4.65.P01

Defluoridation of drinking water by gibbsite

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Several studies established both the risks of high fluoride dosing and the benefits of minimal exposure. The acceptable fluoride concentration in drinking water is generally in the range of 0.5-1.5mg/l. The concentration of fluoride ions in groundwater of many places in the world exceeds the permitable values. People depending on water with high concentrations of fluorine for their daily drinking water may develop fluorosis.

The aim of this work was to assess the effect of adsorption of gibbsite and its calcined product to remove fluorine ion from drinking waters. Gibbsite ($Al(OH)_3$) is a useful analog of naturally occurring aluminum oxides, hydroxides or aluminous silicate minerals, it offers reactive surface sites when in contact with surface and ground waters. Gibbsite is a simple solid that has $>Al_2OH^0$ and $>AlOH^{-1/2}$ surface sites; only $>AlOH^{-1/2}$ is found to be reactive when the pH changes. In this work, a series of experiments were conducted to assess the F adsorption as a function of pH, adsorbate loading.

In the studies, gibbsite are natural samples from Tennessee of U.S.A., and it subjected to heated to air temperatures of 350°C (centigrade) for 2 hours. The stock F solutions used in sorption experiments were prepared by dissolving ACS reagentgrade NaF in deionized water.

Characterization of fluoride sorption behaviour by gibbsite and its calcined product was achieved through adsorption and equilibrium experiments. Laboratory experiments demonstrate that an excellent negative correlation exists between pH values of the solution and the adsorption ability of calcined products of gibbsite. The fraction of fluorine adsorbed on gibbsite is about 66% at pH = 4.0, and decreases to 21% at pH = 6.0 at $[F^-]_{init}$ = 10mg/l in laboratory samples of aqueous fluoride solutions. Similarly, it decreases from 93% at pH = 4.0, to 50% at pH = 6.0 for its product.

The results show the adsorption is effective at low concentrations of fluoride for gibbsite and its product. The fraction of fluorine adsorbed on gibbsite is about 21% at $[F^-]_{init}$ = 10mg/l, and decreases to 14% at $[F^-]_{init}$ = 50mg/l at pH = 6.0. Similarly, it is from 50% at $[F^-]_{init}$ = 10mg/l, to 43% at $[F^-]_{init}$ = 50mg/l for its product.

It is suggested that BET surface area also influence fluoride sorption on gibbsite and its calcined product. BET surface area is 13.62 m^2/g for gibbsite, whereas it is 264.83m^2/g for its calcined product. The experimental study is in progress.

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Dissolved As uptake by inorganic solids at geothermal conditions

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Dissolved arsenic concentration of geothermal discharge from the Sumikawa geothermal fields range from 14 to 20 mgL^{-1} which accumulates to ~5,000 mg/kg in retrieved materials [1]. Two general approaches can be taken to make the retrieved materials economically useable; (1) removal of the dissolved As in the geothermal fluid, and (2) solid phase separation of As from the retrieved materials. The former was investigated in this study.

In situ analyses and predicted dissolved As speciation in the geothermal discharge indicate arsenite as $H_3AsO_{3(aq)}$ is more dominant. Inorganic solids investigated to sorb dissolved As include hydrotalcite, a Fe-oxyhydroxysulfate, a Mg-rich solid and a trioctahedral smectite. These materials were chosen due to their known ability to uptake dissolved trace metals, stabiliy at relatively high temperature (T = 90 - 128°C) and similarity with the composition of geothermal scales.

Addition of Fe-oxyhydroxysulfate is accompanied by an increase in Fe^{3+} content and decrease in pH (i.e. acidic). On the other hand, addition of the Mg-rich solid resulted to an increase in pH (i.e. alkaline) and Mg content. No changes were observed with the addition of hydrotalcite and the trioctahedral smectite.

Sorption experiments show that hydrotalcite and the trioctahedral smectite did not significantly uptake dissolved As in the geothermal fluid. However, the Fe-oxyhydroxysulfate and the Mg-rich solid reduced the dissolved As concentrations to a minimum (less than 2 ppm).

The mechanism of dissolved As removal involves the initial partial dissolution of the inorganic solids and latter coprecipitation-adsorption reactions. The removal of dissolved As at acidic conditions (i.e. Fe-oxyhydroxysulfate) dominantly involves adsorption to surfaces while at alkaline conditions (i.e. Mg-rich solid), coprecipitation dominates as the dissolved As uptake mechanism.

References

[1] Kato et al. (2003) *Geothermics* **32**, 239-273.