

Evaluation and management of arsenic contamination in agricultural soil and water - AgriAs

Laboratory investigations on arsenic removal technologies from water

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Public Summary

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The objective of WP 3.1 was to remove arsenic and other contaminants effectively from contaminated natural waters. The water purification methods studied were membrane technologies, i.e. nanofiltration (NF) and low-pressure reverse osmosis (RO), adsorption, combined RO-adsorption and advanced oxidation-coagulation-filtration (AOCF).

The screening experiments with NF and RO membranes were performed with synthetic waters to find out suitable membrane and operation conditions, i.e. pressure and temperature. The composition of the synthetic water was simulating the surface waters at the pilot sites of the project in Verdun, France and Saxony, Germany.

After the screening stage, the experiments were carried out with real contaminated natural water from the pilot area in Verdun, France. Reverse osmosis membrane was selected for these experiments since it showed higher removal efficiencies in the screening stage. Two low-cost, by-product based adsorbents were selected to the research. Schwertmannite based adsorbent SorpP obtained from G.E.O.S. is prepared from side products of acid mine drainage and Sachtofer from Sachtleben Pigments Oy (currently Venator P&A Finland Oy) is a by-product from TiO₂ pigment production.

In the AOCF experiments, interaction of arsenic and iron during the adsorption process, effects of the co-occurring ions and different chemical parameters were studied. The experiments were performed with synthetic water samples. In the first stage of the process, As (III) was oxidized to As (V) with KMnO₄. Coagulation was performed with FeCl₃ and the filtrations were done with 0.45 µm filters. The chemical speciation and statistical analysis were modeled with Visual MINTEQ.

The results from the membrane and adsorption experiments show that RO is an effective water purification method even in a relatively low pressure and as a stand-alone technology. RO was able to remove arsenic from the contaminated natural water significantly below the WHO drinking water guidelines, even below or close to the limit of quantification. In addition, it was effective in the removal of the other contaminants studied. Nanofiltration and adsorption may be feasible if drinking water quality is not needed. SorpP showed higher As removal rates and efficiencies than Sachtofer. In the future, the effect of higher adsorbent doses on the arsenic removal should be investigated to find out whether higher doses result in higher removal efficiencies.

The results from the AOCF experiments showed that the arsenic adsorption is dependent on pH. At pH 5 and 6, arsenic concentrations below the limit of detection were accomplished. The presence of calcium in the solution was a determinant factor for the arsenic removal. In the absence of coagulant, 70% of arsenic was removed, which is explained by the formation of Ca-As precipitates. This observation provided evidence that Ca has a crucial role in arsenic removal and the arsenic adsorption might have occurred to some extent through the creation of Fe-Ca-As ternary complexes. Silicate was the most significant inhibitor in the coagulation process. Low phosphate concentration restricted its competing capacity for the available adsorption sites. During the whole range of examined initial concentrations, As removal efficiency was higher than 93%.



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