AguaClara Foam Filtration Challenges

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Abstract

The Foam Filtration team is currently designing an emergency response water treatment system that utilized polyurethane foam as a filter medium. The goal for this semester is to finalize the design of the emergency treatment system, evaluate the effectiveness of the cleaning mechanism, build a working prototype of the system for presentation in DC at the National Sustainable Design Expo, and begin collecting data on the overall performance of the system.

- Students: 4-6
- Skills: Fluids, Fabrication, Process Controller helpful but not required

1 Introduction

Previous work on Foam Filtration has shown that point of use (POU) applications would still require the use of a coagulant and therefore would not prove to be a disruptive technology. Additionally municipal scale foam filtration systems have proven impractical due to an inability to clean the filters. Current focus is on designing a scalable foam filtration system for emergency response systems. The emergency system proposed will be a multistage filtration system, using a foam roughing and finishing filter to clean turbid water. The system will also be designed to function as a small scale water treatment facility; including its own input reservoir, linear flow orifice meter (LFOM), chemical dose controller (CDC), filtration system, and disinfection tank. The system will be small enough so that individual filter units can easily be carried by one person.

2 Materials

It is important to find a reliable source of polyurethane foam for the design specifications of the filter (30 and 90 ppi and reasonable compressive strength) and purchase enough foam to begin testing prototype systems. If possible, tube-shaped foam that is the diameter of the filter unit would be ideal. This will ensure that the foam neatly meets the edges of the filter unit and there are no preferential flow paths in the filter bed.

3 Design and Fabrication

The goal for this semester is to apply the principles and constraints learned from previous semesters to design and build a working foam filtration system that can easily be cleaned and that consistently produces high quality water. Based on the work of previous semesters (namely the work to determine optimum filtration depths and head loss through the filtration media) design and build a complete filtration system including a roughing and finishing filter to be used as a demonstration prototype in Washington DC. Produce a Mathcad worksheet capable of producing a design for a full filtration system given a desired flow rate or approximate population to be treated by a single filtration unit. Design a final layout for a complete system including an inflow reservoir, LFOM, CDC, roughing and finishing filter(s), pump/input system, and disinfection tank. The system should be as efficient as possible, using the least amount of space and electricity as possible.

4 Testing

Using the prototype designed for DC, begin testing the performance of the filter. The key performance parameters are solids loading capacity ($\frac{kg}{m^3}$ where the volume is the bed volume) and pC*.

4.1 Overall Filter Performance

Using the prototype filtration system, determine the overall performance and run time of the complete filtration system, rather than the performance of each part individually.

4.2 Cleaning System Performance

Evaluate the effectiveness of the proposed plunger cleaning method. The cleaning method is a key element that will likely determine the success or failure of the foam system. Develop cleaning methods that result in rapid recovery to high pC* values after cleaning. The cleaning methods must also be easy to implement.