Foam Filtration Reflection Report 2

Foam Filtration Reflection Report

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AguaClara Reflection Report
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Abstract

The objective of the foam filtration team is to design a foam filtration unit that can reliably treat the typical AguaClara effluent water with a turbidity of about 5 NTU to a turbidity of less than 1 NTU. To characterize the performance of 90 ppi polyurethane foam, certain variables were held constant while others were varied in order to find the optimal parameters for foam filtration. Previously, we have conducted experiments that varied the flow rates and depths of the filtration unit. An experiment utilizing aluminum hydroxide as a pre-treatment for the foam was also conducted.   We propose to continue our performance study of the foam by varying flow rates, depths, and turbidities.

Introduction

Currently, the Foam Filtration Team is conducting a performance study of the foam apparatus. The goal of the team is to reach optimal filtration levels, resulting in the lowest NTU level possible. In order to do so, all possible variables are being tested. These variables include: water velocity (mm/s), turbidity (NTU), depth of foam (in), alum dose (present or not), and possibly introducing an Aluminum Hydroxide /Sodium Carbonate wash. The water velocity and turbidity, where 5 NTU is the output for raw water from the average AguaClara plant, vary in order to test the foam's effectiveness at various speeds and elevated levels of contamination. These two variables are controlled by the user in a program called Process Controller. Meanwhile, varying foam depth is used to find the least amount of foam used with the best NTU output. Foam depth can be changed by adding more 1 inch foam layers into the tube. The presence of alum currently exists in all AguaClara plants. However, were the foam to prove effective without the alum, it would result in less chemicals being ingested by plant users. Finally, the wash aims to add an extra boost to the filtration process. By pre-soaking the foam in the wash, the chemicals may prove useful in removing extra clay.

Experimental Design

Our last “Foam Filtration Reflection Report” thoroughly detailed the basic experimental setup. However, over the last two weeks, a few things have changed in regards to the overall design. First, a second setup was added so that two experi ments can be runnin g at the same time. This will allow us to test and obtain data for each of our foam filtrati on scenari os (using differe nt combi nations of flow velocit y, foam depth, alloy coating, etc.) at a faster pace. In addition, we could choose to run one certain experiment on both of the setup stations at the same time. This would provide us with two sets of data for the same experiment, which will ultimat ely be benefic ial in our final report and data analysi s by showin g consist ency and accura cy.

Because of the addition of a new experimental station, a third computer was added in order to monitor the turbidity of the second experiment. In summary, two computers are currently monitoring the turbidit y of the effluent for both running experiments, while one computer monitors the turbidity of the raw water (the influent for both experiments).

One week ago, our team attempted to coat the foam sponges with alloy. For the first attempt, the sponges soaked in the alloy solution for approximately 10 minutes. Afterwards, the sponges were taken out one-

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The second attempt at coating began with soaking the sponges in alloy for approximately 10 minutes again. This time, once the sponges were taken out of the alloy solution, they were squeezed in the sink and set aside to dry for around one minute. They were then lowered into the filtration tube and it was noticeable that less alloy was being pressed out of the sponges.

Neither experiment, however, fared very well. The alloy-coated foam filtration unit had almost no significant improvements in filtering performance as compared to the experiments done without coating

. Our team is currently trying to research methods for coating properly and successfully. At this time, our best suggestion remains at letting the alloy-soaked sponges sit and dry for at least one full day.

We also decided to take out the pressure sensor in the experiments because it was not measuring the pressure correctly and was therefore giving inaccurate data. Apparently, the pump was creating a large differe nce in pressur e, so it was hard to determ ine the actual head loss of the individ ual experi ments. When the pump rotor made a full rotatio n, the pressur e readin gs spiked to ~400 cm head loss, wherea s the actual head loss for each experiment should stay consistently around 1 cm. We are presently discussing methods of fixing this problem as well. One idea focuses on adding an attenuator (or something similar) in

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Results and Discussion

A number of problems have occurred in the past 2 weeks which have given us inaccurate data. For example, we ran an experiment in which we soaked the foam in an aluminum hydroxide sodium carbonate solution. The experiment was conducted with a downflow velocity of 6mm/s with 10 inches of foam depth. We expected the results from this experiment, shown in figure 1, to be better than our previous experiment in which we do not pre soak the filters, and otherwise same conditions, shown in figure 2. However, as shown by comparing figure 1 and figure 2, this was clearly not the case—we suspect the turbidimeter was not working properly, and have thus replaced it.

