Electrochemical Arsenic Remediation (ECAR)




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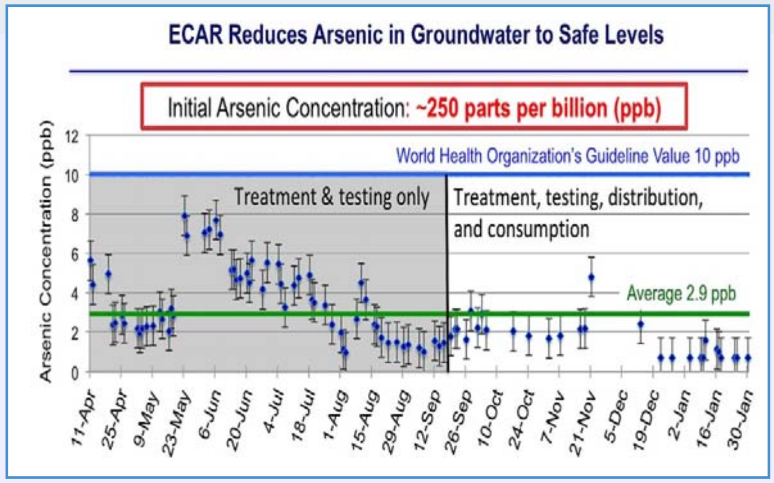
Motivation

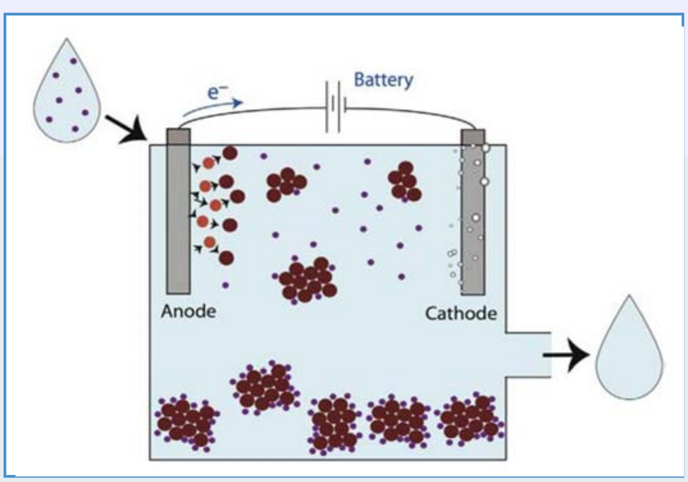
An estimated 200 million people worldwide are exposed to toxic levels of naturally occurring arsenic (As) in the groundwater used for drinking .Chronic ingestion of As at concentrations above the Maximum Contaminant Level (MCL) of 10 ug/L set by the World Health Organization (WHO) and Environmental Protection Agency (EPA) is a major public health concern. Such exposure leads to cancers, reproductive problems, skin lesions, and impaired cognitive function in children. In resource-poor regions of the world, such as South Asia, 140 million people lack the resources and infrastructure to effectively remediate As from groundwater.



Results from our pilot plant in West Bengal, India – April 2016 to January 2017

Technological Challenges

The presence of both As(III) and As(V), nonionized and ionized species at circumneutral pH, respectively, in the groundwater is a challenge for current treatment technologies, such as Reverse Osmosis (RO) and Ion Exchange, that rely on a charged species for effective total As removal. Thus, pre- and post-treatment steps are often required. In addition, such technologies are expensive, difficult to maintain, require excess chemical addition, and generate high amounts of waste. The Gadgil group developed Electrochemical Arsenic Remediation (ECAR), an effective low-cost technology overcoming these limitations, while supporting sustainable operation in resource-poor, rural regions of the world.



Schematic of ECAR process with Fe(0) electrodes

Research

ECAR is based on Iron Electrocoagulation (Fe-EC), which works by applying a small external voltage to a sacrificial Fe(0) anode to promote the oxidative dissolution of Fe(II) ions. The EC-generated Fe(II) ions subsequently migrate from the electrode surface to the bulk electrolyte, where they can be oxidized by dissolved oxygen (DO). The oxidation of Fe(II) by DO produces insoluble Fe(III) and, as a by-product, reactive intermediate oxidants (i.e. Fenton-type products) are produced *in-situ* that effectively oxidize non-ionic As(III) to the readily-sorbed As(V) oxyanion. The insoluble Fe(III) ions polymerize *in-situ*, producing reactive Fe(III) (oxyhydr)oxides with a high affinity for binding As. The As-laden precipitates can then be separated from treated water by gravitational settling and/or filtration. ECAR has been scaled up to 10,000 LPD capacity plant in rural West Bengal, which is providing arsenic-safe drinking water to 2,500 students and teachers and selling the excess water to the surrounding community at less than $0.01 per liter.

References

[1] Ahuja, Satinder, ed. Water reclamation and sustainability. Elsevier, 2014.
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