CHAPTER 4

CONCLUSIONS

High fluoride concentration in drinking water is a problem found in both ground and surface water in various parts of Thailand such as the north and the west. Dental and skeletal fluorosis are the main problem arising from excessive fluoride intake. Defluoridation of water is one of the alternatives already adopted for provision of safe drinking water in some fluorotic areas. This work concentrates on investigating the defluoridation by using fired clay chips as adsorbent. Fired clay is another attractive natural adsorbent due to their controllable particle size, lamellar structures and oxides containing compositions.

Viewing from the adsorbent characteristics, the major chemical compositions of SiO_2, Al_2O_3 and Fe_2O_3 are the ones responsible for the fluoride removal through the adsorption process, whereas, its physical properties of the fired clay chip in term of surface area, pore volume distribution and pore radius are 4.23 m^2/g, 0.024 ml/g and 83.5 Å, respectively. However, its physical characteristics are inferior to those of fired brick chips.

Laboratory batch testing was used to determine the adsorption behavior of fluoride onto fired clay chips. The amount of adsorbed fluoride at equilibrium was determined by using fluoride ion selective electrode. Results of the tests showed that the degree of fluoride removal is dependent on several factors. It can be clearly seen that the fluoride removal increased with the decrease in particle size of the adsorbent

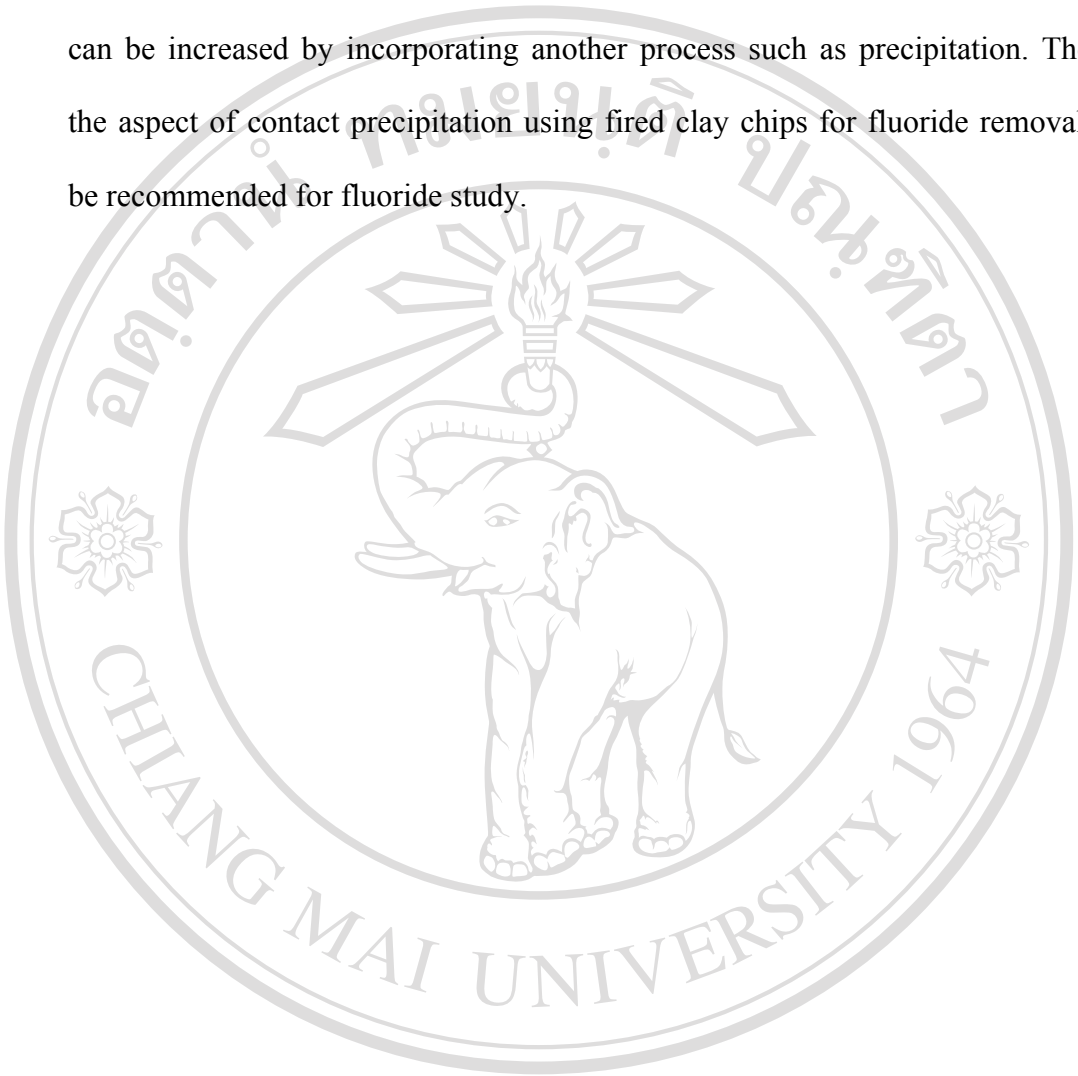
from the experiments of previous study [24]. Fired clay chips with 4-20 mesh size was therefore selected for defluoridation study in order to be able for further comparison based on the particle size. The dynamic condition as slower agitation rate had a significant effect on fluoride adsorption. In terms of the equilibration time, it was found that 2 hours were necessary for the adsorption to reach equilibrium while the amount of fluoride adsorbed per gram of adsorbent was found to increase with increasing initial fluoride concentration. The equilibration time of fluoride adsorption on fired clay chips is longer than fired brick [30] probably due to the natural properties of each adsorbents could adsorb or interact with fluoride ion differently. The time to reach equilibrium condition appears to be independent of initial fluoride concentration. At the same time, the study on the effect of pH on adsorption of fluoride demonstrated that the adsorption was independent on pH change (3-9), but in the high acidic range (3-4) the amount of fluoride adsorbed was higher. The increase in the amount of adsorbed fluoride is not an adsorption phenomenon but due to the formation of fluoride and hydrogen ion in the form of HF_2^- and HF which could not be detected by fluoride ion selective electrode. This happening resulted in the disappearance of free fluoride which may be misled to the understanding of being adsolved. The influence of temperature on the fluoride sorption on fired clay chips at three different temperatures i.e. 30, 40 and 50 °C reveals that it poses only slight effect on fluoride adsorption, even though the adsorption at high temperature seems to be a little bit higher due to the swift movement of the fluoride ions enhances the penetration into the cavities of the porous fired clay structure. The nature of fluoride adsorption on the surface of fired clay chips is an endothermic-multilayer type which is the same as occurred with the fired brick chips. The capacity of fired clay chips for

