

## Non-ion Exchange Water Treatment— What Does it Cost and What Can it Deliver?

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WQA Aquatech USA 2013 • Indianapolis, Indiana

### Learning Objectives

1. Types of non-ion exchange water treatment
2. What do representative products from each type look like?
3. How each type of non-ion exchange water treatment works?
4. Factors to consider in selecting most suitable devices
5. Preliminary results from the survey of the industry
6. Where are we now?
7. Where do we go from here?

## Types of non-ion exchange water treatment



### In broad terms:

- Permanent magnetic
  - nonintrusive
  - intrusive
- Electromagnetic
  - nonintrusive
  - intrusive
- Electric field
- Electrolytic, Electrostatic, and Catalytic
- Media based
- Nanotechnology based

## What do representative products from each type look like?



### Permanent magnetic - nonintrusive



## Permanent magnetic - intrusive

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7

## Electromagnetic - nonintrusive

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# Electromagnetic - intrusive



# Electric field



# Electrolytic

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# Electrostatic

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# Catalytic



# Media –Template Assisted Crystallization





## Media –Nucleation Assisted Crystallization

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15

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# How each type of non-ion exchange water treatment works?



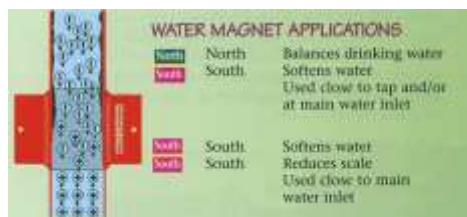
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## Principles behind permanent magnetic 1



“When water moves through a magnetic field, the hydrogen ions and dissolved minerals in the water become charged. This charge causes a temporary separation of the minerals from the molecular water clusters, resulting in improvements in taste - the water will behave like it is naturally soft. Water from lakes, wells, or running streams are naturally charged by the earth’s 0.5 gauss magnetic field. However, during water treatment and transport through underground city water pipes, the charge will dissipate. Treating water with magnetic fields restores this natural energy and balance”



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## Principles behind permanent magnetic 2



“Powerful magnets are placed around the incoming water pipe. As the calcium and carbonate ions enter the magnetic field they are pushed in opposite directions(1), due to their opposite charges. As all of the calcium ions are pushed in one direction and all of the carbonate anions are pushed in the opposite direction, they tend to collide(2). When these collisions occur, the ions stick together forming a solid form of calcium carbonate called aragonite(3). These microscopic crystals can then be filtered out or allowed to pass through your home’s plumbing and down the drain. Because the crystals were forced to form while moving in the water, they do not have an opportunity to attach themselves to your fixtures. Furthermore, since the calcium is no longer in ion form, it does not interact with soaps and detergents, eliminating the build-up of soap scum.”



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## Principles behind permanent magnetic 3



Permanent magnetic device suppliers attribute **Lorentz force** as the primary mechanism behind how their devices treat the water.

$$F = qE + qv \times B$$

The first term is from the electric field. The second term is the magnetic force and has a direction perpendicular to both the velocity and the magnetic field. The magnetic force is proportional to  $q$  and to the magnitude of the **vector cross product  $v \times B$** .

- **F** is the force (in newtons)
- **E** is the electric field (in volts per meter)
- **B** is the magnetic field (in teslas)
- **q** is the electric charge of the particle (in coulombs)
- **v** is the instantaneous velocity of the particle (in meters per second)

## Principles behind permanent magnetic 4



Even if this Lorentz force is at work to deliver a beneficial effect on water the following problems exist:

- There is no electric field; thus, there is **no first component**.
- Flow velocity changes through a 24 hour period based on the demand by the occupants of a household –significant changes in the second component of the Lorentz force; thus, **various degrees of treatment in the same day**.
- The vector cross product is equal to the magnitude of  $v$  times the magnitude of  $B$  times  $\sin \alpha$ , where  $\alpha$  is the angle between  $v$  and  $B$ . This means, the permanent magnet **has to produce a field that is orthogonal** to all the water flowing through the pipe but this is not possible in the real world.

