Foam Filtration with Alum Dose

Experiment 1: Alum Dose of 25 mg/L

In order to determine whether adding alum to the raw water would improve filter performance, an alum dose and rapid mix were added to the experimental set up. In this trial, we used an alum dose of 25 mg/L, 3 inch depth of 90 ppi foam, with the flow rate ramped between .58 and 2.31 mm/s.

Figure 1 shows both the raw water turbidity and the effluent turbidity as a function of the flow rate. The effluent turbidity increases with the flow rate. This shows that filter performance decreases with increasing flow rates, meaning that in order to achieve a desirable effluent turbidity, a lower flow rate and thus a larger filter tank size must be employed. As show in the graph, filtration velocities of less than about 2 mm/s produce an effluent turbidity of less than one, or a pC* of greater than 0.9. The graph in figure 1 appears to be a linear function. This can be explained by the idea that at lower flow rates, the foam is able to capture even the smallest particles, since they have been made sticky from contact with alum. However, as the flow rate increases, it become increasingly difficult to capture smaller particles as they are more difficult for the foam to hold on to. When the flow rate increases, it likely pushes these smaller particles right through the filter, resulting in increased turbidity. Figure 1 shows that as the flow rate increases, the minimum trapped particle size likely increases as well.

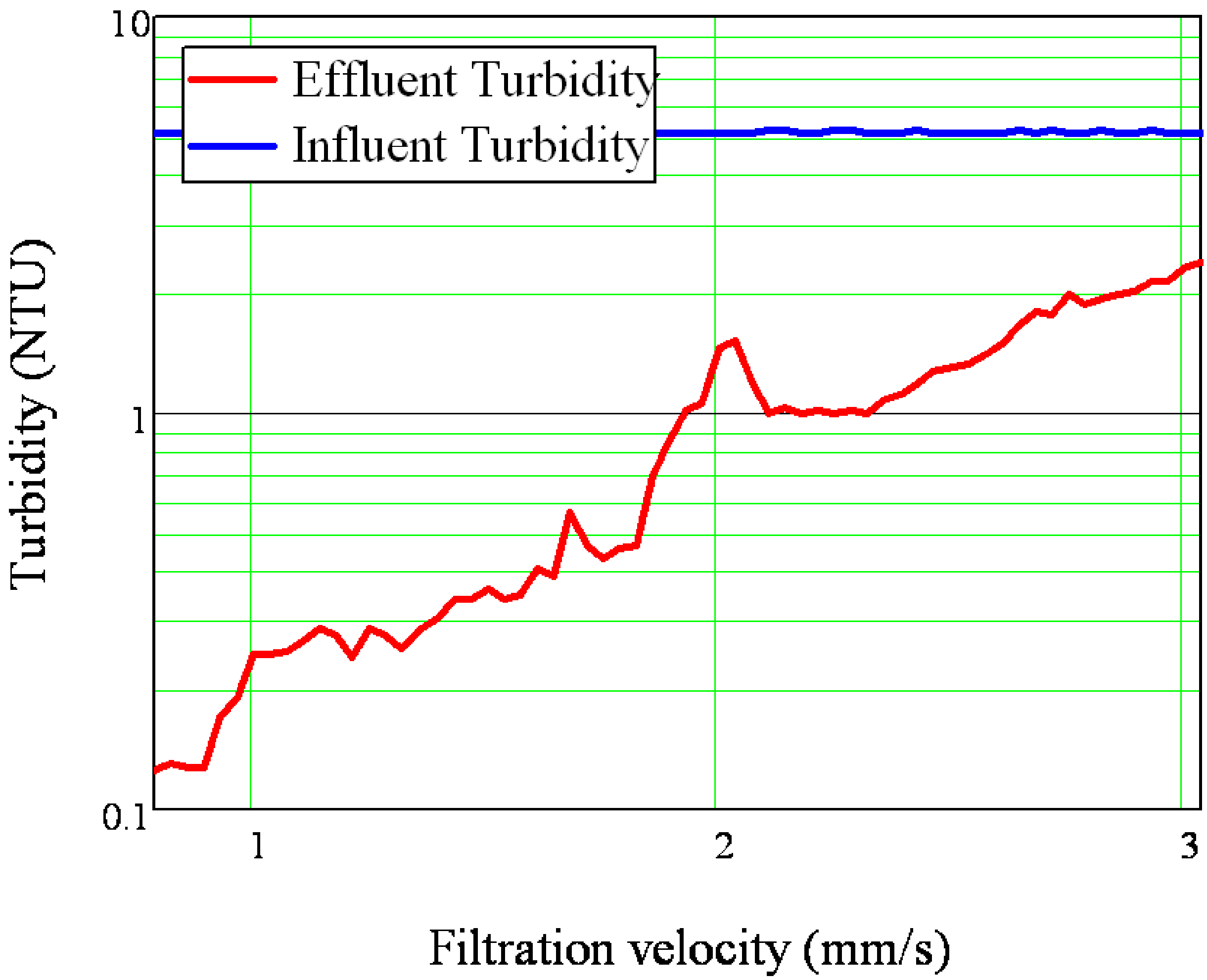

Figure 1: Raw Water and Effluent Turbidity vs Flow Rate

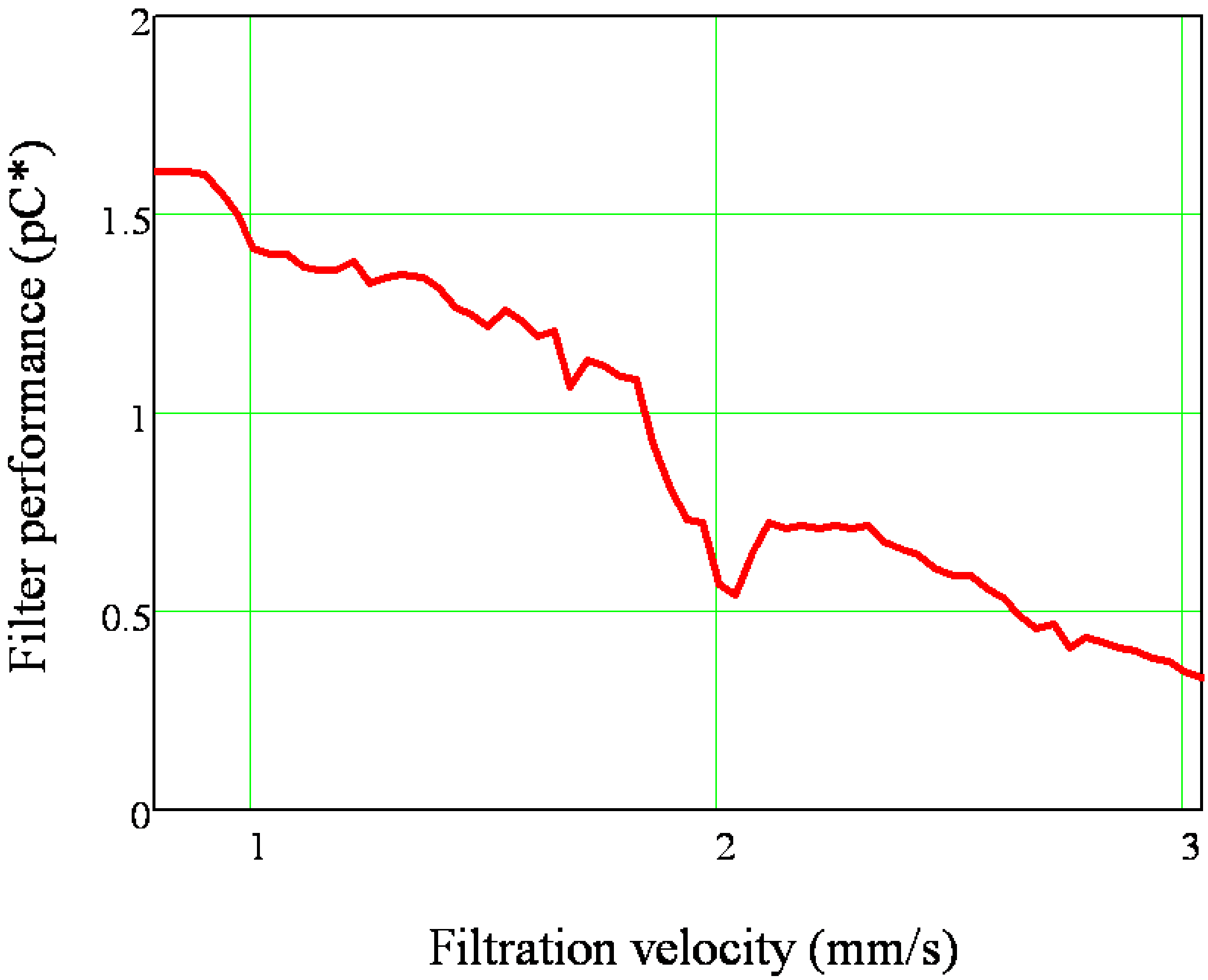

Figure 2: pC vs Flow Rate*While the results obtained using this alum dose were phenomenal, this is a very high, unrealistic alum dose. To actually achieve this alum dose level, it would be necessary to install an additional alum doser prior to the filtration unit.

