Fall 2010 Foam Filtration Reflection Report 2

Foam Filtration Reflection Report

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AguaClara Reflection Report

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Abstract

The purpose of the foam filtration team is to create a new and effective way of filtering water for a variety of systems both on large and small scales. Since previous research showed foam filtration is not feasible for an AguaClara plant, we will be designing a point of use filtration unit that can be used in homes, apartment complexes or schools. We will test the performance of foam filtration for a variety of influent turbidities, different foam pore sizes and determine the head loss through the foam. Additionally, we will submit our filtration unit design to the EPA P3 competition.

Introduction

The beginning of the semester has focused mainly on the design of our point-of-use foam filtration unit for submission into EPA’s P3 competition. Each week, we revise our previous week’s design in a more detailed and

refined manner. Originally, each team member designed his or her specific components in as many different ways as possible. This method was just used to toy around with design schemes and creative ideas.

For the past couple of weeks, we focused our efforts on generating concrete dimensional numbers, given the finalized (as of currently) component designs. These numbers are still in progress as all values obtained yield new insights into previously

generated ideas. For example, if the diameter of the foam filters in order to provide water for x amount of people is extremely small, then we may decide to increase the diameter and recalculate other dimensions accordingly to provide

water
for say
2x
amount
of
people.

Many of the equations used to determine values stem from Monroe's "Flow Control and Measurement" lecture notes online. Once these design values are permanently finalized, we will include them in our biweekly reports. For now, we are still in the

process of discovering efficient methods to use in the design of our foam filtration unit. **Given more experimental data and analysis (including head loss and turbidity calculations), our foam filtration team can converge on an optima**

l and effectiv e design for a foam filtrati on unit as a point-of-use system.

Experimental Design

Within the last two weeks, the apparatus itself has not changed (Figure 1). Since many parts of the apparatus were delayed in arrival, no experiments have been completed yet with the majority of efforts being focused on P3 designs. The experimental apparatus is now completely set up, the electrical connection to the computer is working, and the process controller method for our experiments has been written. For the experiments in the near future, we will be running water with a constant flow rate through the foam (6 mm/s water velocity). We have also added temperature controlled raw water to the experimental apparatus (Figure 2). Using solenoid valves, we will monitor the temperature of the influent water and keep it constant. Now that our apparatus is ready for experimentation, our primary task in the upcoming weeks will be running experiments. Our first experiment will be to determine the head loss through the foam both with clean water running through it, and when failure occurs (the foam collapses).

The turbidimeters have now arrived, and we plan to have them set up so that after the first experiment we can monitor the influent and effluent turbidity of our experimental runs.