## Principles behind electro magnetic 1



“The **induced molecular agitation** (IMA) of the technology causes the unstable mineral ions to precipitate, providing initial nucleation sites for further precipitation of adjacent mineral ions. A snowball effect starts, resulting in growth of many crystals. These insoluble crystal salts become large in size and float with water, thus they do not stick to the surfaces because the **crystals do not have the charges** at the surface anymore.”

“This innovative product produces an oscillating electronic field using a unique and complex modulating frequency wave form that **changes the physical shape, size and charge of the calcium molecules** and causes them to lose their adhesive properties.

Lime scale will no longer form in the pipes or on equipment that comes in contact with hard water.

The surface tension of the water is lessened, which will increase the solubility of the water, making it a better solvent.  
**Water will feel softer and 'wetter', and less detergents will be required.**

## Principles behind electro magnetic 2



The magnetic field created by an electromagnet is proportional to **both the number of turns in the winding,  $N$ , and the current in the wire,  $I$** , hence this product,  $NI$ , in ampere-turns, is given the name magnetomotive force. For an electromagnet with a single magnetic circuit, of which length  $L_{\text{core}}$  is in the core material and length  $L_{\text{gap}}$  is in air gaps, Ampere's Law reduces to:

$$NI = H_{\text{core}}L_{\text{core}} + H_{\text{gap}}L_{\text{gap}}$$

In magnetic circuits with an air gap, the strength of the magnetic field  $H$  depends **strongly on the length of the air gap**.

## Principles behind electro magnetic 3

To put in simpler terms:

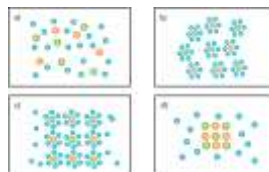
1. Designing electro magnetic devices that work is not easy.
2. One design does not serve the treatment needs of water with varying attributes from one city to another and even within the same city.
3. Often only a portion of the body of water flowing through the device sees the beneficial effects, if any and the rest goes untreated.
4. Current practice is such that the model or the capacity to treat water is chosen based on either no testing of the water or on an estimate of hardness level and the flow through the device.
5. The owner wrapped coils are not equivalent to carefully designed units fabricated by sophisticated machines in a factory.

## Principles behind electrical field 1

“Because mineral ions have electrical charges, they can be manipulated by an electric field. **The Limescale Eliminator uses a specially designed electric field to help ions form crystals in water rather than on pipes.** This electric field rapidly changes direction (it is an AC field) from upstream to downstream. Positive ions are moved one way, negative ions are moved the other. **The field then changes direction along with the directions the ions move.**”



Moving the positive and negative ions that are initially dissolved in the water in opposite directions means they are **much more likely to come into contact with each other, stick together and form clusters**, which help them crystallize.”



## Principles behind electrical field 2



Crystals need a starting point to form, also called a **nucleation site**. If there is nothing else, the side of the pipes will serve as a starting point, and crystals will form on the pipe. However, crystals would rather form on an existing crystal. We can now see how the **formation of even a few "seed" crystals** can prevent the formation of limescale on pipes. Without treatment, when water is heated, the only starting point for crystallization is the surface of pipes. As more ions begin to crystallize, they form on the existing crystals, and the scale on the surface of the pipe grows.

These crystals are about 10 microns in size, i.e. one hundredth of a millimeter, and so are **easily washed out by household water flow**.

## Principles behind electrolytic 1



The anode is the electrode at which **electrons** leave the cell and **oxidation** occurs, and the cathode is the electrode at which electrons enter the cell and **reduction** occurs.

Each electrode may become either the anode or the cathode depending on the **voltage** applied to the cell. A bipolar electrode is an electrode that functions as the anode of one cell and the cathode of another cell.

Water is passed between an anode and a cathode. Ion-selective membranes allow the positive ions to separate from the water toward the negative electrode and the negative ions toward the positive electrode.

The outcome is water free of ionic species, when you need it, where you need it, as much as you need it.

