CHAPTER 7

CONCLUSION AND RECOMMENDATION

7.1. Conclusion

Chitosan and modified chitosan were used to adsorb cutting fluids in the wastewater. It can be concluded as follows:

Adsorption capacity of cutting fluids on either chitosan beads or blended chitosan/PVA increases when speed of stirrer used in mixing process increases from 600 rpm to 1200 rpm. Still increasing in the speed, the capacity does not change. The size of oil droplets in the emulsion is reduced when the speed increases. Chitin extrated from a black tiger shrimp was faded orange flakes and 237.35 g of chitin was extracted from 864.10 g of dried black tiger shrimp shell. chitosan was faded yellow flakes. Chitosan is dissolves by dilution of acid. 168.25 g of chitosan was extracted from 202.46 g of chitin flakes. Chitosan prepared in this work and that purchased from Sea Fresh Co., Ltd. It was found that adsorption capacity of cutting fluids on both chitosans are not much different.

Increasing chitosan concentration from 1.2 % w/v to 2.0 % w/v, the capacity increases from 90 to 135 mg/g. Further increasing the chitosan solution concentration to 2.2 % w/v, adsorption capacity drops significantly. This is due to viscosity of the solution. The adsorption capacity decreases when increasing in percentage of glutaraldehyde. This is due to a bonding between glutaraldehyde and amino groups in chitosan. Crosslinking with glutaraldehyde does not encourage an adsorption because of leakage of adsorbed sites.

Increasing initial cutting fluids concentrations from 0.1 to 1.0 % w/v, adsorption capacity increase due to gradient between bulk phase and surface of adsorbents enhances cutting fluids diffusion to the adsorbed site. Further increase in initial capacity adsorption of chitosan, blended chitosan/PVA 1:1, benzoyl chitosan and quateraminated chitosan decrease significantly. This is due to all adsorbent sites are occupied. There is not enough the sites for adsorbing more cutting fluids. CH-SDS and BCH-SDS showed the higher adsorption capacity. The sodium lauryl sulfate interacted with amino groups of chitosan to render more hydrophobic. The methylene groups in CH-SDS and BCH-SDS substituted on amino groups of chitosan show binding affinity for the adsorption of cutting fluids.

The capacity obtained from synthetic cutting fluids is closed to that obtained from the effluents thus this work can be applied to the wastewater treatment.

The main component of cutting fluids was mineral oil. The alkane appeared 2 peaks at 2925 and 2855 cm^{-1}, methylene and methyl appeared at 1465 and 1375 cm^{-1}. The long chain of the methylene group, more than four carbon atoms, appeared at 720 cm^{-1}. The FT-IR spectra of cutting fluids effluent did not appear to be a long chain and additive of emulsifiers. The absence of long chain and emulsifiers may be friction and heat destroying the chemical structure of cutting fluids effluent, while bacterial growing in water was meant to destroy the long chain of mineral oil. The appearance of alkane, methylene and methyl groups on adsorbents demonstrated that all adsorbents could be adsorb the cutting fluids effluent.

The SEM photographs of all adsorbents showed a bumpy texture and fold of layers which were arranged homogenously. After adsorption of cutting fluids effluent of adsorbent presented significant changes of structure and appearance on all adsorbents. The SEM micrographs revealed that most all of the adsorbents areas were

covered with a muddy-like substance that was adsorbed cutting fluids effluent. The surface of all adsorbents were spreaded and covered with a muddy-like substance or rough surface with bubble-like texture due to the cutting fluids effluent molecules which covered the beads. These bubbles were cutting fluids effluent adsorbed onto all adsorbents. These pictures confirmed that cutting fluids effluent was adsorbed by adsorbents onto its surface.

The amount of C element after adsorption of cutting fluids and cutting fluids effluent raise before adsorption in all adsorbents. This can be proven that all adsorbents can adsorb cutting fluids and cutting fluids effluent. The N element after adsorption of cutting fluids and cutting fluids effluent was decreased in all adsorbents. This may be an advantage to use adsorbents as solid fuel due to reduction of N element reduces oxide of nitrogen (NO_x).

