Project Summary:

Sawyer Water Filter Test System

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Prepared for Sawyer Products

Key Findings of Study

A laboratory system was constructed that ran water continuously through 24 Sawyer PointOne® filters with regular backwash. Key findings:

- After 230,000 liters of flow per filter, which represents 30 years of typical household use for a bucket filter, all 24 filters exceeded the EPA standard of 6 log removal of bacteria.
    - The testing included a month of stressing the filters by pumping WHO challenge water that contained high solids, turbidity, hardness, and salts.
    - The test was run at 10 psi, which is about ten times the pressure and stress of a bucket filter application.
    - Only one of the 24 filters had any bacteria breakthrough, all of the other filters had zero bacteria breakthrough.
- Under the high pressure stress, the filters exhibited a significant reduction in flow rate.
    - A follow-up test of new filters confirmed the slow down.
    - More frequent back-flushing with slightly higher pressure increased flow only marginally. A surging backflush procedure increased flow slightly, but flows did not return to new condition.
    - Cleaning with acid, base, or detergent did not significantly increase flow.

Abstract

This report documents the Sawyer Life Cycle Study system that was designed to circulate water through each of 24 Sawyer PointONE® bucket filters to test the durability and longevity of the filter. Computerized control of the system pumped water continuously with periodic backflush and measurement of flow and pressure.

Over 62,000 gallons (230,000 liters) of WHO challenge water and tap water were run through each of the original filters, which represent about 30 years of a household bucket filter use[1]. Filters were tested before and at the end of the run and all filters exceeded EPA filter removal standards of a log-6 removal. The flow in the filters did slow down during the run, especially after high turbidity WHO challenge water was run through them.

A second run of new filters was performed with tap water to assess the decrease in flow rate. Different back flush and cleaning methodologies were performed. The filters displayed the same pattern of slow-down as in the first test, although not as severe as when the WHO challenge water was used.

The project system has been shut down but the hardware and software are saved and are available should more tests be desired.

[1] Darrel Larson, International Director at Sawyer Products: 20 L (one bucket) per day for small family

Design

The system design was 24 filters in parallel and 24 filters were tested in the first run. Later tests used three or six filters at a time to examine different scenarios. A manifold was used to allow for equal amount of flow through each filter as well as the ability to test multiple filters or isolate or turn off filters. The top and bottom of the manifold are 1" in diameter with 1" piping and fittings making up each of the 24 single lines of the manifold.

Each filter line has a pressure sensor and a flow sensor. The data are recorded by computer and the software can be programmed to record data at one minute intervals or longer. Originally pressure regulators limiting pressure to 10 psi were installed in both the inlet and backflush sides of the filters. Later, the backflush pressure regulators were removed, which allowed the backflush to be up to 18 psi.

The system used two 100-gallon tanks. Water flows from the lower feed tank, through the filters, and into the upper collection tank. From the upper collection tank, water flows by gravity back into the lower feed tank. Thus, only filtered water is in the collection tank while the feed tank can contain solids as in the WHO challenge water test. Backflush is with filtered water from the collection tank backwards through the filters into the feed tank. Two submersible pumps were used, one in the feed tank for forward flow and one in the collection tank for backflush.

Originally normal flow through the filters was downward as in a bucket filter application, but this lead to frequent airlock of the filter lines. Flipping the filters and running forward flow in the upper direction solved the airlock issue. Figure 1 below is a photo of the system.