## Principles behind electrolytic 2



- Water contains positively-charged **cations** and negatively-charged **anions**.
- When a pair of electrodes is inserted with current applied, the electric field drives the cations in the direction of the cathode and drives the anions toward the anode.
- When we insert an ion exchange membrane **made of cation selective resins**, it will block the flow of anions and water molecules ... only cations will be able to pass through to the other side.
- When we insert another ion exchange membrane, this time **made out of anion selective resins**, it will block the flow of cations and water molecules.
- This configuration of membranes and electrodes forms **a CEDI module**, sandwiching a mixture of cation and anion selective resins between the two membranes.
- As feed water is pumped into the system, it is diverted into the concentrating compartment, and the purification compartment.
- Ions migrate and accumulate in the **concentrating compartments** where they are washed away in to the reject stream. The water leaving this compartment contains a concentration of ions approximately 10 to 20 times higher than the original feed water.
- At the **top of the purification compartments** the ion concentration is at its highest. At the **lower end of the purification compartments**, the ion concentration is in the "parts per trillion" level.

## Principles behind electrostatic



The water passing through the device functions as the electrolyte in a voltaic cell, contacting at least two electrodes having different electrochemical potentials; optimum field generation is made possible by a specially formed plastic **(GRP) tube through which the water flows**.

Friction between the water and the inner surface of the pipe generates an electrostatic charge around the outer surface of the tube. The high potential difference between the electrodes results in a narrowly focused, high density secondary field in the form of an electrostatic "curtain" through which the water must pass.

In solution, **calcium, magnesium and other mineral salts are partly ionized and therefore subject to influence by the electrostatic energy-focused secondary electrostatic field causes increased ionization of the soluble content of the water, thereby minimizing precipitation and preventing scaling.**

## Principles behind catalytic



It works through basic principles of **fluid mechanics** coupled with our unique **media design** that converts **chloride particles such as Calcium, Magnesium, Boron and Sodium elements into neutralized nano-particles** that goes into solution and passes through your water supply system. As water passes through our Conditioner the cohesiveness of the scale-causing chloride particles in the water that causes hard water issues is either eliminated or significantly reduced.

A three phase conditioning process is achieved;

1. **Polarization:** Water passes into the unit through flow **modulators that polarize** the water stream along with the materials contained within it. This action formats the water so that the following process can impact the water stream more completely.
2. **Oxidation Reduction (Redox Process):** The propensity and ability for water to scale and harden through oxidation is reduced as water flows over the **Nano-Technology developed Ceramic Media that contains a matrix of minerals and rare earth elements.**
3. **Ionization:** As the water stream passes over the Ceramic Media, the electron fields of the materials within the water stream overlap with the electron fields of the materials contained within the Ceramic Media. The exchange of ions is encouraged and enhanced. The turbulent water flow through these materials creates a **self-generating Piezo Static Electric charge** that aids the entire process.

## Principles behind media - TAC



- Specially prepared polymer bead attracts Calcium from the solution.
- Surface of the bead has been modified to provide a saturated environment and highly favorable nucleation sites (Templates).
- Combination of attraction, localized saturation and nucleation sites allows crystals to form in water that is not supersaturated relative to  $\text{CaCO}_3$ .
- The crystals progress from the nucleation phase to the growth phase due to the favorable environment at the surface of the bead
- When the crystals grow large enough (sub-micron) they are sheared off of the surface and released into the flowing stream.
- The crystals remain suspended in the water (behaving like colloids) and are carried throughout the piping.
- When changes occur to the water that effect the solubility of  $\text{CaCO}_3$ , the crystals serve as favorable nucleation sites to take-up the  $\text{CaCO}_3$  that becomes insoluble.





## Principles behind media - NAC



Phase 1: Unique catalytic media accelerates the transformation of the calcium and magnesium minerals out of the water solution into benign nano crystal particles.

Phase 2: As the calcium crystals flow through the piping systems and equipment, the nano structure of the crystals dissolve additional calcium removing any preexisting calcium deposits.

Phase 3: After the old calcium deposits are removed the unique media forms a smooth 3 to 5 micron thick corrosion prevention layer on existing pipes and equipment.

## Principles behind nanotechnology



RS-2 is able to create a certain atom structure (**template**), which leads to the creation of **crystals**. With a contact time of less than 3 seconds calcium crystals are formed from the dissolved calcium. **The result is 100% scale prevention.**

The second product is the ISF 92 media for the **removal of iron up to 35 ppm**. Also on this media the surface includes atoms ordered in a special way, creating a catalytic effect. The dissolved iron is transformed into a solid, which can then easily be trapped in a filter bed. For the removal of arsenic adsorption medias consisting of ferro hydroxide or titanium are used. **Arsenic** appears in parts per billion, this amount is so small that an adsorption media is better suited.

