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Time-dependent adsorption and resistant desorption of arsenic on magnetite nanoparticles: kinetics and modeling

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ABSTRACT

Arsenic contamination in water is a worldwide problem and poses a significant challenge for the environmental engineers. Magnetite nanoparticles are a highly promising adsorbent for the effective removal of arsenic from drinking water. In the present study, an arsenic adsorption kinetic study was carried out on magnetite nanoparticles at pH 8.0 (a typical pH for groundwater), followed by sequential desorption with arsenic-free background solution. The results illustrate that arsenic adsorption on magnetite nanoparticles is nonlinear and time-dependent. The adsorption kinetics of both As(V) and As(III) are biphasic, where the arsenic adsorption is rapid initially and is followed by a slower adsorption with increasing reaction time. Desorption of both As(V) and As(III) exhibited clear hysteresis, a considerable amount of arsenic is resistant to desorption. Freundlich model, diffusion layer model (DLM), biphasic first-order kinetic model were used to fit the arsenic adsorption on magnetite nanoparticles and multi-reaction model (MRM) was used to describe the adsorption and desorption of arsenic on magnetite nanoparticles. Surprisingly, both of the observed arsenic adsorption and desorption kinetics can be fitted with MRM model very well, indicating that MRM model is potentially useful in modeling fate of arsenic in water treatment with magnetite nanoparticles.This work is important in offering insight into the adsorption mechanism of arsenic from magnetite nanoparticles and predicting the fate of arsenic in magnetite nanoparticle-based water treatment.

Keywords: Arsenic; Biphasic adsorption; Resistant desorption; Multi-reaction model; Magnetite nanoparticles; oxidation

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