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Dec. 12, 2017

PPI Technical Response to "Metal Accumulation in Representative Plastic Drinking Water Plumbing Systems" Published in the November 2017 *AWWA Journal*

The Plastics Pipe Institute (PPI) is disappointed with the level of reporting within the peer-reviewed paper "Metal Accumulation in Representative Plastic Drinking Water Plumbing Systems" published in the November 2017 *AWWA Journal*. In our view, this paper was not professionally designed or conducted, as compared to other *AWWA Journal* papers. Several errors and misjudgments appear to have been made, and its findings are both inconclusive and misleading. This paper was also presented at the AWWA ACE'16 conference in Chicago, where similar questions were raised by the audience.

The following is a list of technical issues with this paper:

- The subject house is somewhat mysterious, having three domestic hot-water (DHW) tanks piped in series. Unless an extraordinary hot-water usage pattern was happening, this would clearly lead to atypical stagnation of the hot water in the tanks. The age of the tanks was not disclosed.
- Is this house owned by Purdue University and used for experimental purposes? If so, then what else is going on in this house? Is it representative of typical residential houses in this location? Such information should have been disclosed in the paper.
- Why was a one-year-old functioning plumbing system removed from this decades-old house? No issues or problems with the PEX plumbing system were reported.
- Further, although the fuel type used in the domestic water heaters was not disclosed in the report, the manufacturer of the PEX tubing shown in images does not allow direct connections to fossil fuel water heaters, so the installation may have been in violation of the PEX manufacturer's literature.
- The media used for the home's water softener was not disclosed. Depending on the settings used for this device, it could have been adding excessive amounts of sodium chloride or potassium chloride to the drinking water, potentially influencing field measurements.
- In the bench-scale testing reported in the section "$FeSO_4$ nucleation and crystal growth" the report states that "low-density polyethylene (LDPE) was chosen as the model plastic…" However, LDPE is a different grade of plastic than crosslinked polyethylene (PEX). In fact, pipes made of LDPE are not approved by any plumbing code for potable water in buildings, and the authors did not cite any research supporting the use of LDPE as representative of PEX surfaces. Thus, the article's findings lack relevance to PEX plumbing pipes, due to differences in test materials and surface properties.

- The paper states that "The greatest metal loading (28.4 mg/m^2) was found on the service line pipe", at the entrance to the house. FIGURE 5 shows that metals detected on pipes taken from throughout the residence varied significantly from floor to floor, and from hot to cold service. No actual pattern of the deposits was detected, and no explanation was given for the wide variance. Without a theory to the observed disparities, these measured results are simply random values.
- Although the paper concentrates on various oxidative induction time (OIT) measurements taken from PEX specimens, industry experts agree that OIT studies on a single specimen of PEX tubing are meaningless. Each type and brand of PEX tubing will have its own characteristic OIT result that is relevant only when compared with other PEX tubing of the same manufacturing source. In fact, OIT testing is not used within this industry to indicate any properties. For example, in product specifications for PEX tubing, such as ASTM Standard Specification F876, there are no OIT test requirements, and Section X1.6 (Appendix X1) of F876 states "*It should be mentioned that OIT tests are not an indicator of life expectancy, nor should differences in OIT values between compounds be construed to indicate differences in the stabilizer effectiveness of respective formulations*."
- What's *not* noted in this report is that the PEXa plumbing pipe material studied did not have any colorant or pigment, and is translucent. So reports of "discoloration" are simply the visible thin layers of metals deposited on the inside of the tubing wall. In the short sections of PEX tubing which are directly connected to the water heater, minor discoloration may also be caused by the exposure of material stabilizers/antioxidants to heat, a normal reaction that does not consume the stabilizers/antioxidants.

No evidence was reported to address "…whether plastics surfaces influence metal scale formation." Therefore, the conclusions of this paper do not match the hypothesis.

With the statement that "Metals found on the pipes…were present in the source water" we can surmise that suspended metals, including products of corrosion of an aging metal infrastructure water system, precipitated out of water when it was stagnant and deposited onto the inner pipe walls. Cleary, plastic pipes were not the source of the detected metals. Further, no concerns about pipe integrity or safety of drinking water are alleged.

Although a control house on the same block with copper plumbing wasn't compared, it is likely that the same metals would deposit onto any plumbing pipe material. In fact, the PEX plumbing system in this subject house appears to have such minor levels of deposits that long-term scaling will not be a problem, like it could be in a metal plumbing system.

Perhaps the only conclusion that can be made from this study is that aging metal pipes should be replaced with plastic water main materials, such as high-density polyethylene (HDPE), to prevent ongoing corrosion and the contribution of dangerous metals to public drinking water. Further, plastic service line and plumbing system materials will prevent corrosion within buildings and the ongoing contribution of metals to drinking water that results from this corrosion.

PPI Member firms in the PEX industry produce PEX piping systems in compliance with national standards such as ASTM F876, AWWA C904 and NSF/ANSI Standard 61[A], as well as model plumbing codes such as the IPC, UPC and NPC (Canada). PPI and our Members work closely with SDOs to help develop these standards. As a result, PEX plumbing systems are highly regulated and controlled to strict product standards, with mandatory third-party certification programs for safe and reliable delivery of drinking water.

The phenomena observed in this study, i.e., deposition of metal impurities in source water on plumbing pipes, likely would occur in any piping system, including copper and other metal pipes. The singular and alarmist focus on PEX is consistent with this researcher's past history. Dr. Whelton and his teams of student researchers have been testing PEX products for several years, while attacking the systems of standards and regulations that control this industry through innuendo and incomplete studies. Each of these papers should call into question the credibility of his sponsoring institutions.

Dr. Whelton has been invited to work directly with NSF International and the plumbing industry to help identify and solve any potential problems or risks, but has declined. Instead, he continues to seek government grants for inconclusive research with irrelevant or improbable theories.

The continued waste of taxpayer money through these National Science Foundation-sponsored projects is troubling to PPI. We will continue to monitor the papers of these research teams, and provide responses when necessary. As always, we are open to participating in any studies that are designed to simulate real-world applications or to address any factually relevant issues.

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[A] NSF International PEX Fact Sheet
[A] NSF International PEX FAQ on Health Effects of PEX Tubing