General Services Administration
Public Buildings Service

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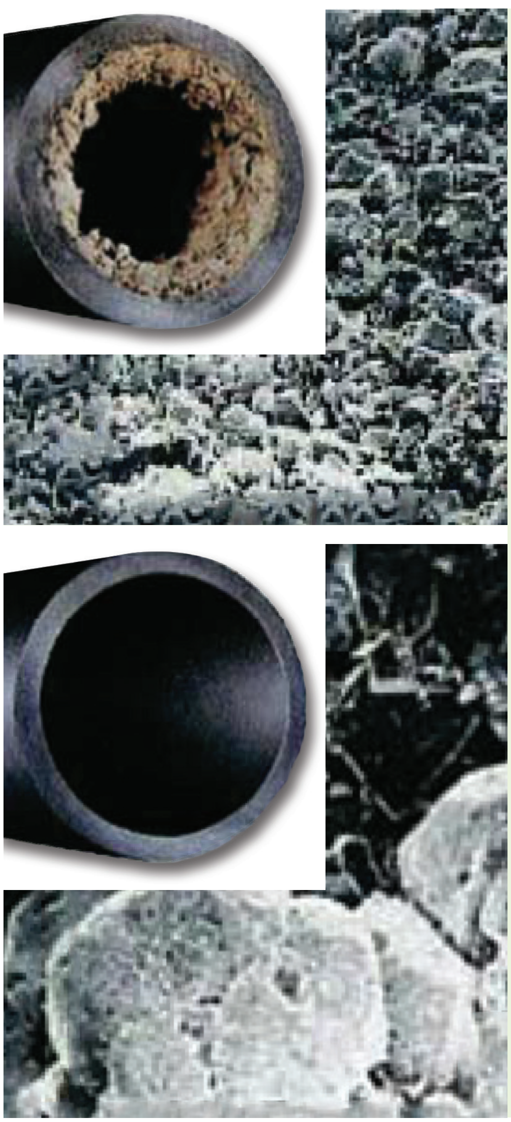
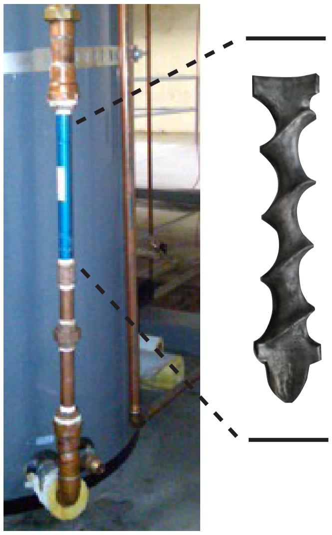
# AWT: CATALYST-BASED SCALE PREVENTION



## Catalyst-Based Device Reduces Calcite Buildup, Requires Minimal Maintenance

According to the US Geological Survey, more than 85 percent of the United States has hard water.[1] In plumbing, hard water leaves calcite deposits that restrict water flow by occluding pipes. In water heaters, calcite coats heating elements, causing them to overheat and eventually fail. Standard approaches to calcite mitigation rely on chemicals, which must be replenished frequently, or ultra-fine-membrane filtering, which uses large amounts of water and energy. GSA's GPG program commissioned Oak Ridge National Laboratory (ORNL) to assess the effectiveness of a catalytic insert that alters the chemistry of hard water to prevent calcite buildup. Researchers assessing the technology at the Frank E. Moss Federal Courthouse in Salt Lake City, Utah, found that non-chemical scale prevention dramatically reduced calcite buildup and had immediate payback when compared to a chemical (salt-based) system. Payback at other locations will depend on the ongoing remediation costs of calcite buildup. Catalyst-based non-chemical scale prevention should be considered for deployment in any heating system that is subject to calcification, including hydronic heating systems and boilers, condensing boilers, and gas and electric water heaters.

# INTRODUCTION



**Pipe with helical insert installed in cold-water and recirculating line**

**Before non-chemical scale prevention**

Calcite buildup after two months of untreated operation caused heating elements to overheat and fail.

**After non-chemical scale prevention**

New heating elements 18 months after installation of the technology show no significant signs of calcite buildup or overheating.

*"Before we installed the catalytic insert, our hot water heating elements failed every six weeks because our water is so hard. With the inserts in place, regular inspections show there is essentially no scale build up at all.*

—Daniel Wang
Property Manager
Frank E. Moss Federal Courthouse
Salt Lake City, Utah
Great Lakes Region
U.S. General Services Administration

## What is This Technology?

### PIPE WITH HELICAL INSERT REDUCES CALCITE PLATING

The non-chemical scale prevention technology assessed in this measurement and verification (M&V) process consists of a length of pipe containing a single fixed helical insert. The insert is made from a proprietary catalytic alloy and is installed directly into the system's water delivery pipe. As water flows over the metallic alloy, calcium and carbon form flushable crystals of the inert mineral aragonite rather than calcite. The technology is installed by removing a section of the cold-water and recirculating line and replacing it with the pipe containing the helical insert. Unit sizing, which corresponds to pipe diameter, ranges from ⅜ of an inch to 16 inches and is determined by the flow rate of water to be treated. Once installed, the system operates as a stand-alone device, requiring minimal maintenance and no chemicals or energy over its 15-year life span.

