

Heating/Piping/Air Conditioning

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Electrostatic descaler testing: an evaluation



1. Specimens removed from piping to and from domestic hot water heater prior to installation of descaler.

No benefits can be attributed to electrostatic descaler after six months' service in domestic hot and cold water piping.

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It is well known that hard water scale is formed by dissolved minerals. In particular, calcium and magnesium salts build up on the interior surfaces of tube bundles, piping, and tower packing to mention but a few notable examples.

In recent years, building and plant engineers, owners' representatives, and purchasing agents have been besieged by vendors of electric or electronic water conditioning devices offering panacea solutions to potential corrosion and scaling problems—solutions that cannot be explained by engineering facts. Energy consumption levels of such devices are often so low as to defy the confidence of those normally engaged in this field.

The promotion of such devices follows a pattern similar to that of approximately 20 years ago, despite the fact that many of these "mir-

acle" devices were then found to be harmless but ineffective.^{1,2} Then, as now, the accompanying literature was filled with scientific jargon—ions, electrons, magnetic fields, polarization—used (often without supporting test evidence) to weave a fascinating tale of mechanisms involving molecular interactions triggered by the devices to work wonders.

What concerns those of us responsible for guarding our clients' interests is that if such devices are in fact ineffective, then their use delays the introduction of proven scale corrosion prevention methods. Higher costs may then be incurred when operating and maintenance problems surface later.

Among the benefits claimed by the numerous companies who manufacture and/or assemble electrostatic descaler apparatus are:

¹Superscript numerals indicate references at end of article.

- Minimal operating costs (eliminating expensive chemical treatment and/or additives).

- Use of inexpensive untreated water for process needs.

- Elimination of polluting effects of acids and other chemical additives (normally discharged to public sanitary sewers), an obvious ecological plus.

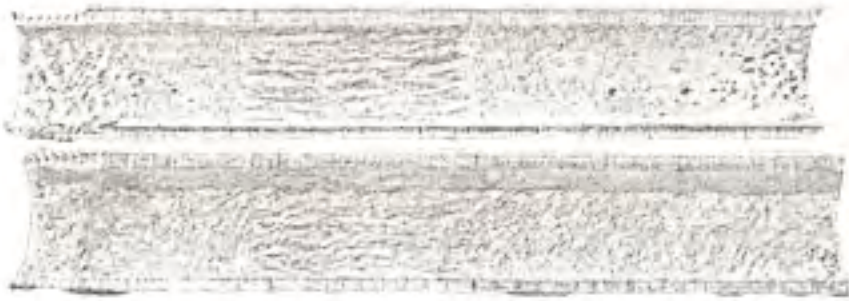
- Removal of previously built-up scale on interior surfaces of operating equipment.

- Increased useful life of operating equipment.

- Operation of equipment at higher average overall efficiencies.

- Elimination of costly chemical and/or mechanical descaling.

Most manufacturers claim that their products utilize electrostatic field focus to inhibit the deposition of calcium carbonate scale. The presence of the electrostatic field is credited with initiation of nucleation of the dissolved metal salts as very small particles that act as seed



2. Specimen removed from new pipping to descaler after six months service (49.0 mg scale per sq. in.)



3. Specimen removed from new pipping to descaler after six months service (45.4 mg scale per sq. in.)



4. Specimen removed from old pipping to new water heater six months after installation of electrostatic descaler..



5. Specimen removed from old pipping from new water heater six months after installation of electrostatic descaler..



6. Specimen removed from new riser for outermost lawn sprinkler six months after installation of descaler.

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nuclei, particularly in areas adjacent to heated surfaces.

We are told, in essence, that by virtue of such polarization effects, the salt ions are attracted to each other and remain in the fluid mainstream. Thus, scale-forming salts that precipitate remain in suspension and are "carried through the system," etc. Removal of previously formed scale is generally claimed to be gradual, but at a steady rate, by virtue of the apparatus' ability to control the solidity equilibrium (to avoid the sudden loosening of large scale deposits) until the existing scale is dissolved and flushed through the system.

We become understandably cautious when we are told that such devices require no maintenance following installation. Further, we rarely see limitations on flow rates or indications of decreasing performance with increasing flow rates.

Following the inquiry of numerous of our clients who had been directly contacted by various water conditioning company representatives, our office felt compelled to conduct a test program aimed at independent verification of the potential of such devices. A system of known character was selected, namely the galvanized domestic hot and cold water piping in my residence, originally installed in 1961.

The test program

A manufacturer of electrostatic descaler devices was selected at random and offered the opportunity of supplying a descaler to us for purposes of testing and evaluation. It was understood that all costs of the testing program were to be borne by our firm as part of our in-house evaluation provided we were given the exclusive right to publish our test results.

Piping modifications required for installation of the representative descaler unit at my residence were completed by the plumbing contractor in June 1972. The galvanized hot and cold water piping had shown evidence of corrosion and scaling during earlier inspections. Just prior to the installation of the device, our glass-lined domestic hot water heater (originally installed in 1964) failed, and a new nominal

50 gal glass-lined heater was installed immediately prior to piping modifications made to accommodate the test descaler.