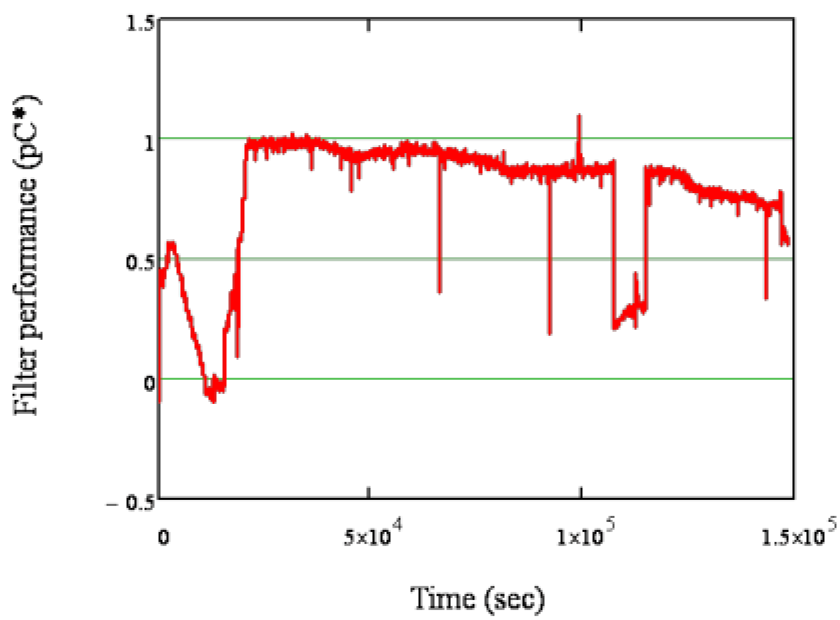

Figure 1. Aluminum Hydroxide Sodium Carbonate Filter Presoak, 6mm/s, 10 inch depth, 1.5 mg/L alum dose, 5 NTU

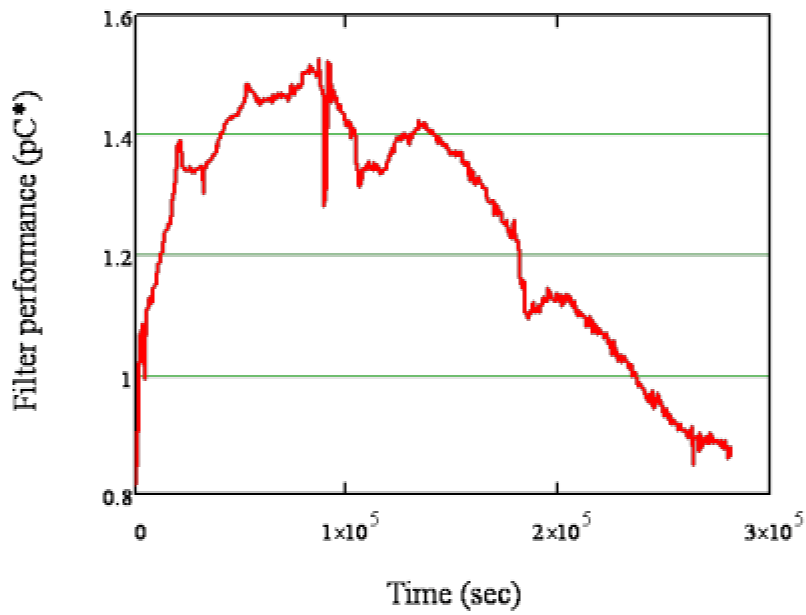

Figure 2. No Filter Presoak, 6mm/s, 10 inch depth, 1.5 mg/L alum dose, 5 NTU

In addition, it was discovered that the raw water turbidimeter had become clogged with a large amount of algae, and the data for the 15 inch depth filter with a downflow velocity 6mm/s, 5 NTU raw water experiment may not have been accurate due to this clog. We are currently rerunning this experimental trial to confirm the results. This data, along with the data for a 5 and 10 inch filter depth can be seen in figure 3. Figure 3 clearly shows that performance increases with increased filter depth. However, it is not directly linear according to depth, as according to the Iwasaki relationship for deep bed filters, where:

In which C is the particle concentration, $_0$ is the initial filter coefficient , z is the media depth. Again, the 15 inch filter depth experiment is currently being rerun to determine whether these results are accurate.

