

Arsenic removal from lake water, river water and groundwater using an electrocoagulation system

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Arsenic (As) is a toxic element that occurs naturally in the environment. The contamination of groundwater by arsenic is a worldwide concern, affecting the health of thousands of people, especially in South-East of Asia (West Bengal, Bangladesh, etc.). The consumption of drinking water represents a major source of human exposure to arsenic, which can lead to the development of different types of cancer, skin lesions, cardiovascular diseases, etc.

A number of studies have investigated the potential to use iron electrocoagulation (EC) as a method to remove arsenic from water. This system is a low-cost water treatment method with low energy requirements, both of which are important requirements for water treatment in decentralized communities. In this system, a current is passed through an Fe(0) electrode which is oxidized and dissolved to Fe(II). Successive reactions including Fe(II) oxidation to Fe(III) generate oxidants (Fenton reactions) able to oxidize either Fe(II) and As(III) to As(V), the less dangerous form of As. Furthermore, Fe(III) forms nanoscale Fe precipitates that efficiently sorb (according to the pH) As(III) and As(V). Subsequently, As-rich iron precipitates can be removed from water by filtration and/or settling (Ratna Kumar, Chaudhari, Khilar, & Mahajan, 2004).

Ions and substances present in the raw groundwater can compete with As for sorption sites of Fe oxides (e.g., phosphates, transition metals, organic matter) and/or oxidation (redox sensitive elements such as Mn) (van Genuchten & Peña, 2017). To test the performance of the system for different water chemistries, lake water, river water and groundwater were sampled from the University of Lausanne campus and spiked with As(III) or As(V).

The different waters were first filtered using a 0.2 µm filter and spiked with 10 µM As(III) or As(V). The experiments were conducted in the presence of natural O₂ (from air) and with the addition of 250 µM of H₂O₂, an oxidant naturally produced in the system. As(III), As(V) and Fe aqueous concentrations (after filtration at 0.2 µm) and Fe and As concentrations in the total phase were measured over time (0, 6, 13, 23 and 32 minutes). Total organic carbon and the major cations and anions were also determined at the beginning and at the end of the experiment to determine which elements are in competition with As.

River water and groundwater generally contained higher concentrations of ions such as Ca, Mg, K and Na compared to lake water. However, the As removal was faster for the lake water than for the other waters. The total organic carbon (TOC) concentrations were similar for the three waters (less than 5 mg L⁻¹). These results provide insight into the control of co-occurring elements on the reactions and the As removal efficiency in EC systems.

REFERENCES

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