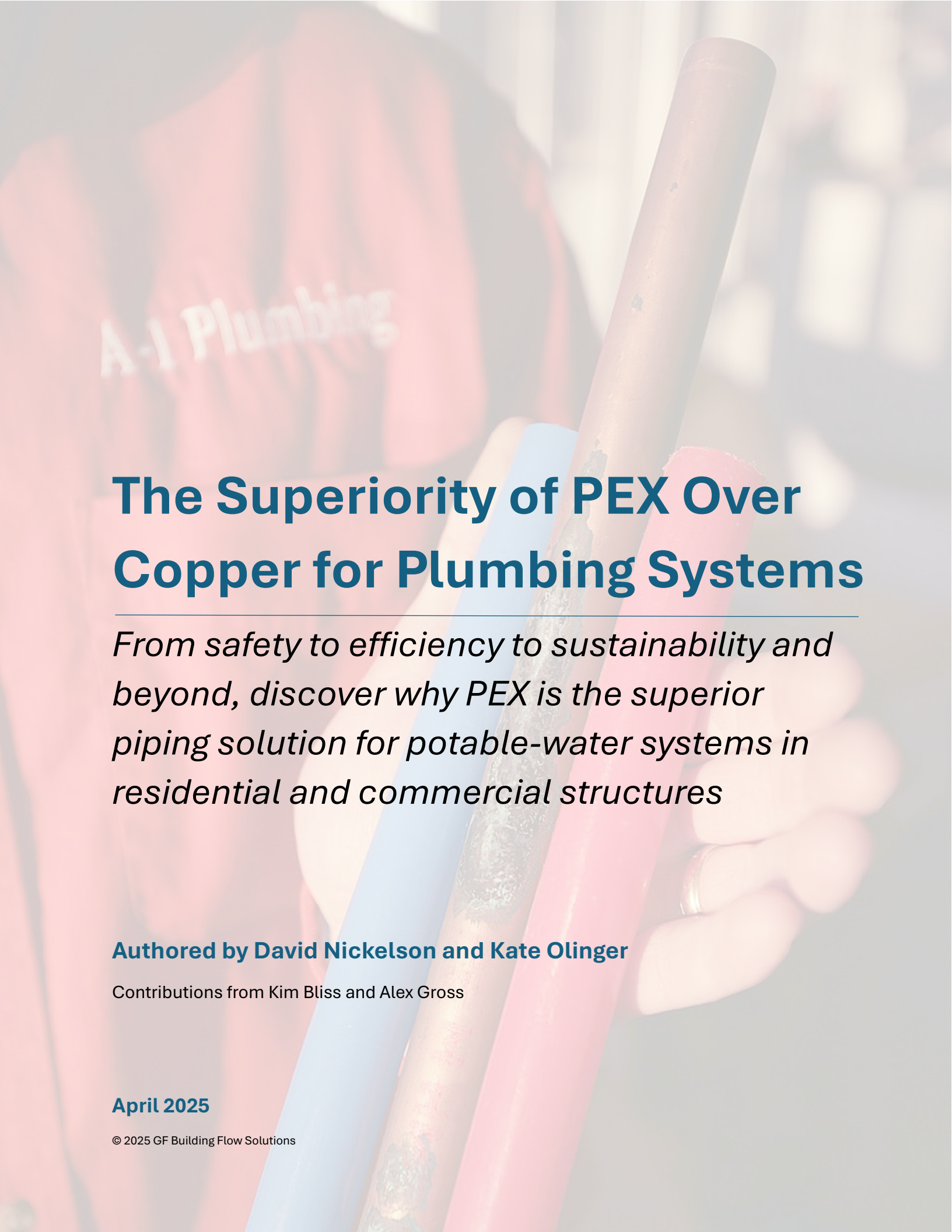

The Superiority of PEX Over Copper for Plumbing Systems

From safety to efficiency to sustainability and beyond, discover why PEX is the superior piping solution for potable-water systems in residential and commercial structures

Authored by David Nickelson and Kate Olinger

Contributions from Kim Bliss and Alex Gross

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Summary

PEX (an acronym for crosslinked polyethylene) is a piping material with decades of reliable service around the world. It is a rigorously tested, high-performance piping solution for delivering safe drinking water in residential and commercial structures.

