This presentation premiered at WaterSmart Innovations

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IAPMO IGC-335 2018
RAPID SCALING TEST
What Can It Tell Us about Scaling Potential and Prevention

A PRESENTATION FOR WSI 2019

By

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Learning Objectives

A. Understand the Chemistry of Hard Water
B. Problems created by Hard Water
C. Ion Exchange Softeners – Pro's & Con's
D. How Physical Water Conditioners Work
E. IGC 335 Rapid Scaling Test
F. What Else Did We Learn
G. The Potential Impact for Water Utilities

The Chemistry

Calcium Bicarbonate

(Dissolved)

$Ca(HCO_3)_2$

Becomes

$CaCO_3$ Calcium Carbonate +

(Solid)

CO_2 Carbon Dioxide +

H_2O Water

DUE TO

“Scaling Events”

Temperature

Above 130 F

Pressure Drop

pH Increased

Scale Sticks to Surfaces

Scale has to form onto something

It won't just spontaneously form onto itself
It has to have a surface or nucleation seed to form onto

Meldrum & Sear – Now You See Them

Science VOL 322 19 December 2008

Scale Sticks to Surfaces – So

- Reduces Life of Equipment – water heaters, faucets, shower heads. Increases maintenance and reduces flow rates
- Energy is Wasted– Calcium scale is 400 times less conductive of Heat than Copper. 1/8” of scale equates to 12% loss in heating efficiency,
- Pumps have to work harder in constricted pipes
- Hygiene is Worse – Scale traps dirt so cleaning is more difficult. Locker Rooms, Assisted Living, Dorms, Drinking Fountains
- Legionella Greater Risk – Scale harbor’s bacteria

2018 Uniform Plumbing Code

Appendix L

L 505.0 Hard Water.

L 505.1 Softening and Treatment.

Where water has a hardness equal to or exceeding 10 grains (170 mg/l) measured as total calcium carbonate equivalent, the water supply line to water heating equipment and the circuit of boilers shall be softened or treated to prevent accumulation of lime scale and consequent reduction in energy efficiency.

Regular Water Softeners Remove calcium by "Ion Exchange"

- Resin beads in Tank dosed with Salt
- Excellent Results
- Well proven technology
- But
- Requires Regular Dosing with Salt
- Plant Costs and Space usage
- Maintenance and Servicing
- Head Loss
- Potability – Elderly and Infants
- Softener Bans – Chloride Effluent Restricts Re-use.

Physical Water Conditioners

Create **nucleation seeds** that encourage scale to form in suspension rather than encrust surfaces.

•Nucleation Seeds – Many forms such as Zinc, Iron (Fe), Silico (Poly) Phosphates, Calcium Carbonate powder plus others – some not yet identified.

Physical Water Conditioners

- Stimulate scale formation in
  SUSPENSION in the Water
- Instead of
  ENCRUSTATION on Surfaces
- **The scale suspended in the water is harmless – its like chalk dust and can be wiped away**

