Fluoride Filter ↑ (EPA P3 Phase II grant)

Skills: fabrication, process controller, experimental design

Big questions to answer

- What configuration of processes is required to optimize performance (mass of Fluoride removed per mass of coagulant, volume of safe water produced per volume of waste produced) and create an operator friendly system?
- Is a flocculator floc blanket/tube settler system as efficient as a sand filter?

Introduction

Fluoride contamination of groundwater is a major health concern. Although this is a well known problem there aren't any highly effective and sustainable technologies available. The World Health Organization suggests that the Nalgonda technique has potential, but it has several serious problems.

The treatment efficiency is limited to about 70 per cent. Thus the process would be less satisfactory in case of medium to high fluoride contamination in the raw water.

A large dose of aluminium sulfate, up to 700–1,200 mg/L, may be needed. Thus it reaches the threshold where the users start complaining about residual sulfate salinity in the treated water. The large dose also results in a large sludge disposal problem in the case of water works treatment.

The removal by some form of coprecipitation with aluminum hydroxide opens the possibility that we could use our expertise in flocculation/sedimentation/filtration to design a much more efficient fluoride removal system. It is possible that PACl will be a better coagulant than alum. Use of direct filtration or some combination of flocculation/sedimentation/filtration may be able to obtain better removal of fluoride at much lower coagulant dose and thus lower operating cost.

During the fall of 2015 the Fluoride filter team demonstrated that fluoride can be removed quite effectively using PACl and a filter column. However, the filter run times are short with high coagulant dosages and thus future research will focus on transitioning to a floc blanket system.

Tasks

- Work with countercurrent stacked floc blanket reactor team to explore improved reactor geometries
- Build a single floc blanket reactor to enable a comparison with the countercurrent stacked floc blanket reactor. The treatment train will consist of a PACl and possibly a clay feed, flocculator, floc blanket, and tube settler. The flocculator collision potential design can be based on experiments conducted by Casey Garland. The goal should be to have about 90% removal of the PACl flocs by the tube settler PRIOR to the formation of the floc blanket. A Gtheta of 5,000 and a G of 70 1/s is a reasonable starting place for the design.The upflow velocity in the floc blanket is 1 mm/s. The tube settler capture velocity is 0.12 mm/s.

- Design experiments to learn what is required to obtain efficient fluoride removal. Use a PACl dose of 20 mg/L Al so that it is easy to compare performance with the sand filter results of fall 2015 that obtained 57% removal of fluoride. Test various clay feed rates (**possibly** needed to form a floc blanket) from 0 mg/s to the feed rate used in the countercurrent stacked floc blanket reactor.
- The fluoride probe only measures fluoride in solution. It is possible that significant fluoride escapes the tube settler in small flocs. Test some of the effluent samples for total fluoride by adding enough hydrochloric acid to lower the sample pH to 3 prior to measure the fluoride concentration.. This should require an acid concentration of 1 mM plus the acid neutralizing capacity of the groundwater or tap water that you are using.
- Work with the countercurrent floc blanket reactor team to write a proposal for a phase II EPA grant and to design a visually engaging reactor demonstration for the EPA expo.