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Carbon Care Solutions

# NON-CHEMICAL WATER TREATMENT



Carbon  
Care  
Solutions

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# **WATER PROBLEMS**

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# THE TOUGHEST, UNDESIREED COMPONENTS AND POLLUTANTS IN WATER PIPES



Hard water and scale



Corrosion and rust



Bacteria and algae

# HARD WATER

## What is it?

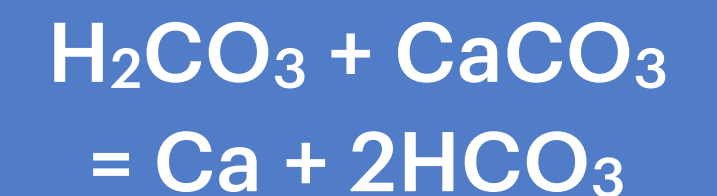
- Water with a higher content of alkali earth (Calcium & Magnesium) bicarbonates
- Prevents soap from lathering due to the development of an insoluble precipitate in the water
- The main problem associated with the use of hard water is 'scale'



# HARD WATER

## How does it form?

- As ocean water evaporates, clouds are formed - which condense and precipitate rain
- When the rain falls, the water encounters carbon dioxide and reacts with it to form **Carbonic Acid**
- As a result, when rain water comes into contact with limestone in the earth it dissolves it, and the limestone solution is mixed with the water



Surface waters also encounter carbon dioxide from the decay of organic materials.

As these waters contact limestone, the stone gradually dissolves and goes into the solution






# SCALE

## What is it?

- A precipitate deposited on surfaces that are in contact with water
- Forms rocklike deposits inside and/or on water pipes and equipment which could cause:



-  Reduction in the flow-rate (it may require increased pressure to maintain flow)
-  Reduction in the efficiency of heat exchangers (as it acts as an insulator)
-  Increased costs associated with operating systems using water conduits

# SCALE

## How does it form?

### Supersaturation

High saturation index enhances scale formation:



### Temperature

Increased temperature decreases solubility of  $\text{CaCO}_3$ , and enhances scale formation

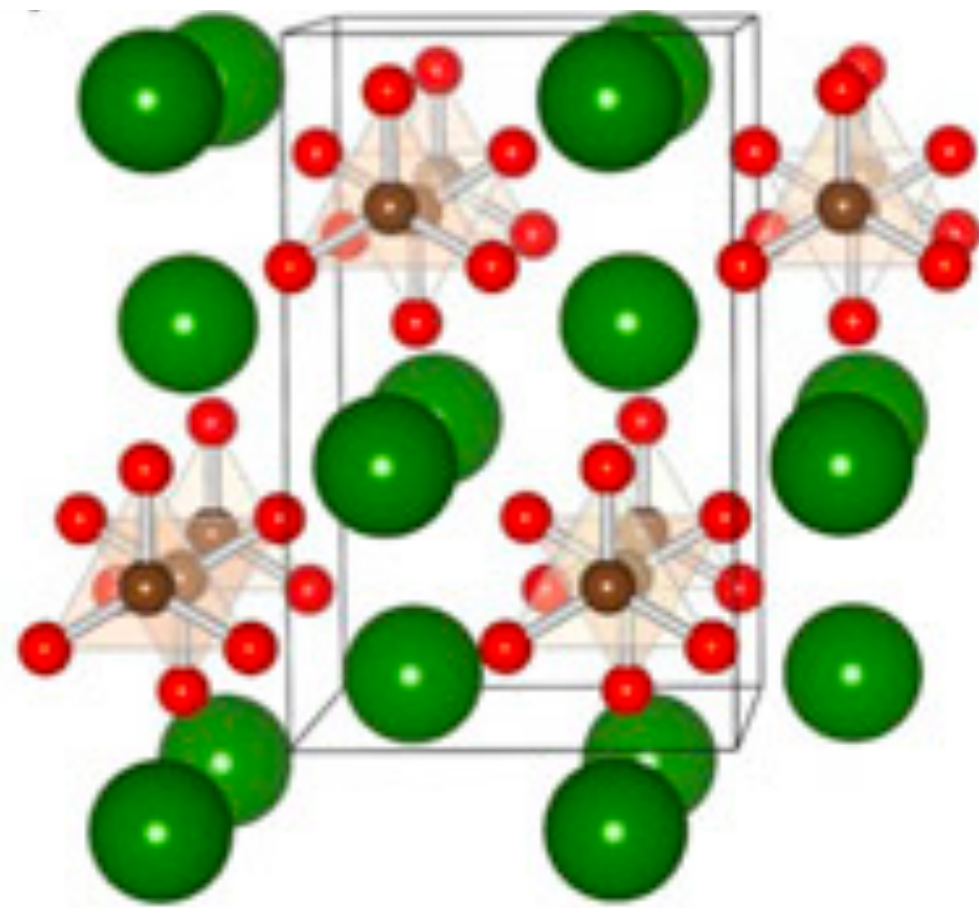
### PH

Increased pH decreases solubility of  $\text{CaCO}_3$ , and enhances scale formation