## Factors to consider in selecting most suitable devices



### Factors:

- Capital cost
- Cost of consumables
- Cost of energy
- Cost of repair and maintenance
- Type of performance guarantee
- Duration of the warranty
- Who installs for the warranty to be valid?
- Range of flow rates
- Ease of Use
- Foot print and space requirements
- Range of pressure loss detected
- What contaminants can it remove?
- What range of hardness capacity?
- Does it meet any national industry standards?
- Health consequences
- Track Record
- References

## Preliminary results from the survey of the industry



## Electrostatic

**CAPITAL COST** - Competitive

**COST OF CONSUMABLES** - Zero

**COST OF ENERGY** - Zero (self energising)

**COST OF REPAIR AND MAINTENANCE** - generally maintenance free, but periodic internal cleaning dependent on inlet water quality

**TYPE OF PERFORMANCE GUARANTEE** - Subject to application

**DURATION OF WARRANTY** - 5 years

**WHO INSTALLS FOR WARRANTY** - Minimal installation requirements (compression, screwed or flanged end caps)

**RANGE OF FLOW RATES** - Select model appropriate to pipe size, full open tube design with no flow restriction

**EASE OF USE** - Operator fool proof

**RANGE OF PRESSURE LOSS** - No pressure loss

**WHAT CONTAMINANTS REMOVED** - Nothing removed, hardness minerals ionised to inhibit hard scale deposition

**WHAT RANGE OF HARDNESS CAPACITY** - 400 ppm

**DOES IT MEET INDUSTRY STANDARDS** - Is there one for this type of device?

**HEALTH CONSEQUENCES - UK** - approved for potable water supplies

**TRACK RECORD** - Performance endorsed by **British Gas** following extended product comparison trials

**REFERENCES** - British Gas

## Electric field 1



**CAPITAL COST** - \$ 595  
**COST OF CONSUMABLES** -  
**COST OF ENERGY** -  
**COST OF REPAIR AND MAINTENANCE** -  
**TYPE OF PERFORMANCE GUARANTEE** – one year  
**DURATION OF WARRANTY** - 3 years on parts  
**WHO INSTALLS FOR WARRANTY** – home owner can install without any plumbing needed  
**RANGE OF FLOW RATES** – no restriction – signal travels throughout the entire house without flow of water  
**EASE OF USE** -  
**RANGE OF PRESSURE LOSS** - No restriction  
**WHAT CONTAMINANTS REMOVED** – no change in composition of water; clusters of Ca and Mg suspended in water that do not attach to surfaces; also removes preexisting scales  
**WHAT RANGE OF HARDNESS** -  
**DOES IT MEET INDUSTRY STANDARDS** – there are no known standards  
**HEALTH CONSEQUENCES** – no removal of healthy essential minerals; -ve on salt  
**TRACK RECORD** – used by utilities – British Gas for over 20 yrs, PazGaz in Israel; in USA >3 yrs; sold to property management; industrial applications worldwide; tested by Onspex Lab for effect on tankless water heaters  
**REFERENCES** -

## Electric field 2



**CAPITAL COST** – depends on the model; payback in < 1 yr  
**COST OF CONSUMABLES** - Zero  
**COST OF ENERGY** - Zero  
**COST OF REPAIR AND MAINTENANCE** – no moving parts; no maintenance required; visual inspection only to verify current going to units  
**TYPE OF PERFORMANCE GUARANTEE** – 90 days +  
**DURATION OF WARRANTY** - 5 years  
**WHO INSTALLS FOR WARRANTY** - purchaser  
**RANGE OF FLOW RATES** – units to meet the needs of all flow rates  
**EASE OF USE** – one time installation  
**RANGE OF PRESSURE LOSS** - No pressure loss  
**WHAT CONTAMINANTS REMOVED** – biofilm, scale, bacteria  
**WHAT RANGE OF HARDNESS CAPACITY** – models designed to fit all ranges  
**DOES IT MEET INDUSTRY STANDARDS** - yes  
**HEALTH CONSEQUENCES** - none  
**TRACK RECORD** - exceptional  
**REFERENCES** – website of the responder