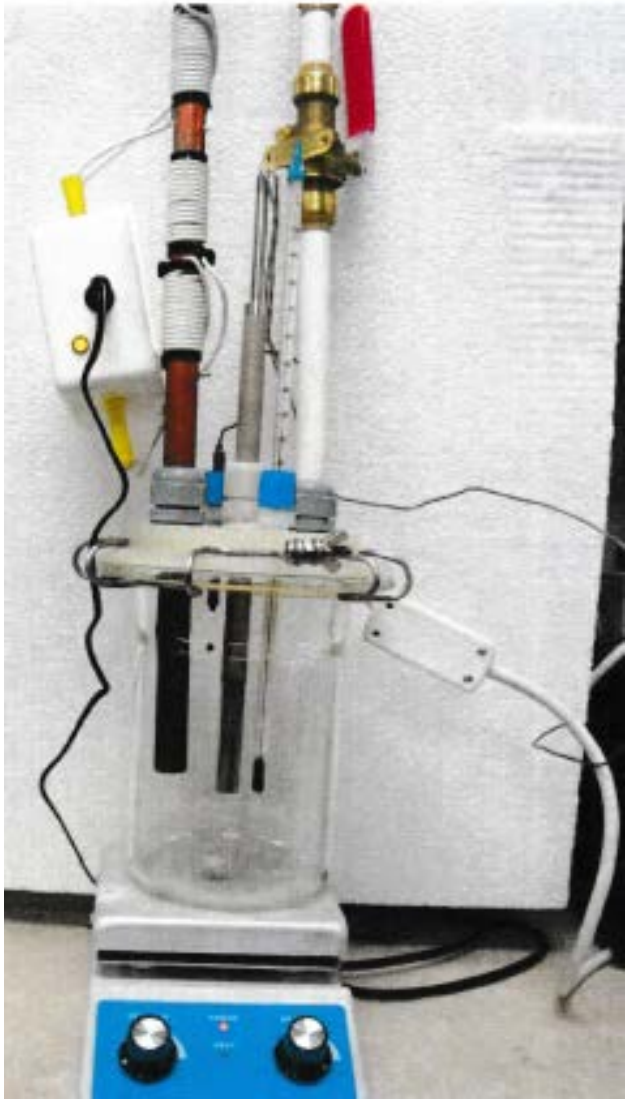
Two Stage Process

- Stage One – Create the **nucleation seeds**
- Stage Two – Use a “Scaling Event” to create the scale on a nucleation seed.

There is no detectable difference in the water, or its content, after stage one.

So to evaluate the effectiveness of a PWC you need to accurately measure its potential to reduce scale.

IAPMO IGC 335 TEST RIG



Uses just over one litre of water Heated at 180 ºF for 23 Hours

Scale deposits on a stainless steel sheath which has been placed over the heater element. It is removed, dried and weighed.

The scale is removed by using Hydrochloric Acid.

The sheath is weighed again.

The difference in weights is the amount of scale deposited on the sheath.

Finding:

- Control test*:

Heat Sheath weight (mg)		Scale deposit net weight
Before HCl	After HCl	WSc (mg)
38005.6	37994.4	11.2
37999.4	37989.0	10.4
37987.8	37977.2	10.6
38001.7	37991.6	10.1
	Mean:	10.6

*Note: Water sample was provided by client, indicated as Las Vegas water.

- Rapid scaling test with device:

Heat Sheath weight (mg)		Scale deposit net weight
Before HCl	After HCl	WSd (mg)
37999.6	37998.1	1.5
37992.6	37991.0	1.6
37999.6	37997.4	2.2
37966.1	37964.2	1.9
	Mean:	1.8

- Efficacy:

$$\eta\% = \frac{10.6 - 1.8}{10.6} \times 100 = 83\%.$$

Repeat 4 times with and without treatment, average the readings and report the difference

IGC 335 uses a small volume of water over a short period of time.

Which means it is easy to test a range of waters. It is simple, inexpensive and quick

It is also capable of delivering very accurate and consistent results

What Else Did We Find?

The Control Test using Las Vegas Water with hardness of 305 ppm produced 10.6 mg of scale

A Control Test using IAPMO Laboratory water with hardness of 170 ppm produced 65.6 mg of scale

This means that the IAPMO Laboratory water produces ten times more scale than the equivalent hardness of Las Vegas water

How Has This Happened?

The Las Vegas water is more than 95% Colorado River water from Lake Mead with significant quantities of different minerals, some of which will act as Nucleation seeds to attract the scale when it precipitates.

The IAPMO water comes from the Chino Desalter Authority. The source is well water with high levels of Chloride. This water is passed through Reverse Osmosis which removes all the minerals with only the later addition of Calcium Hydroxide to reduce corrosion.

Scaling Potential

Nothing else is added that could act as a nucleation seed, This means that the only place where the scale can precipitate is on the heater surface.

The scaling potential of the water is the amount of scale produced on the heater compared with the total amount of scale that could be produced from the volume of water tested. The results show:-

Colorado River Water	3.5%
Chino Desalter Water	35%

This means the Chino water is behaving like water with a hardness of 1,700 ppm, not 170 ppm.

The Potential Impact for Water Utilities

These results indicate that residents of the Chino basin are being provided with water that has a very high scaling potential.

The Inland Empire Water Utility are keen to reduce self regenerating water softeners and offer $2,000 rebate to home owners who remove them.

If the Chino Desalter Authority were to reduce the scaling potential of their delivered water there would be less demand for home water softeners.

Further Research

The Rapid Scaling Test (RST) can tell us a lot more about water and scaling potential than we currently know. The current benchmark of 170 ppm for treatment is misleading.

Further research can be done on “artificial” waters provided by de-salters and RO systems such as Orange County, El Paso and Carlsbad to identify the issues relating to scale.

Additional additives could be tested to evaluate how they can reduce scaling potential, with and without additional treatment provided by Physical Water Conditioners.