Stock Tank

Location: HLS 150

Stock Tank Concentration monitoring with a hydrometer - Goals

One of the big goals of the AguaClara program is to design plants that are easy to operate and that provide appropriate feedback to the operator so that the operator can make appropriate adjustments. One of the critical activities for the plant operator is to prepare and mix the stock solutions of chlorine and coagulant. Unfortunately the operator can't see if the solution is well mixed and there is no way to measure the solution concentration. Thus if an operator makes a mistake while dumping the granular sodium hypochlorite or PACl into the stock tank, there isn't any way for the operator to know that the resulting stock concentration is incorrect. The goal is to provide the operators with the tools so they can check to see if the stock tank is well mixed and if the concentration is correct. The proposal is to use a simple hydrometer that is labeled to read the concentration of PACl or sodium hypochlorite. The other option is to provide a hydrometer and a table that converts the density to concentration.

Concentration measurement using density

The density of PACl prepared from granules was measured by the Coagulant Management team in the Spring of 2013 and found to be

$$PACl = 566.7C + Water$$

where the concentration has units of kgm3. With this equation and a hydrometer that is relabeled to read concentration of PACl it would be possible for an operator to conduct a quick test to see if the PACl concentration in the stock tank was correct. Note that we use up to 200 kgm3 of PACl in stock tanks in Honduras.

Find an appropriate hydrometer that is unbreakable and in the correct density range. Purchase the hydrometer and test it in a 100 mL graduated cylinder where you mix up a PACl solution. Mix the graduated cylinder little by little in a somewhat repeatable fashion with a stirring rod and after each brief stirring event measure the density. Determine if the density of the surface water decreases initially with time after a stirring event as the solution restratifies. Determine if the hydrometer would be a useful measure of when complete mixing has been achieved.

Create a similar system for measuring the chlorine stock concentrations. The density of chlorine solutions is readily available.

Purchase or build appropriate hydrometers and then demonstrate them in Honduras in January of 2014.

Simple centrifugal pump for stock tank mixing - Goals

The purpose of the centrifugal pump mixing system is to provide an energy efficient means for a plant operator to mix the stock tank solutions. This task is relatively easy

for small plants where the stock tanks are 220 L tanks. However, as plant size increases the stock tanks grow in size as well and mixing them becomes more difficult.

We need to determine if our theoretical predictions for the pumping rate and the amount of lift generated by the centrifugal pump is correct. To do this, fabricate a small scale version of a tank and pump system that is sufficiently transparent that the level of the dense solution in the central rotating pipe of the pump can be recorded with a webcam. Devise a method to spin the pump at a known rpm (perhaps using a peristaltic pump drive) and to record the level of the dense solution in the central rotating pipe using a webcam. Determine whether or not this pumping system is feasible for mixing a 750 L stock tank at San Nicolas. This will require calculating the force required to rotate the centrifugal pump. The horizontal pipe in the pump will be the source of the majority of the fluid drag and that fluid drag will be significant for a large tank. Determine if the operator will be able to spin a large pump fast enough and determine if the drag could be significantly reduced by streamlining the PVC pipe. The PVC pipe could be heated and then deformed into an airfoil shape to reduce the drag.

Collaborate with the team that is selecting a hydrometer for concentration measurements and use the hydrometer to test the length of time required to mix a stratified solution.

The best approach to create a stratified test solution would be to use either sugar or salt to create a dense solution. USe red dye #40 at about 100 mg/L (test this with a webcam!) to make it easy to see the difference between the dense solution and the overlying water. For your first tests use a small concentration of sugar and the 100 mg/L of red dye to quickly test if your data acquisition and experimental control system works.

Then for the real tests, fill the stock tank perhaps 75% with tap water. Mix the dense sugar solution (25% of the stock tank volume) in a separate container that has a drain line attached. Insert the drain line into the stock tank all the way to the bottom and then slowly open the drain valve on the container containing the dense solution. Allow the dense solution to flow slowly into the bottom of the stock tank. This will create a highly stratified stock tank for testing the centrifugal pump.