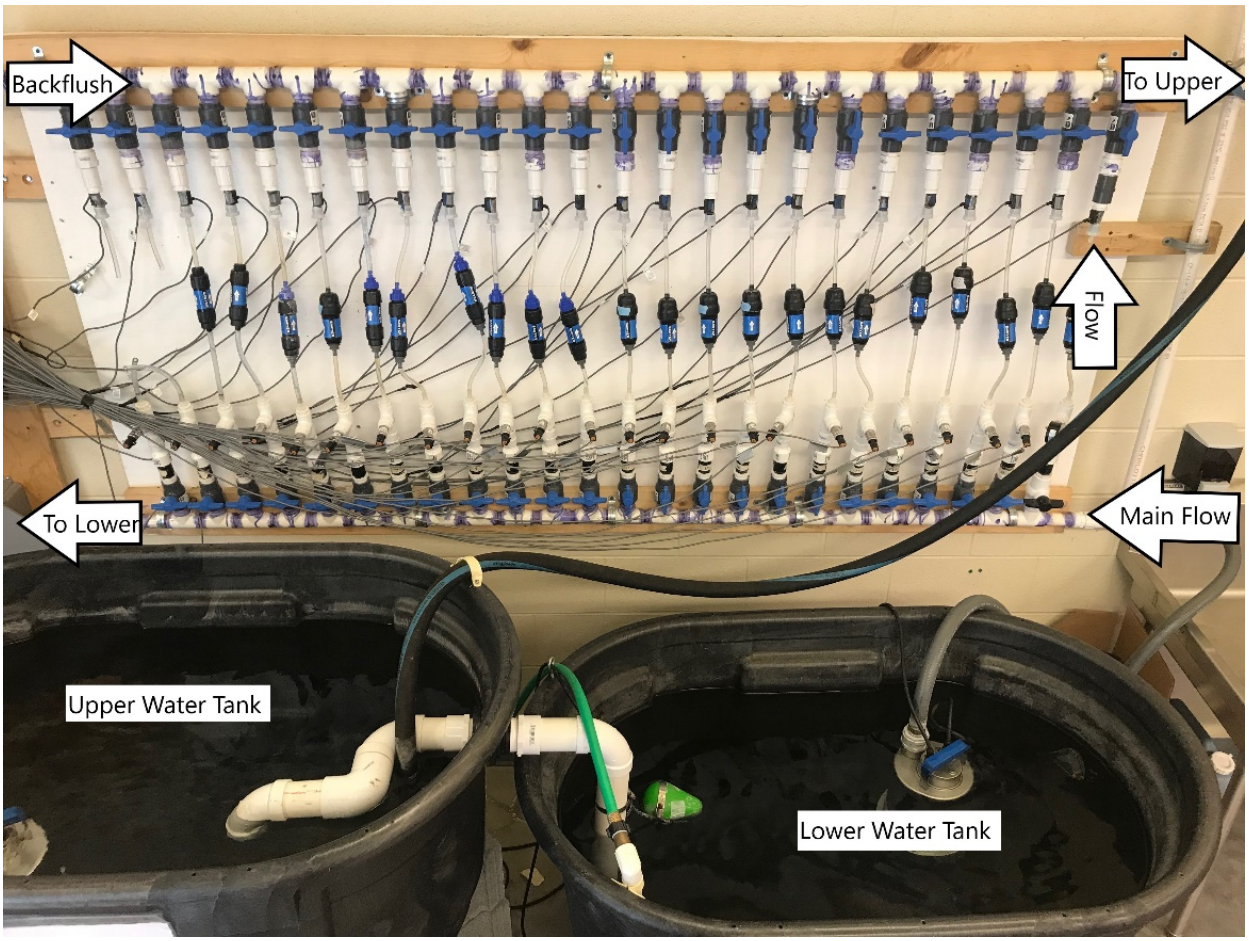

Figure 1. Overview of System

Bacteria tests

After the first year of testing, in which 62,000 gallons (250,000 liters) were run through each of the filters, including the period with the WHO challenge water, the filters were tested for bacteria breakthrough. The tests used were the e. coli membrane filter (MF) test and the Colilert® most probable number test. Filters were retested if breakthrough was observed. 23 of the 24 filters had zero hits of bacteria in the test or retest indicating greater than log 8 removal. Filter 2 had some breakthrough. In the 1 year tests, Filter 2 showed 5.8 log removal in the Colilert test and 6.0 log removal in the MF test. Again, the other 23 filters exceeded 8 log removal.