Industry standards and independent testing confirm its safety, efficiency, and sustainability, demonstrating a variety of distinct advantages compared to copper piping. This paper will reveal data-supported facts and regulatory references to address common misconceptions about PEX.

All technical challenges, including certifications, listings, standards, and national model code compliance, have been addressed, as evidenced by the worldwide acceptance of PEX for use in potable-water systems.

Safe Drinking Water & Protection from Harmful Chemicals

Since its introduction in 1968 by Dr. Thomas Engel, PEX has become a trusted, proven, and reliable piping system for new construction and renovation projects. PEX has been used in potable-plumbing systems throughout Europe since the early 1970s and in North America beginning in the mid-1990s. The product meets stringent safety and chemical standards, promoting clean and reliable water delivery.

Assertions about contamination or health risks are unsubstantiated and counter to evidence from scientific research.

- **Certified Safe:** PEX is manufactured and tested to NSF/ANSI/CAN 61, *Drinking Water System Components – Health Effects*, which establishes minimum requirements for chemical contaminants and impurities indirectly imparted to drinking water from products, components, and materials used in drinking water systems. This standard tests for thousands of chemicals to ensure the safety of PEX for potable-water systems. In fact, according to a case study on the Environmental and Economic Life Cycle Assessment of PEX and Copper Plumbing Systems in the *Journal of Cleaner Production*, "Switching from copper piping to PEX piping improves human health impact substantially; human health (cancer) for 99% and human health (noncancer) for 42%."[1]

- **Meets Fire Safety Standards:** PEX undergoes more fire testing than copper pipe, including ASTM E84 (plenum applications), ASTM E814 (firestop systems), and ASTM E119 (fire-rated assemblies). This testing proves PEX meets all applicable fire safety requirements and is a safe choice for plumbing systems. Unlike soldering copper, which requires torches, open flame, and fire-watch requirements, PEX relies on a simple, secure fitting technology to create reliable connections that are designed and manufactured to last. This eliminates fire risks, chemical exposure, and the need for a dedicated fire guard.

- **No Reformulations:** Claims have been made that PEX is reformulated every few years because of the pipe's chemicals leaching into the water supply. Such claims are baseless and categorically false. There are currently three methods for manufacturing PEX, categorized in the industry as PEX-a, PEX-b, and PEX-c. PEX-a uses a hot crosslinking process with peroxide to generate piping crosslinked to 80% or more. PEX-b uses the silane process to generate piping that is 65 to 70% crosslinked, and PEX-c uses the radiation method to create 70 to 75% crosslinked pipe. The higher the crosslinking, the more flexible and durable the pipe. PEX-a has maintained the same core material composition for over 50 years, which is high-density polyethylene (HDPE), peroxide, and stabilizer. This composition has performed reliably, and there has been no evidence of safety issues requiring reformulation. Concerns about the safety of copper piping, however, are evident as the EPA created the Lead and Copper Rule.[2,3] No such rule has been created for PEX.

- **Sanitization Compliance:** Section 610 of the International Plumbing Code requires a plumbing system to be "filled with a water/chlorine solution containing not less than 50 parts per million (50 mg/L) of chlorine, and the system or part thereof shall be valved off and allowed to stand for 24 hours; or the system or part thereof shall be filled with a water/chlorine solution containing not less than 200 parts per million (200 mg/L) of chlorine and allowed to stand for 3 hours."[4] This requirement does not pose any problems for PEX. Additionally, depending on the manufacturer, some PEX pipes have a hydrostatic temperature rating of 200°F at 80 psi. Claims that PEX cannot

be flushed with chlorine or high-temperature water to remove legionella are false. PEX can be sanitized, similar to copper.

