Fall 2010 Foam Filtration Reflection Report 5

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

The foam filtration's previous work has focused on collecting experimental data on the properties of polyurethane foam as a filtration media and designing a point of use filtration unit. . The goal of our team work and research is to design an efficient foam filtration unit that can provide clean, drinking water (of less than .3 NTU) to communities without access to clean, treated water.

Recently, we have attempted to determine the performance capacity of our experimental apparatus, but have encountered problems preventing our experimental runs from being successful. Future work includes finding solutions to these problems, implementing the solutions, and finally running successful experiments. Most likely, next semester's work will have to focus on testing different combinations of foam in order to determine whether an optimal combination exists. If it does, the team will need to find this combination so that the point-of-use design can be further improved by using this foam arrangement.

Introduction

Throughout the semester, the foam filtration team has been working on running head loss experiments and improving our point of use filter design. We were able to measure the head loss through the foam with clean water running through it. In addition to this head loss measurement, we also want to measure the head loss through the foam as a function of filter run time. We were able to collect over 24 hours of data over two experiments of head loss measurements through the foam. We believe head loss may be linearly related to time, however an additional experiment must be done to confirm this. Similarly to previous weeks, problems with our experimental apparatus have prevented us from running the foam

filter until failure due to collapse. After troubleshooting the apparatus, we discovered that dissolved air in the water was causing air build-up in the column and have developed a solution to this problem.

Additionally, we have been working on designing components of the point of use filter unit. Throughout the semester we have been improving these designs, and we have plans to construct the filter in the future (next semester). **Through this experimental and design work, we hope to design an effective point of use foam filtration unit to be utilized in communities without access to safe drinking water.**

Experimental Design

We are currently conducting experiments to see the performance of our filter in treating turbid water and to measure the head loss of the foam over time. The experimental apparatus, which was previously finalized, has stayed mostly the same (Figure 1).

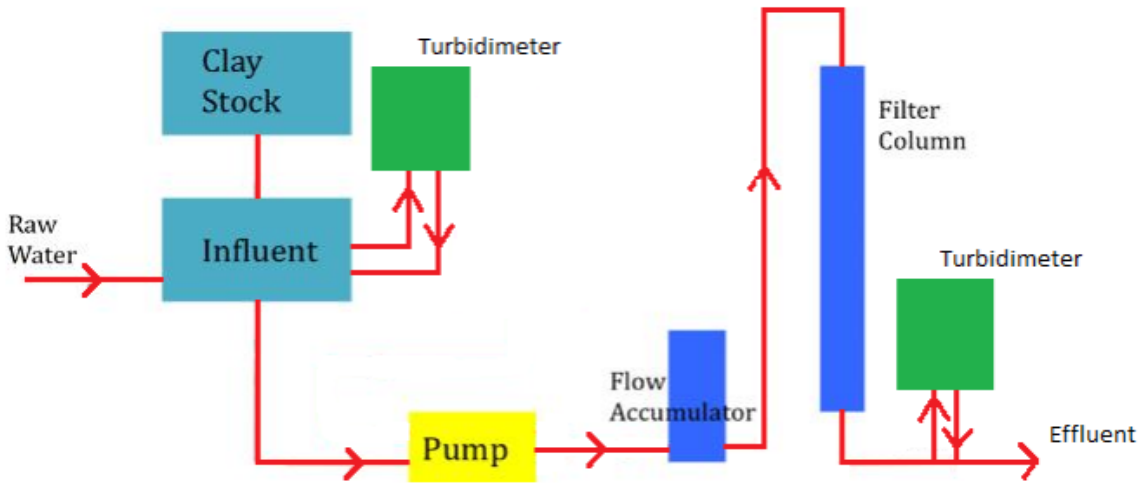


Figure 1: Foam filtration experimental apparatus.