## What We Did

### RESEARCHERS ASSESSED THE TECHNOLOGY'S IMPACT ON SYSTEM CALCIFICATION IN HIGH HARD WATER CONDITIONS

Researchers from ORNL tested the catalyst-based technology in an electric domestic water heater. The water heater provided an ideal test bed because it is located in an area of high groundwater hardness and had no installed calcite control technology. Over the course of 18 months, ORNL conducted pre- and post-installation assessments of calcite formation on water system heating elements and documented energy use, incidence of element failure, and labor and material costs. Researchers also conducted a preliminary economic analysis of installed cost and potential savings on the courthouse's cooling tower.

# FINDINGS

**CALCITE BUILDUP DRAMATICALLY REDUCED** Before installation of the catalytic-based technology, and in the absence of any kind of water treatment, commercial-grade heating elements at the Moss Federal Courthouse had such significant calcite buildup that they overheated and failed after only two months of operation. After installation, elements had little visible calcite buildup even after eighteen months of operation.

**PAYBACK WILL BE SITE-SPECIFIC** The catalyst-based system had minimal operational costs beyond the initial installed cost of $1,692. At the Moss Federal courthouse, simple payback was less than two years, when compared to the cost of replacing failed heating elements. When compared to the cost of a conventional salt-based system, payback is immediate. The harder the water, the more likely non-chemical scale prevention will be cost-effective.

**MINIMAL OPERATIONS AND MAINTENANCE** Little training is needed for site personnel, as there are no moving parts or chemicals added. In installations where there is high iron content, the catalytic device may require periodic cleaning. In systems without a drain, calcite can form a soft sediment in the bottom of the tank, which should be removed either manually or with a wet/dry vacuum every 18 to 24 months.

**DEPLOY WHERE THERE IS HIGH WATER HARDNESS** Catalyst-based non-chemical scale prevention technology should be considered for any GSA facility with calcification issues. Remote locations, where access to power, chemicals, and labor makes conventional water softening impractical and expensive, may benefit particularly from this technology.

## Non-chemical scale prevention vs. Salt-Based System in Salt Lake City

Payback for non-chemical scale prevention is immediate compared to a salt-based system

| | Salt-Based System | Catalyst-Based Non-Chemical Scale Prevention |
|---|---|---|
| Equipment Cost | **$2,600** | **$1,192— ¾" diameter unit**<br>Unit pricing ranges between $798 for a ⅜" pipe and $96,360 for a 16" pipe. |
| Installation Cost | **$600** | **$500 —10 hours @ $50/hr**<br>Installation for new construction is $0, as it incurs no additional costs over baseline. |
| Maintenance Costs/year | **$1,850—$350 chemicals, $1,500 labor** | **$100—biannual tank cleaning**<br>Required in systems without a drain. |
| Simple Payback | | **Immediate** |

# CONCLUSIONS

These Findings are based on the report, “Catalyst-Based Non-Chemical Water Treatment System, Frank E. Moss U.S. Courthouse, Salt Lake City, Utah,” which is available from the GPG program website, www.gsa.gov/gpg

For more information, contact GSA’s GPG program gpg@gsa.gov

## What We Concluded

### TECHNOLOGY PREVENTS CALCITE BUILDUP AND SAVES ENERGY

At the Moss Federal Courthouse, the catalyst-based non-chemical scale prevention prevented calcite buildup with minimal O&M costs. The technology should be considered for any heating system with calcification issues, including hydronic heating systems and boilers, condensing boilers, and gas and electric water heaters. The harder the water, the more likely non-chemical scale prevention will be cost-effective. As a next step, GPG will evaluate the technology in cooling tower applications, following preliminary modeling that found it to be life-cycle cost-effective.

## Lessons Learned

**Device sizing key to effective performance** Initially, calcite buildup and overheating continued because the device was sized based on design flow rather than measured water flow. A flow test using ultrasonic meters should be used to determine appropriate device sizing.

**Appropriate element capacity yields maximum effectiveness** Electric heating elements should match appliance specifications. The heating elements originally installed in the courthouse’s water heater were designed for residential use. Because they did not meet commercial capacity or building system specifications, they failed every six weeks, far more frequently than commercial-grade elements, which would have failed approximately every six months under similar conditions.

## Barriers to Adoption

**Technology relatively new to U.S.** Developed in Europe in 1973, the technology is deployed in 40 countries, with more than one million installations. It was first marketed in the U.S. in 2010, and certified by the National Sanitation Foundation in 2013. Currently, there are approximately ten thousand U.S. installations.

**Higher First Costs** The technology can have higher first costs than some other water treatment systems, though substantial savings are still possible because it uses no energy or chemicals and has minimal O&M costs.

### Footnotes

[1] USGS, http://water.usgs.gov/owq/hardness-alkalinity.html (>60 mg/liter)

*Technology for test-bed measurement and verification provided by Fluid Dynamics.*