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Understand Chloramine's Effect on Elastomer Components

BY DONOVAN LARSON

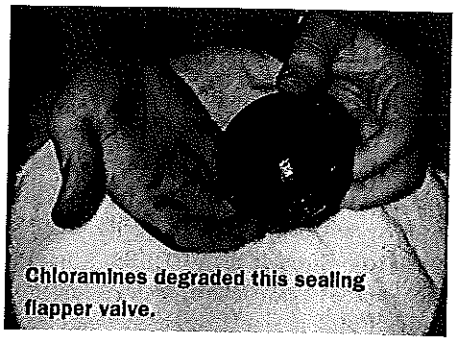
Chlorine compounds provide the disinfection component for most finished drinking water in the United States. But they can cause unintended disinfection by-products, which became a health concern several years ago. Subsequently, chloramines became the favored disinfectant because chloramines last longer in the distribution system and convert less organic material into unwanted chlorocarbons.

Like most good things, however, there can be a downside. Chlorine and chloramines attack most artificial and natural rubber or, more accurately, elastomers, which are a component of water system check valves, butterfly valves, gate valves, joint gaskets, and toilet-tank flaps. Although manufacturers study the effects of chlorine and chloramines on these devices, distribution system personnel must understand the choices manufacturers face. Purchase choices made today will dictate how long distribution systems hold up under the effect of chlorine compounds. Years after installation, a rubber check valve flap may lose its flexibility, or a rubber-faced gate valve may swell and delaminate.

INVESTIGATING CHLORAMINES

The staff of Louisville (Ky.) Water began studying these disinfection effects in the early 1990s. Rubber toilet flaps and other household gaskets were deteriorating rapidly in some water systems. And, as chloramine use increased, disintegration of rubber components accelerated.

The Water Research Foundation funded a study (Project 2932) at the University of Louisville (Ky.) to investigate the effect of chloramines on various rubber compounds used in the water supply industry. To study real-world applications, the researchers created aqueous environments—with higher temperature and chlorine concentration—that would degrade or break down certain elastomers, such as natural rubber, neoprene, nitrile, styrene butadiene rubber (SBR), and ethylene propylene diene monomer (EPDM).



Chloramines degraded this sealing flapper valve.

PHOTOGRAPH: DONOVAN LARSON

DEGRADATION DIFFERENCES

Degradation occurred primarily when the chloramine compound broke the elastomer's molecular bonds and oxidized the elastomer matrix. The matrix then swelled, allowing chloramine to penetrate farther into the matrix. Clearly, this process would be less destructive to a pipe gasket with a small surface area (relative to volume) exposed to chloramines than to an elastomer with a large exposed surface area (relative to volume).

Most importantly, the researchers discovered that different rubber compounds degraded at different rates and in different ways. Failure occurred through

- material swelling, which is important when clearance is a factor.
- loss of strain, which is important when continual flexing is necessary.
- loss of hardness, which is important when wear resistance is necessary.

Material Swelling. Swelling might cause a valve with an encapsulated gate to fail because of bonnet clearance. By far, the elastomer material most resistant to degradation over time was EPDM, followed (in order) by nitrile, SBR, natural rubber, and neoprene. The researchers concluded that peroxide-cured EPDM rubber (EPDM-P) was generally more stable than sulfur-cured (EPDM-S) rubber.

Loss of Strain. Strain reduction may cause a diaphragm that depends on flexibility to fail. The elastomer material most resistant to degradation was EPDM-P, followed by natural rubber and nitrile. Strain reduction over time was noticeably greater with SBR, neoprene, and EPDM-S.

Loss of Hardness. Loss of hardness may cause a flap-gate seal to fail. The elastomer material most resistant to degradation over time was natural rubber, followed by neoprene. Tests were inconclusive for EPDM-P, nitrile, SBR, and EPDM-S.

Generally, the hardness of an elastomer with a large mass relative to exposed surface area experiences less degradation, such as in a pipe gasket. This was validated in research reported in *Journal AWWA* (April 2004, page 153), where pipe gasket degradation in a 110 mg/L chloramine solution was found to be negligible.

CHOOSE PRODUCTS WISELY

Always be sure to specify and compare similar products made of different elastomeric materials. Many elastomer features affect product design; i.e., some curing procedures result in less functionality. In addition, more chloramine-resistant elastomers may be prohibitively expensive.

All elastomers aren't equal. That's why it's important to analyze the aqueous environment, determine the amount of surface exposure (relative to volume), and determine an elastomer's critical characteristics. Operators should be aware of the effects chloramines have on elastomers and think about costs and long-term usefulness of each water system component.