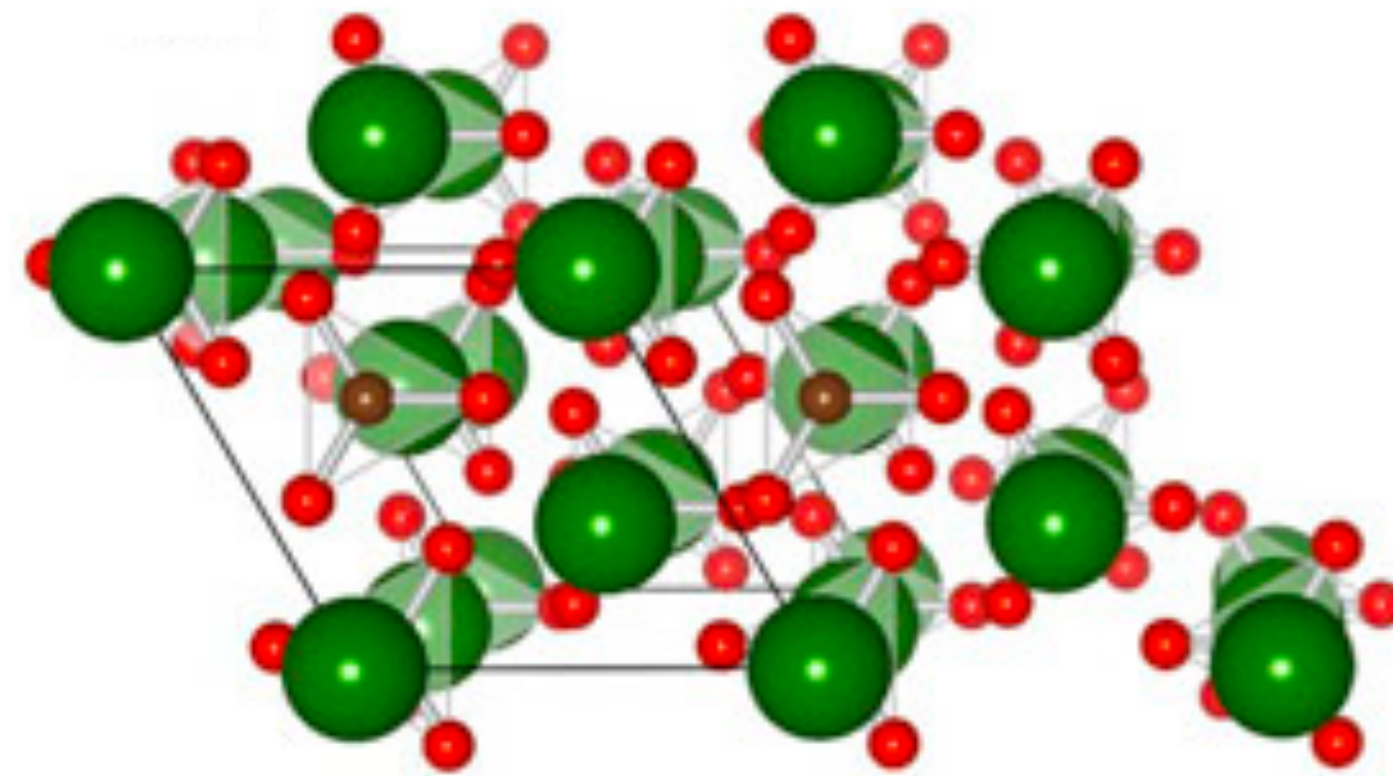
Plus pressure and organic processes

# SCALE

## CaCO<sub>3</sub> Crystal Forms



Orthorhombic  
Aragonite



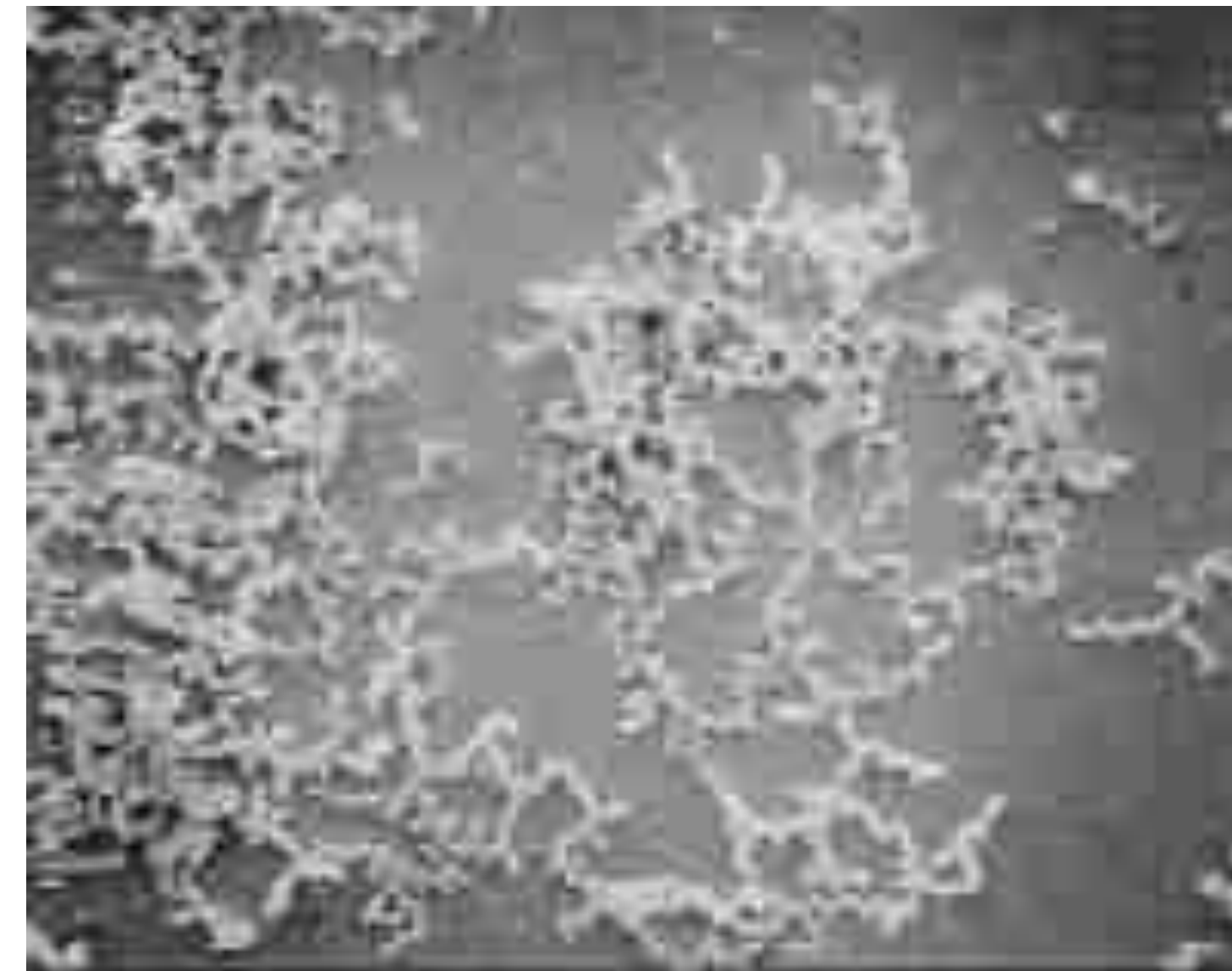
Hexagonal  
Calcite

- Limescale is only a problem if calcium carbonate precipitates as **hexagonal calcite crystals**, which need a surface to precipitate upon
- **Orthorhombic aragonite crystals** are 19x more soluble than calcite - so less prone to form hard scale. Aragonite may nucleate in solution and form a soluble substance, which does not adhere to surfaces



# SCALE

Electron microscope photographs for water samples with (left) and without (right) scale



