

Effective removal of iodate (IO_3^-) by coprecipitation with barite

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Radioactive iodine (^{129}I) is of great concern owing to its high environmental mobility and long-term radiotoxicity (^{129}I : half-life= 1.6×10^7 years). In the environment, iodine exists in two oxidation states (-1, +5) and mostly is dissolved in natural water and radioactive wastes liquid as iodide (I^-) and iodate (IO_3^-). To date, formation of AgI is the only method for I^- removal and there is no effective method for IO_3^- removal from contaminated natural water and waste liquid. In the present study, we developed a new technique for removing radioactive IO_3^- from aqueous solutions by using barite (BaSO_4).^[1] Barite is quickly precipitated by mixing BaCl_2 aqueous solution in Na_2SO_4 aqueous solution. Although a variety of toxic and/or radioactive elements in cationic form and selenium oxyanions (SeO_3^{2-} and SeO_4^{2-}) can be removed from aqueous solutions by coprecipitation with barite^{[2]-[4]}, removal of IO_3^- has not been investigated.

This study investigated the coprecipitation of IO_3^- with barite and found that IO_3^- can be effectively removed by this method. A diagram of IO_3^- coprecipitation with barite is illustrated in Fig. 1. Extended X-ray absorption fine structure analysis indicated that the incorporated IO_3^- was strongly bound to the crystal lattice of barite by substituting the SO_4^{2-} site in the structure when the IO_3^- concentration was low. It is believed that the charge compensation problem due to the substitution of IO_3^- for SO_4^{2-} was achieved by the substitution of Na^+ for the nearest Ba^{2+} because Na^+ , which was not detected in the barite prepared without IO_3^- , was detected in the IO_3^- -bearing barite.

We then investigated the influence of competitive anions on IO_3^- removal efficiencies by comparing with adsorption on hydrotalcite-like Mg–Al layered double hydroxide (LDH). Mg–Al LDH is a well-known inorganic layered mineral with a high anion exchange capacity, and anion was intercalated into interlayer spaces. Many papers have been published on removal of anionic contaminants by LDH. Figure 2 shows the distribution coefficient (K_d) of IO_3^- for barite prepared under the optimum condition and that for the Mg–Al LDH with and without addition of NaCl in the initial aqueous solution. K_d is the ratio of concentrations of a solute (in this case, IO_3^-) between a liquid phase and a solid phase (barite or Mg–Al LDH). The higher the K_d , the higher the selectivity of the solute to the solid phase. The K_d for Mg–Al LDH decreased with increasing competitive Cl^- concentration, while the K_d for barite was nearly independent of Cl^- concentrations. At the initial Cl^- concentration of 10 mmol L^{-1} , the K_d for barite was two orders of magnitude

greater than that for Mg–Al LDH. Hence, the coprecipitation method using barite is superior to the conventional adsorption method using LDH for IO_3^- removal when competitive anions are present. IO_3^- was also effectively removed from the aqueous solutions in the presence of NO_3^- and SO_4^{2-} , which are also environmentally common anions. Coprecipitation with barite would be a promising tool for removing radioactive IO_3^- from various aqueous solutions contaminated with IO_3^- .

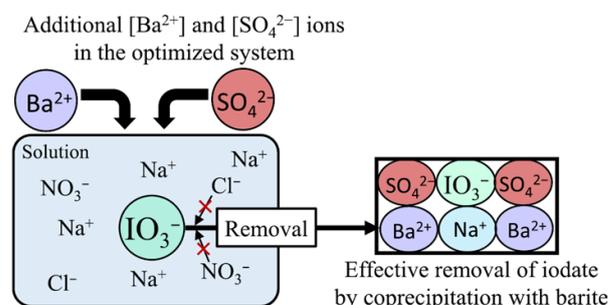


Fig. 1. Design of IO_3^- coprecipitation with barite.

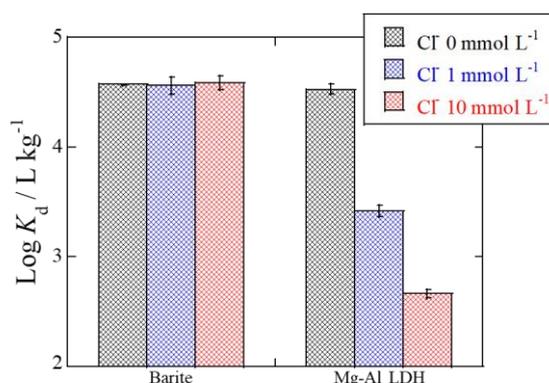


Fig. 2. IO_3^- removal from aqueous solutions containing Cl^- .

References

- [1] K. Tokunaga *et al.*, Chemosphere **226**, 129104 (2021).
- [2] K. Tokunaga *et al.*, J. Hazard. Mater. **359**, 307-315 (2018).
- [3] K. Tokunaga *et al.*, Environ. Sci. Technol. **51**, 9194-9201 (2017).
- [4] K. Tokunaga *et al.*, Chemical Geology **447**, 59-69 (2016).