E2-54: Modeling of kaolinite-induced de-flouridation processes

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Fluoride is both an essential and toxic trace element to human health. The WHO required that fluoride be present in the range of 0.5 to 1 mg/l in drinking water to prevent tooth and bone problems. In tropical parts in the world, such as in Sri Lanka, the drinking water contains high fluoride, 20 - 40 mg/l in some cases. Hence the fluoride concentration in drinking water should be regulated carefully to meet stringent conditions imposed by WHO. Previously kaolinite was suggested as a potential starting material for drinking water defluoridation. However, exact chemical mechanism of kaolinite-induced defluoridation process is not yet resolved. Hence, the aim of this research was to provide a mechanistic interpretation for fluoride adsorption process over a range of experimental conditions that are important environmentally.

Titration data showed that kaolinite (location:Rattota) possessed pHzpc at 8.9. Present experimental data signal the presence of 2 types of anion binding sites on kaolinite; namely >A10H and >SiOH. Generalized diffuse-layer model calculations showed the following intrinsic acidity constants of protons. The overall fluoride adsorption mechanism onto kaolinite is quantitated considering the following reaction stoichiometries:

$$>AlOH + H^+ + F^- \rightarrow >AlF + H_2O;\ \log K_{>AlO\text{-}F} = 15.16$$
$$>SiOH + H^+ + F^- \rightarrow >SiF + H_2O:\ \log K_{>SiO\text{-}F} = 13.10$$

The physico-chemical data generated in this research provide the essential first step needed for the development of unit process for defluoridation of fluoride-rich drinking water.