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Verification of the removal mechanism of Arsenic by Fe under the Arsenic (III) and Arsenic (V) coexisting conditions by the geochemical modeling.

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Arsenic (As) is a hazardous element, commonly found in acid mine drainage (AMD). This makes the treatment of drainage before discharging to natural water bodies a necessity. Adsorption using Ferrihydrite (FHD) is an attractive technique for immobilizing As in AMD treatment [1, 3]. Ions such as Arsenite (As(III)) and Arsenate (As(V)) adsorb on FHD via different mechanisms [3]; however, the adsorption behavior of As under conditions when As(III)-As(V) coexist is not well understood. In this study, immobilization of As was performed by adsorption on FHD under the As(III)-As(V) coexisting condition. Moreover, to clarify the immobilization mechanism, the adsorption behaviors of As(III) and As(V) were verified numerically by geochemical modeling using PHREEQC.

In the case of the experiment with As(III)-As(V) coexisting, the adsorption density for As(V) did not change, while the one for As(III) decreased compared to the corresponding single-component condition, indicating that the adsorption sites for As(III) were disturbed by the adsorption of As(V).

In the As removal experiment considering the coprecipitation with Fe under the condition of As(III)-As(V) coexisting, the values of removed As(III) and As(V) were higher than those of adsorption experiments only. This result was due to the inclusion of surface complexation and surface precipitation reactions. The removal of As(V) by coprecipitation was reproduced by PHREEQC modeling, which included surface co-precipitation using the K_{sp} value ($10^{-9.6}$) that was determined experimentally. However, the simulated value of coprecipitated As(III) was smaller than the experimental result (Fig. 1). Hence, removability of As(III) would be influenced by the spatial distribution of the adsorption site in pores, and/or the extending of outer sphere adsorption. The underestimation of the removal of As(III) in equilibrium calculation would be attributed to these specific adsorption properties, which were not assumed in the model calculation presented in this study.

Reference

[1] Tokoro et al., *Adv. Powder Technol.*, vol. 32 (6), 2021, pp. 1943-1950.

[2] Dixit et al., *Environ. Sci. Technol.*, vol. 37 (18), 2003, pp. 4182-4189.

[3] Meng et al., *J. Hazard. Mater. Adv.*, vol. 13, 2024, No. 100398.

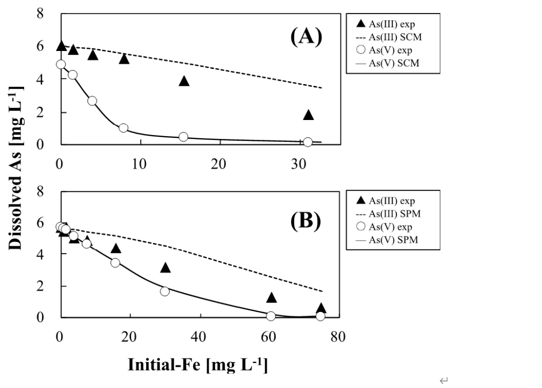

Fig. 1 The relationship between the concentrations of initial-Fe(III) and equilibrated-As in the adsorption (A) and coprecipitation reactions (B) under As(III)-As(V) coexisting condition. Plots (▲: As(III), ○: A(V)) and lines (dotted: As(III), solid: As(V)) indicate the dissolved As(III) or As(V) concentration of the experimental results (exp) and equilibrium modeling (A: the surface complexation model (SCM), B: the surface precipitation model (SPM)), respectively.