

Plumbing Contractor News

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Not All Plastic Plumbing Systems Perform The Same Oxidation Reduction Potential (ORP) and Effects of Disinfectants Vary by Product Type to Alter Long-Term Performance and Reliability

In the plumbing wars, many people generically consider the choice to be between copper and plastic. But plastic is a broad category, consisting of many different products, each with its own chemical properties, strengths and weaknesses.

There are two primary families of plastics used in the plumbing industry today—vinyl based, which includes PVC and CPVC, and polyolefin, which includes polyethylene, polybutylene, cross-linked polyethylene (PEX), and polypropylene. In the same way that stainless steel is different than copper, so is vinyl very different from polyolefin.

PVC and CPVC have been used successfully in the American plumbing industry for more than 40 years in a variety of applications, including potable water service supply, DWV, hot and cold water distribution and irrigation.



This polybutylene pipe looks fine on the outside despite the internal decay and flaking.

During that same time period, plumbing products made from two different types of polyolefins have experienced massive failures that have led to class action lawsuits and, ultimately, termination of their use in certain applications.

One is polybutylene (PB), which had been used in hot and cold water distribution, and the other is polypropylene, which had been used as the dip tube in hot water heaters. Neither material is used in these applications any longer. A more recent entrée into the U.S. plumbing industry is cross-linked polyethylene (PEX).

Few people in the industry can forget the nearly billion-dollar polybutylene pipe failures back in the 1980s. At that time, the only thing that saved many contractors from being financially devastated by the polybutylene crisis was the fact that the primary polybutylene manufacturer was Shell, which had pockets deep enough to cover the damages and related replacements costs. Today, however, few polyolefin manufacturers have those types of resources to save contractors from financial liability. So it's important to choose your materials wisely and understand possible vulnerabilities.

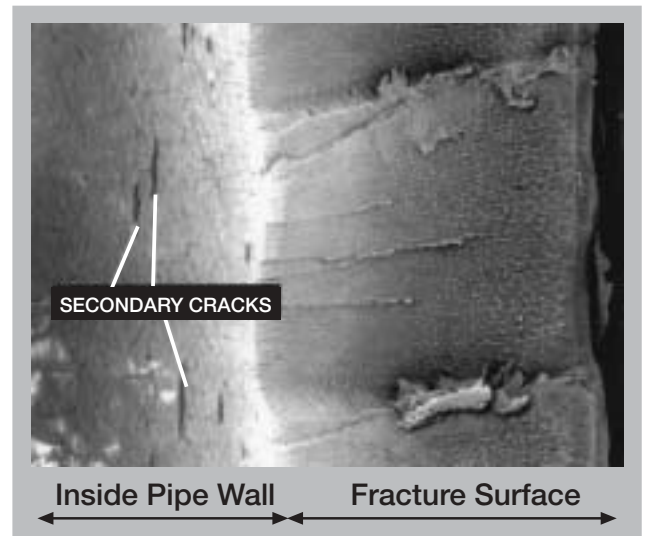
Evaluating Long-Term Performance and the Effects of Disinfectants

When evaluating the various plastics, a critical consideration is the long-term performance and reliability of the product, since no one likes callbacks resulting from a system that has failed prematurely.

Today, there is a focused interest in the effects of various types of water disinfectants on the long-term performance of plumbing products. Municipal water disinfectant additives, such as chlorine, ozone and chloramines, increase the Oxidation Reduction Potential (ORP) of the water. ORP is a measure of both the pH and the disinfectant level of water. Water with high ORP values has been proven to reduce the oxidative stability of certain plastic materials.

Studies show that not all plastics stand up as well to oxidative degradation over the long term. Polyolefin failure, for example, has been directly correlated to the ORP of the water supply.