- **International Acceptance:** PEX is included in the International Code Council (ICC) family of codes, which is one of many national and international model codes that accept PEX. These codes are developed using multiple nationally recognized standards, and the products are then third-party certified to these standards. The development of a plumbing code is a rigorous task that takes place over many years. The fact that PEX has been included in the ICC family of model codes (specifically, the International Residential Code and the International Plumbing Code) since 1997 demonstrates a proven track record of being a safe and reliable plumbing product.
- **Microplastics:** In the current market, there are two types of plastic products — durable and disposable. Both must be considered when taking into account microplastics and their contamination into drinking water. Plastic piping systems are considered durable piping products. According to the Plastics Pipe Institute (PPI), durable plastic products (i.e., those that do not wear in their intended application) are not considered significant contributors of microplastics during their service life.[5] Copper piping is corrosive and deposits small copper particles into the water supply, which can be ingested and poses a serious threat to human health with overconsumption.[6]
- **Copper Concerns:** In 1974, Congress passed the Safe Water Drinking Act, which determines safe levels of chemicals in drinking water through Maximum Contaminant Level Goals (MCLGs). The MCLG for copper is 1.3 ppm, as the EPA deems exposure above the MCLG causes negative health effects.[7] Ingestion of levels of copper above the MCLG is toxic and dangerous, and there were enough substantial cases to cause the EPA to set an actionable limit for copper in drinking water. One would assume the EPA would set similar regulations on PEX if there were substantiated cases where PEX leached chemicals into the water supply. Such has not been the case. Copper is specifically called out by the EPA in 40 CFR 141.80 and 141.86 with limits on allowable copper in drinking water due to its potential toxicity and leaching issues. Copper is known to corrode over time and is a main source of copper particles entering the food and water we consume.[6,7] Exposure to excess copper results in copper poisoning, which poses serious health risks, including gastrointestinal distress and, over time, anemia as well as disruption to the liver and kidneys.[6,7]

The Safe Water Drinking Act determines safe levels of chemicals in drinking water through Maximum Contaminant Level Goals (MCLGs). The MCLG for copper is 1.3 parts per million. There is no MCLG regulation for PEX.

Labor and Installation

According to the previously referenced case study in the *Journal of Cleaner Production*, PEX took half the time to install compared to copper and offered a labor savings of $12,364.88 over copper. The study also found PEX usage resulted in an overall savings of $109,711 compared to copper.[1] This and other independent industry tests confirm the efficiency, installation ease, and material savings of PEX over copper.

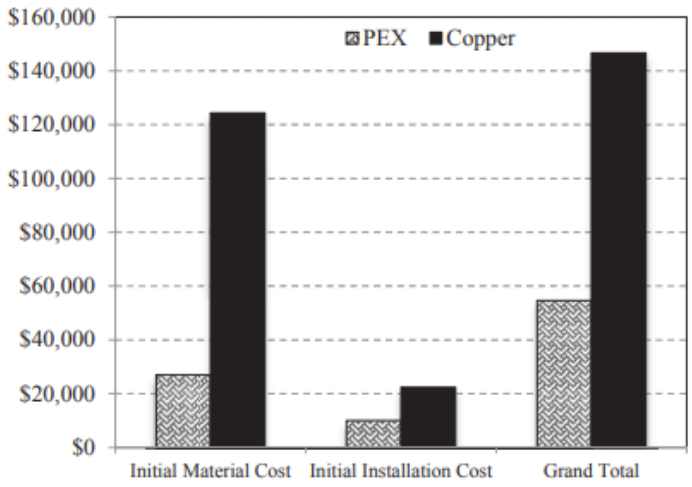

Figure 1: PEX and Copper Labor and Installation Costs Comparison (source: Journal of Cleaner Production)

- **Proven Labor Savings:** Verified by the Mechanical Contractors Association of America (MCAA), the gold standard for industry labor data.
- **Case Studies:** Real-world installations, including major commercial projects, document significant reductions in labor time and cost. Metropolitan Mechanical Contractors (MMC) of Eden Prairie, Minn., found that PEX piping for the risers and the unit piping in a new hotel saved crews about two to three days of installation per floor. On a 13-story project with 50 units per floor, that adds up to almost a month of installation time savings.[8] Copper piping takes longer to install and results in additional labor costs compared to PEX. Major cities around the world have successfully adopted PEX piping into their plumbing codes. In fact, only New York City and Chicago are the two remaining areas in North America that do not allow PEX for plumbing.

