CASE STUDY

Corzan®
MATERIAL & PIPING SOLUTIONS

PRECISELY ENGINEERED. REAL WORLD TESTED.

The Potential Health Hazard of PP-R Pipe Degradation in Potable Water Delivery System

Chlorine and chloramine, commonly used disinfectants in U.S. municipal drinking water systems, are known to degrade polyolefin-based piping materials.

This includes frequently used polypropylene (PP) products such as polypropylene random copolymer (PP-R) and polypropylene random copolymer with modified crystallinity and temperature resistance (PP-RCT).

Chlorine dioxide (ClO_2), sometimes used to treat water on site, is another chemical that can degrade PP-based materials. In fact, some PP-RCT manufacturers state not to use it at all in systems where ClO_2 is present.

Nonetheless, PP-R and PP-RCT are approved for use in all model plumbing and mechanical codes for various applications, including potable water delivery. How is that possible given the degradation issues outlined above?

Sacrificial Antioxidants and PP-Based Piping

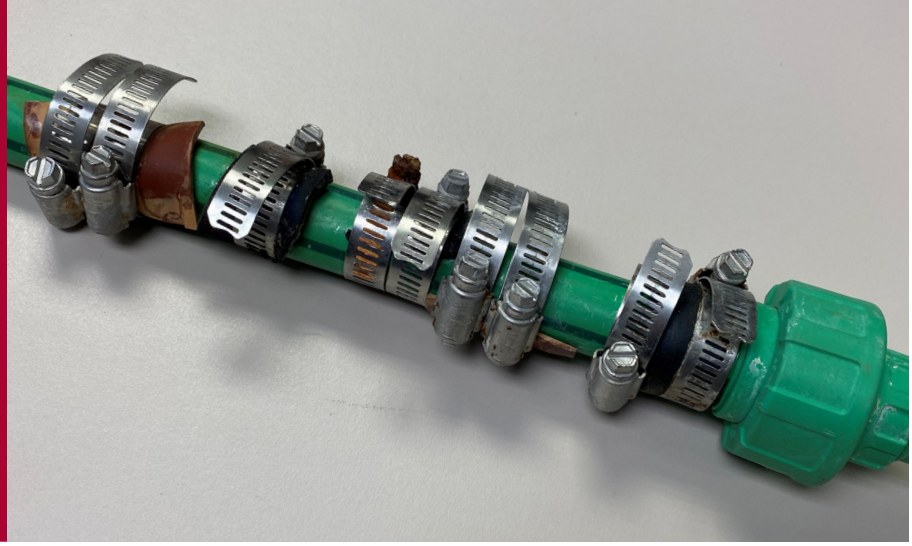
To protect from the damaging effects of oft-used drinking water disinfectants, PP-R and PP-RCT manufacturers add sacrificial antioxidants to their pipes that prevent material degradation. And those antioxidants do provide adequate support.

However, as the term *sacrificial* suggests, the antioxidants aren't intended to last forever and tend to wear off over time. As they do, the pipes become increasingly susceptible to degradation — at varying rates — amid the presence of the chemicals mentioned above. Put simply, the more chlorine, chloramine, or ClO_2 in a system, the faster the rate at which PP-based materials can decay. In practice, this often results in spot maintenance such as patching or section replacement within a system. Alternatively, engineers may suggest a full system replacement.

Real-World Tested

For a multi-family residential complex in southern California, engineers and site managers chose Corzan® Material and Piping Solutions for a re-piping job of the site's existing PP-R piping material. The PP-R potable water delivery system had become heavily degraded in several sections during its 10-year in-service life.

The site's pipes underwent patchwork for years until they deteriorated to the point where a full-building re-pipe became necessary. In contrast to PP-R piping, CPVC materials such as Corzan piping are considered naturally resistant to chlorine, chloramine, and ClO_2.



Hidden Implications?

It's a common reality: PP-R and PP-RCT pipes are known to break down as anti-oxidants wear off amid commonly used drinking water disinfectants. Industry professionals know this and accept it. But a recent case study suggests a lesser-seen concern.

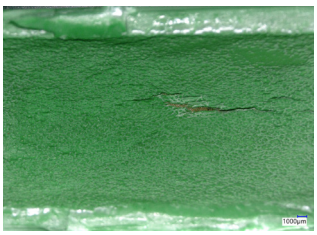
Background

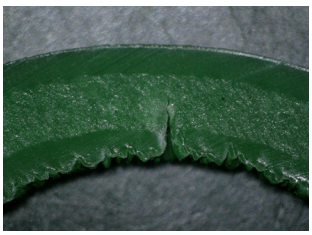
In 2023, a multi-family residential complex in southern California selected Corzan® CPVC piping and materials for a re-piping job of the site's existing potable water delivery system. Engineers and site managers chose Corzan CPVC to replace the system's existing PP-R piping material, which had become heavily degraded in several sections during its 10-year in-service life.

Suspecting that the existing PP-R system's mode of failure may have been chlorine- or chloramine-induced, we collected both cold- and hot-water pipe samples and water samples from the site to investigate.

The Findings

The pipe samples all showed tell-tale signs of degradation, with rough edges, cracking, and green sludge visible to the naked eye.





This section of 2-inch pipe recovered from the site is visibly degraded. When new, PP-R pipes are smooth inside and out. However, this pipe's interior had become ridged, with deep cracks nearly extending to its exterior.