Magnification 2000x

# CORROSION

## What is it?

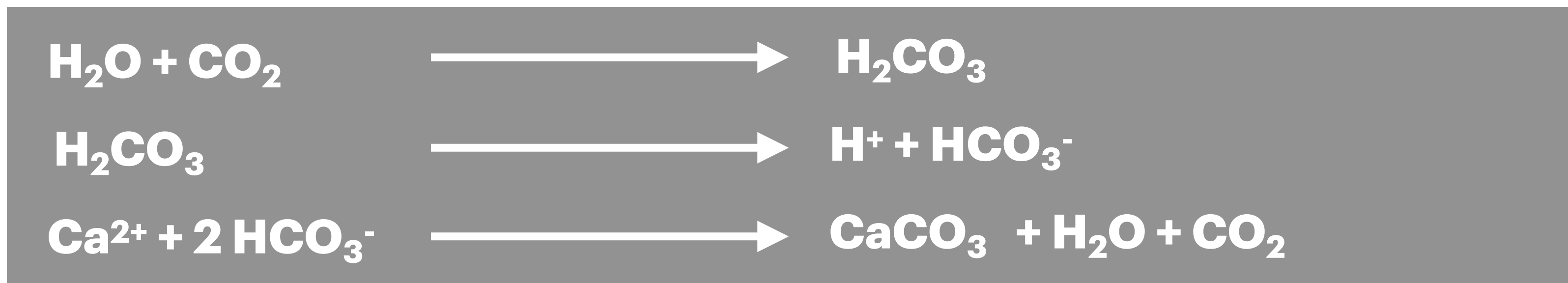
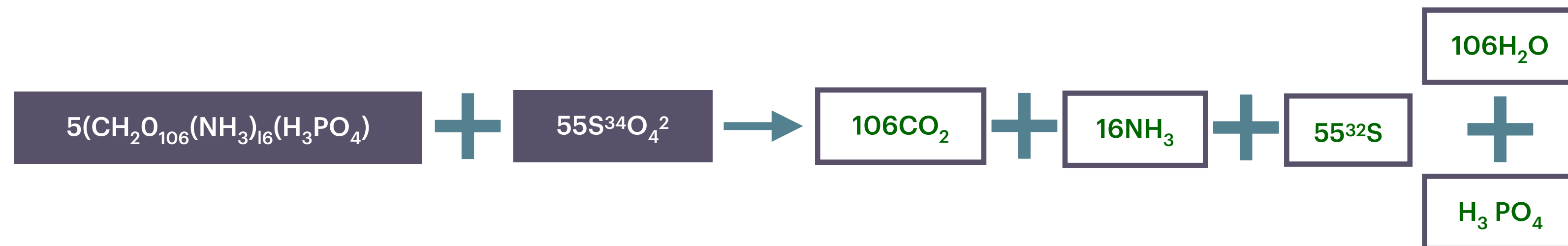
- The result of some bacterial and/or chemical reactions inside pipes
- Rust is a combination of trivalent iron with oxygen i.e. ferric oxide ( $\text{Fe}_2\text{O}_3$ )
- Corrosion leads to biting in water pipes, which can mean great maintenance costs



# BACTERIA

## Sulfate Reducing Bacteria (SRB)

In pipes, SRB can be catastrophic by enhancing scale, poisoning water, and causing pipe biting



# BACTERIA

## Infectious bacteria, algae and viruses

- These include pathogenic (disease producing) bacteria, viruses, algae and protozoans (micro-organisms)
- These organisms constitute a major problem for drinking water portability



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# **WATER TREATMENT**

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# WATER TREATMENT

## What is it?



The process of making water suitable for its different applications and uses via physical, chemical and/or biological methods including:



➤ The removal of scale and water hardness (water softening)



➤ The prevention of corrosion of water pipes

➤ The removal of bacteria, algae and other organic compounds



# SCALE REMOVAL

## Comparing different methods



### Chemical

- Flushing out the system with acid
- Corrosive (early renewal of piping)
- Bad for the environment
- Plant shutdown needed
- Recurring expenses

### Mechanical

- Labour intensive
- Plant shutdown needed
- Recurring expenses

### Physical

- Environmentally friendly
- No corrosion
- No plant shutdown needed
- One-time investment
- Capital equipment lasts longer

# PHYSICAL METHODS



## Advantages and disadvantages

### Electrolysis

- Static electric field
- Invasive
- Low-effectiveness
- Electrodes corrode and will have to be renewed

### Magnetic

- Restricted use (not suitable for large pipes)
- Needs technical filter up-stream
- Low effectiveness
- Environmentally friendly

### Electromagnetic

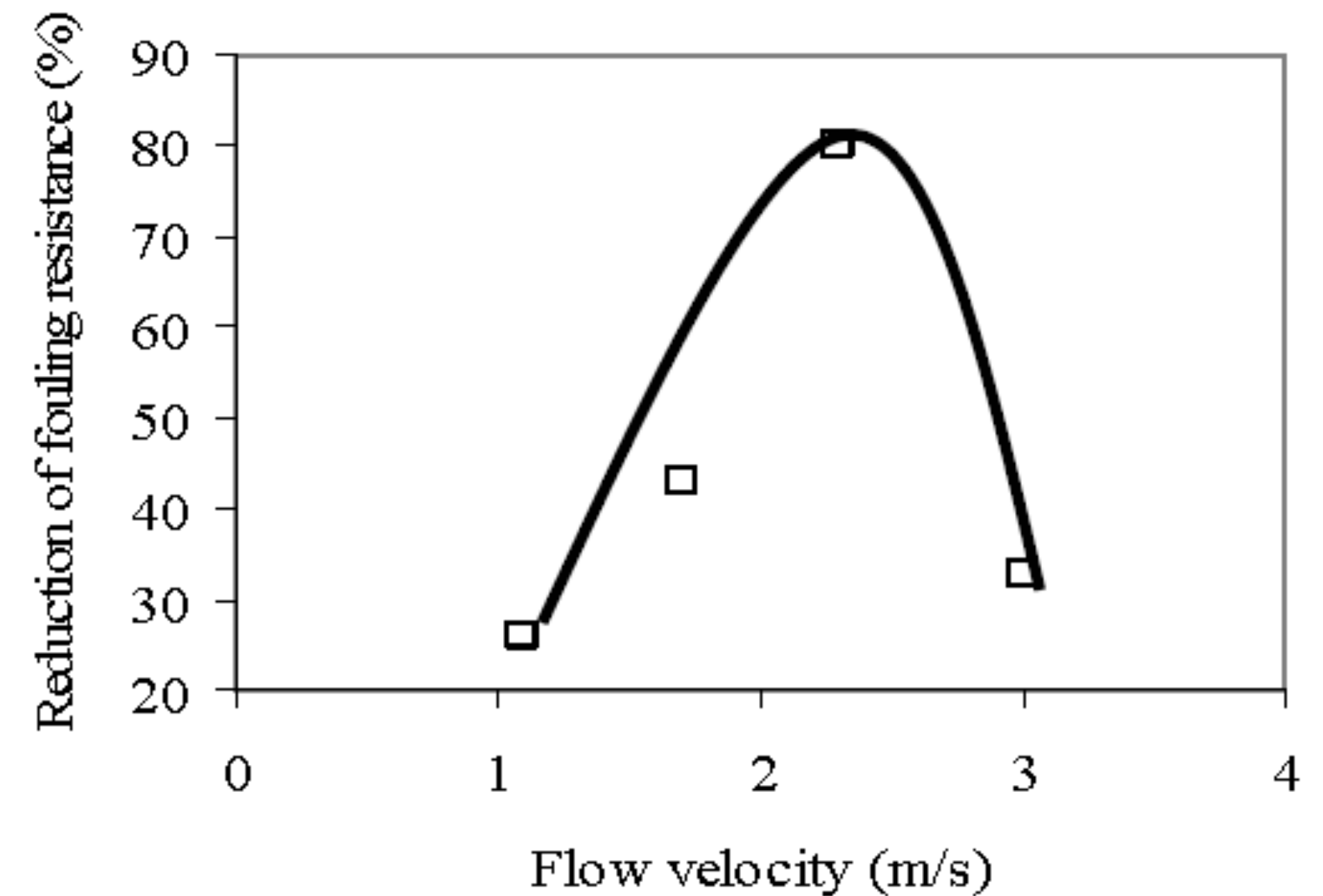
- No filter up-stream required
- No chemicals needed
- No maintenance
- No pollution
- No restrictions in pipe size
- Life span of 20+ years
- Removes old carbonate scale layers
- Environmentally friendly



