Contribution ID: **604** | Type: **Oral Presentation**

A novel technology to remove co-occurring arsenic and atrazine in the groundwater used for drinking

Thursday, 2 June 2022 09:40 (15 minutes)

Water supplies of many communities are contaminated with both naturally occurring arsenic and anthropogenic toxic chemicals. Globally, 200 million people are exposed to toxic levels of naturally occurring arsenic in the groundwater used for drinking (Podgorski and Berg 2020). Chronic exposure to arsenic causes various types of internal cancers, cardiovascular diseases and low I.Q in children (Smith et al. 2002). Further, unsafe levels of persistent organic contaminants (e.g., insecticides, nematicides, and antibiotics, from farming activities) are observed in the arsenic contaminated groundwaters (Duttagupta et al. 2020). Low-income resource-poor communities are disproportionately impacted by groundwater contamination because of the lack of affordable remediation technologies that can be operated over long periods (Amrose, Burt, and Ray 2015).

Recently, we reported Air Cathode Assisted Iron Electrocoagulation (ACAIE) as a promising low-cost technology to remove arsenic in the groundwater used for drinking. In ACAIE, low-voltage direct current is applied between a steel plate (anode) and an air diffusion cathode (herein called "air cathode") to promote anodic dissolution of Fe(II) from the anode and cathodic reduction of O2(g) from air, to form H2O2 in the solution at the air cathode. In bulk solution, Fe(II) and H2O2 react rapidly to form insoluble Fe(III) (oxyhydr)oxides which have high affinity for As(V) adsorption. Reactive intermediates (*OH*,O2−, Fe(IV)), generated during the oxidation of Fe(II) by H2O2 , oxidize dissolved As(III) to As(V) that can be easily adsorbed (Hug and Leupin 2003), and can also breakdown toxic organic contaminants (Bocos et al. 2016) to non-toxic byproducts.

Although ACAIE is a promising technology to treat contaminated groundwater for drinking, long-term performance of ACAIE–especially the longevity of the air cathode –is poorly understood. In ACAIE, the Fe(III) (oxyhydr)oxides precipitates formed in the bulk solution can deposit on the air cathode causing a decrease in H2O2 generation. Poorly conducting iron oxides, can increase the charge transfer resistance and can also catalyze the decomposition of H2O2 at the surface, which leads to decreased H2O2 concentrations in the bulk solution (Pham et al. 2009; Rusevova Crincoli and Huling 2020). Adequate production of H2O2 is critical for efficient contaminant removal in ACAIE.

In this work, we demonstrate the effectiveness of ACAIE in removing co-occurring realistic concentrations of arsenic and atrazine to safe levels in a realistic water matrix. Further, we will discuss the influence of operating time and electrolyte composition on the longevity of the air cathode with respect to the Faradaic efficiency of H2O2 generation. Various analytical characterization tools (e.g., SEM, XPS, Raman, LSV) are used to understand the mechanisms responsible for the decrease in H2O2 Faradaic efficiency. Finally, we will present effective strategies for the regeneration of fouled air cathodes to recover their H2O2 Faradaic efficiency to near the original value.

Acceptance of the Terms & Conditions

Click here to agree

MDPI Energies Student Poster Award

No, do not submit my presenation for the student posters award.

Country

United States

References

Amrose, Susan, Zachary Burt, and Isha Ray. 2015. "Safe Drinking Water for Low-Income Regions."https://doi.org/10.1146/annurev-environ-031411-091819.

Bocos, Elvira, Enric Brillas, ngeles Sanroma, and Ignasi Sire. 2016. "Electrocoagulation: Simply a Phase Separation Technology? The Case of Bronopol Compared to Its Treatment by EAOPs."https://doi.org/10.1021/acs.est.6b02057.

Duttagupta, Srimanti, Abhijit Mukherjee, Animesh Bhattacharya, and Jayanta Bhattacharya. 2020. "Wide Exposure of Persistent Organic Pollutants (PoPs) in Natural Waters and Sediments of the Densely Populated Western Bengal Basin, India."Science of the Total Environment 717 (May): 137187. https://doi.org/10.1016/j.scitotenv.2020.137187.

Hug, Stephan J., and Olivier Leupin. 2003. "Iron-Catalyzed Oxidation of Arsenic(III) by Oxygen and by Hydrogen Peroxide: PH-Dependent Formation of Oxidants in the Fenton Reaction."Environmental Science and Technology 37 (12): 2734–42. https://doi.org/10.1021/es026208x.

Pham, Anh Le Tuan, Changha Lee, Fiona M. Doyle, and David L. Sedlak. 2009. "A Silica-Supported Iron Oxide Catalyst Capable of Activating Hydrogen Peroxide at Neutral PH Values."Environmental Science and Technology 43 (23): 8930–35. https://doi.org/10.1021/es902296k.

Podgorski, Joel, and Michael Berg. 2020. "Global Threat of Arsenic in Groundwater."Science 368 (6493): 845–50. https://doi.org/10.1126/science.aba1510.

Rusevova Crincoli, Klara, and Scott G. Huling. 2020. "Hydroxyl Radical Scavenging by Solid Mineral Surfaces in Oxidative Treatment Systems: Rate Constants and Implications."Water Research 169: 115240. https://doi.org/10.1016/j.watres.2019.1152

Smith, Allan H., Peggy A. Lopipero, Michael N. Bates, and Craig M. Steinmaus. 2002. "Arsenic Epidemiology and Drinking Water Standards."Science 296 (5576): 2145–46. https://doi.org/10.1126/SCIENCE.1072896.

Time Block Preference

Time Block C (18:00-21:00 CET)

Participation

In person

Primary authors: Dr BANDARU, Siva Rama Satyam; Dr KUMAR, Arkadeep (Lawrence Berkeley National Laboratory); Dr NAHATA, Mohit (University of California Berkeley); Ms HERNANDEZ, Dana (University of California); Prof. GADGIL, Ashok (University of California Berkeley)

Presenter: Dr BANDARU, Siva Rama Satyam

Session Classification: MS02

Track Classification: (MS02) Porous Media for a Green World: Water & Agriculture