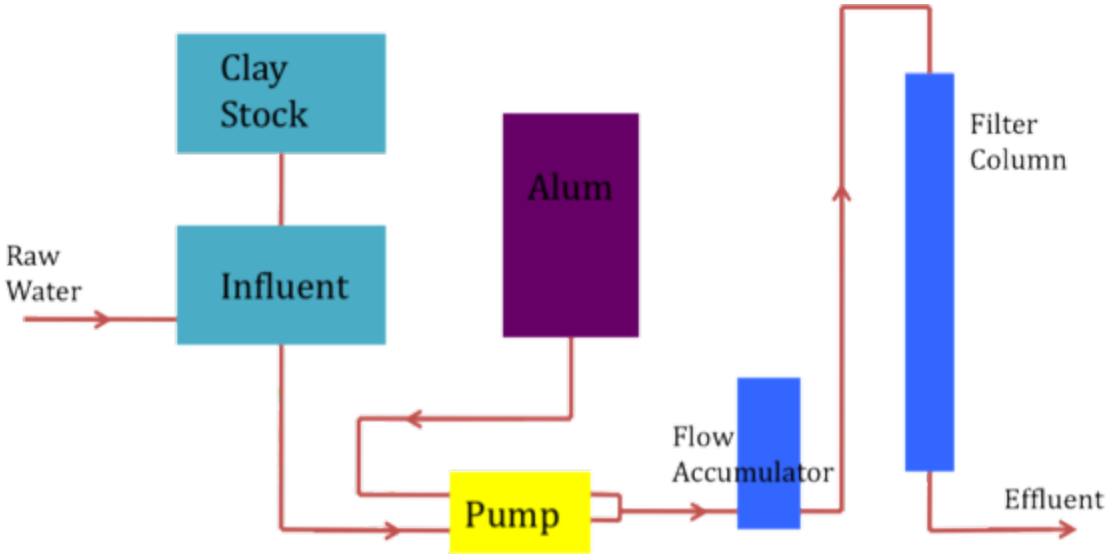

Figure 1: Foam Filtration Experimental Apparatus

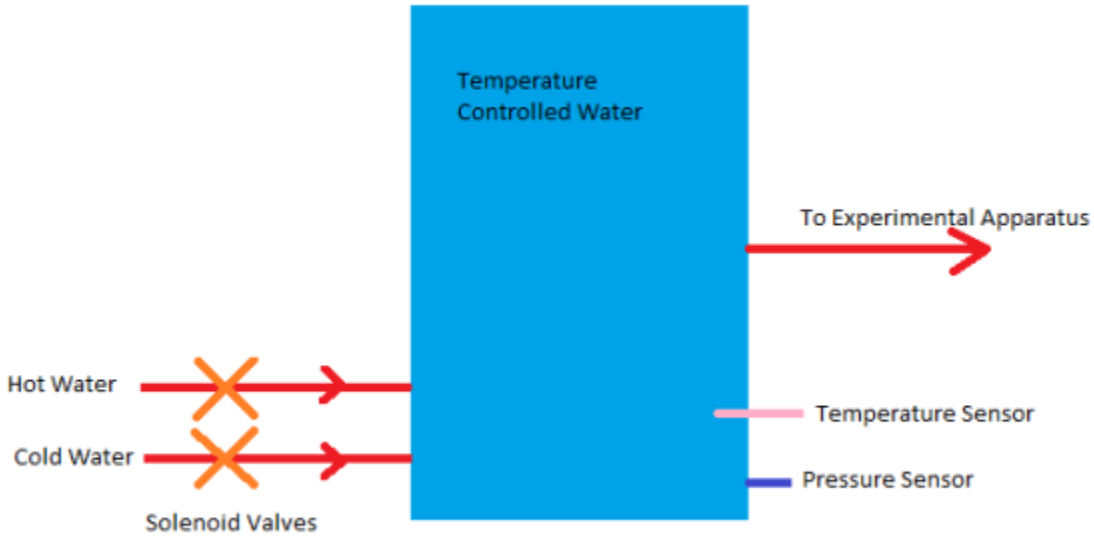

Figure 2: Foam Filtration Raw Water Supply System

Results and Discussion

When designing our filter unit, we are considering four separate situations. First, a filter unit will be designed for a family who has access to a tap of untreated water. Each person in the family (7 to 10 people) will use the filtered water for all of their needs: drinking, cooking, cleaning, and bathing. The second situation is a family without a tap. Since this family must carry all of the water they use to the filter, they will not use the filtered water for cleaning, just drinking and cooking, which will decrease the amount of filtering capacity needed for this design. The third case is a filter unit for an apartment complex, which has access to a tap. This filter will be designed for the same uses as the family with a tap, but will be larger to accommodate more people. Lastly, we will be designing for a village that does not have access to a municipal water distribution system. The filter will be brought to a river or lake and each family will use the filter at the water source. Use of water will be the same as the family with no tap access.

For the situations with a tap, there is no need for a holding tank as the tap would be able to connect directly to the filter. However, if we consider a small village or family units with no tap water source, a holding tank will be required. To control the flow of water through the filter, there will be a float valve on top of the filter to keep a height of water to maintain constant flow through the filter. An alum doser will also be used. The initial design incorporated a linear flow orifice meter, but later considerations deemed this unnecessary since we have not yet determined the range of influent turbidities for which the filter works. At this point it time, it is assumed the filter will only work over a small range of turbidities that would all require the same alum dose. If later research proves the foam can successfully filter water over a large range of turbidities, a linear flow orifice meter will be added to the design.

We decided to use the base of the bucket (or PVC tube) itself as a screen to support the foam in the filter column.

A MathCAD file was created to take the approach velocity, the number of people wanted to

provide clean water for, along with the number of liters per day those people consume and calculate the theoretical diameter of the foam needed. Then, the program looks at available diameters for purchase and finds the

actual diameter needed. Using flow control equations, the user inputs the number of orifices they would like to drill at the base of the holding unit and the file determine the diameter of each of those orifices needed to keep the flow

through
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filter at
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velocity
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The exit chamber of the Foam Filtration Unit will consist of a chlorine doser and a distribution tank . Within the distribution tank, there will be either a platform or box that will induce turbulence between the chlorine and filter effluent . The purpose of this

is to achieve rapid mix to ensure that the chlorine is evenly distributed among the effluent.

The size of the distribution tank will vary depending on how the filter is being used, however every system will have the rapid mix platform and chlorine doser.

Future Work

Now that our experimental apparatus has been set up, we will run our first experiment next week. We will be determining the head loss through the foam both with clean water running through the filter. We will also monitor how the head loss through the foam changes as the filter approaches collapse with dirty water running through the filter. We will visually document failure occurring by taking pictures while the experiment is running. Once the head loss experiment has been completed, we will move on to layering pore sizes of foam, and testing different influent turbidities to determine the range in which the filter will perform successfully. Since we now have turbidimeters, we will be able to keep track of influent and effluent turbidities of future experiments.

Team Reflections

As our experimental apparatus is being finalized, the team has written the process control file for the experiments. We initially had problems understanding how to write the file because of the many complex states and rules involved. However, after looking at a previous process control file, we were able to determine the correct methods to take when writing it. Writing the process control file was beneficial for our team members who were unfamiliar with process controller, helping us to better understand the program and processes involved.

Although our team has yet to obtain physical data, a lot has been accomplished in our design work. Each of us was able to further develop our design for the point-of-use foam filtration unit by considering a number of different cases where our filter would be applicable. A literature review was done to determine the typical water consumption levels in each of these different cases in a country like Honduras. Discussions on each of our designs have helped to improve each group member's understanding of the design as a whole, allowing us to exchange ideas for improving the overall design of our filter.

Although the experimental apparatus is now complete, we had minor issues with electrical connections. We were unable to get a signal in the stamp box from the computer. However, this is now fixed and we can begin collecting data next week.