and 19.97% for B5, R31 and MB, respectively. The main advantage of the adsorption process on synthesized CNPs is its simplicity in the operation and recovery by magnetic system.

6.2 Recommendation for future work

From the experimental results, the batch adsorption performance of typical dye is investigated. The present work is the early step of revealing the formation of CNPs adsorbent and its adsorption mechanism. Surface modification of CNPs should be applied for more dye adsorption. For applied to large scale production, growth mechanism of CNPs, pilot-plant of dye removal and separation with external magnetic field should be studied for more details.