  Below (and on the following page) are several examples of commercial high-rise projects that included PEX for their plumbing systems. Note that this is a brief list of projects. There are numerous high-rise projects with PEX piping installed throughout North America.

  - 99 Hudson, Jersey City, NJ; 79 stories, completed 2020
  - 321 West Sixth Street, Austin, TX; 58 stories, completed 2025
  - Auberge on the Park, Toronto, ON; three towers, 29, 39, and 45 stories, completed 2024
  - Journal Squared, Jersey City, NJ; three towers, 54, 60, and 68 stories, completed 2024
  - Loring Park Tower, Minneapolis, MN; 36 stories, completed 2014

- Lumina, San Francisco, CA; 42 stories, completed 2015
- Pinnacle on the Park, San Diego, CA; 46 stories, completed 2015
- SkyHouse Apartments, Austin, TX; 23 stories, completed 2014

- **Flexibility and Efficiency:** PEX can bend to change direction in a piping system, requiring fewer fittings to streamline installation. Copper piping is rigid and requires a fitting with each change in direction, requiring longer installation times compared to PEX.[1]
- **Proper Installation Promotes Security:** Claims have been made that chemicals from the external ambient environment surrounding plastic pipes leach into the pipes because they are permeable. Risk is low since the pipes are installed inside of buildings. Additionally, PEX manufacturers advise proper installation and protection of the pipe to prevent against leaching. Further, this is a baseless concern given the fact that buildings should not contain harmful chemicals.
- **Copper Installation Challenges:** Copper piping requires additional soldering, specialized labor, and corrosion-prevention measures, increasing complexity and costs. The connection process for PEX is simple, efficient, and eliminates open flame and fire-watch requirements. Plus, PEX is naturally corrosion-resistant, eliminating the need for costly, labor-intensive corrosion-prevention measures.

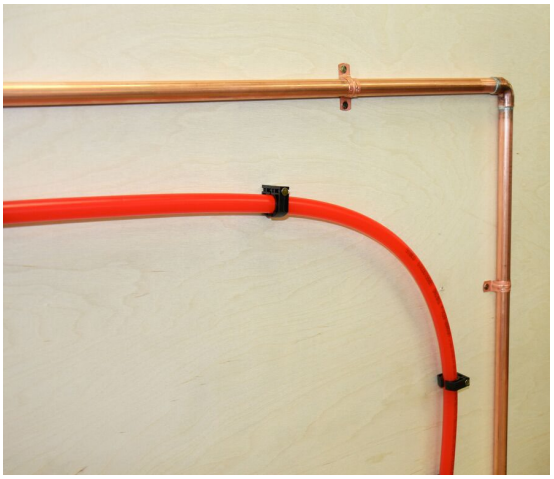

Figure 2: PEX Flexibility

Figure 3: Copper Corrosion

Sustainability of PEX

PEX offers several environmental benefits, and lifecycle assessments (LCAs) reveal its advantages over copper.

- **Lower Environmental Impact:** Studies indicate the carbon footprint of PEX is lower than copper when considering material extraction, processing, and installation. For example, according to the *Journal of Cleaner Production*, "...energy and global warming potential reductions for PEX piping compared to copper piping (average for copper pipes types K, L and M) are 44% and 64%."[1] Additionally, the *Journal of Cleaner Production* further states that "acidification potential, water intake, criteria air pollutants, smog formation potential, ozone depletion potential, ecological toxicity, and habitat alteration categories improve from 21% to 85% by electing PEX pipes over copper."[1] Furthermore, on a global level, a series of independent studies by the Flemish Institute for Technological Research (VITO) measured the environmental footprint of various types of polymer pipes based on a full lifecycle assessment. The results proved PEX pipe manufacturing processes require less production energy than alternative materials.[9]
- **Recyclability:** PEX is recyclable through specialized processes. In fact, a partnership between four corporations — Neste, Borealis, Uponor, and Wastewise — began an initiative aimed at the chemical recycling of PEX waste from pipe production operations into feedstock for new PEX pipe production.[10]
- **Resiliency in Freeze/Thaw Cycles:** PPI Technical Report TR-52 proves the exceptional resiliency of PEX pipe in freeze/thaw cycles. This flexibility and resilient strength help reduce the risk of system damage, repipes, and unnecessary product waste.[11]
- **Copper Drawbacks:** While copper is recyclable, its mining process is resource-intensive and contributes to significant environmental degradation while also resulting in generations of significantly more greenhouse gas emissions than PEX.[1] Additionally, the rigid nature of copper makes it susceptible to damage in freeze/thaw cycles, adding to repipes and product waste.