## Electrolytic 1



**CAPITAL COST** - \$ 4,500 to \$ 6,500

**COST OF CONSUMABLES** – chlorine removal \$ 50/yr; tank module \$ 100/yr; EDI module \$ 150/yr

**COST OF ENERGY** - \$ 85 to 115/yr

**COST OF REPAIR AND MAINTENANCE** – only consumables as noted above

**TYPE OF PERFORMANCE GUARANTEE** – daily output to 300 gpd; minimum 70% reduction of ionic contaminants

**DURATION OF WARRANTY** - 2 yrs pro-rated after 1 full year full warranty on entire EDI system

**WHO INSTALLS FOR WARRANTY** – professional water treatment dealer

**RANGE OF FLOW RATES** – typical system is sized to provide 300 gpd for a family of 4

**EASE OF USE** – home owner would require annual or biannual filter change; EDI module replaced every 2 yrs by service technician; home owner does nothing

**RANGE OF PRESSURE LOSS** – only that associated with pretreatment; pressure is boosted in the recirculation loop slightly to go thru' the EDI system so that pressure in is equal to out

**WHAT CONTAMINANTS REMOVED** – all ionic species

**WHAT RANGE OF HARDNESS CAPACITY** – 10 to 30 gpg

**DOES IT MEET INDUSTRY STANDARDS** – Applying for NSF61 wetted materials parts and WQA electrochemical demineralization protocol. UL electrical cert to be completed in 2013

**HEALTH CONSEQUENCES** – none; EDI process results in lower TDS drinking water in the range of typical bottle waters

**TRACK RECORD** – base technology CDI has been employed in high purity applications for > 20 yrs. Lab and field testing has been underway with raw water for 3 yrs; there is limited release to residential and commercial segments underway

**REFERENCES** – various users; contact the responder

## Electrolytic 2



**CAPITAL COST** - \$ 800 plus freight

**COST OF CONSUMABLES** - Zero

**COST OF ENERGY** - \$ 36/yr

**COST OF REPAIR AND MAINTENANCE** – vinegar 4 times - \$5/yr

**TYPE OF PERFORMANCE GUARANTEE** - none

**DURATION OF WARRANTY** - 1 year

**WHO INSTALLS FOR WARRANTY** – home owner to plumber

**RANGE OF FLOW RATES** – up to 20 gpm

**EASE OF USE** – very easy, just routine cleaning

**RANGE OF PRESSURE LOSS** - < 1 psi at 10 gpm

**WHAT CONTAMINANTS REMOVED** – n/a

**WHAT RANGE OF HARDNESS CAPACITY** – 10 to 50 gpg, but have done to 126 gpg

**DOES IT MEET INDUSTRY STANDARDS** – was listed by IAPMO and ETL

**HEALTH CONSEQUENCES** – tested by NSF to comply per IAPMO

**TRACK RECORD** – conditioner on the market > 7 yrs treating up to 1,000 gpm. Hotels, apt complexes, restaurants, HUD housing, assisted living complexes

**REFERENCES** -

## Media – Template Assisted Crystallization



**CAPITAL COST** – comparable to a traditional ion exchange system  
**COST OF CONSUMABLES** - none  
**COST OF ENERGY** - none  
**COST OF REPAIR AND MAINTENANCE** – lower than traditional systems  
**TYPE OF PERFORMANCE GUARANTEE** – scale potential reduced in the 90% + range,  
**DURATION OF WARRANTY** - 2 yrs on media; 5 to 10 yrs on tank type systems  
**WHO INSTALLS FOR WARRANTY** – water treatment dealer or plumber  
**RANGE OF FLOW RATES** – 1 to 75 gpm and even more with multiple units  
**EASE OF USE** – very simple  
**RANGE OF PRESSURE LOSS** – minimal; no loss due to media bed compression  
**WHAT CONTAMINANTS REMOVED** – scale reduction only  
**WHAT RANGE OF HARDNESS CAPACITY** - up to 100 gpg; higher hardness possible with caution  
**DOES IT MEET INDUSTRY STANDARDS** – certified under NSF 61; meets lead free  
**HEALTH CONSEQUENCES** - none  
**TRACK RECORD** – selling from 2005 of 1000s  
**REFERENCES** – ASU study, testimonials, trade magazine articles

