Blue Stains:

Copper Pipe Leaching and Proper Electrical Grounding

A Case Study from New Mexico

By Peter Ostwald

Summary: *Many residents experience blue staining that can affect the water quality from all sources within the home. Usually, the problem can be traced to incorrect grounding of electrical systems. This article provides steps in ensuring proper grounding as well as three case studies where similar problems were solved.*

If you have blue stains on porcelain fixtures or a crusty blue green addition to the edge of your faucets, you most likely have copper leaching from the pipes that are depositing on these surfaces. The water entering your home isn't the source of the problem, but only the carrier that makes it evident. Simply stated, blue stains are the copper pipes in your home slowly dissolving.

This can be as a result of:

1. Uniform corrosion—pitting or scouring—associated with water chemistry;
2. Microbially induced corrosion whereby certain bacteria or biofilms attack the piping;
3. Galvanic corrosion caused by dissimilar metals or alloy imperfections in materials used in the plumbing system;
4. Erosion corrosion from high flow rates and sizing of plumbing pipe that constricts flow, and/or
5. Improper grounding of electrical currents in the home.

The problem is that the cause isn't just a matter of electrical currents, the water source or plumbing—all three can be contributing factors. So neither hydrological, chemical or electrical engineers nor members of the plumbing community may be able to pre-diagnose a cause or identify a possible solution.

Typically, the water is blamed as the source of the problem, since it contains the dissolved copper and leaves blue stains when the water evaporates. In north central New Mexico, the problem occurs in such diverse areas as East Mountain, Placitas and Santa Fe—occurring in some homes, but not in others, with the same water coming from the same source.

There are many reasons why copper leaching may occur in a home. Some are easily identified and addressed. For example:

PH

The alkalinity in the water plays a significant role. Water can be acidic, neutral or basic and is rated by the level of pH on a scale of 0 to 14—7.0 is neutral, less is more acidic and greater is more basic. Ideally, you want your water to be 7.0 or slightly above. If it's below 7.0, the water may begin to attack the plumbing as it drops further into acidic territory. The pH can be easily established by bringing a sample of water to a local lab for water analysis.

Any water treatment dealer can obtain a test package for pH, copper and a host of other water quality parameters through their supplier or hardware store. If the water is significantly acidic, you can use a whole house pre-filter housing with a replaceable calcite filter cartridge. Acidic water will dissolve the calcite, changing it to a neutral pH in the range of 7.0.

Recirculating hot water pumps

These popular pumps can have the effect of enhancing problems associated with blue green staining.

Several simple adjustments that might reduce this problem:

- Hot water concentrates the copper problem. Reduce the hot water heaters' rated temperature to 120°F.
- Reduce the speed of the recirculating pump or use a heavy duty timer to turn it on only when it's needed most (i.e., morning or evening showers and with an over ride for wash days).
- Increasing the recirculating pipe size would help, but would prove difficult due to implementation— under the home or inside walls— and cost prohibitive.

Softeners

Water softeners have occasionally been blamed for creating this problem. Joint studies by the U.S Environmental Protection Agency (USEPA) and the Water Quality Association (WQA) have proven this to be absolutely false.[1]

Unfortunately, without a commonly understood cause, this theory has been given undue credence. Neither the salt content nor the softening process

contributes to the blue staining problem. One proposed solution is to allow hard water to be reintroduced to the home water system after it's been softened. This would cause water using appliances (i.e., hot water heater, dishwasher, clothes washer, coffeemaker, etc.) to deteriorate. Eventually, it will decrease the inside diameter of the pipes, causing a restricted water flow.

Soil pH or caliche content

It has been theorized that the acidity or caliche content of the soil can cause the copper leaching problem. Due to the depth of most wells, top-soil has next to no impact on the water. If the soil were the problem, leaks would be regularly occurring in the pipes that were buried under a concrete slab. Further, the problems would be occurring on the outside of the pipes and wouldn't cause blue-green staining to occur inside the home. If the pipe corrodes on the outside, it cannot cause blue-green staining in the home. If the corrosion is through the pipe, a leak would be created but without staining.

Grounding

There are two types of grounding—electrical and mechanical. The first is quite common. When you plug an electrical appliance into almost any outlet, you have three prongs. One is positive, one negative and the third is the electrical ground.

The second type of grounding is a mechanical—the bare wire in an open electrical outlet is a good example. Additionally, it's the wire attached to your hot water heater across the inlet-outlet lines that grounds this device per New Mexico State Electrical Code (see *FYT).* Here, the plumbing and electrical codes overlap. There are two different types of grounding—electrical (used with the home's electrical outlets) and mechanical. The latter is used to ground the electrical panel box as well as the house plumbing system.

