Influence of flocculator length and alum dosage on flocculation

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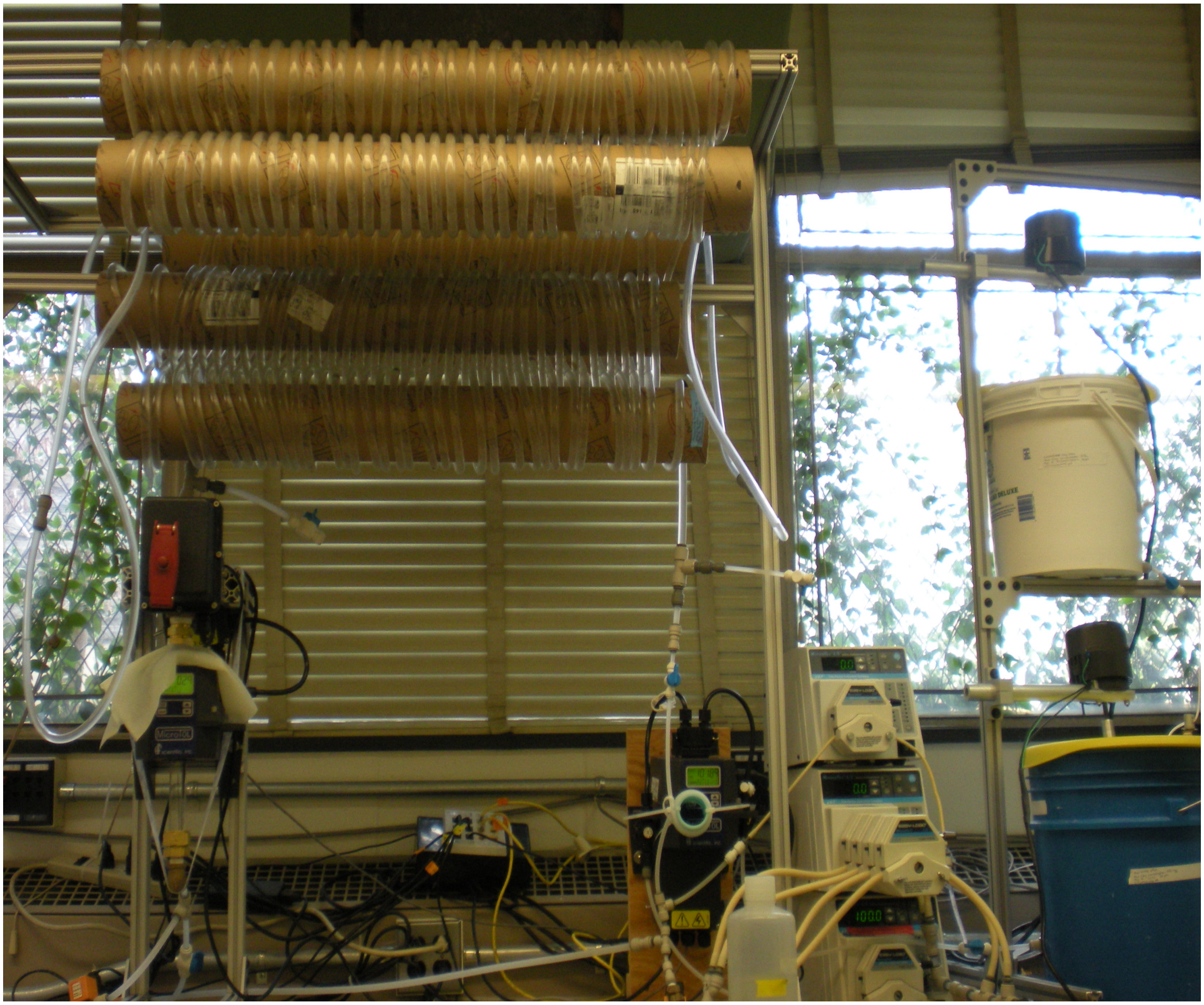
Overview



Experimental Set-up

Abstract

Flocculation in water treatment plants is essential as it helps settle out colloidal particles with the use of a coagulant agent to facilitate particle collision and growth. The AguaClara Tube Floc Team's goal is to conduct experiments to further understand and optimize hydraulic flocculation. Specifically, the team will narrow down key design parameters such as the optimum length of the flocculator and optimum alum doses for each length and varying influent conditions tested.

