Foam Filtration (EPA P3 Phase I award effective August 2014)

Location: B63

Skills: fabrication, experimentation, design

Number of students: 3

Foam filtration has the potential to be a very low cost, flexible, and high performance water treatment system. Foam of different pore sizes can be stacked or used in filters in series to achieve high removal efficiencies starting from high turbidity raw waters.

Agua Para el Pueblo is eager to test the foam filter in a town in Honduras. Before doing that we need to assess the risks of chemical leaching from the reticulated foams. Reticulated foams are used for drinking water treatment (see technical foam services). Contact manufacturers that provide reticulated foam for drinking water to get their specifications on leached chemicals. Professor Damian Helbling may also be able to test for leached chemicals from reticulated in 2015.

The goal is to ship a working foam filter to Honduras this summer. We will need to stay in contact with Antonio Elvir and Drew Hart to see how their testing of the foam filter evolves and see if it is best to ship an entire foam filtration unit or if they want to fabricate a new compression system just based off of a design that we create (and test) in our labs.

Evaluate and Simplify the compression system

Measure the maximum compression velocity attainable with the pulley system with the foam. Compare with the target of approximately 0.2 m/s that was obtained by the Foam Filtration team in the Spring of 2014 (see page 23). If this compression velocity can not be reached using the current pulley system evaluate options for increasing the compression velocity including reducing the mechanical advantage, using two people to compress the foam, or switching to a hydraulic compression system (see below).

The compression system can be simplified before shipping to Honduras. Paul Charles has great ideas for an improved compression frame. It may also be possible to have the fabricator that builds the dose controllers fabricate a lightweight frame. There are two big options for the frame. The frame could be a simplified 80/20 system or a lightweight design could be fabricated in a shop with aluminum welding capabilities. This is more likely how the frame would be fabricated in Honduras (or India).

If the frame is fabricated in a shop it should have the following characteristics.

- The frame should disconnect from the drum without requiring any tools. Clamps or latches could be used to connect to the drum.
- The sleeve that the compression piston slides through could be a square aluminum tube.
- The height of the sleeve could be as short as possible while still providing good stability to the piston. The sleeve should also extend as far down into the drum as possible rather than extending high above the drum to reduce the overall length of the piston.
- The frame of triangles that connects the sleeve to the drum should be welded together so that the interior of the sleeve is not affected by fasteners.

Reduce the head loss or increase the capacity to handle head loss

Flow through the foam filter in Tamara, Honduras was limited by head loss that caused the drum to overflow. Measure head loss accumulation and effluent turbidity as a function of PACl dose for 500 NTU raw water. Determine how much head loss the foam system produces at the onset of the increase in effluent turbidity. If this head loss is larger than can be accommodated with the 55 gallon dr um, then explore options to extend the possible runtime of the filter.

- Use larger reticulated foam at the top of the filter to reduce the head loss. Larger pore reticulated foam is available up to 10 pores per inch.
- Use a deeper filter body. Explore the option of using HDPE pipe.
- Lower the effluent pipe as the head loss through the filter increases. Explore options for automating the lowering of the effluent pipe.

Chemical dosing and Flow Measurement

Add an LFOM and half size 2 lever dose controller to the foam filter. The LFOM will make it possible for the operator to quickly measure the flow rate. The LFOM will need to be designed to be integrated with the float for the dose controller. It is possible that the LFOM will be reversed from the normal entrance tank in an AguaClara plant. The raw water and the float could be inside a 15 cm diameter LFOM and the water would flow out of the holes and fall into the filter body. Some sort of a drop tube may be necessary to prevent splashing.

The LFOM should be designed to have 10 cm of head loss to drive the half size dose controller system. Design the compression frame and dosing/flow measurement system to be integrated.

Performance testing

Once the entire system is fabricate it will need to be tested through cycles of filtration and cleaning to characterize performance and explore design options. It will be easy to compare different combinations of reticulated foam pore sizes.

Evaluate hydraulic compression option

This option is only possible if we switch to a filter body made from pipes. HDPE would be an great material to use and spin welding could be used for connections. Perhaps the clamping system developed by the LRSRSF team could be used to attach a bottom to the filter. Note that during compression the connection between the bottom of the filter and the filter body has to withstand 500 lbs of tension.