Flow Observations

Significant slowdown of flow was observed in the filters from the initial flow rate of over 1 gallon per minute (4 liters per minute). The slowdown was observed even before the WHO challenge water was introduced. Figure 2 below shows the slowdown.

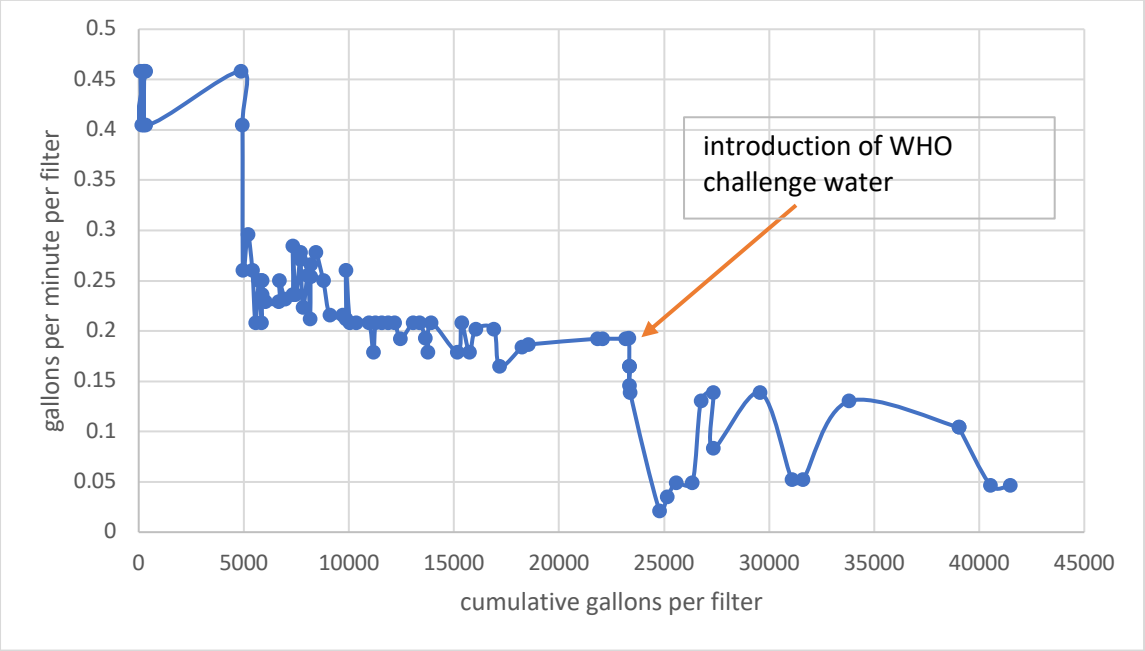

Figure 2 Flow in original test

Six new filters were mounted on the system and the software programmed to measure pressure and flow every minute and more precisely investigate the flow slowdown. Tap water, which is softened well water, was run through the system and the flow and pressure monitored. As seen in the figure below, all six filters exhibited the same pattern of rapidly decreasing flow at first followed by a more gradual decrease.