Fig. 1 shows representative sections removed from the inlet and outlet piping connected to the old hot water heater. The degree of scaling and/or corrosion is readily apparent. These sections, together with a water sample drawn on 6/15/72, were forwarded to Truesdail Laboratories for testing and analysis at that time.

Installation of the descaler was achieved simply by cutting and threading the existing water line and inserting the descaler in a vertical position (using dielectric unions, 1, 1½, and 2 in., and dielectric flanges, 3, 4, and 6 in., as appropriate). Most descalers operate on 110-120 v AC single phase power and draw approximately 0.10 amp or less, which is claimed to produce the voltage necessary for electrostatic operation of the unit. A light or other type of indicating device is often provided to demonstrate that the unit is energized.

A section of lawn irrigation piping (most westerly sprinkler head and ¾ in. pipe extension) was removed and a new nipple installed to serve as a control. The existing system was modified so that the test descaler would feed the house service only, leaving a raw water supply to the lawn sprinklers. In this way, the scaling of the originally installed irrigation piping, with the exception of the new nipple, could subsequently be compared with that of the piping now served by the electrostatic descaler.

The main supply system pressure ranges from 100 to 115 psi, and a pressure reducing valve at the house is set at approximately 50 psi. The electrostatic descaler was turned on at 8:10 AM on June 15, 1972 and has been running continuously since that time.

What happened?

Four days following installation, a plugged aerator in the rear bath lavatory prompted a service call to the plumbing contractor. The aerator fitting was found to be plugged with iron oxide scale. This fixture is located approximately at the opposite end of the house run from where the house line enters through the exterior wall.

On three subsequent occasions

following installation, spanning a period of three months, the kitchen sink and lavatories required removal of aerator fittings to remove line blockage. After removal of aerator fittings at each fixture, both hot and cold water faucets were separately flushed. Additionally, one service call was attributed to line plugging at the washing machine.

After cleaning of aerator fittings, the first water drawn was clearly a reddish-brown color, which cleared up after 2 to 3 min. The hot water appeared to be slightly more discolored, and following drawing of the tap, iron oxide scale lined the bottom of the bowl. After this period, line plugging subsided and things appeared to return to normal operation.

Approximately six months after installation of the electrostatic descaler and removal of samples, various pipe sections were removed and delivered to Truesdail Laboratories for examination and evaluation. These pipe sections were considered to have been in service long enough to indicate the effectiveness of the device.

On 12/27/72, the following pipe sections were submitted:

- One section of *new* ¾ in. pipe from the descaler feed line, shown in Fig. 2.

- One section of *new* ¾ in. pipe from the descaler outlet line, shown in Fig. 3.

- One section of *old* ¾ in. pipe from the domestic hot water heater feed line, shown in Fig. 4.

- One section of *old* ¾ in. pipe from the domestic hot water heater outlet line, shown in Fig. 5.

- One section of *new* ½ in. pipe from the outermost lawn sprinkler riser, shown in Fig. 6.

All of these sections were cut longitudinally in order to facilitate examinations.

The samples that had been taken in June (Fig. 1) were very badly corroded and scaled, and both appeared to be in essentially the same condition. No true evaluation could be made of them.

The specimens in Figs. 2 and 3 were taken from new piping installed to and from the descaler. These representative samples were used to estimate the scale deposition during our initial six month test period. The scale was mechanically removed from each pipe and weighed, with these results:

Table 1—Chemical analysis of domestic water supply.*

Percent of total supply	77.7
Specific conductance (K x 10 ³)	320
pH	8.36
Temperature range, F	37-77
Dissolved residue (calculated), ppm	199
Total hardness (CaCO ₃), ppm	82
Calcium (Ca), ppm	24
Magnesium (Mg), ppm	5.1
Sodium (Na), ppm	33
Potassium (K), ppm	3.6
Alkalinity (CaCO ₃), ppm	113
Sulfates (SO ₄), ppm	28
Chlorides (Cl), ppm	14
Nitrates (NO ₃), ppm	0.8
Silica (SiO ₂), ppm	22
Iron (Fe), ppm	0.05
Boron (B), ppm	0.41
Fluoride (F), ppm	0.56

*The Los Angeles Owens River Aqueduct supplies most of the San Fernando Valley and the City of Los Angeles proper north of Pico Blvd. and west of Robertson Blvd. (data from Reference 8).

- Piping to descaler, 49.0 mg of scale per sq in. of pipe surface.

- Piping from descaler, 45.4 mg of scale per sq in. of pipe surface.

These results show a slightly lower value for scale density on the outlet section as compared with the inlet section. The difference is not believed to be significant in view of the fact that scale deposition would be expected to decrease with increasing distance from the feed source because of depletion of scale-forming minerals.

The specimens in Figs. 4 and 5 were too heavily corroded and scaled to permit an evaluation of differences in scale density. In general, they appeared to be fairly heavily scaled, again indicating a lack of effectiveness of the descaler.