# PHYSICAL METHODS

## The issue with 'simple' magnetic treatment

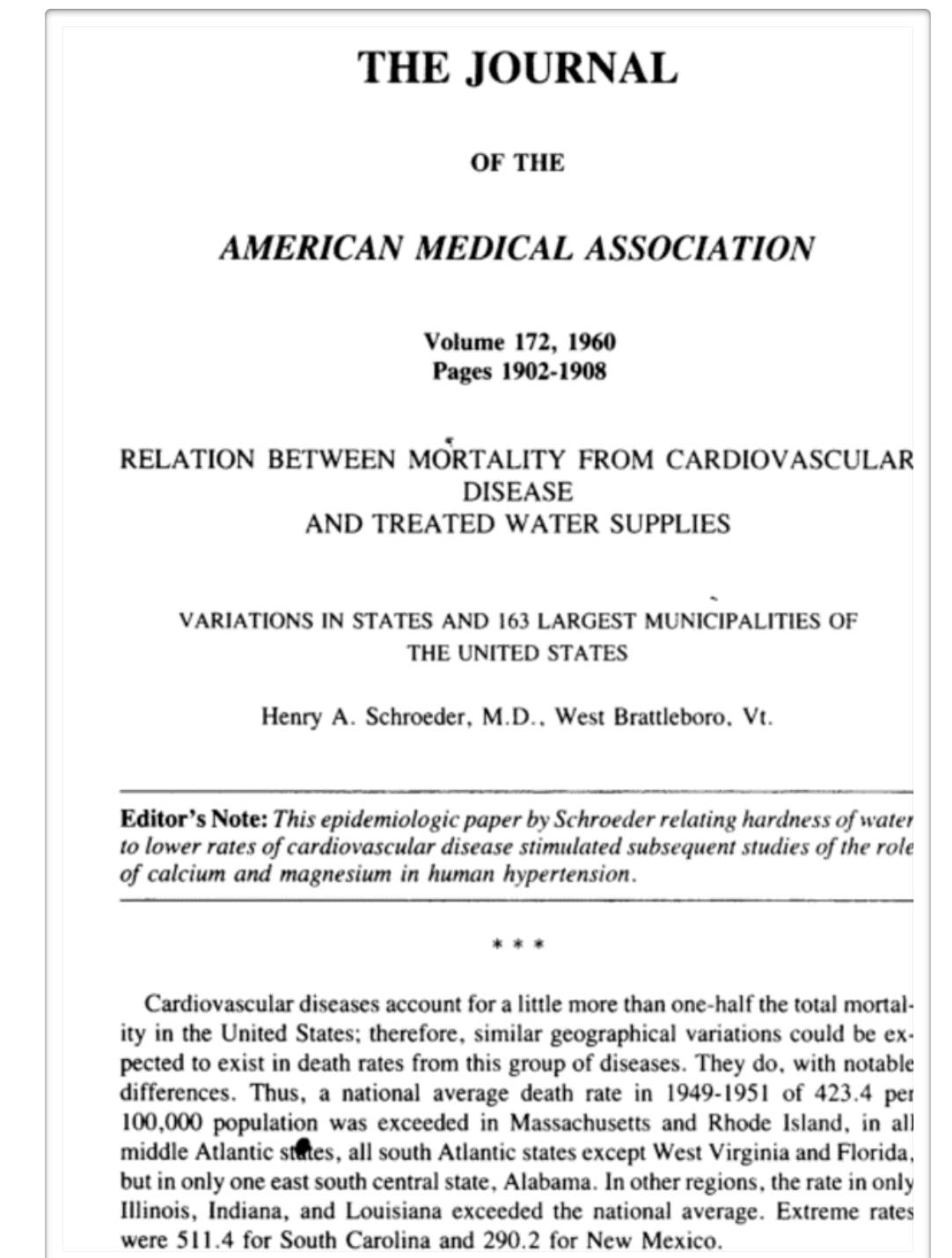
- This graph shows magnetic treatment results compared with the rate of flow of water through the magnet
- Flow rate is critical - and ideal at 2.3m/s in this application. Electronic waveforms developed by Carbon Care Solutions do not suffer from this limitation



# WATER SOFTENER ISSUES

As well as cost and corrosion, there are hidden issues

- The Water Regulations Advisory Scheme (WRAS) recommend that where water needs to be softened (salt, resin, ion exchange), a separate non-softened supply be fitted for drinking water
- In 1960, Schroeder studied the relationship between cardiovascular disease and treated water supplies, concluding that the calcium and other minerals in hard water were responsible for higher death rates in areas of softer water
- Other studies show sodium present on water from salt softening can cause hypertension and other health issues



# BACTERIA CONTROL

## Comparing methods



### Chlorination

May be harmful for health  
May always add  
disinfection byproducts  
(e.g. trihalomethane like  
chloroform)

### Ozonation

Can create undesirable  
byproducts that can be  
harmful to health (e.g.  
formaldehyde and  
bromate)

### Ultraviolet (UV)

Not suitable for water  
with high levels of  
suspended solids,  
turbidity or soluble  
organic matter



Corrosion is also typically treated using chemicals

# CARBON CARE SOLUTIONS

**Natural and effective water treatment for: scale removal and water hardness; corrosion and rust; and bacteria / other harmful organisms**

