

Practical performance of arsenate (As(V)) removal using mesoporous zerovalent iron-magnetite nanocomposites (ZVI-MNCs)

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Arsenic pollution is a serious environmental problem occurring world due to its adverse effect on our ecosystem. Considering the hazardous and carcinogenic effects of arsenic, the world health organization (WHO) and the ministry of the environment (MOE), Japan fixed the upper limit of exposure of arsenic at 0.01 and 0.1 mg L⁻¹, respectively.

The common practice for arsenic sequestration is through an adsorption process using metal oxides because of their simplicity and low-cost. However, practical evaluation of metal-oxides adsorbents for arsenic uptake in the presence of several co-existing anions including chloride, nitrate, sulfate, carbonate, silicate, and phosphate is still lacking in the literature. Thus, these potential adsorbents lack credibility in the field application. Herein, practical assessment and removal behavior of mesoporous zerovalent iron (Fe⁰)-magnetite (Fe₃O₄) nanocomposites (ZVI-MNCs) for As(V) in the presence of co-existing anions were elucidated through kinetic study and electrokinetic potential.

The adsorption experiment was carried out at pH 5 in the presence of 50 mg L⁻¹ co-existing anions to understand the effect of interfering anions on the adsorption rate of As(V). Based on the findings, the presence of several co-existing ions including nitrate, chloride, sulfate, carbonate, silicate showed no significant effect on As(V) removal. Whereas, the adsorption rate of As(V) was decreased substantially in the presence of the phosphate probably because of their similar removal mechanism. The uptake of As(V) was predominantly through surface adsorption on active sites of ZVI-MNCs, as evidenced by the pseudo-second-order kinetic model and Weber-Morris model. The surface analysis by electrokinetic potential further confirmed that the As(V) and phosphate were immobilized through inner-sphere complexation. Whereas, other co-existing anions were removed via outer-sphere complexation. Thus, a noticeable decrease in the retention rate of As(V) in the presence of phosphate was due to their similar removal behavior unlike other anions with different uptake mechanism. This study is significant in creating a sustainable application of ZVI-MNCs for practical remediation of As(V) contaminated water.