Experiment 2: Alum Dose of 1.5 mg/L

A more realistic alum dose of 1.5 mg/L was used in this experiment. This value was calculated based on the assumption that about 5% of the particles remain, and they were originally exposed to a 30 mg/L alum dose prior to flocculation and sedimentation. The 5% remaining particles estimation is based on the idea that 5 NTU is 5% of 100 NTU, which is a rough estimate of the raw water turbidity coming into an AguaClara plant. Therefore, our alum dose is 1.5 mg/L, which is 5% of of 30 mg/L. This experimental trial was also run using a 3 inch depth of 90 ppi foam, with the flow rate ramped between .58 and 2.31 mm/s.

Additionally, this experiment was done using 3 consecutive ramp states. This was done because a layer of particles forms on top of the foam sheets during the duration of the experiment. A governing hypothesis for 3 consecutive ramp states was that during the first ramp state, a layer of film was developing and affecting performance and thus performance could not be isolated and could be accounted for either by varying flow rate or the accumulation of a film layer.

Figure 3 shows the three ramp states as a function of flow rate. The first ramp state has a significantly higher turbidity than the following two. This suggests that this film may have an effect on the performance of the filter. In order to prove or disprove this, experiments will be run with the filter column on its side so this film is unable to perform, and by comparing these results, we will reveal the importance of the film layer. Also, it is important to note that with this lower alum dose, not as many of the smaller particles are being made "larger" or "sticker" from contact with alum, since there is less alum to come in contact with. Therefore, the minimum turbidity achieved with a low alum dose is not as low as the minimum turbidity achieved with the high alum dose. This factor makes the turbidity levels achieved seem constant, versus the linear function achieved in Figure 1. However, Figure 1 and Figure 3 are actually showing similar results, with the exception that the higher alum dose is able to trap smaller particles at lower flow rates since more will come in contact with the alum. This can not be done with the lower alum dose, so the results appear to be more constant with flow rate.

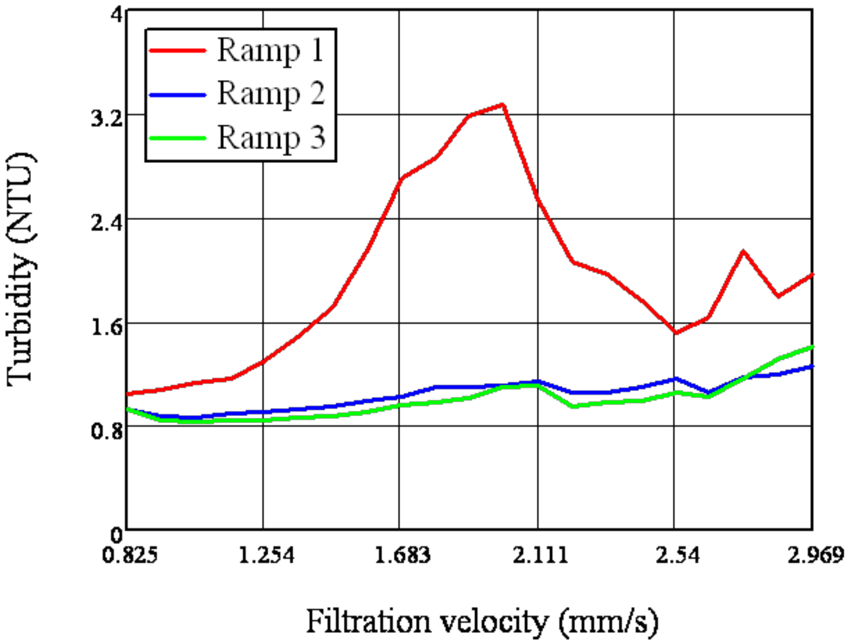

Figure 3: Effluent Turbidity vs. Flow Rate

After it was determined that the film that forms on top of the foam sheets affects performance, it was necessary to test and see if foam filtration is actually a function of depth: Depth Filtration