Figure 4: Copper Mining Effects

Other Facts and Clarifications

Misinformation about PEX is often based on isolated cases or misinterpretations of policies. Below are key clarifications:

- **Limited Copper:** Copper is a limited resource and should be reserved for other applications, such as electrical grids, where alternatives are not available. PEX, on the other hand, is not a limited resource. This fact also makes PEX a safer alternative on construction jobsites. The risk of copper theft on jobsites is high, posing time and cost challenges for projects trying to meet construction schedules and tight budgets. With PEX, there is no concern about theft as well as the damage that often accompanies break ins on a jobsite.
- **Insurance Concerns:** Claims that most insurance companies in Florida do not insure homes with plastic piping are false and unsubstantiated. Certain insurers (typically smaller) that provide insurance in Florida have, in the past, stated they will not insure a building if specific plastic pipes are installed. However, this is not a representation of the majority of insurers. Additionally, it is common for insurance underwriters to narrow allowable coverages in the state of Florida, for example, due to hurricane prevalence.
- **Rodent Resistance:** While rodents may chew through plastic, they also damage copper wiring, which poses a greater fire risk. Proper pest control is essential regardless of piping material. All materials, except the hardest metals, concrete, and stone, are susceptible to damage from rodents.[12]
- **NYC Support:** Even though New York City has yet to add PEX to its plumbing code, recent city legislation regarding Accessory Dwelling Units (ADUs) utilized the New York State Plumbing Code, which supports the use of PEX piping as a safe and reliable plumbing solution. The legislation, as presented, received no opposition from any city agencies on record.
- **Copper Toxicity:** The EPA has set an action level for copper in the Lead and Copper Rule [40 CFR Part 141.80(c)(2)], confirming the need for monitoring due to potential health risks from leaching. PEX is not corrosive and does not require monitoring for potential health risks.
- **Copper Corrosion and Failures:** Copper pipes are susceptible to pinhole leaks and corrosion, particularly in aggressive water conditions. These issues can lead to costly repairs as well as water contamination that poses significant health risks if not addressed properly.[6,7]
- **The History of Plumbing:** For decades, lead pipes were considered safe for drinking water until research proved otherwise. Then, the industry moved to copper, asserting its safety over lead. However, in reviewing the Lead and Copper Rule from the EPA, it appears copper piping has similar defects as lead piping and can potentially be just as dangerous. It is imperative the industry adopts safe options for piping materials as new research reveals copper poisoning and the serious health risks associated with it.

Conclusion

PEX is a safe, reliable, and sustainable piping solution that meets and exceeds industry standards for plumbing systems in communities around the globe. Claims against it are often misleading or unsupported by factual evidence. The reliability, safety, and installation efficiencies associated with PEX make it a superior plumbing product for any construction project, and its use will continue to expand as the residential and commercial construction industry discovers the consistent high performance, low environmental impact, and reliable longevity of this efficient solution.