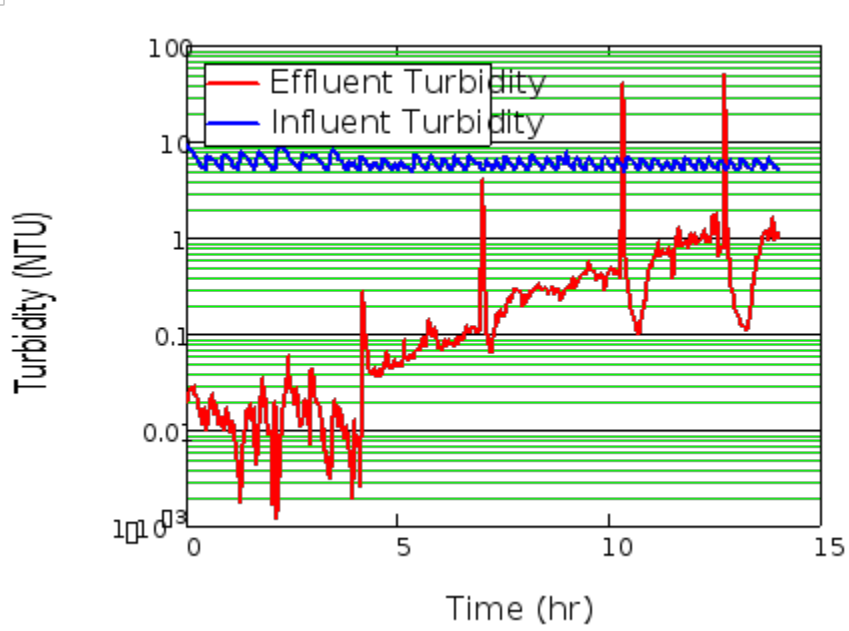
Prior to the start of each experiment, the foam in the filter is thoroughly cleansed. The foam is removed from the filtration column, and individual layers are rinsed and compressed to release trapped clay particles from previous experiments. After the individual layers are cleaned, they are replaced in the filtration column in the same order to maintain consistency in our experiments. As each layer is being replaced, great care is taken to ensure that air bubbles are not present in the filter as this may cause our experiments to terminate prematurely and result in inconsistencies in our experimental data. The clay and alum s [KS1] tocks are also refilled prior to the start of each experiment.

During operation of the filter, which is controlled by Process Controller software, the temperature of the raw water is monitored as it comes out of the hot and cold faucets. This is mixed with concentrated clay stock to achieve a desired turbidity of approximately 5 NTU in the influent water. The turbid water is then pumped through a flow accumulator, which helps to lessen the pulsing effect from the pump, and into the filter. After the water moves through the filter, the effluent turbidity is monitored with a turbidimeter to determine how much turbidity was reduced by the filter. In addition to monitoring changes in influent and effluent turbidity, we also record the head loss through the foam. These recordings, which are done through Process Controller, allow us to see how turbidities and head loss are related to the duration of the

experiment. A camera was set up so that we could record what the foam looked like as it compresses; team members took turns throughout the week to take pictures of the foam, as well as to check for failure of the experiment.

The results of our experiment, which we anticipate to be a significant reduction of effluent turbidity, will help to confirm our hypothesis that foam media is capable of filtering water to meet EPA standards.

Results and Discussion



Over the past two weeks, we were able to collect a lot of data regarding head loss through the foam as it varies over time. However, we are not confident in this data because of problems with our experimental apparatus. Dissolved air in the water created bubbles in the foam column, which over time resulted in a pocket of air in the column. Additionally, there was air between the layers of foam. This air in the foam would result in lower than expected performance because the water has less surface area to travel through which produces a higher velocity. In order to fix this air bubble problem, air was run through air diffusers to aerate the temperature controlled water. This will hopefully fix the problem of air bubbles in the column

Figure 1: Influent and Effluent [KS2] turbidity vs time, 5 NTU influent, 10 in foam depth, 60 ppi

