Demo Plant Team Detailed Task List

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Our goal is to update the current demonstration plant and to complete the demonstration plant so that the AguaClara water treatment technologies can be presented at the EPA P3 competition in April of 2012. The size of the demonstration plant should be built small enough to travel with and easy to set up. The current demonstration plant has incomplete components of sedimentation tank and SRSF which need to be completely designed and fabricated. In order to work toward completion of DP on time, the team of 7 students are divided into 3 different sub-teams; dose controller team (Muhammed and Tim), sedimentation tank (Sahana and Thalia), and SRSF (Miree, Diana, Meena). Since the tube flocculator is the most completed component of the current DP, the team decided to integrate it later with other parts of DP. The team will meet on every Wednesday 4:30 to 5:30 pm. The task list of Spring 2012 has been created as following.

Part I

Flow Measurement and Dose Control

Following the process undergone by the Fall 2011 Demo Plant team, the new team shall take that work and further develop it. First by testing the dose lever and current incarnation of the LFOM, and then possibly recreating an LFOM of different hole sizes to test for contrast. This will inform if the current lever dosing method can be incorporated into the newly designed Demo Plant because we plan to create a metric that backs the use of it and shows if it accurately creates a linear relationship to the raw water flow into the plant. We then plan to explore the use of long laminar flow tubes to create the linear relationship that we are seeking. After running through the conceptual design, we shall create a CAD drawing to use for manufacture and the begin fabrication. Testing of this method will inform how it compares against the already standing lever dose method. The main goal of the flow/dose method sub team will be to incorporate an easily adjustable and understandable doser method that works with other processes in the plant.

Tasks & Deadlines

- Weeks 1, 2 (2/9 – 2/22)
  Further test the current dose method
  Create the metric
- Weeks 3, 4 (2/23 – 3/7)
  Test the other dose method (long laminar flow tubes)
  Design through rough/sound calculations
- Weeks 5, 6 (3/8 – 3/17, Spring break, 3/26 – 3/29)
  CAD drawings
  Fabrication
- Weeks 7, 8 (3/30 – 4/12)
  Testing
  Integration
  Further testing and troubleshooting

Part II
Sedimentation Tank

The goal for the sedimentation tank is to design and fabricate an effective small-scale sedimentation tank for the demo plant. Based on the designs from ENGR 1131, possibility of building a floc blanket at this scale was recognized. We have yet to incorporate floc blankets on a small scale so this will present a challenge. We need to keep in mind that the unit process needs to be small, yet a larger sedimentation tank will be more effective for sludge removal. We plan to replace the plate settlers used in earlier design by a simple tube settler. We also plan to focus on building an effective floc weir and floc hopper and testing the use of floc recycling to improve the performance of the plant.

Tasks

- Conceptual design of sed tank; the sedimentation tank should consist of a transparent PVC pipe with a vertical section for the floc blanket connected by an elbow to a tube settler consisting of the same diameter PVC pipe. There should also be some drainage system in the vertical section (i.e., the floc weir and hopper).

- Calculate volumetric flow rate, based on the limiting downflow rate of the stacked rapid sand filters: this will allow for calculation of capture velocity, and thus give an indication of capture-able floc diameters.
- Required pipe diameter to be calculated given a target floc diameter, keeping in mind the sedimentation velocity.
- Design the tube settler dimensions based on calculated floc diameters and sedimentation velocities (including consideration of the fact that the flocs in the floc blanket may grow in size and thus their sedimentation velocities will increase).
- The floc blanket should have a depth between 30 and 60 cm.
- Inlet conditions for the flocculated water in the sedimentation tank should be carefully considered, taking into account the required upflow velocity of the water and the jet's energy dissipation rate (which needs to be low enough that it won't cause excessive floc breakup, i.e. < 10 mW/kg).
- The optimal configuration is a jet that enters through the bottom of the tank so that no jet reverser is required.
- A conical collector should be located at the bottom of the sedimentation tank, in order to direct settled flocs to the jet for re-suspension.
- Some sort of drainage system needs to be implemented in the floc blanket: perhaps a drainage pipe into a bottle.
- Because the demonstration plant runs for a short period of time, and floc blankets take a while to build, some way to increase the speed with which the floc blanket is built, needs to be devised. This may be as simple as building one in the lab, ensuring a supply of clay in the bottom of the filter when the plant is off, which will be re-suspended once operation begins again.

Deadlines

- Calculations : by 02/23/12
- Design : by 03/01/12
- Fabrication : by 03/29/12
- Testing : by 04/12/12

Part III

Stacked Rapid Sand Filter

The goal for the Stacked Rapid Sand Filter (SRSF) team is to improve on the design from last semester and to complete fabrication of the SRSF. While a full scale unit has 6 layers of 20 cm sand filter layer depth, the demo plant (DP) will require scaling the depth of the filter layers down to 4 layers of 4 cm depth. Also, to maximize the visibility of filtration process in the DP, as many components as possible will be transparent including inlet and outlet manifolds. For the design calculation draft, 1 mm/s is set for flow rate of SRSF with sand effective size 0.5 mm and uniformity coefficient of 1.6. The backwash velocity is 11 mm/s. Whether to use a scaled-down siphon control system or to use a valve for the backwash mechanism will be decided based on design calculations.

Tasks

- Compute and compare the theoretical results of filtration velocity between four 4 cm and six 2 cm filter layers using the Stacked Rapid Sand Filter Mathcad design file.
- Organize the ordered fabrication materials from the last semester to determine which materials are going to be used and order more if needed.
- Perform calculations of flow rates within pipes and inlet / outlet boxes (inner diameter of 9 mm tubes and a 1.3 cm-diameter pipe for the main body of the SRSF) and flow distribution between layers.
- Decide whether the inlet and outlet manifolds are going to be manufactured using stainless steel or PVC tubes with tiny slots.
- Four inlet pipes from the bottom of the inlet box connecting to the bottom of the sand filter and four outlet pipes from the outlet box will be installed.
- Vertical drop tubes on inlet side of filter need to be large enough to accommodate counter air and water flow, tubing inner diameter (ID) needs to be approximately 9 mm.
- Angle the vertical drop tubes slightly (from the vertical) to allow for easier water flow down the bottom of the tube and easier air flow up on the side of the tube.
- Decide how the backwash mechanism will be designed using a siphon or valve.
- The water level during backwash should be low enough that the 3 upper inlets are effectively isolated.

- Possibly use smaller diameter sand than in full scale plant (0.5 mm); if so, need to reduce backwash and filtration velocities; communicate with SRSF team for any insights.

Deadlines

- Calculation: by 02/23/12
- Design : by 03/08/12
- Fabrication : by 03/29/12
- Testing : by 04/12/12