Lab analysis of the water samples (post transition to Corzan CPVC piping) also confirmed the presence of chlorine and chloramine in the system supply, consistent with the type of degradation observed.

Presence of Chlorine and Chloramine in Water Supply System

When *tested, the water on site fell within the EPA's' requirement of no more than 4.0 mg/L. However, even under these circumstances the pipe degraded beyond the point of failure.

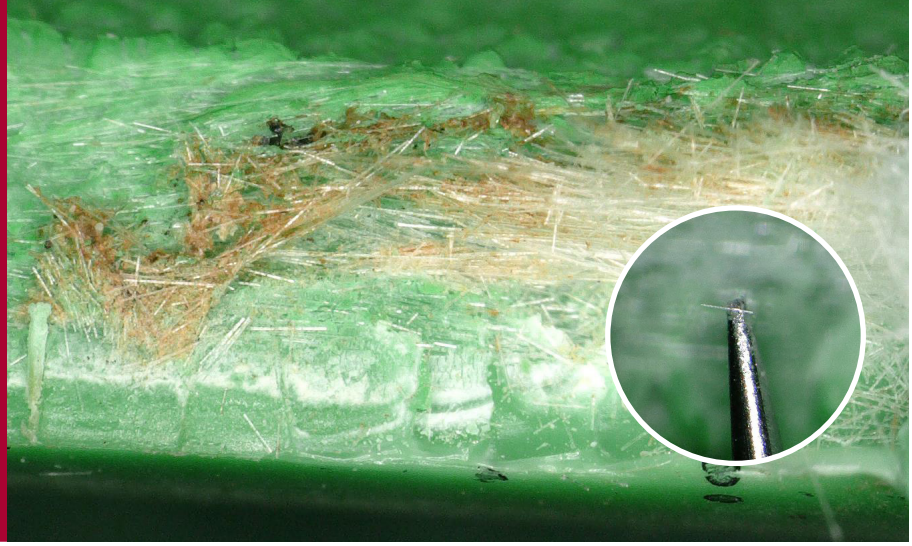
Water Heater	Result	RDL	MDL	Units
pH (at Site, grab)	6.7	1.0	1.0	pH Units
Chlorine Dioxide	ND	0.10	0.10	mg/L
Chlorine Residual (Total) at site	0.76	0.10	0.10	mg/L
Chlorine Residual (Total)	1.1	0.10	0.017	mg/L
Chlorine Residual (Free)	0.032	0.10	0.027	mg/L
Chloramine as Cl2	1.0	0.10	0.069	mg/L*
Copper	150	5.0	3.3	ug/L

Restroom Sink	Result	RDL	MDL	Units
pH (at Site, grab)	6.5	1.0	1.0	pH Units
Chlorine Dioxide	ND	0.10	0.10	mg/L
Chlorine Residual (Total) at site	2.1	0.10	0.10	mg/L
Chlorine Residual (Total)	2.1	0.20	0.035	mg/L
Chlorine Residual (Free)	0.042	0.10	0.027	mg/L
Chloramine as Cl2	1.0	0.10	0.069	mg/L*
Copper	26	5.0	3.3	ug/L

Backflow	Result	RDL	MDL	Units
pH (at Site, grab)	6.6	1.0	1.0	pH Units
Chlorine Dioxide	ND	0.10	0.10	mg/L
Chlorine Residual (Total) at site	2.2	0.10	0.10	mg/L
Chlorine Residual (Total)	2.2	0.20	0.035	mg/L
Chlorine Residual (Free)	0.093	0.10	0.027	mg/L
Chloramine as Cl2	0.98	0.10	0.069	mg/L*
Copper	48	5.0	3.3	ug/L

*Babcock Laboratories in October 2023.

Microscopic magnification revealed an abundance of loose glass fibers protruding from the sample interiors. The fibers were loose enough that scientists could easily shuffle them around and pull them out by poking and prodding in the cracks with a dental probe.



A Closer Look

To further investigate, our scientists placed the samples under a microscope. Focusing attention on several large cracks, magnification revealed an abundance of loose glass fibers protruding from the sample interiors.

The fibers, typically added to PP-R and PP-RCT composites as a cost-effective means of reinforcing a pipe's dimensional stability, were loose enough that scientists could easily shuffle them around and pull them out by poking and prodding in the cracks with a dental probe.

What Might These Findings Suggest?

Consider that these pipes delivered drinking water to the site's residents for a decade. Although the pipes didn't display visible signs of degradation on the outside until recent years, degradation could have begun internally much earlier.

If this were the case and considering that our scientists could easil move and release loose fibers, then it's possible the fibers could have entered the site's drinking water supply during a relatively long period of time — a concerning prospect.

Our View

In fairness, it's possible that this case is an isolated incident. It's important to acknowledge that each drinking water system is unique, and various factors, such as water quality, disinfection practices, and operating conditions, contribute to variability in outcomes.

However, as the industry strives to ensure the safety and reliability of drinking water systems, it's crucial that we don't overlook lesser-seen examples such as these.

The findings presented here underscore the need for further investigation into the potential for degraded PP-based piping to release potentially harmful materials into drinking water systems.

If you want to learn more about how environmental variables can impact a piping system's material selection process, visit corzan.com.

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The Lubrizol Corporation, a Berkshire Hathaway company
9911 Brecksville Road ■ Cleveland, Ohio 44141-3201 USA
216.447.5330 ■ corzan@lubrizol.com

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