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EVALUATION AND AUTOMATION OF SMALL PRESSURE FILTER SYSTEMS

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Problem and Research Objectives:

Recent passage of amendments to the Safe Drinking Water Act required the USEPA to specify where filtration of surface water sources is mandatory. Disinfection was also required for public water systems using surface water supplies. The filtration and disinfection requirements are being proposed as treatment techniques to protect against exposure to Giardia lamblia, viruses, Legionella, and other pathogenic organisms. Common filtration methods used for removal of particulates, destabilized precursor material, and microbial contaminants and applicable for small water systems include the following options: package conventional or direct filtration treatment plants; ultrafiltration (membrane or cartridge); slow sand filtration; and precoat (diatomaceous earth) filtration. Package and ultrafiltration treatment plants have been known to effectively reduce precursor material; package plants by coagulation, e.g., alum addition, and ultrafiltration by size exclusion. Package plants are defined as factory-assembled, skidmounted units incorporating individual processes similar to conventional or direct clarification treatment plants. Their compact size, minimal installation requirements, and ability to operate with little supervision makes them attractive to small communities. However, the necessity for controlling chemical coagulant dosage is an inherent disadvantage to small communities with limited resources for hiring and keeping skilled water treatment plant operators. Large chemical dosages can also increase the cost of providing drinking water because of the increased chemical usage and sludge volumes requiring proper handling and disposal. Ultrafiltration has successfully reduced THM precursors from ground water supplies in Florida. However, operating pressures up to 100 psi and pretreatment processes similar to a package plant may be required for water supply sources with low to moderate color and turbidity levels.

This project designed, constructed and installed a field scale pressure filter system for the Town of Contoocook, NH. The system was then fun for seven months to evaluate the success of this technology for surface water treatment.

Principle Findings and Significance:

The influence of precoat DE size, precoat DE loading or dose, and bodyfeed DE size and dose on the treatment and operational performance of the pilot filtration system were evaluated during the study. During these various filtration trials, the operator took the opportunity to evaluate the filter hardware and computer software features in terms of operation and maintenance requirements and system reliability. The results from the completed 12-month study are summarized below.

Software:

The software system accomplished all primary objectives. The hardware could use more expansion slots to allow telephone notification capability.

Precoat DE Size: The influent flow rate decreased over time as the headloss in the filter increased because the DE pilot plant was operated at constant gravity with no flow controller. The best hydraulic performance was obtained by the medium grade DE (Celite 503). The 503 grade had slow headloss

development, but did not treat quite as much volume as the larger 545 grade DE. Visual inspection of the filter coat by the operator showed uneven filter coating with the 545 grade at all precoat doses.

The best treatment performance was obtained by the medium grade DE (503). Initial effluent turbidity levels were similar for all three grades of DE. However, the larger and smaller grades exhibited turbidity breakthrough, as shown by rising effluent turbidity levels, after treating less water than the 503 grade. As expected from previous studies, no differences between DE grades were observed for NPDOC removals.

Precoat DE Dose: The optimum precoat dose for both the 503 and the 545 DE grades, as determined by headloss development, was 0.15 lb/ ft2. For all grades of DE tested, 0.15 lb/ ft2 was the optimum dose for maximum volume of water treated at a minimum terminal headloss.

The best treatment performance was obtained at the 0.15 lb/ ft2 precoat loading for the 503 and the 545 DE grades. The Hyflo-Super Cel performed best at the 0.10 lb/ ft2 precoat loading. The lighter (0.10 lb/ ft2) and heavier (0.20 lb/ ft2) precoat loading exhibited turbidity breakthrough after treating less water than the 0.15 lb/ ft2 precoat loading for both the 503 and 545 DE grades. Again, no differences between precoat loading was observed for NPDOC removals.

Bodyfeed Dose and Size: After determining the optimum precoat grade and loading, i.e., Celite 503 at 0.15 lb/ ft2 dose, various bodyfeed combinations of DE size and dosage were tried. All bodyfeed application rates resulted in faster headloss development than using precoat only. Influent flow rates decreased more rapidly for all bodyfeed application rates than for precoat only.

The best treatment performance was obtained using only the precoat. Turbidity removals were better than using only the precoat, at the lowest bodyfeed application rate with the same size bodyfeed DE as the precoat. Again, no difference between bodyfeed rates and precoat were observed for NPDOC removals. Consequently, bodyfeed additions were not found to be beneficial to optimize filter precoat operational performance.

Challenge Run: The challenge run was performed on the optimum precoat. The optimum was determined by the previous trials to be 0.15 lb/ ft2 503 precoat without any bodyfeed. The influent water was spiked with primary effluent from the town's sewage treatment plant after the precoat had been applied, and the filter equilibrated for approximately two hours.

Headloss development occurred rapidly, although the influent flow rate was lower than in previous trials. Treatment performance, as measured by effluent turbidity, was slightly better when compared to previous trials; however, breakthrough occurred much sooner, possibly due to the significantly higher raw water turbidities observed during the challenge run.

Results of the bacteria tests were inconclusive, and further study is necessary before any conclusions about bacterial reductions can be made.