StaRS Filtration Theory

Skills: lab experience, fluids, Process Controller

Read the final report from the spring semester. The first step in setting this semester's goals is to fully understand the results from the spring of 2014. One of the intriguing results is that the head loss is directly proportional to the accumulated mass of coagulant applied. This relationship could be caused by an increase in floc strength as a function of coagulant dose that results in flocs being able to fill in more of the sand pores before the shear level gets too high. If this is the case, then it should take longer for the pores to fill up and thus filter performance should remain good for a longer time as coagulant dose is increased. An alternative hypothesis is that as coagulant dose increases the flocs grow larger before they reach the filter. Larger flocs have lower density and thus the pores are filled more rapidly by these larger flocs. If this is the case, then it should take less time for the pores to fill up when the coagulant dose is increased.

The high head losses measured in the spring of 2014 are surprising because an upflow sand bed should lift when the head loss through the bed is equal to the height of the sand (see the 4540 notes on filtration for the explanation for why this is true). Check the 200 kPa pressure sensors to make sure that they are configured correctly and run an experiment to see if you get the same results as were obtained previously.

Design experiments that measure head loss, influent turbidity, and effluent turbidity over the course of a filter run. The length of the experiment could be set based on maintaining an effluent turbidity of less than 2.5 NTU (after an initial ripening period) given an influent turbidity of 5 NTU. We expect filter run times to be approximately 12 hours, but confirm this by experimenting. Collect a family of performance curves (pC* and head loss) by varying the coagulant dose while maintaining a constant raw water turbidity.

While the experiments are running, develop a model for the mass of clay that can fill a pore before the flow path through the pore has a smaller diameter, the velocity is higher, the shear is higher and hence no more particles attach. See if you can create a model with a minimum of unknown parameters for the pore storage volume as a function of the coagulant dose. The model should also predict head loss as a function of coagulant dose and mass of solids accumulated.

One of the possible applications of this research will be to evaluate the selection of 20 cm as the layer depth for SRSF. In addition it may be possible to provide guidance for the maximum head loss that a SRSF can sustain before particle breakthrough becomes excessive. Finally, it may be possible to provide recommendations on the optimal coagulant/clay ratio for efficient filtration.