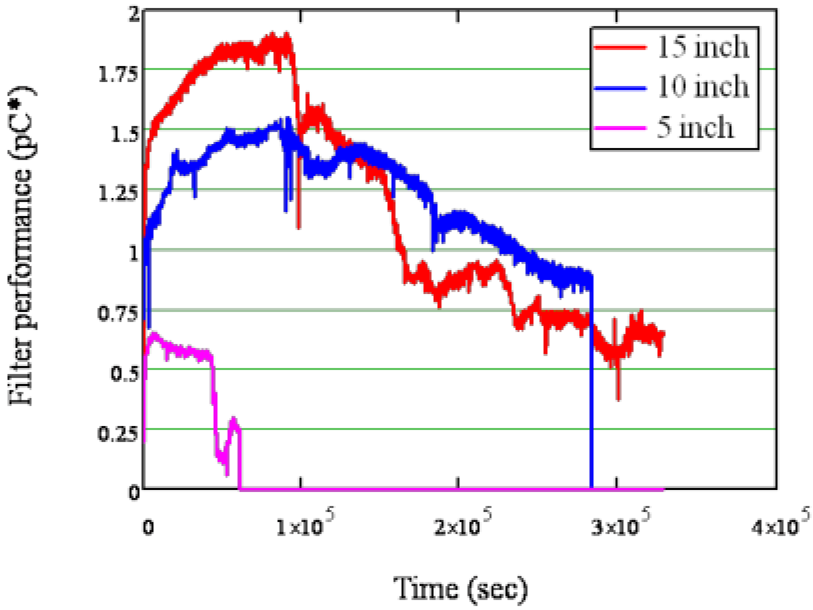

Figure 3. pC* vs Time for 15, 10, and 5 inch filter depths at 6mm/s downflow velocity, 5 NTU, 1.5 mg/L alum dose

Despite the questionability of the actual influent NTU(we suspect that the actual raw water NTU could have been higher, but not lower), the data for the 15 inch column is nonetheless promising for filtration. As indicated in Figure 4, both the 10 inch and 15 inch columns were below the US EPA standards of .3 NTU for about 45 hours, and below our goal of 1 NTU for about 80 hours. This run time is very promising, especially given the high filtration velocity in comparison to rapid sand filtration, were filtration velocities are typically 0.7- 2.8mm/s.

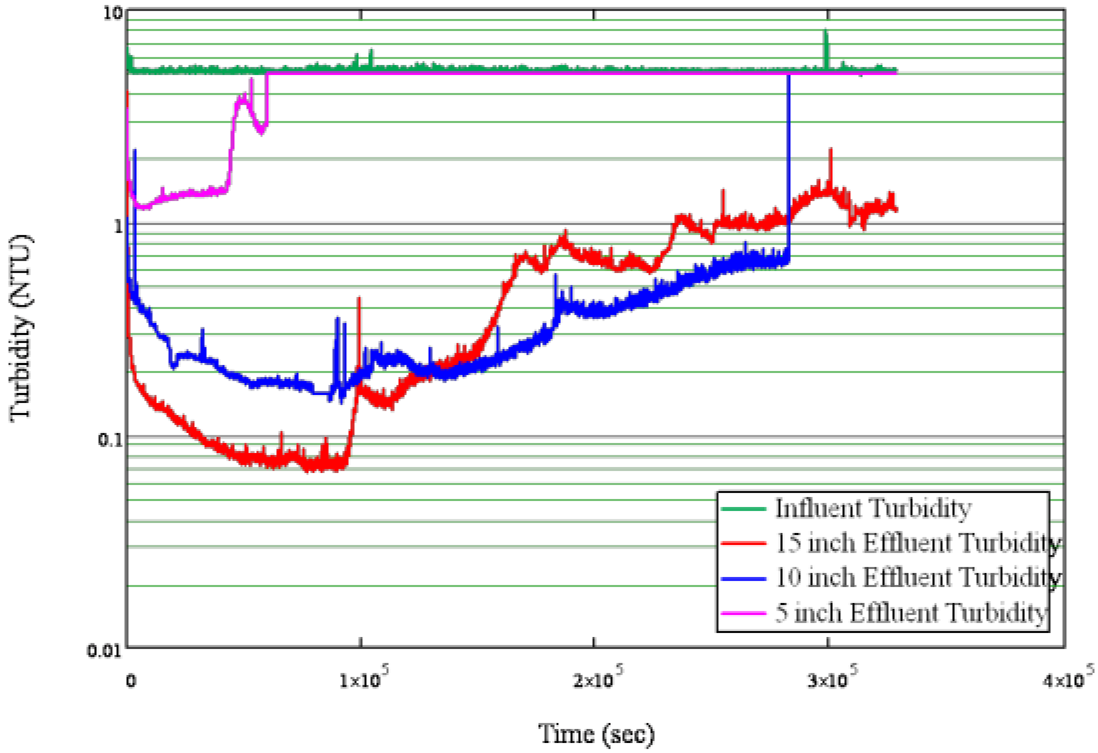

Figure 3. Effluent Turbidity vs Time for 15, 10, and 5 inch filter depths at 6mm/s downflow velocity, 5 NTU, 1. **5** mg/L alum dose

