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

Location: Project Lab in basement

Major findings in summer 2013

- Sand drain (1-2 minutes to empty filter of sand). This is a big success.
- Ball valve on sand drain failed due to sand.
- Backwash initiator - preliminary evidence that it is helpful and breaks up rising plugs
    - can feel if bed is fluidized
- Fluidization tester using ball joint
    - hard to move and keep it watertight
    - needs an o'ring seal to make it watertight with less friction

The SRSF has been a remarkable success for a brand new technology. The very first SRSF built at full scale in Tamara, Honduras continues to operate and to produce water that meets US EPA standards. The SRSF are also being deployed in Jharkhand, India this fall for 2 village water supply schemes.

We still have many things to learn about SRSF operation. The challenge for this team is to develop an improved LFSRSF that is easy to fabricate, easy to operate, and that produces high quality water. This team should be in contact with Maysoon Sharif who is directing the AguaClara project in India to see if there are any immediate research needs for deployment or troubleshooting of the LFSRSF in India.

Simplified hydraulic controls for LFSRSF

This is a very high priority because the LRSRSF is already being replicated and we may have the ability to significantly improve the design and operation. The challenge is to design and build a pressurized LFSRSF that uses the hydraulic controls (similar to the system at Tamara) rather than valves for the inlets and outlets. See if it is possible to operate an LFSRSF with a single valve on the backwash outlet pipe that switches between filtration and backwash modes. Develop fabrication techniques and a design that makes the plumbing system compact and user friendly. Consider using a 12” diameter filter for the prototype.
Explore options for reducing the size of the inlet and outlet piping to make it more compact.
Develop a method to fabricate inlet and outlet tanks including the weir system that is used to divide the flow between multiple LRSRSF.

Develop new method to close off sand drain

The sand drain system with the inverted U pipe works well except that it isn’t easy (or possible) to turn the sand stream on and off using the valve because the valve malfunctions when it is full of sand. Invent a method to open and close the sand stream so that the operator can easily unload the sand into a series of buckets or porous bags. Possibilities include

- pinch a flexible tube

- raise the level of a flexible tube above the hydraulic grade line to stop the flow
- There must be a better method! Invent!

Backwash initiator

Fluidization requires a high flow rate up through the bed and obtaining a high flow rate through the settled sand bed requires a very high head. Large rapid sand filters don't have a problem fluidizing the bed because the entire bed can lift as a unit and then break apart and fall back through the water column. In SRSF this isn't possible due to the many pipes embedded in the sand. Thus, the result is that the head loss to initiate fluidization is much higher than the head loss required to maintain fluidization. We need to design a fluidization initiator.

A vertically mounted rotating square rod was tested during the summer of 2013 and there are initial indications that it could be a success. The square rod backwash initiator needs further testing including measurements of the actual head loss required to fluidize the ENTIRE bed at once when the bed is clogged with clay and coagulant. An additional potential improvement would be to add a larger radius element at the bottom of the backwash initiator to make it easier to feel if bottom of bed is fluidized. Thus it is possible that the backwash initiator could serve two functions and be used to detect fluidization as well.

The bottom of the backwash initiator should be round and should be held in place by a collar that is some small distance above the bottom of the filter so that the collar will be in the zone of bed that is fully fluidized.

Design, build, and test multiple methods to initiate backwash after filter has been clogged and evaluate which system is the easiest to build and performs the best. Options include:

- Install a rotating flat bar (1 cm by 1 cm) that is the full height of the filter and that can be rotated through the cap (this is our current design)
- Install a rotating flat bar (0.5 cm by 2 cm) that is the full height of the filter and that can be rotated through the cap (this would make it easier for the operator to feel if the bed is fluidized and would open a larger vertical hole)
- There may be further innovations here!!! Invent!

Construction Techniques & Ease of Operation

The improved filter design will need to incorporate improvements to fabrication, including the specific techniques and materials used in the process. The goal will be to minimize the cost and increase the ease of fabrication of the filter. Review how the LFSRSF is being fabricated in India and see if you can develop improved fabrication techniques.