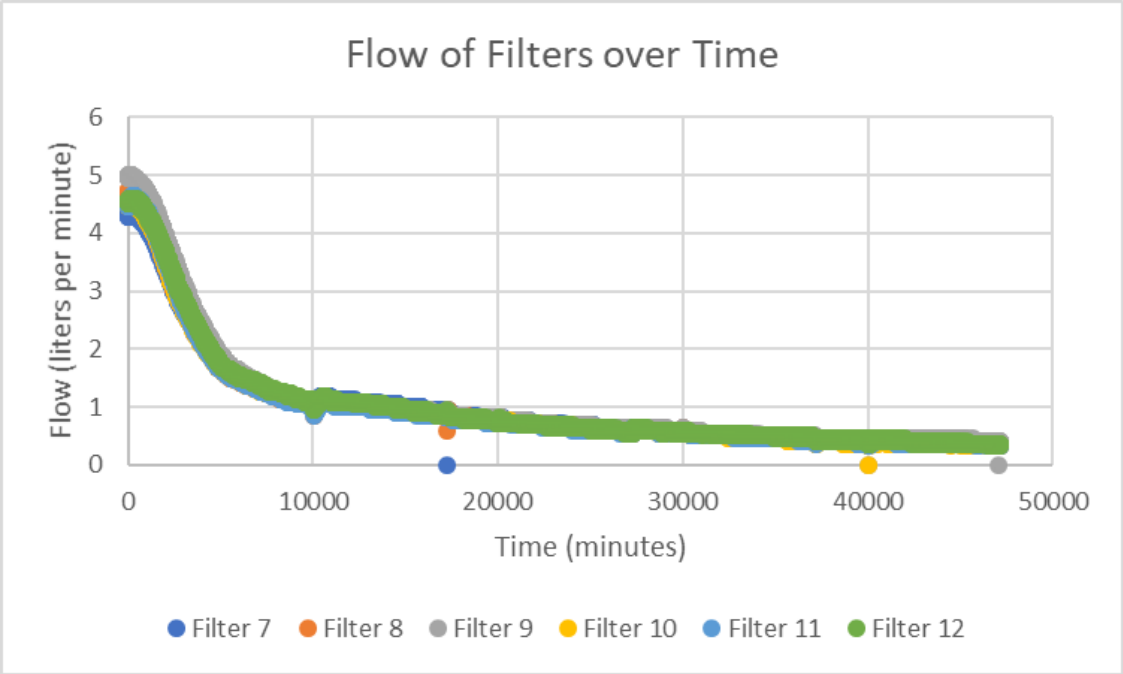

Figure 3 Flow test of six new filters

Because the manifold equalizes pressure between the filters and the pressure regulators limit pressure, the filter inlet pressures increased only slightly during the test as seen below.

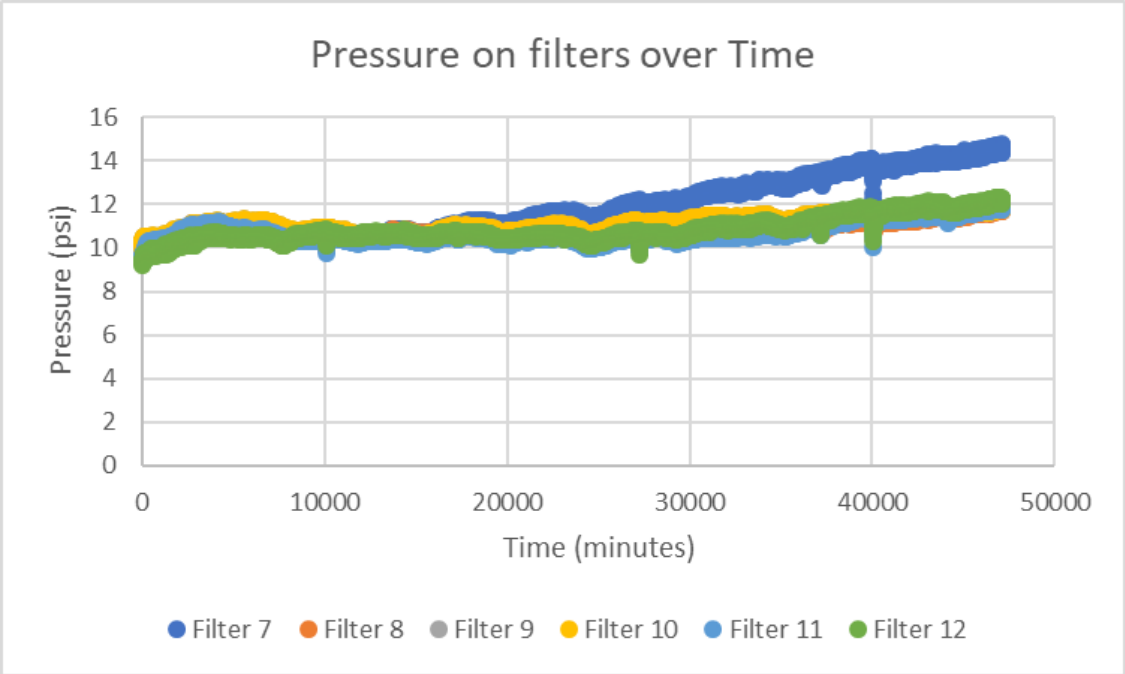

Figure 4 Inlet filter pressure

Two Sawyer mini filters were also tested in the system and showed the same flow pattern.