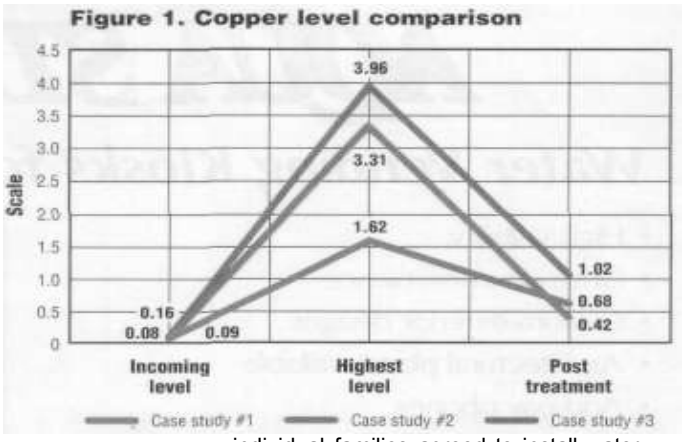
Previously, in the National Electrical Code (NEC), grounding rods were required to be installed according to the following rules: "The grounding rod shall be driven 8 feet straight down, can be driven at an angle of no more than 45 degrees or buried horizontally at a minimum of 2-1/2 feet down." Although the NEC has been recently changed to allow using the reinforcing bar in the concrete slab as ground, it remains to be seen whether this change will affect the copper leaching.

The NEC doesn't take into account the dry soil conditions in New Mexico or the fact that the soil is so full of rocks that it's rare that the grounding rod is properly installed vertically. It's widely believed that the lack of moisture in the ground is a major (if not the primary) reason the problem is occurring. Short of removing an installed grounding rod, there's no way to verify it's been driven the specified eight feet straight down. In the third case study in Santa Fe (see below), the grounding rod was driven in by the electrician and cut off when he hit a rock only 18 inches below ground. It was the major contributing factor to the problems experienced by this family.

Three case studies

Assistance was provided by a variety of individuals from electrical engineers and hydrological engineers to an electrical contractor who specializes in grounding and protecting very large water tanks against lightning strikes.

Three different families, on three different water systems, established that they had severe plumbing problems. They ranged from pipes being leached and perforated to a person's blond hair actually turning a shade of green. The individual families agreed to install water systems and make required grounding modifications throughout the home. In return, we guaranteed a reduction in the copper level content to be below USEPA acceptable levels. Copper levels in excess of the USEPA limit of 1.0 part per million (ppm) are harmful to people and animals.



Case study #1

The prospective customers were located on Thunder Mountain Road in the East Mountain area near Albuquerque. The incoming water lines in their garage started to develop holes, causing water damage to the home. The customers were well aware that this wasn't caused by the water utility, but weren't sure what was actually causing the problem. Their water was tested prior to any modifications at four different locations in the home. The copper content results showed a range from 0.08 ppm in the incoming water to 1.62 ppm in the master bathroom in copper content and well exceeded the USEPA limit—prompting them to make the recommended changes.

Case study #2

Another East Mountain resident in Paa-ko was experiencing extensive blue-green staining in their home and was referred to us by a contractor. We proceeded to test their water in the same way. Rather than wait for the lab results, the customer was anxious to get this situation resolved quickly. Equipment and an extensive grounding

package at the home were installed immediately, which included the guaranteed copper reduction. The subsequent lab tests results proved the concerns were real and the customer was glad to have reacted quickly.

The graph here (see *Figure 1)* shows an increase in the copper levels between the incoming water line at 0.09 ppm and the highest point in the home—the guest bathroom—at 3.31 ppm.

Case study #3

The third family is located in Santa Fe. They had the previously described copper staining and a family member of the house had their hair tinted green from excessive levels of copper in the water.

It was discovered that the grounding rod had been improperly installed, driven in 18 inches and not the code-specified eight feet. This was one reason why the problem started to occur, but not the only one.

The copper levels in this home were the highest we have seen to date. The incoming water copper level from the well was 0.05 ppm and grew to 3.96 ppm. We succeeded in getting the copper levels down to just above the USEPA guidelines.

FYI—Electrical codes

- Institute of Electrical and Electronics Engineers—http://st3ndarclsJeee.org/
- National Fire Prevention Association—http://www.nfpa.org/Codes/index.htm!
- New Mexico Electric Code—http://www.eengr.com/codes/nmelecco de.htm

Charting results

The graph in Figure 1 shows the lab certified copper levels at the following locations:

First—the initial incoming water copper level,

Second—the highest copper level established in the home, before equipment and grounding packages were installed, and

Third—the copper level at the same location after the modifications were made.

Conclusion

In closing, the blue staining problem found in some homes' water systems often is a matter of inappropriate grounding of electrical systems and the resulting electrochemical corrosion of copper pipes. It's correctable by customizing the solution for each home.

Acknowledgments

Sincere thanks goes to the following individuals who assisted in defining what was occurring and allowed development of the theory that proved so effective. They are: G.H. of Santa Fe, N.M., a Kinetico customer; Garry Ellis of Kinetico in Newbury, Ohio, and Buck Electric in Edgewood, N.M. ❑

References.

1. Sorg, T., and Michael Schrock, "Don't Blame Your Water Softener: Ion Exchange Softening and the Leaching of Metals from Household Plumbing Systems," *WC&P,* December 1997.

About the author

♦ *Pete Ostivald is the owner of Ostwald Enterprises, which does business as Kinetico Quality Water Systems of Central New Mexico in Albuquerque. He can be reached at (505) 342-1656, (505) 342-1668 (fax) or email: peteostwal@aol.com*