Sedimentation Tank Hydraulics

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Abstract

The goal of this research is to evaluate sedimentation tank bottom geometry, jet location, and the design requirements for a floc hopper in an AguaClara sedimentation tank. Inlet jet geometry along the bottom of the sedimentation tank is critical in the resuspension of flocs. The inlet end of the sedimentation tank needs to be redesigned to re suspend flocs. A floc weir will be needed to set the upper limit of the floc blanket level and a floc hopper will be needed to consolidate the wasted flocs.

skills   fabrication, experimentation, fluids, process controller

1 Larger diameter Jet reverser

The current design of the drop tubes and jet reverser require precise alignment and this is difficult using the fabrication techniques that were used at Atima. We will be developing new fabrication techniques over the summer of 2012. The first challenge for the STH team is to test the reliability of larger radius jet reversers to determine what the failure point might be. To test failure, create a floc blanket and then slowly reduce the flow rate until sludge begins to enter the jet reverser. Record that flow rate and then repeat for a series of different size jet reversers. Perhaps use 1", 2", and 3" diameter jet reversers. Another option for the design of the jet reverser would be to have the diffuser tubes directed toward the one side of the jet reverser so that the jet doesn't split into two streams. It is possible that this offset would actually be more stable. Test both antisymmetric and asymmetric designs.

Explore the effect of alignment errors on the failure of the jet reverser. How precise must fabrication be to achieve a stable floc blanket? Explore elevation errors and off center errors.

2 Stable Floc Blanket

What is required to operate a stable floc blanket? Conduct experiments with varying influent characteristics (turbidity or coagulant dose) to see how the floc blanket responds and how effluent turbidity is affected. There are anecdotes that floc blankets can suddenly expand and cause effluent turbidity problems. The goal is to learn about floc blanket instabilities and identify what causes the floc blanket to expand or contract. The expectation is that a reduction in floc strength would lead to smaller flocs, reduce the floc sedimentation velocity, and thus decrease the floc concentration. Thus a reduction in coagulant dose could cause the floc blanket to rapidly expand.

3 Floc hopper geometry

The parameters of interest are the ratio of the plan view area of the floc hopper to the plan view area of the rest of the sedimentation tank, the volume of the floc hopper, and possible the angle of the bottom of the hopper. We are also interested in knowing how the geometry of the floc hopper influences the required sludge flow rate. The depth of flow and flow rate over the floc hopper weir is also of interest. The depth of flow over the floc hopper weir is not expected to be significant design constraint.

The critical design constraint is expected to be during high turbidity events when the floc volume fraction is high and hence the flow of flocs into the floc hopper will be the greatest. The fractal flocculation model predicts that at 500 NTU the floc volume fraction is 0.08. Thus the flow over the weir would be $0.08Q_{SedBay}$. The floc volume fraction is proportional to the turbidity for high turbidities and thus at 1000 NTU the floc volume fraction is 0.16. Without consolidation of the flocs it would be necessary to waste 16% of the flow during a 1000 NTU event. AguaClara plants have already treated water in excess of 700 NTU and so it would be reasonable to design the floc hopper to handle a 1000 NTU event.

A floc hopper can be installed in the 2d sedimentation apparatus (Figure **??**). You could start with a floc hopper that occupies 15% of the plan view area of the sedimentation tank. The bottom slope could be very steep so that the sludge hopper extends all the way to the bottom of the sedimentation tank. A peristaltic pump can be used to remove sludge from the very bottom of the floc hopper. The flow rate of the pump can be slowly varied and the depth of the flocs in the floc hopper can be measured. This will give a relationship between the required plan view area of the floc hopper and the corresponding required sludge wasting rate. The steady state depth of sludge in the floc hopper will increase as the sludge wasting rate decreases. There may be problems with this experimental method because the sludge may consolidate so well that the pump won't be able to remove it.

The plan view area and time required for floc consolidation is not easily estimated. The fractal flocculation model predicts that at 1000 NTU the floc volume fraction is 0.16. Thus the flow over the weir would be $0.16Q_{SedBay}$. Does this mean that the area of the floc hopper should be about 16% of the sedimentation tank area? We need some modeling work here to understand what controls this consolidation process. A literature review would be useful and experimental work is needed. Images of this floc weir in action and the consolidation would be very useful in understanding how these processes work.

The goal is to develop an understanding of how floc consolidation works and to determine the top width of the floc hopper.