## Media – Nucleation Assisted Crystallization



**CAPITAL COST** - Around 85 - 98 % savings over 12 months, compared to conventional ion-exchange technologies.  
**COST OF CONSUMABLES** - Zero  
**COST OF ENERGY** - Zero  
**COST OF REPAIR AND MAINTENANCE** – only the replacement of the media every 3 to 5 yrs  
**TYPE OF PERFORMANCE GUARANTEE** – clear yellow test  
**DURATION OF WARRANTY** - 3 years  
**WHO INSTALLS FOR WARRANTY** -  
**RANGE OF FLOW RATES** – 0.5 to 180 cubic meters/hour (2 to 750 gpm)  
**EASE OF USE** – very easy  
**RANGE OF PRESSURE LOSS** – none to 0.2 bar in large systems (0 to 8 psi)  
**WHAT CONTAMINANTS REMOVED** - *primary function to convert temporary water hardness to sub-micron carbonate crystal; has strong adsorption capacity for Iron, Copper, Manganese and Lead.*  
**WHAT RANGE OF HARDNESS CAPACITY** – to 75 gpg  
**DOES IT MEET INDUSTRY STANDARDS** - NSF 61; successfully tested for "soap reduction" in Germany and for scale prevention performance in UK.  
**HEALTH CONSEQUENCES** - positive  
**TRACK RECORD** –  
**REFERENCES** - Malta

## Where are we now?



## In simple terms

1. Most non-ion exchange water treatment devices can only reduce scale.
2. In most cases, these devices offer this benefit without negative health consequences. These are not softeners due to not taking anything out.
3. There are exceptions, however, to the above statements.
4. Certain non-ion exchange technologies can deliver more at higher capital cost.
5. Many of the suppliers, however, do not understand the scientific principles behind even their own devices.
6. Yet, much of the writings, promotional and marketing efforts by the suppliers of non-ion exchange devices have focused on the negative aspects of salt or chemical using water softening devices and types of non-ion exchange devices other than their own.
7. The above has led to the end buyers becoming confused and suspicious of even the devices that are credible.
8. Non-ion exchange devices fulfill our quest for solutions that meet the sustainability and going green goals of this planet. And this is the most significant driver in growing the market size for this industry.



## Where do we go from here?



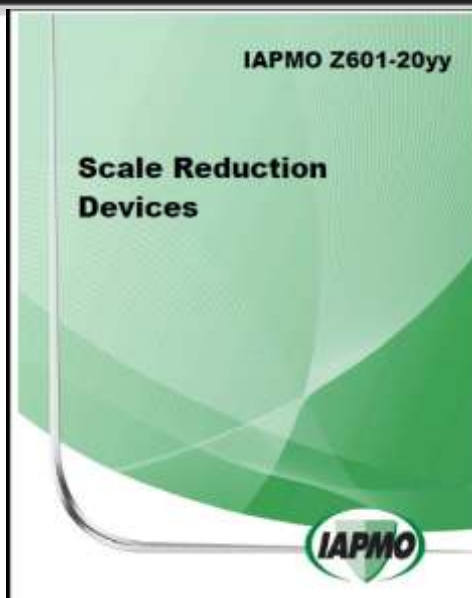
### Constructive Objectives 1

1. Focus more on the merits of your own device.
2. End buyers do not care about what you think of someone else's technology.
3. Suppliers of non-ion exchange devices needing a trade association of their own is a bad idea. Given the fragmentation, if only 2 left, there would be 3 trade associations.
4. Leaving WQA also is a bad idea. Change is brought about by being on the inside.
5. Highly talented engineers and scientists need to invest time and resources into meeting goals that would benefit the non-ion water treatment device industry en masse' and their customers.

