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Arsenate interaction with the surface of nanomagnetic particles. High adsorption or full release

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Abstract

The interaction of arsenate species in aqueous media with the surface of nanomagnetic particles with equivalent structure, magnetite (Fe_3O_4) and nickel ferrite ($NiFe_2O_4$), was investigated with adsorption isotherms at pH 4, 7, 9 and 12, desorption kinetics, electrophoresis, XRD, TEM, FTIR, N_2 adsorption and magnetism. Arsenic uptake in both solids was high at pH 4 and decreased as pH increased, becoming negligible at pH 12. The adsorption behavior was typical of anions that form inner-sphere surface complexes with surface metal ions. The reached understanding of the adsorption behavior enabled to achieve, depending on what it is necessary, high and fast adsorption, or complete and rapid desorption by a simple pH change. A flow system was developed for the first time to quantify the ability of a magnetic field to remove nanoparticles with adsorbed arsenate from a dispersion and to measure removal half-lives of the nanoparticles. Both, Fe_3O_4 and $NiFe_2O_4$ exhibited fast and strong responses to the action of the external magnetic field, thus they could be removed in a few minutes with a magnet, leaving a clear and arsenic free solution. The removal half-lives of nanoparticles varied between 75 and 135 seconds, and were randomly affected by the presence of adsorbed arsenic. These sorptive and magnetic properties make the synthesized nanoparticles useful to be applied in water cleaning technologies and analytical systems, where high adsorption efficiency, fast and complete desorption of arsenic, and full recovery of the adsorbent are needed.

Keywords: magnetite, nickel ferrite, nanoparticles removal, arsenic, remediation, preconcentration.