Arsenic

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Overall Goals:

- Design and improve AguaClara filtration unit to remove arsenic from influent

- Evaluate the feasibility of implementation

This Semester's Goals:

- Fabricate a sand filtration unit for continuous flow experiment

- Establish a rigid experimental procedure to ensure safety of researchers and minimize hazardous waste

- Improve arsenic detection method using the graphite furnace atomic absorption spectrometer

- Perform continuous flow experiment and evaluate filter capacity to removal arsenic from influent

The processes of flocculation, floc blanket formation, plate settler sedimentation, and filtration are expected to remove As (V). The removal of arsenic by precipitation is expected to be limited by the transport of arsenic to the solid surface of the coagulating agent (either iron or aluminum salts). The flocculation process for groundwater containing arsenic is expected to be inefficient due to the low floc volume fraction. To compensate for the low floc volume fraction it may be necessary to use a longer residence time. Loss of coagulant to the walls of the reactor will also likely be a major problem for small scale reactors given the low solid surface area in suspension. It may be advantageous to use a contact chamber for rapid mix and initial precipitation to reduce losses to the reactor walls.

If this is the case, then a floc blanket consisting of precipitated coagulant could be an efficient reactor for arsenic removal.

Current Research

A critical aspect for this research is to develop a reliable and sensitive method to measure dissolved As in the samples. Options include a Graphite Furnace Atomic Absorption Spectrometer (GFAAS), inductively coupled plasma and wet chemical methods (see Hach). The best available method with high sensitivity in our lab is the GFAAS and a lot of work has been done to verify the efficacy at very low Arsenic concentrations.

In Spring 2013, the team set up a safety protocol to prevent hazards in the AguaClara lab. Additionally, it was determined that aluminum coagulants may be as effective as iron salts for arsenic removal.

In Fall 2013, the team arranged its laboratory space and begun bench experiments. The team initially prepared the lab area for hazardous chemicals with the proper personal protective equipment and appropriate warnings. Then it collected all pertinent testing equipment such as the tube tumbler, test tubes, and gathered the appropriate chemicals to create groundwater. Once all of the materials were collected the team begun testing sedimentation and filtration in a small scale reactor. The GFAAS was not fully operational at the time.

During Spring 2014, the team was ready to proceed with a prototype. A sand filter was assembled using a 1.6 cm diameter PVC pipe of 1.2 m length. This design would allow continuous flow experiments with minimal amounts of contaminated effluent water. Simultaneously, progress on the GFAAS was made, first to make it work and further on to evaluate the sensitivity of the machine and obtain accurate readings down to < 10 ppb concentrations of Arsenic. The final achievement of this team were the experimental results of the continuously flow experiment which proved that a very high efficiency of Arsenic removal using filtration/coagulation is feasible.

Future Research

The primary goal for the proceeding continuous flow experiments is to evaluate which method of coagulant addition, pretreatment or co-treatment is more significant for removal. This should provide more insight about the pattern of coagulant distribution in the filter and suggest different schemes to optimize efficiency, Additionally, through further experiments the goal is to obtain insight about the mechanism by which coagulant removes Arsenic.

Future experiments will evaluate Arsenic removal with respect to the following parameters:

- Co-treatment dosage
- Pretreatment only
- Pretreatment & co-treatment method
- No treatment
- Coagulant saturation over time
- Arsenic influent concentration
- pH (range 6.5-8.5)
- Contact time
- Ferric vs Aluminum coagulant

The overall goal is to design a compact, low-energy filter that can remove relatively high concentrations of Arsenic to safe drinking standards with minimal operational difficulties and for long duration. We believe in the feasibility of the project but need to further elucidate the following factors:

1. The optimal coagulant treatment and dosage
2. The volume of water it can treat
3. Backwash: process and fate
4. The sensitivity of Arsenic removal at different environmental conditions.

Members

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Documents

	Challenges	Tasks	Symposium	Final Presentation
Spring '14	? Unknown Attachment	? Unknown Attachment	? Unknown Attachment	? Unknown Atta
Fall '13	? Unknown Attachment	? Unknown Attachment	? Unknown Attachment	? Unknown Atta
Spring '13		? Unknown Attachment	? Unknown Attachment	? Unknown Atta