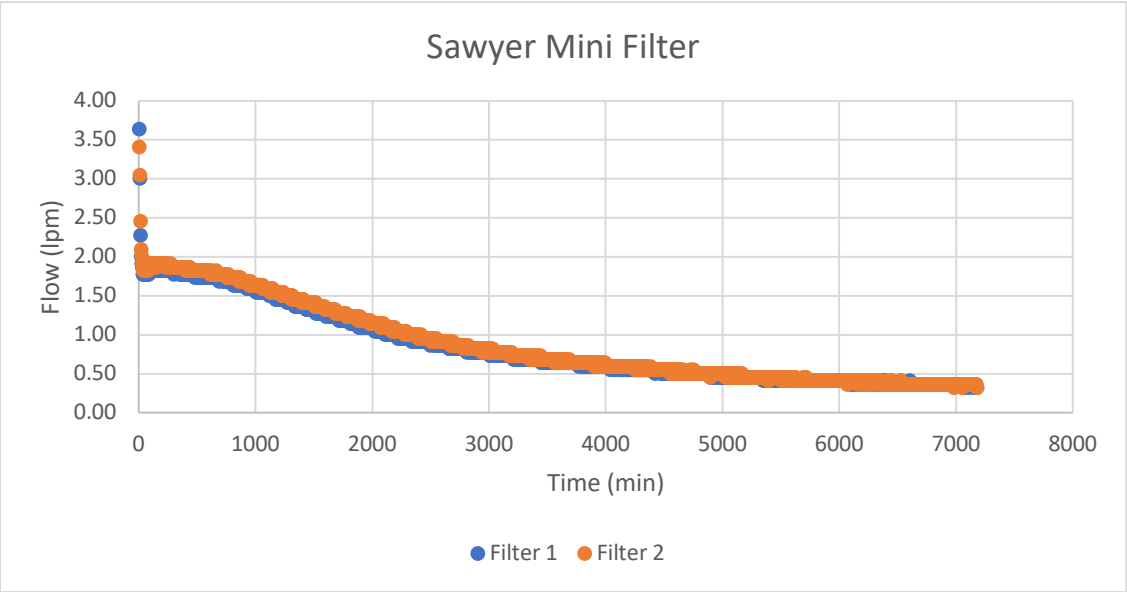

Figure 5 Mini filter flow

Backflush and Cleaning Tests

Several variations of backflushing and cleaning were employed to test if they could increase flow in the slow filters from the original run. These methods included:

- More frequent backflushing
- Longer backflushing
- Higher pressure backflushing: backflush pressure increased from 10 psi to 18 psi
- Surge backflushing: forward and backflush pumps are cycled back and forth for 1 second each during backflush for 3 to 8 times
- Cleaning with acetic acid
- Cleaning with caustic soda
- Cleaning with detergent

Of these, surge backflushing was the most effective, but only increased flow by about 10-20% and did not return flow close to the initial flow.

The laboratory test system has been shut down and the tanks moved to storage. Currently the filter assembly is intact and mounted on the lab wall. We anticipate that filter assembly may be taken down and disassembled next year if the wall space is needed for other projects.

Conclusions

The Sawyer PointOne® filters continued to function and meet EPA standards for bacteria removal from water after filtering water volume equivalent to 30 years of household use. This longevity of filter performance was demonstrated while the filters were being stressed at a pressure 10 times higher than typical field pressures. The filters showed a slowdown in flow throughput over time but remained functional.