Coagulant Management

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Abstract

Coagulants are a significant operating cost and thus it is important to use them efficiently. Coagulant management includes stock preparation, testing stock concentrations, dosing with the chemical dose controller, and injection of the coagulant into the raw water. As part of the AguaClara design philosophy these steps need to be done efficiently and we need to provide appropriate feedback to the operators so that they know when they have done these task well.

- Skills: Fluids, Plumbing Design, Fabrication, Process Controller

1 Coagulant injector (fabrication)

AguaClara has used several methods of injecting coagulant into the raw water. We have not yet provided detailed drawings showing the exact injection method. Coagulant injection is critical for successful operation and efficient usage of the coagulant. The failure modes are...

1. Low head loss in the diameter delivery tube allows oscillation flow inside the delivery tube. Raw water and coagulant mix inside the delivery tube and the coagulant precipitates on the delivery tube wall. The solution to this problem is to use a small diameter deliver tube or injection orifice so that head loss is sufficient in the delivery tube to prevent reverse flow from happening. The flow oscillations occur due to wave action or air entrainment downstream from the LFOM.

2. Injection point near the wall of the rapid mix pipe is inefficient from a mixing standpoint and from the excessive deposition of the coagulant on the wall of the rapid mix pipe. The solution is to inject the coagulant into the center of the flow.

The injection point should be easily serviced. The tubing should be replaceable while the plant is operating. The injection point should be in the vena contracta upstream from the macro mixing location.

2 Practical maximum coagulant concentrations & stock tank mixing

Test maximum concentration of PACl and of Alum that is easy to mix up. See if you can replicate the problem that was occurring at Atima where a precipitate was forming in the dose control tubes. Create a method to eliminate this problem. Perhaps use a more dilute stock or allow stock to settle for a period of time before using it. Determine if the settled material is a coagulant or is a contaminant by testing it for coagulant properties in a jar tester. Study the mixing challenges at a small scale using a 1 L (or smaller) stock container and testing full strength stock solution preparation. Brainstorm alternative chemical mixing procedures that would require less energy input from the operator. For example, would there be a method of gradually adding the granular chemical to the incoming water as the stock tank fills? Would there be a way of having the incoming water enter the stock tank from the center of the bottom of the tank so that it provides mixing as the tank fills? You can test these ideas at small scale.

3 Hydrometer

Develop a hydrometer that is labeled according to the concentration of the stock solution for both alum and PACl. This can either be a commercial hydrometer or it can be one that you design and build. It is very likely that we can use a commercial hydrometer. If you make a hydrometer consider the effects of temperature change and avoid materials that will expand significantly with increased temperature.

4 Density measurements

Measure or obtain from the literature the density of alum and PACl solutions. The density of alum solutions is widely available from manufacturers. Develop functions that return the density of each of these chemical solutions as a function of the concentration.

5 Stock tank centrifugal pump mixing system

Given the density of the stock calculate whether the centrifugal pump mixing system will be able to lift the dense solution from the bottom of the stock tank to the top. If the pump system doesn't work, then invent an alternate stock tank mixing system. Test a small scale model of the stock tank mixing system and use your knowledge of fluid mechanics to assess if the system would work at full scale given the limitations of human powered cranking of the pump.