The specimen in Fig. 6, a new riser pipe from the sprinkler system, showed a minimal amount of scale. Since it was used only intermittently and was distant from the water source, it would be expected to show light scaling. It was not considered significant in evaluating the descaler.

From the overall examination of the pipe sections and in particular from evaluation of the specimens in Figs. 2 and 3, we concluded that the test descaler was not effective in preventing scale deposition, and we were unable to detect any measurable reduction in corrosion potentials.

Langelier Index analysis

Calcium carbonate, the principal scale former in domestic water, can

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handily be used as a measure of the tendency of a given water to corrode or form a protective coating. Thus, use of the saturation index developed by Langelier to predict the tendency of natural (or conditioned) water either to deposit or to dissolve calcium carbonate may provide some insights as to possible mechanisms.

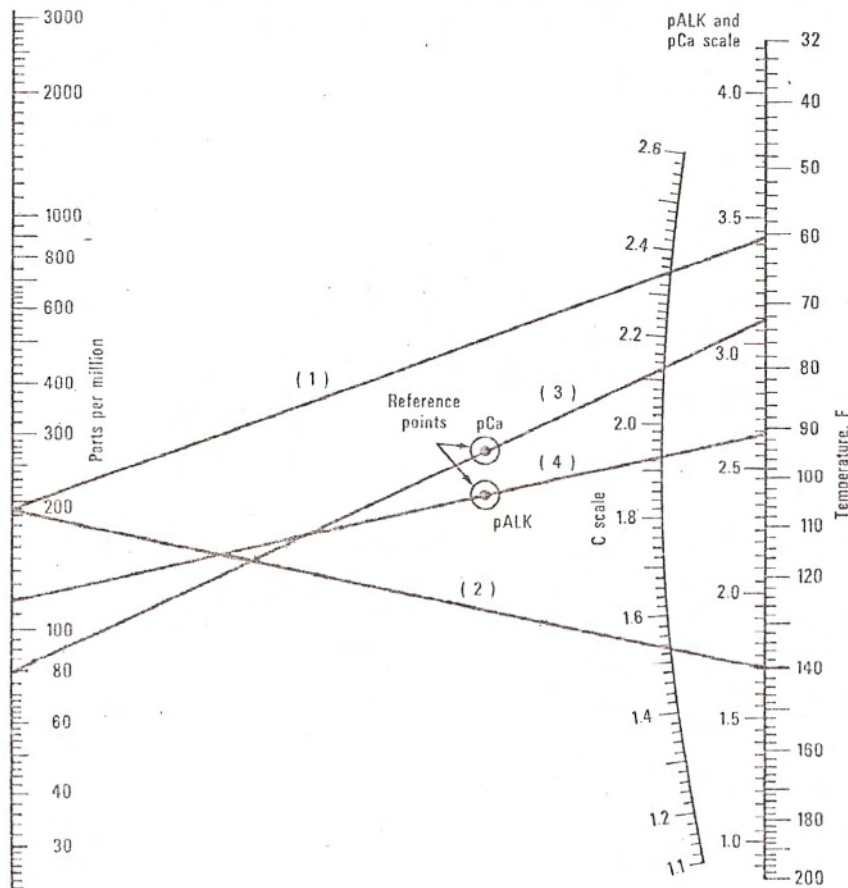
The saturation index is defined as the algebraic difference between the measured pH of water and the calculated pH at saturation with calcium carbonate:

$$SI = pH - pH_s$$

A positive index indicates a tendency to deposit calcium carbonate, and a negative index indicates an under-saturation condition with respect to calcium carbonate, or a tendency to dissolve any existing calcium carbonate. A zero index indicates that the water is in equilibrium with respect to calcium carbonate.

Fig. 7 offers a quick means of determining the saturation index.

7 Nomograph for Langelier Index. For water analyzed in Table 1, pH₆₀ at 60 F = 2.35 + 3.09 + 2.62 = 8.06 and pH₁₄₀ at 140 F = 1.54 + 2.62 + 3.09 = 7.25. Index at 60 F = 8.36 - 8.06 = +0.30; Index at 140 F = 8.36 - 7.25 = +1.11. (Nomograph reprinted by permission from Reference 9.)



If we consider water whose composition is shown in Table 1 at both 60 F (normal cold water) and 140 F (normal hot water), then referring to Fig. 7, we find that the saturation index varies from +0.30 at 60 F (normal cold water temperature) to +1.11 at 140 F (normal hot water temperature). In other words, our water source possesses a moderate scale-forming tendency at the cold water temperature and a noticeably more aggressive character at the elevated domestic hot water temperature. Therefore, valid conclusions could be drawn from our test.

General observations

Following our initial line plugging problems, we concluded that much of the scale accumulated in the system over the years was probably loosened by physical handling of the pipe during installation of the test unit and the new hot water system, as well as by the inrush of water when the system was reconnected. This is supported by the fact that the problem lasted a short period and has not returned.

The manufacturer's claim that noticeable results are evident after installation is probably based on similar results and should not be considered significant. Testimonial letters should not be allowed to pull us into a false sense of security.

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