Demo Plant Team

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October 5, 2011

Abstract

The technology behind the AguaClara water treatment process features contaminant removal through coagulation and flow/dose control using gravity. The goal of the demonstration plant team is to create a demo scale version of the technologies presently being implemented in AguaClara plants that are currently set up throughout rural communities in Honduras. The demonstration plant currently in use effectively shows how water moves throughout the plant, however there are technologies that have not been incorporated into the demonstration plant which would further aid the educational aspects of AguaClara.

Background:

Since many of the modules in the AguaClara plant are being updated and created anew, there is no reliance on the current demonstration plant for designs and measurements (such as the flow rate). New parts need to be machined and tests done based on a new set of constraints that will inform the decision on allowable flow rates through the plant. Research on the tube flocculator system will be done however, the flocculator will be essentially the same and the team focus will be on the flow measurement through an Low Flow Orifice Meter (LFOM), the dose controller, and the sedimentaion tank with an operable floc blanket. MathCad files are available to us for the full scale LFOM. We hypothesize, based on the output from the current MathCad files, that the LFOM at this small scale will NOT generate a linear relationship between flow rate and water height; however we will make significant efforts to make it work.

Methods:

We calculated the flow rate for the old demo plant by measuring the volume of fluid that flows through the plant in 60 seconds (which was calculated to be approximately 22 ml/min), however this is largely invalid becasue we will be updating it significantly and adding new components (specifically the filter) which may set new constraints for flow rate. We emailed the code developer who previously worked on the LFOM MathCad file, who has agreed to assist us in updating the code. The old code had spacing between each orifice roughly equal to the size of each orifice. Our demo plant will have orifices of a significantly smaller diameter and therefore needs proportional spacing in between each orifice. Once we update the MathCad files, we can determine if it is feasible to make an LFOM with small holes to model the Sutro Weir which will serve as a great measurement tool because of the linear relationship between water level and flow through the plant. The miniaturized array of holes will need to match the approximate area of the Sutro Wier for the LFOM to work properly. To test if our LFOM works, we will conduct experiments to observe if the LFOM adequately corresponds to the flow rate through the plant.

Analysis:

In order to begin designing the new LFOM, the starting point was chosen to be figuring out an appropriate range of flow rates for water flowing through the plant. The flow rate is calculated initially using this equation:

$$Q = \Pi_{vc} A_{or} \sqrt{2gh} \tag{1}$$

which bases the flow rate on the area of the circle. The area of the circle will be found using the LFOM MathCad file. A determination will then be made on whether the LFOM is working correctly by comparing the flow rate to the height of water in the stock tank. The area of the orifice will be determined using the following function in the LFOM Mathc\Cad file:

$$A_o = \frac{Q_o}{\Pi_{vc}\sqrt{2gh_o}} \tag{2}$$

These calculations are essential to the correct operation of the Sutro Wier on the full scale, and thus will be important to the operation the small scale demonstration plant. Equation (2) corresponds to the area of a single orifice in the sutro wier formation that will relate to the flow rate.

Conclusion:

With the creation of a new demonstration plant, there are a new set of constraints need to be worked around in order to make the demo plant perform educationally as a realistic model. For example, the water running through the plant will not be as well treated as in the real plant, however it is more important to make the processes observable and understandable.

Future Work:

During the next two weeks, successful fabrication of a small scale coagulant doser and LFOM measuring pipe will depend on good engineering calculations, and good development and understanding of the constraints. As research has been done on the way that the dose controller, flow controller and LFOM should work, the next step will be to run the engineering calculations contained in the MathCad files to aid the design of the module. After hearing back from the developer of the MathCad LFOM file, we will be able to get outputs that will aid our design of the LFOM. After the conceptual design has been established, fabrication can begin. Our experimentation with the fabricated parts will then inform the decision for incorporation into the demonstration plant as a whole. For the design of the new demonstration plant, experiments will need to be run to figure out the correct flow rate that will correspond to the sizing of the LFOM and effective operation of the demonstration sedimentation tank. The flow rate of the plant will need to correspond to the critical flow at which sedimentation of flocs occurs on an observable scale and also allows for the floc blanket to work. The flow through the plant will also relate to the demonstration flocculation tank. Experiments will be run to find out what the critical flow rate is that will allow our constraints to be accounted for. The flow rate will also be supported theoretically by engineering calculations that relate flow rate to collision potential, flocculation, sedimentation, and filtration.