More cutting fluids could be adsorbed on adsorbents in acidic condition. CH-SDS shows the higher adsorption capacity around 2516 mg/g, at pH 3. It is noticed that increasing pH of emulsion in the basic, pH 7 to 11, CH-SDS adsorbed less cutting fluids from 747 to 309 mg/g. The pH of cutting fluids plays an important role an adsorption capacity. Destabilization of the emulsion was obtained at acidic condition due to negative charge of cutting fluids deformed stability. Adsorption capacity increased with the addition of salts i.e. NaCl and $CaCl_2$ due to the emulsion reducing the thickness of the electrical double layer. Increasing ether NaCl or $CaCl_2$ from 0.01 to 0.05 M does not effect on cutting fluids adsorption capacity.

The equilibrium adsorption data fitted very well into a Freundlich isotherm for chitosan, Langmuir isotherm for blended chitosan/PVA 1:1, CH-C-Tab, CH-Tween 80, BCH-C-Tab and BCH-Tween 80, while the BET isotherm fitted very well for benzoyl chitosan, quateraminated chitosan, CH-SDS and BCH-SDS.

The rate of adsorption of all adsorbents were found to follow a pseudo-second-order kinetic model and cutting fluids adsorption was found to be controlled by intraparticle diffusion at the later stages.

The rate of adsorption of cutting fluids and cutting fluids effluent increased with increasing temperature. The adsorption of cutting fluids and cutting fluids effluent were endothermic reaction. The Gibb free energy varied in range from 69 - 88 kJ/mol for adsorbed cutting fluids effluent at pH 3 and 66 - 88 kJ/mol for cutting fluids effluent at pH 6.8.

The height column may not suitable for the adsorption of cutting fluids due to low percentage of the breakthrough. The variable flow rate and height of bed can affect the breakthrough curve. Higher uptake is obtained at higher bed height due to an increase in the surface area of adsorbents. The BDST model and constants evaluated can be used to design a column over a range of feasible flow rate to predict adsorption performance when operation at other condition.

For removal of cutting fluids effluent from the turning processes in industrial application it was found that chitosan used a budget of 2.64 baht, while CH-SDS and BCH-SDS used a budget increasing of 79.20 and 293.82 baht to treat cutting fluids effluent about 1.0 l (see appendix L). In was found that BCH-SDS shows the highest to prepare adsorbent after that CH-SDS and chitosan, respectively. Chitosan, CH-SDS and BCH-SDS 1.0 g presents heat of combustion at 17.1, 21.4 and 20.1 kJ/g, respectively. It was found that chitosan showed the lowest of budget but presents the lowest for heat of combustion. The BCH-SDS shows the highest of budget to prepare adsorbent, while heat of combustion obtained moderate. The CH-SDS presents the moderate of budget to prepare adsorbent to adsorb cutting fluids and CH-SDS show the highest heat of combustion. Fuel oil presents heat of combustion 40.1 kJ/g, while

average price of fuel oil is 15 baht/liter. Thus using CH-SDS and BCH-SDS to adsorb cutting fluids may be suitable due to both adsorbents exhibits good resistance to acid and base but the budgets are high when compared to chitosan. While chitosan shows lower heat of combustion than fuel oil about 2.3 times. Comparison between chitosan and fuel oil it was found that to obtain the same amount heat of combustion as fuel oil, chitosan needs only 6.1 baht. Thus chitosan is the appropriate adsorbent to adsorb cutting fluids due to it saving of about 8.1 baht.

7.2. Recommendation

For improving of adsorption capacity of cutting fluids from turning processes, further study should be recommended to the following aspects.

1. A modification of chitosan-sodium lauryl sulfate and blended chitosan/PVA-sodium lauryl sulfate should be continues to increase ability of cutting fluids adsorption. The elastic materials may be modified as a choice to improve adsorption capacity of adsorbent.

2. The fixed-bed presented a little adsorption of cutting fluids while the fluidized bed column may enhance adsorption capacity for cutting fluids.

3. The amount of nitrogen oxide and sulfur oxide should be carefully analysis when types of the adsorbent need to be charged.