Decontamination of Plumbing Pipes Contaminated with Per- and Polyfluoroalkyl Substances (PFAS) from Aqueous Film Forming Foams (AFFF)

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Overview

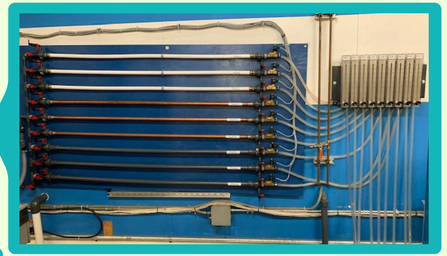
The U.S. Environmental Protection Agency (EPA) is the lead federal agency responsible for working with water utilities to protect water distribution systems from contamination and to clean up systems that become contaminated. Intentional and unintentional contamination of distribution systems can result in large amounts of water and miles of infrastructure that must be cleaned to return the system to service. The EPA conducts full and pilot scale research to address contamination in water systems.

Home plumbing can be contaminated with PFAS from aqueous film forming foams (AFFF) through accidental backflow resulting from firefighting related activities, including back-siphoning during routine maintenance of equipment. This exact incident occured in Wyoming, OH in 2018, Neville Island, PA in 2019 and Westmoreland County, PA in 2020.

As of now, no known, intentional studies of PFAS persistence on any home plumbing materials have been performed. Furthermore, flushing is the primary method available for homeowners to decontaminate their home plumbing. This study examined the effect of flushing on the persistence of PFAS in plumbing pipes, and if stagnation after flushing resulted in the release of previously bound PFAS from the walls of the pipes.

Experimental Setup

A pilot scale setup containing copper, polyvinyl chloride (PVC), and cross-linked polyethylene (PEX) pipes was built at EPA's T&E facility in Cincinnati, OH. Three pipes of each material were installed so that triplicate experiments could be conducted simultaneously. Pipes are 1-inch diameter, 55 inches long and are supplied with local tap water. Flow through each pipe is regulated with a solenoid valve that opens on the hour between 7:00 am and 4:00 pm for 10 min and allows flow at 2 gpm. This demand pattern results in 200 gallons flowing through each pipe each day, with stagnation between scheduled flow periods. Pipes were conditioned using this flow pattern for four months.



Two separate experiments were conducted with pipes replaced in between and conditioning restarted. After conditioning, the pipes were contaminated with a 3% solution of 3M Light Water AFFF, which is an older formulation containing PFOS and PFOA or Phos-Chek 3%, which is a newer C6 foam. The AFFF contamination contacted the pipes for 4 hours. After the contamination period, the pipes were flushed for 20 minutes at 4 gpm. After flushing, the normal daily demand pattern was reestablished for two days, with one additional four-day period of stagnation thereafter. PFAS was determined by LC/MS/MS compliant with DOD QSM Table B-15 aqueous matrix.

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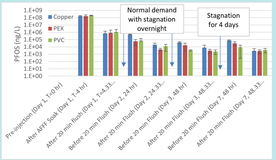
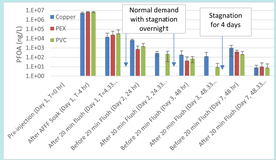
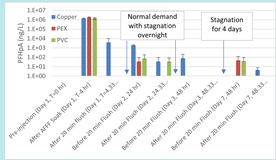
Results

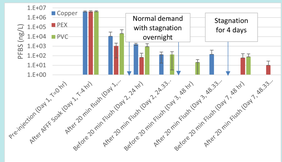
3M Light Water

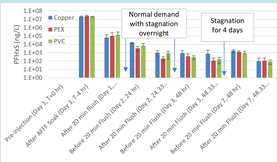
- PFBS, PFHpA, PFHxS, PFHxA, PFOS and PFOA were detected after the 3M Light Water contamination
- High levels of each PFAS compound were present during contamination, but over 99.99% was removed during the flushing event after contamination or in the subsequent days
- All compounds re-emerged into the water phase after four days of stagnation
- Flushing times longer than 20 min, and performed more frequently may be needed to remove more PFAS

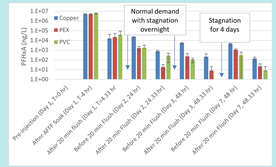












Phos-Chek

- 6:2 Fluorotelomer Sulfonate (6:2 FTS) was the only compound consistently detected after injection of Phos-Chek
- High levels were present during contamination, but over 99.98% was removed by the final day of the experiment
- 6:2 FTS re-emerged into the water phase after periods of stagnation
- Flushing times longer than 20 min, and performed more frequently may be needed to remove more 6:2 FTS