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Qiu Shen's Individual Contribution Page

Last semester I worked with foam filter preflocculation team. We designed and build a bench-scale foam filter with tube flocculator. Together with my teammates we conducted over 40 tests and the conclusions are summarized below.

From the preliminary tests of the apparatus, the lowest coagulant dose to create flocs for 50 NTU of clay and water (with 100 feet of Flocculation) is between 3.1 mg/L and 5.4 mg/L. It may be the case that in our tests we are going above the necessary coagulant dosage, but it is most likely not a significant amount such that very large flocs are being created that are clogging the foam.

Our data for finding an optimal coagulant dose is not consistent enough to draw conclusions from. It seemed as though 10.7 mg/L was the best coagulant dose and that may be true; however, the second test of 10.7 did not yield the same results. Since the only difference between the test would have been the amount of clay and organic matter left in the filter from the last backwash, backwash efficiency could have caused our results and not the sensitivity of performance based on coagulant dose.

In experiments with only clay, the preflocculator leads to shorter runtime and lower loading capacity than that without flocculator. In experiments with clay and organic matter, we have a longer runtime and better pC* without flocculator than that without flocculator. Further tests shows that the flocculation that happens in the foam pores should be sufficient for filtration. Therefore, it can be concluded that there is a not a need for preflocculation of the team's design in the foam filter system. This conclusion, however, does not suggest preflocculation as a whole is ineffective in improving filter performance, but specifically the team's design does not increase performance time. Therefore, the initial hypothesis that a high energy dissipation rate was needed to create smaller flocs that can prevent clogging of the foam may not actually be a critical factor in increasing the performance of the filter.

The biggest problem the team faced this semester was effectively cleaning the foam in between runs. The tests shown in figure 8 demonstrate that backwash setup at a relatively high velocity could not completely remove the clay, organic matter, and coagulant in the foam. We could not achieve consistent consecutive tests of the same conditions even after backwashing between runs, implying that the incomplete cleaning of foam compromised the performance of the filter. The inability to consistently achieve 100% backwash efficiency pushed the team to have to hand-wash and compress the foam bed in between every run instead of backwashing to assume completely cleaning of the foam. This method, however, is shown to be impractical on-site. Therefore, cleaning of the foam ultimately limits the ability of the foam filter system to perform optimally.

A series of tests varying foam depth with and without flocculator were ran to further explore the filtration theory of the foam filter. We have observed that the first layer of foam (10 cm depth) works well as a flocculator. Without preflocculation, foam functions as both flocculator and filter. While headloss increases over time as a result of mass accumulation, Gin foam filter increase and flocculation became more sufficient, thus flocs grew bigger. As bigger flocs can be captured easier by the foam, pC* increases with time until the foam reached its loading capacity.

The tests varying foam depth also reveal a good linear relationship between runtime and foam depth. The x-axis interception is theoretically the minimum length for the foam to function with pC*>1. Foam depth only improves pC* up to around 30 cm of foam depth, which means flocculation mainly happens in the first 30 cm of foam. The rest of foam mainly functions as filters. The loading capacity of foam with flocculator is larger than that without flocculator. We think when the flocs are smaller, larger depth of clean foam is needed to remove them. So it weakened the loading capacity of foam.

When comparing foam filter with StaRS sand filter, the foam filter ran longer than the sand filter at similar flow rate, and the solid loading capacity of foam is greater than sand. But sand filter have higher pC*. We also found that the runtime and loading capacity of foam filter at a low flow rate is much longer than that at a high flow rate. This could be due to less shear exerted on the pores than at higher velocities. This suggests if possible, a lower approach velocity can lead to a better performance of the filter in real world application.

This semester I am working with High rate UASB team.