

Investigation of sorbents synthesised by mechanical–chemical reaction for sorption of As(III) and As(V) from aqueous medium

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Abstract Efficiency of Fe_2O_3 and mixture of Fe_2O_3 and MnO_2 nanoparticles synthesised by mechanical–chemical reaction for inorganic As(III) and As(V) sorption was examined. Sorbents (Fe_2O_3 and mixture $\text{Fe}_2\text{O}_3\text{:MnO}_2 = 3\text{:}1$) synthesised by mechanical–chemical treatment in planetary ball mill with different milling times were tested by batch experiments. Experimental data were fitted both to Freundlich and Langmuir adsorption models. Efficiency of sorption was in good correlation with the time of milling in case of pure oxide. There were small differences in sorption between As(III) and As(V). In the case of mixture of oxides results were different. The best results were obtained by 30 min of milling. With prolonged milling, the sorption decreased to 3 h and after that increased again. These results were explained by phase transition. Sorption kinetics, influence of pH and the presence of other anions were examined for mixture of oxides with highest sorption capacity. The bioavailability of sorbed arsen was tested using modified Tessier procedure.

Keywords Arsenic removal · Adsorption · Kinetics · Isotherms

Introduction

Arsenic is a ubiquitous element found in the atmosphere, natural waters, soils and living organisms. It is mobilised through a combination of natural processes such as weathering, volcanic emissions, biological activity and geochemical reactions as well as through a range of anthropogenic activities. Of the various sources of arsenic in the environment, consumption of drinking water with higher level of arsenic probably poses the greatest threat to human health (NRC 1999).

Dangerous concentrations of arsenic in groundwater have been reported in many countries around the world like the USA, China, Bangladesh, Chile, Taiwan, Hungarian and others. In the northern region of Serbia, Vojvodina, groundwaters contain elevated concentrations of arsenic. Only 11 % of all water supply systems in Vojvodina have arsenic concentrations below 10 $\mu\text{g/L}$, of which 50.4 % have 11–50 $\mu\text{g/L}$ and 38.6 % have over 50 $\mu\text{g/L}$ (Jovanovic et al. 2011).

The technology for removal of arsenic should meet several basic criteria. The system should be able to supply water in adequate quantity, technology should be robust and should not have an undue adverse effect on the environment. This system must be economically feasible and operational safety must be ensured (Dong et al. 2009).

Adsorption and ion exchange, reverse osmosis, coagulation and precipitation, biological removal processes have been applied to remove arsenic from aqueous systems. Some of these removal technologies are most effective at removing higher arsenic oxidation state as arsenite is predominantly non-charged below pH 9.2. Although oxidation step does not remove arsenic from solution, many treatment

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