

Piloting an Electrical, Modular, and Distributed ZLD Arsenic-Removal Technology

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Challenge

Many small rural communities rely on groundwater as their water source. In thousands of communities in the U.S. the aquifers are contaminated with geogenic arsenic. Currently, the USGS estimates that 10.7 million Americans are exposed to high levels of arsenic in the groundwater they use for drinking. Chronic exposure to arsenic causes serious harm to health. Effective technologies for removal of arsenic exist, but become unaffordable and expensive at small scale, and thus out of reach of small communities. Currently the only available option for families in such small communities, is to drive to the nearest large town to purchase bottled drinking water. This project aims to develop reliable, modular, and affordable precision arsenic-removal technologies to provide access to clean water for a wide range of small communities currently unable to afford access to it.

Research Approach

We will pilot test two novel electrical technologies in the field, each with the potential for precision removal of arsenic to levels well below the EPA's arsenic Maximum Containment Level (MCL) (of 10 $\mu\text{g/L}$). These technologies are suitable for use in distributed settings (e.g., in small communities with populations below 5000), and each has the potential to become locally affordable. These two technologies are Air Cathode Assisted Iron Electrocoagulation (ACAIE) and Fe-EC with external OXidizer (FOX). We will design, build, and operate a pilot plant to test these two novel technologies to locally produce potable water at a site where groundwater is contaminated with unacceptably high levels of arsenic. We will implement automation and remote monitoring to demonstrate the feasibility of reducing on-site labor costs. Additionally, our project aims to demonstrate the potential for these technologies, when operated as a water treatment and filling station, to become technically and financially viable for a small community's drinking water supply.

Approach

The project will support future commercialization of a fully electrical, near-autonomous drinking-water filling-stations in communities with arsenic contaminated groundwater.

Such communities often have no alternative than procuring bottled drinking water from long distances, imposing additional costs on an already low-resource population. If successful, we will have two pilot-tested technologies that can address the needs of treating arsenic contaminated groundwater for many, or most, of relevant small communities in California and the U.S. Prior laboratory results show that both technologies can remove arsenic from 1500 ppb to below 10 ppb, at typical pH values and in the presence of realistic concentrations of phosphate (the strongly competing anion in arsenic removal).

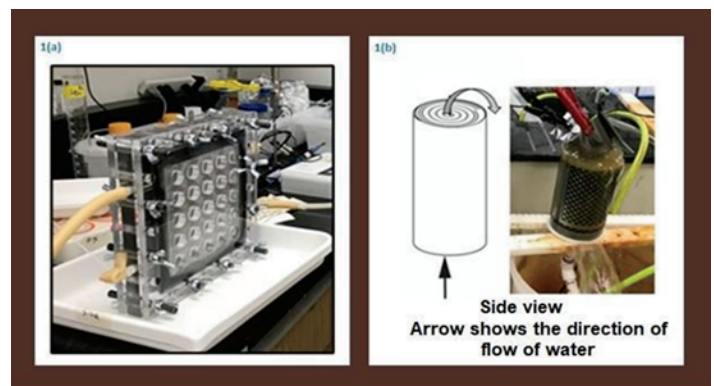


Figure 1. The compact designs of ACAIE and FOX reactors (1(a) and 1(b) respectively) were invented for high throughput.

RESEARCH PARTNERS

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References

Belitz, K.; Fram, M.S.; Lindsey, B.D.; Stackelberg, P.E.; Bexfield, L.M.; Johnson, T. D.; Jurgens, B.C.; Kingsbury, J.A.; McMahon, P.B.; Dubrovsky, N.M. Quality of Groundwater Used for Public Supply in the Continental United States: A Comprehensive Assessment. ACS EST Water 2022, 2(12)

Smith, A. H.; Steinmaus, C. M. Health Effects of Arsenic and Chromium in Drinking Water: Recent Human Findings. Annu. Rev. Public Health 2009, 30 (1)

Bandaru, Siva RS, Case M. van Genuchten, Arkadeep Kumar, Sara Glade, Dana Hernandez, Mohit Nahata, and Ashok Gadgil. "Rapid and efficient arsenic removal by iron electrocoagulation enabled with in situ generation of hydrogen peroxide." Environmental science & technology 54, no. 10 (2020)