Stacked Rapid Sand Filtration

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Abstract

Stacked Rapid Sand Filters are an adaptation of rapid sand filters optimized for flows between 6 and 100 L/s that don't require any flow control or backwash. They are a "game changing" technology invented by the AguaClara team that is significantly simpler to operate than conventional rapid sand filters.

Students	3-4 (could divide between research tasks and invent tasks)
Skills	fluids, AguaClara water treatment processes, process controller, fabrication
Location	AguaClara lab 2 right end of bench AND HLS 160 R

1 Research Tasks Pilot Scale (AguaClara lab 2)

These experiments will be conducted using a 10 cm diameter filter column.

- Measure flow distribution between layers
- Perfect hydraulic controls for cycling between filtration and backwash mode
- Evaluate possible methods to create automatic cycling between filtration and backwash.

2 Research Tasks Bench Scale (HLS 160 R)

These experiments will be conducted with a 2.5 cm diameter filter column with full process control for chemical feeds, backwash, and turbidity measurements. It may be possibe to install a two layer stacked filter in the small diameter filter column.

- Compare performance of an upflow layer and a downflow layer to confirm that filtration performance is similar

- Evaluate the possibility of using smaller sand grain size and determine if there would be advantages to making this change. Smaller sand size potentially changes backwash velocity, filtration velocity, filter manifold slot size, required layer depth, and filter solids capacity.
- Determine what combination of flow, turbidity and dissolved organic matter (DOM) can be accommodated with either a 12 hour or 24 hour interval between backwash.
- Explore addition of a very low PACl dose (perhaps $100\frac{\mu g}{L}$ as aluminum) to improve filtration performance. Note that this can only be reasonably tested if a full flocculation/sedimentation step is provided upstream of the filter. Then the effect of PACl addition prior to the filter could be measured.

3 Invent Tasks

- Take lessons learned from construction and feedback from the plant operators to create recommendations for changes to the design.
- Explore options and recommend methods to extend the flow rate to less than 6 L/s.

3.1 Automated Control

The filter could easily be designed to begin backwash at a set filter head loss by adjusting the length of the siphon tube in the siphon box. If we could add a method to end the backwash and revert to filtration then we could have a fully automated filter. This would be particularly useful for very small communities that can't afford to have an operator on site all of the time. The challenge is to have a delay for 10 minutes while backwash proceeds, open a valve to break the siphon for a few seconds and then close the valve again. Finding a solution for this will require some very creative hydraulics. The siphon air valve could be operated by a float that is in a tank that is emptied and filled. We need a whole series of ideas here.

3.2 Scaling to smaller flow rates

Develop new construction methods that would make it possible to fabricate a SRSF at dimensions that are not large enough for a human to enter the filter box. Another possibility is to reduce the sand grain size so that the filter and backwash velocities are reduced so that the area of the filter is larger. The filter box could be constructed of large diameter PVC pipe and the manifolds could be assembled inside this pipe be reaching in from above and from below prior to connecting the section of the filter with the manifolds to the rest of the filter box.