Figure 5: Coil of PEX Pipe

References

[1] Environmental and Economic Life Cycle Assessment of PEX and Copper Plumbing Systems: A case study

[2] https://www.epa.gov/dwreginfo/lead-and-copper-rule

[3] About Lead and Copper – Utah Department of Environmental Quality

[4] https://codes.iccsafe.org/content/IPC2021P3/chapter-6-water-supply-and-distribution#IPC2021P3_Ch06_Sec610

[5] PPI STATEMENT AB -2023 – Microplastics and Plastic Piping for Potable Water

[6] Washington State Department of Health – Copper in Drinking Water

[7] EPA Archived Consumer Factsheet on Copper

[8] Metropolitan Mechanical Contractors Cuts Installation Time in Half with Uponor's PEX Pipe - MCAA

[9] https://www.teppfa.eu/sustainability/responsible-consumption-and-production/environmental-footprint/

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[12] PPI TR-11-2023 - Resistance of Thermoplastic Piping Materials To Micro- And Macro-Biological Attack

About the Authors and Contributors

David Nickelson

With 25 years of engineering expertise and a concentration on codes, standards, and compliance in the PEX piping industry, David Nickelson is a highly respected professional on local, national, and international regulatory requirements for plumbing and HVAC systems. As the codes manager at GF Building Flow Solutions, David ensures products and systems adhere to relevant industry and regulatory standards to promote safety, quality, and consistency while also upholding the reputation of PEX as a durable, reliable, and sustainable solution for plumbing, heating, and cooling systems. His industry affiliations include chair of the ASTM E60.13 subcommittee on Sustainable Manufacturing, vice chair of ASTM E60.21 on Sustainable Terminology, vice chair of the Plastic Pipe and Fittings Association (PPFA) Technical Committee and member of the Code Policy Committee, member of the PPFA Publications Task Force for Polyolefins PLC, Fire Sprinkler PLC, and Technical Committee PLC, member of the Technical Committee for the National Fire Protection Association (NFPA) 13D and 13R, member of the International Code Council (ICC) International Plumbing Code Technical Committee for the 2027 code cycle, and he is assigned to his local jurisdiction's Board of Code Appeals in Winchester, VA. In 2017, David was recognized with the prestigious Plastics Pipe Institute (PPI) Building and Construction Division's Member of the Year Award. He has a Bachelor of Science in Mechanical Engineering from Pensacola Christian College and is a Certified Fire Protection Specialist (CFPS) through the NFPA.

Kate Olinger

With more than 20 years of experience in the water industry, Kate Olinger is a driven, dedicated professional with a background in process engineering, new product development, product management, and project management. In her current role, she oversees industry relations and regulatory affairs to support the North American business for GF Building Flow Solutions. Kate plays a key role in bringing together internal strategies, external affairs, and industry organizations to advance key initiatives and achieve company goals. With her decades of knowledge, she skillfully advocates on behalf of the company as well as the plumbing and HVAC industry, serving as an expert to both internal and external entities on a variety of key social and governmental issues that allow GF Building Flow Solutions to conduct business throughout North America. She has a Bachelor of Science in Chemical Engineering from the University of Minnesota – Twin Cities and is a board member of the Plastic Pipe and Fittings Association (PPFA) as well as a board member and treasurer of the Plastics Pipe Institute (PPI).

Kim Bliss

Kim Bliss is the manager of technical and marketing content at GF Building Flow Solutions. She holds more than 30 years of published writing, editing, and content development experience with a focus in the manufacturing and trades industries. She has contributed to several published white papers, including *Centralized Plants with Decentralized Solutions* and *Leveraging Radiant and Hydronics to Help Achieve Decarbonization Goals*. Her articles can be found in various trade publications, including *Consulting-Specifying Engineer*, *Plumbing & Mechanical*, *PM Engineer*, *Plumber*, *Contractor*, *Mechanical Hub*, and more. She holds a Bachelor of Arts in Journalism from California State University, Sacramento.

Alex Gross

As the marketing specialist at GF Building Flow Solutions, Alex Gross is passionate about crafting compelling, informative content to generate awareness and drive subsequent understanding and appreciation about products, systems, and solutions for the plumbing, heating, and cooling industries. From marketing literature to digital content to technical materials, Alex leverages a wide breadth of subject matter for positive impact and maximum exposure. A graduate of Metropolitan State University in St. Paul, Minn., Alex has a Bachelor of Arts degree in Public Relations/Image Management.