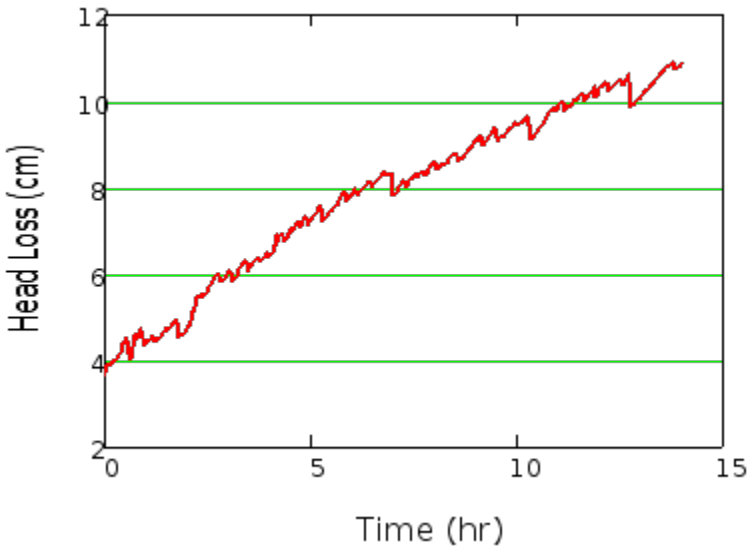


Figure 2: Head Loss as a function of time [KS3] , 5 NTU influent, 10 in foam depth, 60 ppi

This data suggests that performance decreases over time and head loss increases linearly over time. However, because we do not know when the amount of air in the column became significant, it is hard to know if these results are representative of what happens when the experimental apparatus is functioning correctly. Another experimental run must be conducted to prove if these results are accurate. [KS4]

These turbidity results suggest that filter performance is constant for a certain period of time and effluent turbidity rises linearly. However, we believe that the point at which the effluent turbidity starts increasing corresponds to the point at which the amount of air in the foam column started effecting filter performance. This means that the amount of air in between the foam layers is significant compared to the cross sectional area of the foam. Previous [KS5] experiments have shown that the filter can produce effluent turbidities on the order of 0.3 NTU for longer periods of time than this experiment suggests, meaning that the air bubbles caused the filter to fail more quickly than it should have. Additionally, head loss through the foam is linear in relation to time. The original head loss is recorded as 4 cm, however we know that head loss through the foam column and foam is greater than 4 cm from previous experiments, so it is likely that the pressure sensor was not zeroed before the experimental run began. [KS6] Further experimental work is required to either prove or disprove these results.

In addition to experimentation, the foam filter team has also been working on the designs for the point of use filter unit. We done calculations for orifice sizes required for flow control and head loss through a filter bed. These measurements will help us to properly dimension the filtration unit when we begin construction. Additionally, we are in the process of calculating needed measurements for the chlorine doser, however they are not yet complete.

Future Work

Over the next few weeks, we will continue running experiments with the foam column. We have gotten some good head loss data in the past two weeks; however we have not yet been able to measure the head loss as we run an experiment to failure . Since we have devised a solution [KS7] to the 'air in the column' problem, we should be able to get these results quickly. After this, we plan to start running experiments with varying foam pore size in hopes of optimizing the layering and increasing performance levels. We will also continue to work on the design of the point of use foam unit and finish the EPA P3 proposal.

Team Reflections

During the past two weeks, we have attempted to run four different experiments with a 10 inch depth of 60 ppi (pores per inch) foam and an approach velocity of 4 mm/s. However, all of our attempted experiments have been unsuccessful. The first two experiments were interru

pted due to the closing of water valves during run-time. The second two experiments were ruined because of the entrance of air into our filter column.

We have discovered that the air entering our column is a result of dissolved air within our water source. Apparently, during winter months, experimentation with foam becomes difficult due to this problem. We are looking into installing a de-aeration device into our water source

so that this dissolved air will no longer be a problem. However, the faulty air pumps in the new AguaClara lab are preventing this solution from being incorporated. We may have to focus our efforts on the EPA P3 proposal and the design of our point-of-use foam filtration unit

until this problem can be solved. Most likely, successful data from our experimental apparatus will not be obtained until next semester.

[KS1] Don’t use an alum solution that is older than three days. It starts to form polymer chains.

[KS2] Good graph. Your influent turbidity varies more than it should. I can tell by the cyclical nature of the data that you should reduce the ‘off time,’ try 20 seconds.

[KS3] Under what conditions? You want the captions and graphs to be independent of the paper that you can skim and know what was being tested. (influent turb? Depth of filter? Ppi of foam?)

[KS4] Agreed

[KS5] The air bubbles were coming in continuously, so the filter was filling with air continuously, causing it to fail more quickly than it should have.

[KS6] This is probably the case.

[KS7] You never documented this. If I was from a future semester and we were having issues with air in the column, I would need to know about the aerator.