Adsorption of Trace Levels of Arsenic from Aqueous Solutions by Conditioned Layered Double Hydroxides: Batch and Flow Experiments

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Arsenic is found in water in the form of oxyanions. Relatively high concentrations of As have been reported both in power plant discharges, as well as, in fresh water supplies. Inorganic As may be present in the 3+ (As(III), arsenite) and 5+ (As(V), arsenate) oxidation states1. Protracted contact with As-containing water is thought to cause arsenicosis, a form of poisoning in humans2. The International Agency for Research on Cancer (IARC) currently classifies As as a group 1 chemical, which is considered to be carcinogenic to humans.

The focus of the present work is to do a systematic study of the adsorption of As by conditioned calcined layered double hydroxide (LDH) adsorbents. Conditioning the adsorbent significantly reduced the dissolution observed with uncalcined and calcined LDH3. The adsorption rates and isotherms have been investigated in batch experiments using particles of four different particle size ranges. As(V) adsorption is shown to follow a Sips-type adsorption isotherm. The As(V) adsorption rate on conditioned LDH increases with decreasing adsorbent particle size; the adsorption capacity, on the other hand, is independent of particle size. A homogeneous surface diffusion model and a bidisperse pore model were used to fit the experimental kinetic data. The homogenous surface diffusion model estimated diffusivity values dependent on the particle size, whereas the bidisperse pore model predicted an intracrystalline diffusivity, which is fairly invariant with particle size4.

The removal of As(V) on conditioned, calcined LDH adsorbents was also investigated in continuous operations. In packed-bed column experiments, the impact of important solution and operational parameters such as influent As concentration, pH, sorbent particle size and flow rate were studied. An early breakthrough and saturation was observed at higher flow rates and at higher influent concentrations. On the other hand, a decrease in the sorbent particle size and decrease in influent pH resulted in an increase in the bed volumes at breakthrough. A film surface diffusion model, which accounts for both the external film diffusion in the liquid phase and intraparticle diffusion resistance within the sorbent, has been developed to simulate the fixed bed sorption of As (V) onto LDH. Mass transfer coefficients were calculated using correlations. Predicted simulation results were found to be in close proximity to the experimental results.
References:

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