Manufacturers of some of the polyolefins, including PEX, incorporate antioxidants into their final compound to offset their natural tendency to undergo oxidative degradation. The antioxidants function sacrificially as a shield, being preferentially attacked and destroyed by chlorine in the water before the polyolefin is attacked. Eventually, chlorine, which is used in all municipal water supplies as a primary disinfectant, consumes these antioxidants, leaving nothing to protect the polyolefin. When the antioxidant is consumed, the polymer itself will be attacked with resulting polymer chain breakage, ensuing loss of strength and brittleness, and ultimately premature mechanical failure.



Fracture surface of a polyethylene specimen exposed at 80°C to 3 ppm chlorine at 2.57 MPa. The pipe failed after 1 017 h (brittle). On the inside of the pipe wall secondary cracks can clearly be seen.

It was this embrittlement of the pipe itself, and not the failure of the fittings (as was commonly believed back in the 1980s) that caused the problems with polybutylene plumbing systems. Similarly, the chlorine oxidized the

polyolefin material, polypropylene, used in the water heater dip tube mishap. In contrast, CPVC pipe and fitting compounds like those used in FlowGuard Gold CPVC plumbing systems are inherently resistant to oxidative degradation. CPVC itself is over 60% chlorine, and the chlorine on the polymer chain protects it from further attack by disinfectants. In fact, as the end use performance and chemical resistance characteristics demonstrate, the additives used to disinfect municipal water treatment systems have no negative effect on CPVC materials.

Even at elevated concentrations, CPVC compounds are not negatively affected by contact with chemicals customarily used in municipal water treatment. This is important to note since municipal treatment plants do not chlorinate evenly throughout the year. During the hot summer months, for instance, many municipalities chlorinate more heavily to offset microorganisms and bacteria that are more likely to grow in that environment. If you have city water, you can actually taste the difference in the summer, as many water supplies take on a stronger chlorine taste. That's why in-depth lab tests have gone far beyond concentrations ever found in treated municipal water to prove the resilience of CPVC which has, in fact, been conveying high ORP water in the U.S. for more than 40 years.

Comparing Track Records

One of the biggest differences between CPVC and PEX pipes is in the area of longevity and proven performance.

As was stated before, CPVC has been around since the 1960s, so there have been 40 years of testing to determine the influence of different chemical environments on the long-term performance of CPVC pipes and fittings. Many of the early systems are still functioning today without any sign of wear. During this 40-year-time span, numerous chemical resistance tests have been conducted under both static and stressed conditions to determine performance.

In addition to its proven performance in residential and light commercial applications, CPVC materials have been commonly used in industrial fluid handling applications at much higher concentrations than the levels found in municipal drinking water.

Corzan™ CPVC industrial pipes and fittings, the industrial counterparts of FlowGuard Gold CPVC plumbing systems for residential and commercial use, have handled extremely high concentrations of disinfectants, including fluids consisting of 12% sodium hypochlorite (industrial-strength bleach) and industrial chlorine water with thousands of ppm of chlorine (drinking water contains chlorine at less than 5 ppm). Such real-life field tests prove that CPVC resins and compounds can withstand extremely high oxidation reduction potentials regularly and over long periods of time.

PEX, on the other hand, is a relative newcomer to the American plumbing scene. Introduced into the U.S. in the mid 1990s, much of its field application has been in Europe, where water supplies are generally treated with much lower concentrations of disinfectants than in the U.S.

It should be noted, however, that PEX has seemingly been used safely in radiant heating in the U.S. The difference is that radiant heating is a closed loop system, which means the chlorine is introduced only one time when the system is filled and is quickly consumed as the water is recirculated around the system. In plumbing applications, fresh chlorine is reintroduced continuously, so it's difficult to draw a valuable comparison between the two applications.

It's also important to note that there are many different manufacturers of polyolefin-based plumbing products in the U.S. today. Some have recognized the weaknesses of PEX and have attempted to incorporate safeguards. So if choosing a polyolefin such as PEX, always remember to check the background of the manufacturer and find out what, if any, manufacturing modifications have been made to allow for ORP and the long-term effects of chlorine on the system.

To learn about alternative plumbing materials, visit www.flowguardgold.com.