Fall 2010 Foam Filtration Reflection Report 3

Foam Filtration Reflection Report

Primary Authors: Catherine Hanna, Rachel Philipson, Melissa Shinbein, Kevin Wong

Primary Editor: Rachel Philipson

AguaClara Reflection Report

Cornell University

School of Civil & Environmental Engineering

Ithaca, NY 14853-3501

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Abstract

Since the beginning of the semester, the foam filtration team has focused mainly on the design of a point of use filtration unit. The objective of our design is to create a filtration system that can effectively reduce turbidity in water to minimal levels while being econo

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have been completed. Future work in the upcoming weeks will focus on testing the filter performance under a range of turbidities, additional head loss measurements for the collapsed state of foam, and polishing the EPA P3 applications for submission.

Introduction

In the past two weeks, we have worked on running experiments and continuing our designs for the point of use foam filtration unit. Our designs have not changed, but we are working on refining aspects of it to ensure simplicity and ease of use. We currently have dimensions for most aspects of the unit design based on different use situations, which are discussed in the following sections. In the remaining part of the semester, we will continue to work on refining our designs

Optimization of these designs will be based on the experimental results we collect over the rest of the semester. We have begun running experiments, this week we determined the head loss through the foam. These results, and results from future experiments will give us a better understanding of how foam functions as a filtration mechanism. **With this greater understanding of how foam filtration works through experimentation, our team will be able to design an optimized point of use foam filtration unit.**

Experimental Design

This week, we conducted four experiments total in order to find the headloss through the 90 ppi and 60 ppi foam (two experiments for each type of foam) using the experimental apparatus show in figure 1, except there was no alum used and there was no turbidity in the influent water. We used a foam depth of 10 inches and an approach velocity of 4 mm/s. To conduct this experiment, we used two free surfaces – the filter column and the water exit. We placed the water exit tube at a specific height approximately midway between the foam depth and we filled the filter column with water. As the water drained, its height approached the equilibrium in the column relative to the height of the exit tube. This height was marked with yellow tape.

Then, water was pumped into the filter column at a constant flow rate of 121.61 mL/min, or velocity of 4mm/s. It took around five minutes for the height of the water to stabilize as water flowed in from above the foam surface and water flowed out through the exit tube.

This height was again marked with yellow tape. Both procedures were repeated once more and this change in height from the first piece of yellow tape to the second for both experiments given one type of foam was measured. This height is equivalent to the headloss

through the foam. The results obtained can be found in the data table below (Table 1).

	Experiment One	Experiment Two
60 ppi	7.8 cm	7.6 cm
90 ppi	8.5 cm	8.3 cm

Table 1. Headloss through 10 inches of foam at 4 mm/s

These headloss values will allow us to optimize our foam filtration design without neglecting these losses. With these values, we can recalculate inlet and exit orifice diameters to perfectly obtain constant flow through the filter.

Results and Discussion

In addition to our headloss experiment, we have continued to work on the design for our point of use foam filtration unit:

Influent water flow control:

For the case where there is a tap water source, there would not be a need for a large holding tank because the tap can send the water directly into the filter. Those without this source would need to bring buckets of water to a holding tank where it will be filtered. We determined the amount of water required for our four different design scenarios (Table 2). A 15-gallon (56 L) holding tank was considered suitable for the family with no water distribution. For a village of 200 people, assuming half will be carrying water and each person carrying 4 gallons at a time, the total water filtered in one trip would be 1,514.16L, which allows for 7.57L/person/trip. If we assume the maximum number of people getting water at a specific time is 10, then a 40-gallon holding tank would be sufficient.

Foam Filtration Unit

The foam filtration unit has not changed in design since the last reflection report. The system itself does not have any concrete numbers. Currently we predict the use of a 10 inch foam depth with 2 inches of water on top of the filter bed and a 4 mm/s approach velocity. However, everything else (in terms of design) needs more experimentation in order to be determined. The diameter of the filter column will be dependent on the amount of people expected to use the device. The size of entrance and exit orifices will be dependent on future experimental results and schematic findings.

Case	Family Unit with Water Distribution System	Family Unit without Water Distribution System	Apartment Building with Water Distribution System	Business / School with Water Distribution System (without shower)	Small Village without Water Distribution System (only drinking)
Number of Expected People Using the Filter	7 people	7 people	50 people	50 people	200 people
Average Water Consumption per Person per Day	100 L/person /day	20 L/person/day	100 L/person /day	40-45 L/person /day	20 L/person/day

Table 2. Different cases for point-of-use filtration unit design

Distribution System

For the exit and chlorination chamber, the main work was determining the size and necessity of a mixing tank to ensure rapid mix with effluent water and chlorine. However, upon further discussion it was determined that the fall into the distribution tank will produce micro scale mixing to distribute the chlorine throughout the effluent water. However, the chlorine doser must be slightly modified to ensure that macro mixing occurs; in the upcoming weeks we will be discussing an easy way to do this.

Future Work

We propose to conduct the following experiments in the next two weeks:

(1) Head loss measurements for foam over the entirety of an experimental run (with turbid water) and in its collapsed state

(2) Tests on the performance of foam under varying influent turbidities to find a range of turbidities for which the filter is able to perform

(3) (Possibly) Experiments on the effect of layering foam of different porosities

At the same time, we will be working on our designs for the point of use filter. Our application for phase one of the EPA P3 competition is underway, and we will continue to refine our application for submission.

Team Reflections

During these last few weeks, great progress has been made in finalizing our apparatus and we have finally begun experimentation. This past week, our team has calculated the head loss through the foam (see *Experimental Design* for more details). Also, with the arrival of the turbidimeters, we will be able to start a series of experiments measuring effluent turbidity. Our set up work is still not done, we still need to calibrate the turbidimeters and fix a few kinks in the process controller method. Though these small set-up tasks take up a lot of our time, we need to ensure that everything is set up correctly to minimize technical problems in the future. In spite of this, the past two weeks were by far our most productive in terms of experiments, and it exciting that we will finally be able to move onto this section of our team's research. The experiments we will run in the upcoming weeks are crucial to understanding how foam works as a filtration mechanism so we can design the optimal foam filtration unit. Additionally, we have continued our work on designing a filtration unit and we are getting closer to optimizing the design. The EPA P3 proposal is also underway, and we hope to submit this within the next few weeks.