fluoride adsorption as a monolayer at 30 °C was found to be about 0.95 μmol/g. While the heat of adsorption was found to be 1.321 kJ/mol. In addition, the effect of coexisting ions such as sulfate, phosphate, nitrate, chloride, sodium, potassium, iodide, calcium and magnesium posed slight or no effect on the adsorption of fluoride, whereas calcium and magnesium ions did probably dues to the precipitation of fluoride as CaF_2 and MgF_2, respectively when the concentrations of Ca^{2+} and Mg^{2+} are high enough.

As for the column operation, the influence of the amount of fired clay chips for packing the column was studied by varying adsorbent weights of 500, 1000, 1500 and 2000 g It was found that the quality of fluoride adsorption increases with the increasing of the amount of fired clay chips. This is due to the higher amount of the adsorbent gives rise to the more surface area and pore volume distribution. While the flow rate of tested water passing through the packed column at 5, 10 and 15 ml/min affected the fluoride removal efficiency by which the slower flow rate was significantly better than the faster flow rate. It is because the contact time between fluoride ions and fired clay chips at slower flow rate is longer resulting in a higher extent of adsorption. Additionally, the study of water qualities after defluoridation by fired clay chips under various parameters such as pH, hardness, turbidity, conductivity, taste, odour, fluoride, magnesium, calcium and sulfate revealed that they are acceptable for consumption and not different from most natural drinking water except the reduction of fluoride.

Fired clay is therefore proven on its capabilities for removing fluoride ion from drinking water to a certain degree, even though its capacity is not that high, but its commercial availability as inexpensive goods is a major adventage providing the

use of this material as a potential fluoride remover. However, since the removal of fluoride is believed to be based solely on adsorption process, the removal efficiency can be increased by incorporating another process such as precipitation. Therefore, the aspect of contact precipitation using fired clay chips for fluoride removal would be recommended for fluoride study.



The relevancy of the research work to Thailand

The geology of Thailand, especially the northern and western parts, is one of the countries in the world where fluoride occurs in high concentration, not only in rocks and soil, but also in surface and ground water. Surface and ground water are the major sources of drinking water in both urban and rural areas. People become ill from drinking surface and ground water containing excessive fluoride (> 1.5 mg/l). Dental and skeletal fluorosis are the main problems arising from excessive fluoride intake. Therefore, defluoridation of water is one of the alternatives already adopted for provision of safe drinking water in some fluorotic areas. Several methods have been studied for defluoridation of water, viz. precipitation, adsorption, ion exchange and electrolysis. Of these methods, adsorption is the most widely used method for removal of fluoride.

This work concentrates on the defluoridation of drinking water by using readily available adsorbing media. Fired clay chips is one of the alternative natural adsorbent in fluoride removing. It is proved on its capability on removing fluoride from drinking water. Its commercial availability as inexpensive goods is a major adventage providing the use of this material as a potential fluoride remover. Therefore, the fired clay chips would certainly be able to usee for defluoridation daily consuming water at a household levels.