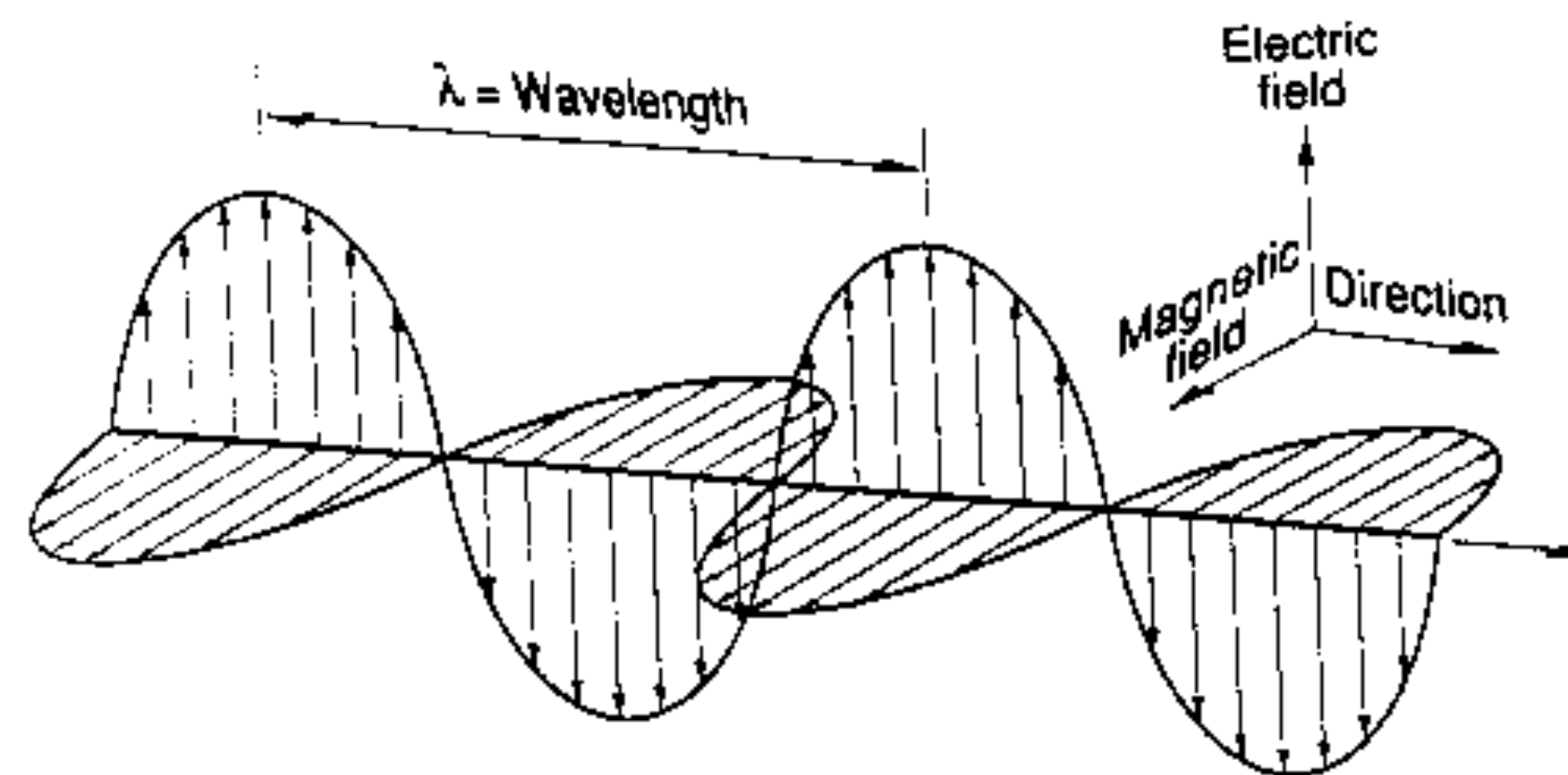
As you have seen, conventional solutions may themselves lead to extra problems. Our electronic equipment uses a natural (physical) phenomenon leading to:

- ✓ Reduced maintenance expenses
- ✓ No undesired hard-scale in pipework
- ✓ Extended equipment life
- ✓ No more chemicals
- ✓ Bacteriological control
- ✓ Reduced corrosion
- ✓ Improved water texture
- ✓ No reduction in heat exchange efficiency
- ✓ Easy installation
- ✓ Suitable for all types of pipes
- ✓ Environmentally friendly
- ✓ Payback typically within 3-12 months

# CARBON CARE SOLUTIONS

## How does it work?

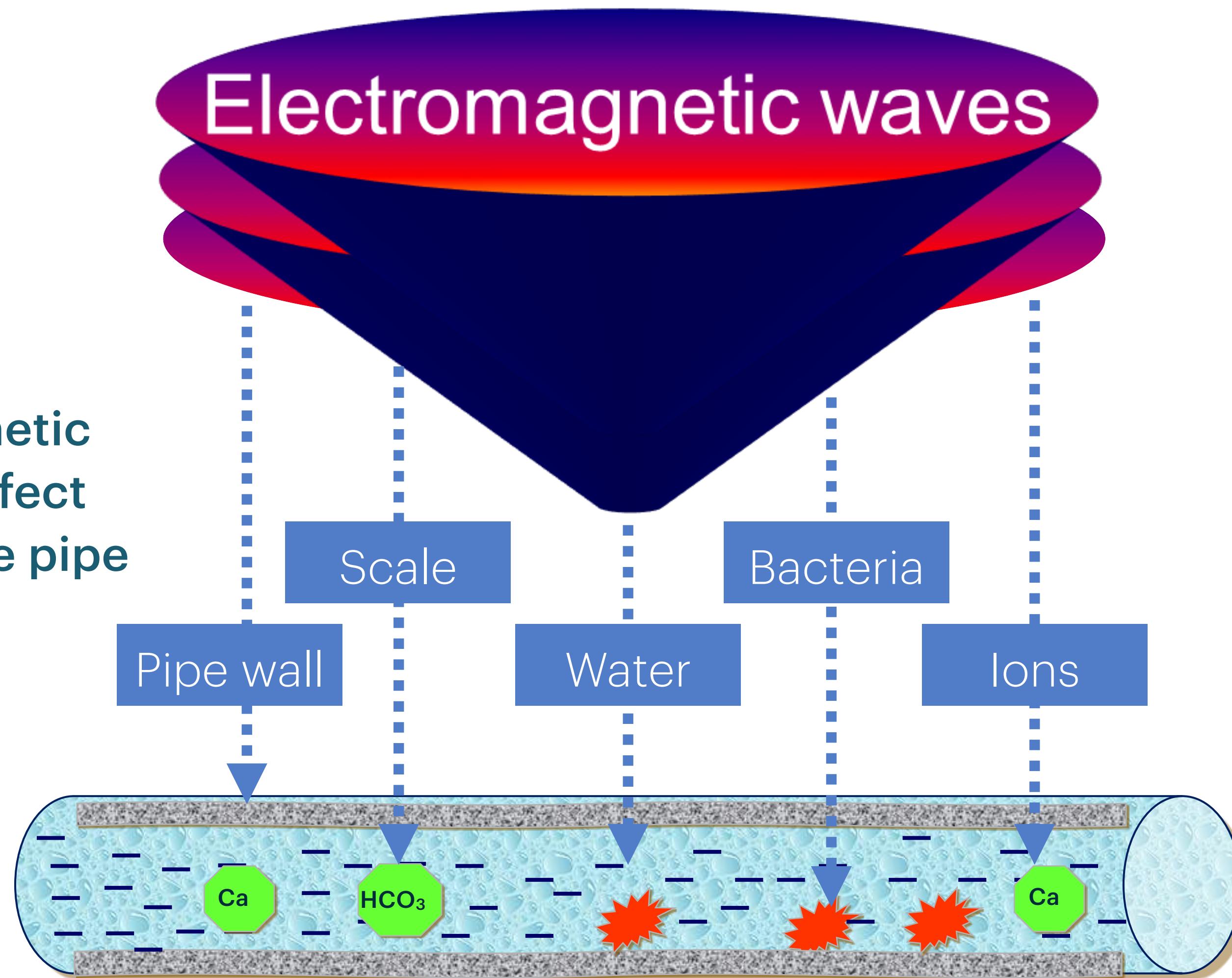
Our microprocessor-based device creates a specially designed electronic waveform to generate a varying electromagnetic field through the inductor coil unit. This is wrapped around the supply pipes, and the electric field penetrates the pipe to apply forces to the dipole moments of the water molecules



