Home Plumbing Simulator for the Study of Copper and Lead Corrosion and Release, Disinfectant Demand, Biofilm Activity and General Water Quality

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The corrosion of household or premise plumbing materials (such as copper, brass, and solder) and the metal release that results from that corrosion can cause numerous problems, ranging from "blue" water to copper pinhole leaks. If left untreated, these problems can lead to health and financial issues. Factors that may impact corrosion and metal release include plumbing configuration, plumbing materials, water temperature, plumbing age, water use patterns, and other factors. In addition to corrosion issues, the long residence time often associated with premise plumbing and reactivity of plumbing materials can impact disinfectant residual, biofilm, taste and odor, metal release and other issues.

To better understand and prevent premise plumbing issues, a home plumbing simulator was constructed and operated for nearly two years to date. The results of this study will help to better understand the factors that influence the lead and copper corrosion in home plumbing systems, as well as new insights into the changes that new plumbing goes through as it ages.

The plumbing system, which spans two floors of the pilot laboratory, was planned and constructed by EPA staff to represent a "typical" household plumbing configuration and water consumption rates. Specifically, the simulator consists of ½ inch diameter copper pipe, lead and non-leaded soldered joints, four faucets, a shower, a toilet, a hot water tank and a hot water recirculating pump. An acid feed system injects enough acid (HCl) to drop the pH of the incoming water (tap water from Cincinnati, Ohio) to approximately 7. A fixed volume of water is passed through the system during the week based on an estimate of weekly water usage for a family of four. Flow usage goals are met by opening faucets and shower valves, and flushing the toilet at specified intervals and frequencies by staff. Hot and cold water samples are collected from the faucets after periods of stagnation twice a week. The pH, temperature and free chlorine of both the hot and cold water lines are monitored daily.

The plumbing simulator has been in operation for nearly two years to date. As data was collected shortly after starting the project, there was evidence of high levels of copper and lead. The data showed copper level as high 2 mg/L and between 20 and 30 μ g/L of lead depending on the stagnation period. However, as time progressed, these levels dropped closer to 0.5 mg Cu/L and almost zero μ g Pb/L. Another noticeable outcome associated with this project is the effect of the hot water system that continually recirculates hot water. Continually cycling hot water lowers the chlorine concentration of the water in the system. This could pose a problem if the chlorine levels reached a concentration low enough to allow microorganism growth within the system.