Future Work

We will continue performing experiments to characterize the performance of polyurethane foam. Like before, different variables will be varied while holding others constant in order to determine the optimal parameters for the foam filtration unit. For the next two weeks, we are likely to perform experiments that vary the flow rates and depths of the filtration unit. If time permits, we can also run experiments with varying turbidities (increasing the turbidity from 5 NTU to 10 and 15 NTU). We will be performing data analysis on the results of our experiments and uploading our work on the online wiki.

The experiments bolded in the table below are those that we propose to conduct for the next two weeks.

	Velocity(mm/s)	Turbidity (NTU)	Depth (in)	Alum Dose			
Vary Flow:					Done?	Started	Finished
Experiment 1	6	5	10	1	YES	10-Jun	13-Jun
Experiment 2	12	5	10	1	YES	14-Jun	16-Jun
Experiment 3	18	5	10	1	YES	1-Jul	
Experiment 4	3	5	10	1			
Experiment 5	38	5	10	1	YES	1-Jul	1-Jul
Vary Depth							
Experiment 5	6	5	15	1	YES	22-Jun	26-Jun
Experiment 6	6	5	10	1			
Experiment 7	6	5	5	1	YES	28-Jun	28-Jun

Experiment 8	12	5	15	1		
Vary Turbidity						
Experiment 9	6	10	10	1		
Experiment10	6	15	10	1		
Vary Alum						
Experiment11	6	5	10	0		
Headloss						
Experiment12	Empty Column					
Pre-Treat						
Experiment13	6	5	10	1	YES	1-Jul

Team Reflections

The past two weeks have been a great trial and error learning experience for the Foam Filtration subteam.

To test the limits of foam filtration, we ran an experiment at 18mm/s. The experiment ran for an hour before an abundance of air bubbles appeared in our filter column. We hypothesize that the pressure difference between the top and bottom of our sponge filter was too great, which either caused dissolved air in the water to be pulled out, or air to seep through tubing connections. Another issue with this flow rate was that turbidity readings never fell below 1NTU even after 1 hour. The ripening time of our other experiments have been below 1 hour. This experiment was repeated 3 times with the same results. We came to the conclusion that this experiment's problems were not realistic to solve, given the effluent turbidity results, and instead we will continue to test slower velocities to determine what flow rates our experimental design can handle.

Recently, our main setback has been technical problem with our influent raw water and its turbidimeter. Some of our experiments must be repeated because our influent raw water turbimeter became clogged earlier in the semester with large chunks of algae, which was causing the turbidimeter readings to shift wildly between 1.5 and 60 NTU. This turbidmeter was cleaned, and one of the experiments we ran when the turbidimeter was clogged will be rerun to see if the turbidimeter was giving accurate readings, despite the clog.

We have also had issues with a third turbidimeter we brought up that was previously used at the pilot plant. One of the turbidimeters was not giving accurate readings. When a sample of clean distilled water was placed for a reading, it was reading values about 2 NTU. As a result, we replaced this turbidimeter. Large amounts of growth occurred in all the fittings of the replacement turbidimeter, and resulted in large pieces being pushed through into the turbidmeter, resulting in inaccurate readings. All fittings have been thoroughly cleaned, and this will hopefully cease to be a problem.

The aluminum hydroxide pretreatment experiments were one of the ones affected by the faulty turbidimeter. We predicted the results of this experiment to be superior to the experiment lacking the wash, however our results were worse. The turbidimeter was one variable for the experiments failure, but another problem we need to work on is how to standardize soaking the sponges in aluminum hydroxide. To regulate the chemical dose, we have discussed fully submerging the foam in a specific concentration of aluminum hydroxide, as well as soaking and then drying the sponge to ensure the chemicals remain on the sponge. These issues will be resolved through more testing.

Overall, our problems taught us something about our experiment and gave us more insight on what we need to consider if foam filtration were to one day be applied to Honduras filtration plants.