# ELECTROMAGNETIC WAVES

- Polarity changes from positive to negative many thousands of times per second
- Discrete pulses generate frequencies varying from 1,000 cycles per second to 21,500 cycles per second: a wave of frequencies wide enough to affect the water and the materials in the water over a wide range of pipe sizes
- Amplitude is varied up to several amps on larger models, with a unique spectral density to ensure the correct power exposure at each pulse frequency
- This means that the water molecules and the material in the water are being subjected to a wide range of electric field forces

Induced electromagnetic waves will exert an effect on the contents of the pipe



# PREVENTING SCALE FORMATION

## 1

The alternating / switching directions of the Electromagnetic Multi-Frequency Fields uniquely created by our **Digital Descaler** rotate the ionised calcium and bicarbonate molecules towards alignment with the changing field.

## 2

This rotation for alignment agitates and breaks the bonds between the molecules and bonded water molecules





# PREVENTING SCALE FORMATION



## 3

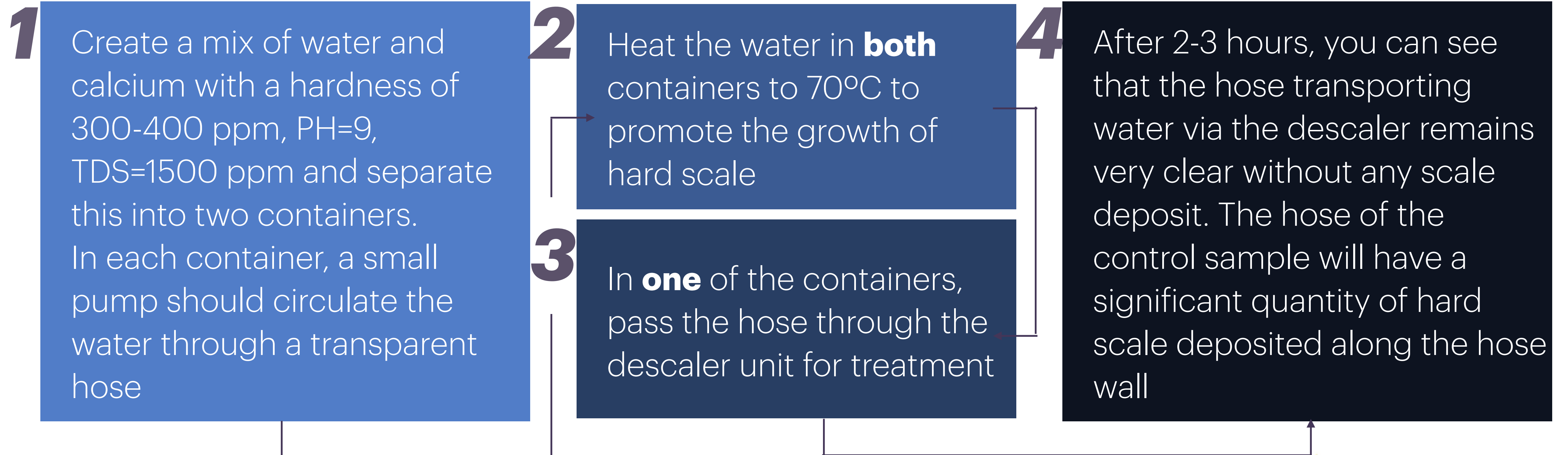
The oppositely-charged ions (i.e.  $\text{Ca}^{2+}$ ,  $\text{HCO}_3^-$ ) are forced to move in opposite directions, producing collisions. With the correct collision velocity, microscopic seed nuclei will form that cause the calcium carbonate to precipitate within the water as **aragonite** rather than on the pipe surfaces as hard, insoluble **calcite**

## 4

When the Ca and  $\text{HCO}_3$  ions are freed in solution they combine to form aragonite - not calcite because only aragonite polymorph can be formed at this higher energy level: collision velocity is the key

# ELECTROMAGNETIC DESCALING

## A simple experiment



Note: treatment is easy in small pipes in test conditions.

Carbon Care Solutions regularly treat pipes of up to several feet in diameter.



# WHAT WILL YOU NOTICE?



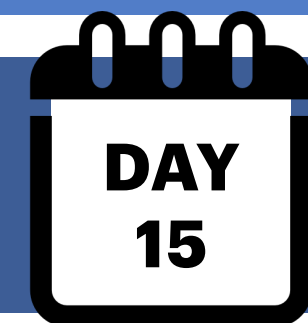
The scale immediately starts to soften in the complete hot and cold water system. People often notice an immediate difference with skin feeling softer and hair more silky



Scale begins to come off the boiler immersion heater. Small particles may be seen in the water from a "hot" tap.



It should be noticeably easier to wipe clean ceramic, plastic, glass and metal surfaces. By now you should have reduced the quantity of foam oils used in the bath, softening agents in the washing machine, and washing up liquid. Scale should be starting to soften on the shower pipe and rose and in the kettle if it is used frequently.



Scale should be flaking off the element of the kettle and shower rose if frequently used. The thermostat for water boilers can be turned down, and a better water flow should be experienced throughout the water system.



Scaly crusts in a WC and under taps in the basin will be easier to remove. No new stain or crust should form, slight calcium residues may form but these will easily wipe off. Mould will begin to disappear on your shower curtains and will not reappear if cleaned off. Your hot water thermostat can often be turned down yet again.

Gradually, as the existing scale is removed from the fibres of clothes in the wash, they will retain or recover their natural colour and softness. Depending on the location, amount of scale and amount of hardness the full effects can take up to 12 weeks and sometimes longer.



