



## Corrosive Water Problems

F 137

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### The Problem

Corrosive water is a term used to describe “aggressive” water that can dissolve materials with which it comes in contact. While aggressive water is usually not dangerous to consume by itself, it can cause serious drinking water quality problems by dissolving metals from plumbing systems. Many homes have pipes, solders and/or plumbing fixtures made from copper, lead or other metals. Corrosive water can sometimes dissolve enough of these metals to create both aesthetic and health-related problems in drinking water. In certain cases, corrosion can be severe enough to cause leaks in the plumbing system.

Corrosive water can dissolve high concentrations of copper from pipes and fixtures. Copper can cause bluish-green stains in sinks and a metallic taste to water, especially with water in contact with pipes for several hours (overnight). Corrosive water can also dissolve lead from solders joining copper pipes or occasionally from lead pipes. Lead was a common component of solders used in plumbing systems until it was banned in 1991. If your home was built prior to 1991 and has a metal plumbing system, it is likely that some lead is present. Lead can cause many health effects in adults and children (see *Drinking Water Standards*). Lead is harmful at concentrations in water that can only be detected by water testing. A recent survey of private water systems in Pennsylvania found that about 20% contained dangerous amounts of dissolved lead.

While most corrosive water problems occur with metal plumbing systems, corrosion of plastic PVC plumbing components is also possible resulting in dangerous amounts of vinyl chloride in drinking water. This usually only occurs when inferior plastic pipe that was not approved for drinking water systems has been used. Approved plastic pipe is directly

stamped with a “NSF” (National Sanitation Foundation) seal on the side.

Approximately 60% of the wells, springs and cisterns serving individual homes in Pennsylvania have corrosive water. Corrosive water tends to be most common in northern and western Pennsylvania where more acidic groundwater is prevalent although areas underlain by Triassic shales in southeastern Pennsylvania also produce corrosive water. It is least common in the agricultural valleys underlain by limestone but the sandstone ridges between these valleys often yield corrosive water. Cistern water can also be quite corrosive unless it is stored in an unlined masonry cistern.

### Detecting Corrosive Water Problems

In some cases, it may be obvious that you have corrosive water based upon symptoms exhibited by your water. You may notice the telltale bluish-green stains in your sinks, metallic taste of the first water out of the tap, or small leaks in your metal plumbing components. In addition to these symptoms, water testing can be used to measure the level of corrosivity of your water and to determine if metals like copper and lead are above recommended or health-related standards.

#### Symptoms of Corrosive Water

- \* **Bluish-green stains in sinks**
- \* **Metallic taste to water, especially first water in the morning**
- \* **Small leaks in plumbing system**

Many characteristics of water determine its corrosivity including pH, calcium concentration, hardness, dissolved solids content and temperature. Water that is soft and acidic (pH < 7.0) tends to be more corrosive but the generally accepted measures of water corrosivity are the stability or saturation indices. These indices use chemical characteristics of the water, such as hardness and pH, to estimate the corrosiveness of the water. The Langelier Saturation Index (LSI) is the most common and the index for which there is a secondary drinking water standard. Negative values of the LSI indicate corrosive water while positive results indicate non-corrosive water. Another common index is the Ryzner Stability Index or RSI. A RSI greater than about 6.5 indicates water that is probably corrosive with higher values being increasingly corrosive.

An alternative to measuring corrosivity is to test directly for products of corrosive water such as lead and/or copper. Unlike testing for most water pollutants, testing water for lead and copper is normally accomplished by collecting the first water out of the drinking water tap in the morning (also known as the “first-draw” water). Copper and lead concentrations are usually highest in the first water out of the tap since this water has been in contact with the plumbing for a longer time. Metals concentrations from corrosion will decrease as water is flushed through the plumbing system. If this doesn’t happen, the source of the metals is most likely your well water itself.

Contact a certified commercial water-testing laboratory to arrange to have your water tested for corrosivity, copper, or lead. You can obtain a list of certified commercial water testing laboratories from your local Cooperative Extension office. Ask for Agricultural and Biological Engineering fact sheet number F-105 entitled *Where to Have Your Water Tested*. This list is also available on-line at [www.wqext.psu.edu](http://www.wqext.psu.edu).

## **Drinking Water Standards**

Because corrosive water is not a drinking water concern by itself, there is only a recommended or secondary drinking water standard that water be non-corrosive (i.e. the LSI should be greater than zero). However, the by-products of corrosion (principally copper and lead) do have drinking water standards. Copper has a secondary drinking water standard of 1.0 mg/L because it causes a bitter, metallic taste to water and a blue-green stain in sinks and bathtubs. Copper also has a primary drinking water standard of

1.3 mg/L because it may cause severe stomach cramps and intestinal illnesses at higher concentrations.

Lead is a more serious health concern in drinking water. It has a primary drinking water standard of 15 micrograms per liter (mg/L) or 15 parts per billion (ppb). Long-term exposure to lead concentrations in excess of the drinking water standard has been linked to many health effects in adults including cancer, stroke and high blood pressure. At even greater risk are children, whose rapidly growing bodies absorb lead more quickly and efficiently. Lead can cause premature birth, reduced birth weight, seizures, behavioral disorders, brain damage and lowered IQ in children.