Experiments were conducted to find the optimum alum dosages for different lengths of the flocculator and different influent turbidities. From these experiments so far, it's evident that as alum dosages increase, the residual turbidity decreases. However, at a certain point, a limit is reached where residual turbidity remains constant as alum dosage increases. Also these experiments have shown that with increased flocculator length, the behavior of the floc depends on whether the influent turbidity is high or low. The optimum alum dose seems to decrease as we increase flocculator length. This suggests that alum costs can be reduced by designing a flocculator of an appropriate length. Alum dose and flocculator length also affect the mean sedimentation velocities. These effects vary with influent turbidities. At 100 NTU, mean sedimentation velocities increase up to a certain alum dose and then velocities decrease. For 500 NTU, mean sedimentation velocities increase until it reaches a threshold reflecting the presence of equilibrium in the flocculator.

Introduction

The turbidity of water is caused by colloidal particles in suspension (and the presence of natural organic matter and other organic and inorganic contaminants). Colloidal particles are too small to settle and due to their negatively charged surfaces, electrostatically repel each other. Flocculation transforms colloidal particles into larger flocs that can settle out in the sedimentation tank. The number of sequential collisions in a flocculator depends on energy dissipation rate and residence time in the flocculator. As flocs collide, they grow in size making it easier to remove them in the sedimentation tank.

There are different types of flocculation, such as charge neutralization and sweep flocculation. In AguaClara, sweep flocculation methods are utilized, in which we need to add a coagulant agent, alum for our purpose, which forms a precipitate of aluminum hydroxide that covers particles and enables them to stick together when they collide in the flocculator. However, charge neutralization is also occurring in the flocculator and it is actually the predominant mechanism for high turbidity water.

Conventional design guidelines for a hydraulic flocculator are incomplete and the dynamics of how physical parameters affect flocculation are not well understood. The goal of the Tube Floc Team is to try to improve the understanding of flocculation for a variety of influent water qualities and provide better guidelines in designing a flocculation system.

Conventional design characterize a flocculator with a laminar velocity gradient, G, and residence time, (Tambo and Watanabe, 1979). Although G doesn't apply to turbulent flow flocculators, it is an appropriate parameterization of laminar flow flocculators such as the tube flocculator used in this research. Currently the Tube Floc team is studying the effects of length and alum dose on varying influent turbidities and will determine the optimal values for these two conditions.

Material and methods

For studying the function and development of the flocculator, there are many possible experimental setups and analysis methods. In the case of our experiments, we have been assigned to study the tube flocculator and have used several essential computer programs, such as Process Controller and Mathcad, to retrieve and analyze data. The following links will show more details on the specific apparatus and methods we have used:

*Experimental Apparatus
*Operating and Troubleshooting FReTA
*Data Acquisition
*Data Analysis

Results and discussions

Currently, this project has not been completed, and not enough data has been collected to for a solid conclusion. Therefore, as for now, the team is focusing on the collection and organization of different experimental data. The results to each experiment has been organized in an excel file for a graphical overview and error analysis. Replicates of each experiment have also been made for verification of the collected data. The following link will show more details on the data gathered from the experiments conducted.
*Effect of Alum dose and Flocculator length on Tube Flocculator Performance

Participating teams

Fall 2009

*Fall 2009 Goals
*Fall 2009 Weekly minutes
*Future Challenges

Spring 2010

*Spring 2010 Goals
*Spring 2010 Weekly Minutes
*Future Challenges

References

Tambo, N. and Watanabe, Y. (1979) *"Physical characteristics of flocs. I. The floc density function and aluminum floc"*, Water Research, **13**(5), 409-19