# SCALE REMOVAL

- Calcium and bicarbonate ions are removed from water in the form of inert aragonite
- As a result, the water loses some of its alkalinity and becomes undersaturated with calcite
- This makes the water capable to attack the old scale surrounding the pipe wall, and dissolve it



# RUST / CORROSION REMOVAL

- The induced stream of electrons transform trivalent iron into divalent iron
- Rust particles are dislodged and flushed out until a protective film of saturated ferrous oxide is formed inside the pipe



# BACTERIA REMOVAL

- Alternating and pulsed electromagnetic fields have been shown to **inhibit** bacterial growth (Smith et al 1993)
- This is in contrast to strong magnetic fields, which have been shown to **enhance** the growth of Escherichia coli structure (Okuno et al 1993)
- It has also been proven that scale is an optimum substrate where bacteria (e.g. SRB) live, so removing scale using Carbon Care Solutions will provide an environment no longer suitable for bacteria to live



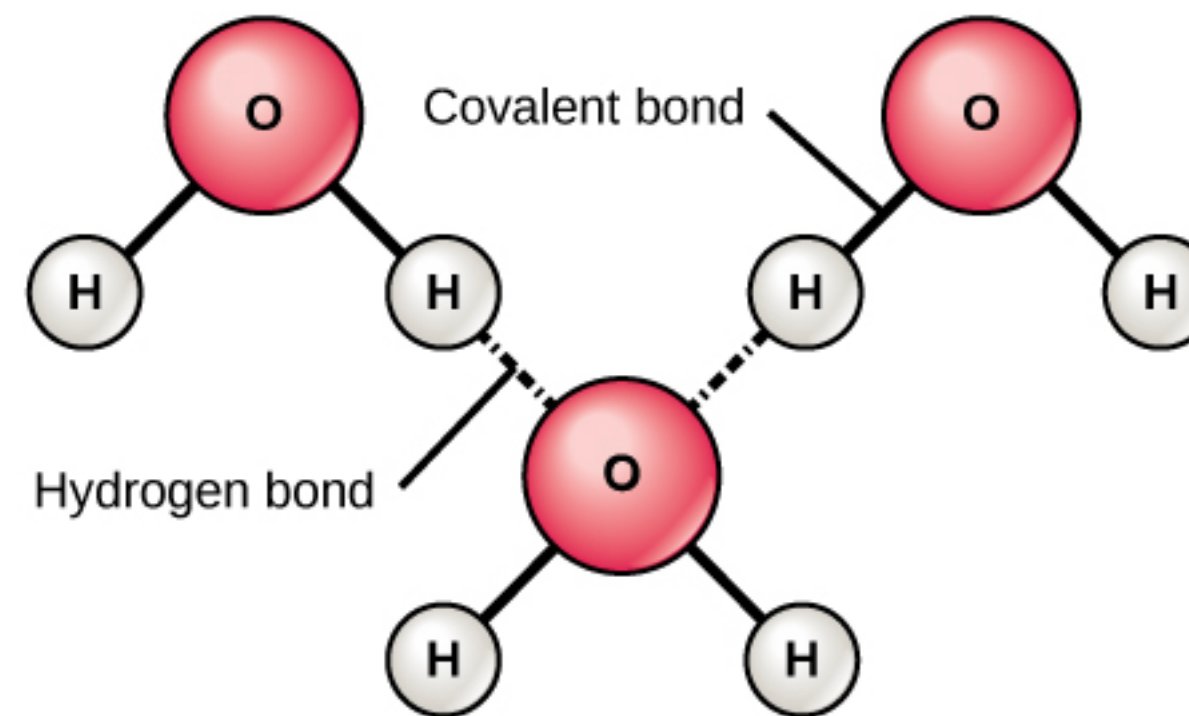
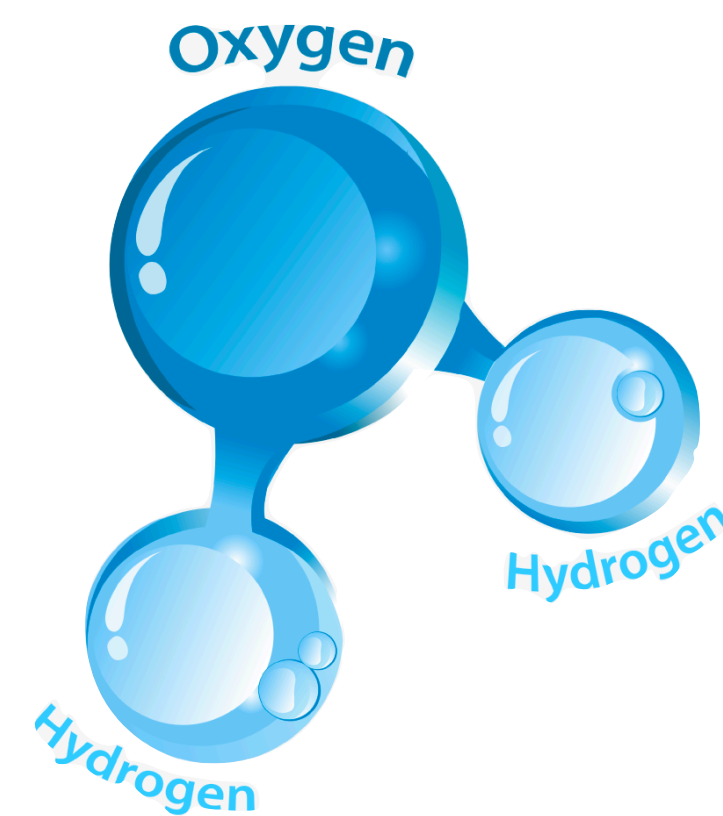
# BACTERIA REMOVAL

- Sonic audio compression waveforms have also been shown to disrupt the biofilms surrounding bacteria to expose the membrane surface aiding better cell wall permeability
- Ayrapetyan in 1994 proposed that Magnetic and Electric fields alter the ion polarity surrounding a cell, increasing the cell membrane permeability
- Carbon Care Solutions offer both electromagnetic and sonic compression fields, both enhancing disinfecting properties as bactericides like chlorine more quickly permit the cell walls