## Constructive Objectives 2

6. Non-ion exchange device industry needs a series of consensus standards through IAPMO, WQA, NSF, or ASTM International.
7. These standards can cover materials, products, performance, testing, inspection, installation, practice and other.
8. Non-ion exchange device suppliers need to invest more into certifying and independent validation testing that are based on sound science.
9. Counting on placebo effects to satisfy the home owner would only lead to more consumer lawsuits.

## New Standard



## Z601 Subcommittee on Scale Reduction Devices

D.E. Parke, IWP, *Chair*

R.P. Regunathan, ReguNathan Associates, Inc., *Vice-Chair*

A.I. Murra, IAPMO Research and Testing, Inc., *Secretary*

A. Aspenson, Hankscraft H2O Products

M. Brotman, Kinetico Incorporated

M. Davis, Inland Empire Utilities Agency

P. Fox, Arizona State University

S.H. Fox, Next Filtration Technologies, Inc.

G. Gruett, Water-Right Incorporated

J. Harrison, Water Quality Consulting

R. Herman, NSF International

J. Im, Inland Empire Utilities Agency

J.K. Jeyapalan, Civic Enterprises, LLC

S. Murphy, Watts Premier

K. Myhre, EcoWater Systems, LLC

T. Palkon, Water Quality Association

H. Parker-Morrison, U.S. Environmental Protection Agency

J. Seccombe, Lifescience Products Ltd.

R. Slovak, Next Filtration Technologies, Inc.

S. Tanner, U.S. Environmental Protection Agency



## What is in the IAPMO Z601 Standard?



- 0.1** Although several physical water treatment devices have the potential to offer solutions to consumers' need for scale reduction, lack of an appropriate test protocol that can be used to certify their effectiveness has slowed their adoption.
  
- 0.2** This Standard is written to enable testing of devices that have the potential to reduce scale in water in a wide variety of residential and similar applications and associated plumbing. To encourage competition among manufacturers for the benefit of consumers, the definition of a "device" has been intentionally left open so that any means or methods with the effect of reducing scale can be tested for their effectiveness. This approach makes it possible to test a variety of devices including those based on permanent magnetic, electromagnetic, electric, electrolytic, capacitive, catalytic, media, chemical ion exchange technologies, and other emerging technologies.

- (a) First, the four-station test apparatus is tested without any test specimens, to establish the similarity of scale production in each station (i.e., the calibration test).
- (b) Next, the specimens are conditioned for testing.
- (c) Two test specimens are connected to two of the four stations and tested for 20 days, simulating the use in a household, using water with a hardness of  $342 \pm 34$  mg/L ( $20 \pm 2$  gpg) and natural elements that would be present in most tap waters.
- (d) Finally, the scale produced in the two test stations is compared to the scale produced in the two control (untreated) stations. The scale produced must be less than 20% of the scale produced in the control (untreated) stations for acceptance. In addition, to validate the test each time it is run, the scale produced in the control (untreated) stations is compared to the scale produced in the original four-station calibration test conducted to validate the similarity of their scale production at the beginning.



## Electrolytic scale reducers



*Limescale can be controlled by the use of chemical limescale inhibitors, combined corrosion and limescale inhibitors, polyphosphate dosing, electrolytic scale reducers or water softeners.*

“Limescale can be controlled by the use of chemical limescale inhibitors, combined corrosion and limescale inhibitors, polyphosphate dosing, **electrolytic scale reducers or water softeners.**”

## Choose your advocates carefully



1. Non-ion exchange devices are also called “physical water treatment devices.”
2. Thus, most of the principles are from physics and not from chemistry.
3. The scientific writings by physicists have always been supportive of this industry.
4. The literature, however, is filled with negativity and suspicion of this industry by those who understand only chemistry.
5. Therefore, I suggest that you choose your advocates carefully.

## Once upon a time



1. There was a trickster in a village who won against all but a sage.
2. The sage finally decided to accept the challenge.
3. The trickster was holding a bird behind his back and asked the sage “tell me whether the bird is alive or dead?” while thinking “I will squeeze the bird hard until it stops breathing if the sage says ‘it is alive’ but gently pat the bird if the sage says ‘it is dead.’ ”
4. The sage rubbed his silver beard and responded “how do I know – the bird is in your hands.”
5. Whether the non-ion exchange water treatment industry thrives or not is solely in the hands of this industry.

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# Thank you.

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