

## Low Flow Stacked Rapid Sand Filtration (Phase II EPA P3 project)

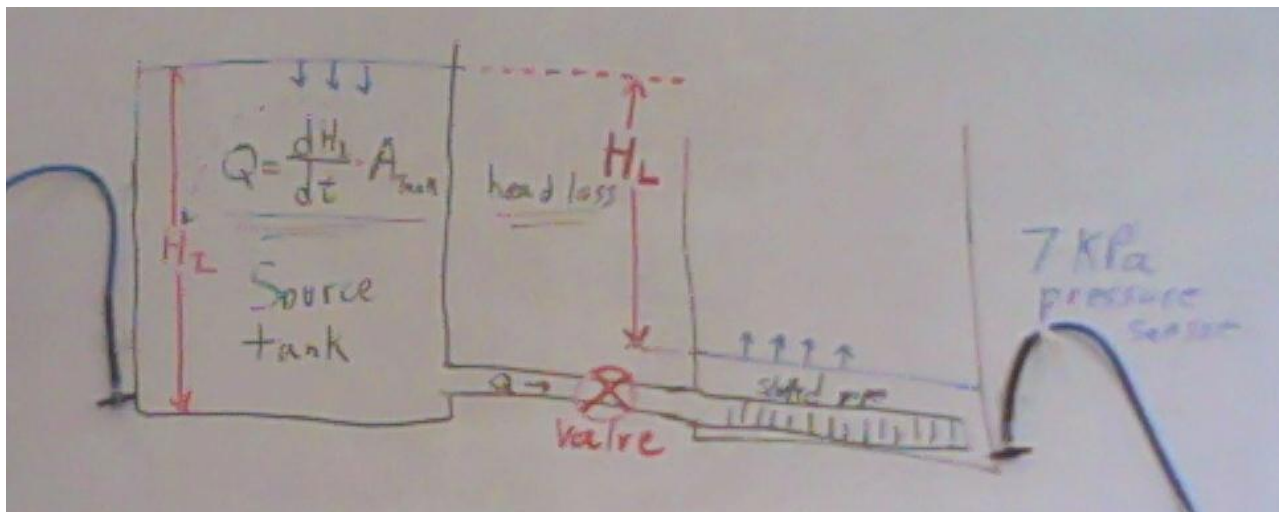
Location: Project Lab in basement

Skills: fluids, fabrication

Number of students: 4-5

### Tasks and goals

- Remove pressure sensors from the filter column to keep them dry while performing initial testing.
- The head loss through the filter is higher than expected especially in backwash. We suspect that the head loss through the slots is higher than predicted. It is also possible that there is excessive head loss in the manifold past the slotted pipes that pass right through the manifold. Measure the head loss through a slotted pipe manifold system as a function of flow rate and compare with theoretical expectations. Submerge a single slotted pipe manifold in a tank of water. Connect the slotted pipe to a second tank that serves as a supply. Connect pressure sensors to each tank to measure the water levels in the tanks. The two sensors provide enough information to track both the difference in elevation between the two tanks and thus the head loss AND the rate of change of depth in the tanks which can be used to measure the flow rate. Design the pipe and valve connecting the two tanks to be large enough so that head loss through that pipe and valve is small. Measure that head loss by running the system without the slotted pipe attached. Then subtract the piping head loss from the total measured head loss to get the head loss through the slotted pipe. Compare the measured results with the orifice equation prediction for the slotted pipes.



- Determine what must be changed to reduce the head loss during backwash and replace/upgrade that component.
- Add an extension on both inlet and outlet tanks using the hose clamp, stainless steel strap, and gasket material. The outlet tank must be higher than the top of the filter so that the filter can be filled with water so that the backwash siphon will work properly.

- Ability to cycle between filtration and backwash
  - Set the pipe stub heights as low as possible for reliable operation
  - lower the inlet and outlet tanks as much as possible to improve operator access
- Evaluate flow distribution between sand layers using differential pressure sensors spaced 10 cm apart in the middle of each sand layer.
- Measure the head loss required to fluidize the bed for clean and clogged bed conditions
- Determine how much head is required to initiate backwash of a clean and of a clogged filter using the 2 layer at a time system.
- Evaluate the option of adding flow restrictions on the inlet pipe stubs for the top and bottom inlets to achieve better flow distribution between layers.
- Refine the design for required elevations of inlet and outlet tanks, pipe stubs, and backwash outlet.
- Develop a method to fabricate inlet and outlet tanks including the weir system that is used to divide the flow between multiple LFSRSF.
- Test the sand drain and see if any improvements are needed
- Figure out a method that enables the operator to know if the sand is fluidized