For more detailed information on lead in drinking water consult Penn State Cooperative Extension Circular #416 *Lead in Drinking Water*. This free publication is available from any county extension office or on-line at <http://pubs.cas.psu.edu/FreePubs/ec416.html>

## **Solving Corrosive Water Problems**

Problems with corrosive water can be solved using a variety of approaches. These include replacement of plumbing system components, treating water to make it less corrosive, or reducing the products of corrosion such as lead and copper. Each approach has advantages and disadvantages that must be considered when solving a corrosive water problem.

### ***Plumbing System Replacement***

Since corrosive water attacks plumbing system components, one way to correct the problem is to install plumbing components that are resistant to corrosion. Most often this involves replacement of copper pipe or substandard plastic pipe with approved plastic PVC pipe. Approved plastic pipe is directly stamped with “NSF” (National Sanitation Foundation) and “Drinking Water” on the side.

### ***Water Treatment to Reduce Corrosivity***

Treatment units such as neutralizing filters or chemical feed systems can be installed to reduce water corrosivity by adding alkaline chemicals to the water. Since corrosion affects the entire plumbing system, these treatment devices are installed where the water enters the home to treat all of the household water (Point-of-Entry or POE).

Acid neutralizing filters are very simple water treatment units that are intended to increase pH and add calcium thereby decreasing corrosivity. They

consist of a tank filled with calcium carbonate (limestone) chips, marble chips, magnesium oxide, or other alkaline material. The acid neutralizing filter is usually installed after the pressure tank. Raw water flows through the tank and as it contacts the media, its pH is increased and corrosivity decreased. It is important to note that this process will increase the hardness of the water but this is necessary for proper corrosion control. Also, the resistance of the neutralizing material may lower water pressure.

Frequent maintenance is required for neutralizing filters. The tank must be routinely refilled with neutralizing material as it is dissolved. The rate of refilling can range from weeks to months depending on the raw water corrosivity, water use, and the type of neutralizing material. Backwashing is recommended to remove trapped particles and oxidized metals unless a sediment filter is installed ahead of the unit.

Corrosivity can also be treated by injecting a sodium hydroxide or soda ash solution using a chemical feed pump before the pressure tank. This treatment system is simple and inexpensive and it does not increase water hardness. Since the unit is installed ahead of the pressure tank, there is no reduction in water pressure that sometimes occurs with neutralizing filters. There is significant maintenance including filling solution tanks and maintaining the feed pump. Soda ash is preferred over sodium hydroxide because it is safer to handle. Sodium hydroxide is extremely caustic and must be handled using accepted safety practices.

### ***Reducing Metals Concentrations***

In many cases, water corrosivity is not severe enough to cause leaks in the plumbing but it does cause increases in copper and/or lead in the water. In this case, various options are available to reduce or eliminate the metals from the drinking water.

Since copper and lead normally accumulate in drinking water as the water sits in contact with the metal plumbing, the most simple and inexpensive solution is to flush your plumbing system by running the water for one minute before drinking the water. This draws fresh water from the pressure tank or well that has not had sufficient contact with the plumbing system to accumulate metals. Flushing is only necessary if the water has been in contact with the plumbing for at least one hour. If you choose this

method, you should collect a water sample after you have run the water for one minute and have it analyzed for copper and lead to insure that they are reduced to safe concentrations. You can conserve water by flushing the plumbing system in the morning and filling a container with drinking water for use during the day.

If excessive lead and copper persist after flushing, or if flushing is an undesirable method, there are numerous alternatives for reducing lead and copper in water. Unlike the neutralizing filters and chemical injection units discussed above that treat all of the water entering the home by preventing corrosion of metals, these units are smaller point-of use (POU) devices that remove the metals at individual taps. Distillation, reverse osmosis, and activated alumina filters are all acceptable methods but they will generally only treat enough water for drinking and cooking during the day. Granular activated carbon filters are not recommended for copper and lead removal. An excellent discussion of the relative merits of some of these devices is contained in the January 1990 issue of *Consumer Reports* magazine.

### **For More Information**

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More information and details on all of the treatment methods available for reducing corrosivity or removing copper or lead are available from the NRAES-48 publication entitled *Home Water Treatment*. This 120-page publication is available for \$15 from the Penn State College of Agricultural Sciences, Publications Distribution Center at 814-865-6713.

For more discussion on the advantages and disadvantages of treatment equipment and for guidance on equipment selection, consult Agricultural and Biological fact sheet F-131 *Home Water Treatment in Perspective*. This free publication is available from your county Cooperative Extension office or on-line at [www.wqext.psu.edu](http://www.wqext.psu.edu).

## Additional Resources

For further information and resources on:

- Drinking Water Quality (see fact sheet
- F 101 *Drinking Water Publications from the Penn State College of Agricultural Sciences*)
- Groundwater Protection Watershed Monitoring & Control Systems

Please access:

Website: <http://wqext.psu.edu>  
Email: [mxh16@psu.edu](mailto:mxh16@psu.edu)  
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For more information about other Outreach Publications and Resources from the Department of Agricultural and Biological Engineering:

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