# EFFECT ON WATER MOLECULES

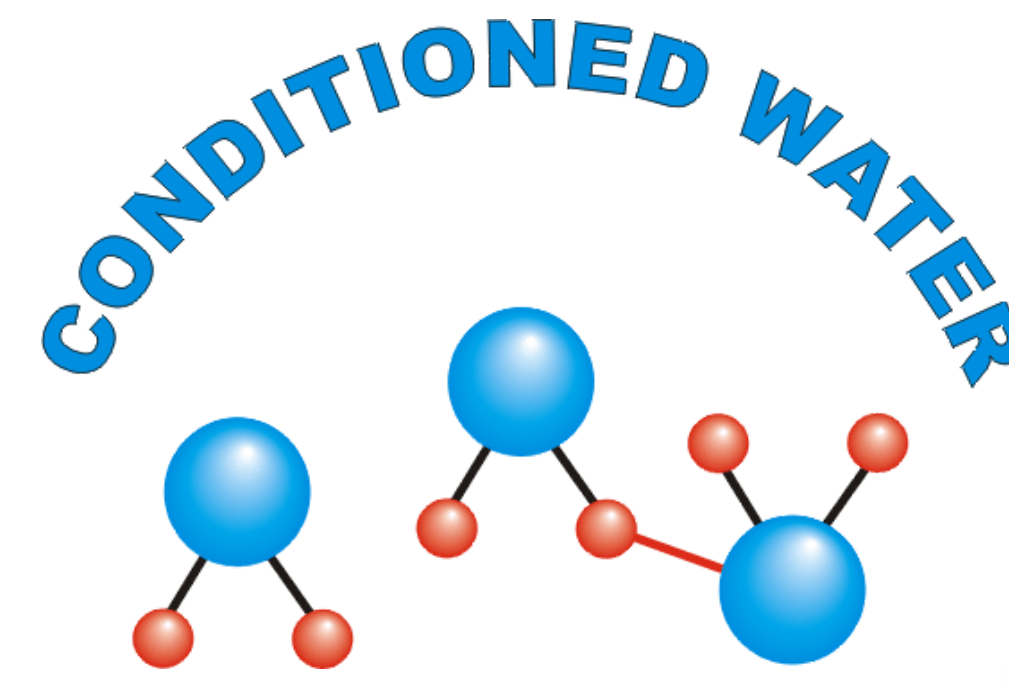
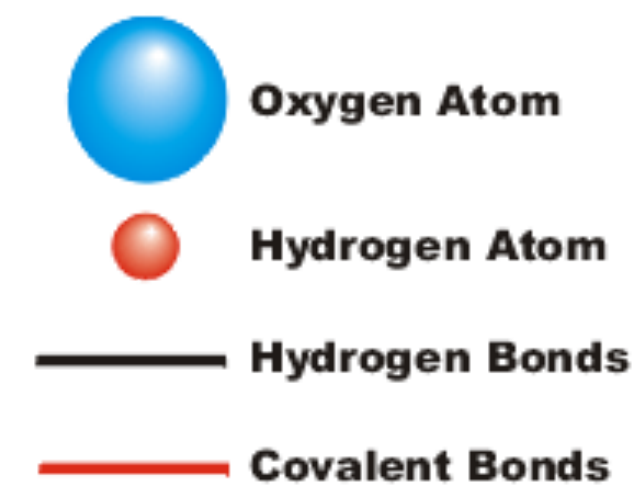
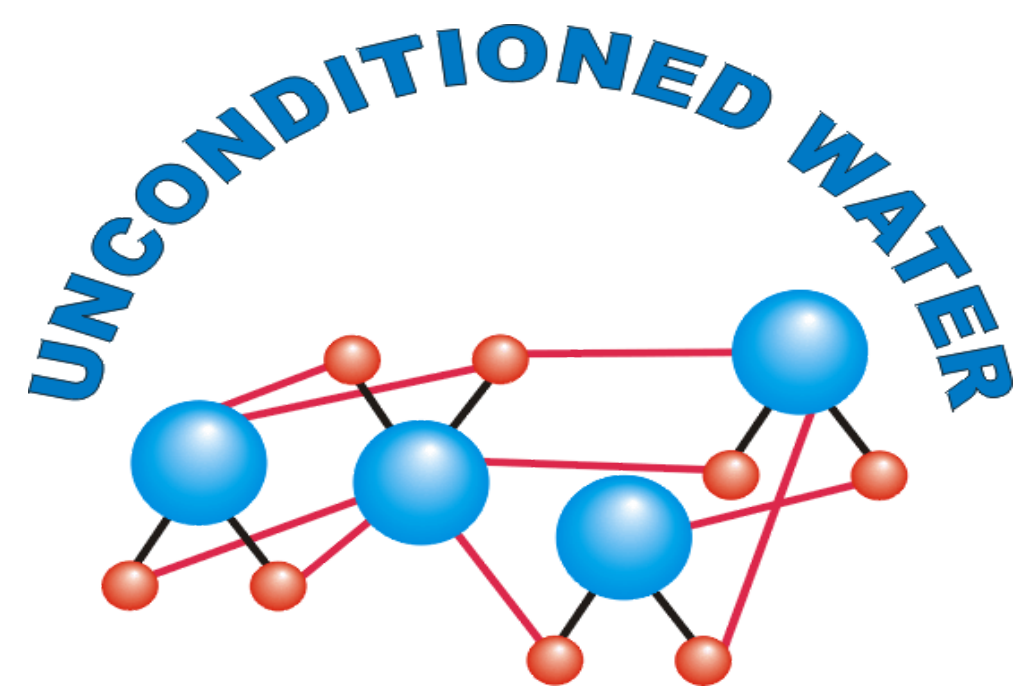
- $\text{H}_2\text{O}$  molecules link up to each other because of the dipole nature of the individual  $\text{H}_2\text{O}$  molecules
- There is a trade-off between the covalent and hydrogen bond strengths: the stronger the H—O hydrogen bond, the weaker the O-H covalent bond, and the shorter the O—O distance
- Electromagnetic fields may affect the bonding strength, with bonds breaking due to the more energetic state





# “WETTER” WATER

- “Wetter water” is the result of reduced covalent hydrogen bonding between adjacent water molecules
- The surface tension will be reduced by approximately 8% and separated water clusters may be formed
- “Wetter water” is more reactive. It enables soap and detergent to break up into smaller groupings and interface with the smaller H<sub>2</sub>O groupings, as well as allowing chemical reactions to take place more quickly, and increase thermal transfer



# IN SUMMARY

Carbon Care Solutions water treatment can lead to:



Disintegration of existing **hard scale** in pipelines / equipment



No **corrosive** pipes



Cleaner system resulting in lower **bacteria** level

As well as a saving in energy consumption, and regulating heat exchange due to scale prevention and removal

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# **APPLICATIONS**

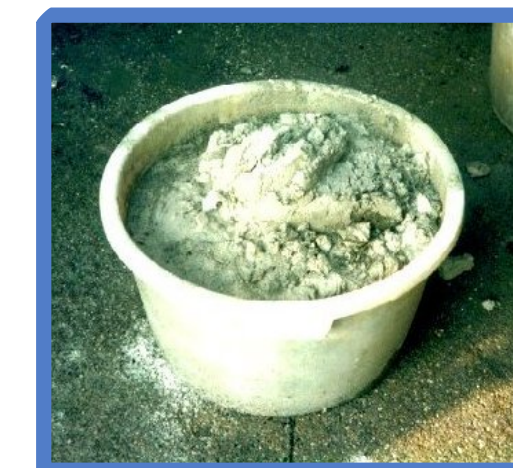
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# COOLING TOWERS

It takes only 3-6 months to dissolve 2 tons of solid impurities from the coiler in a cooling tower after installation of our chemical tree water treatment

- ✓ Enhanced bacteriological control
- ✓ Reduced scaling
- ✓ Enhanced heat transfer
- ✓ No expensive chemical additives
- ✓ No environmental pollution
- ✓ Payback generally in less than 8 months

Plus, the reduced water surface tension increases dispersion of the water drops, leading to a better heat exchange and cooling effect



*Dissolved deposits removed from cooler within just 4 weeks*

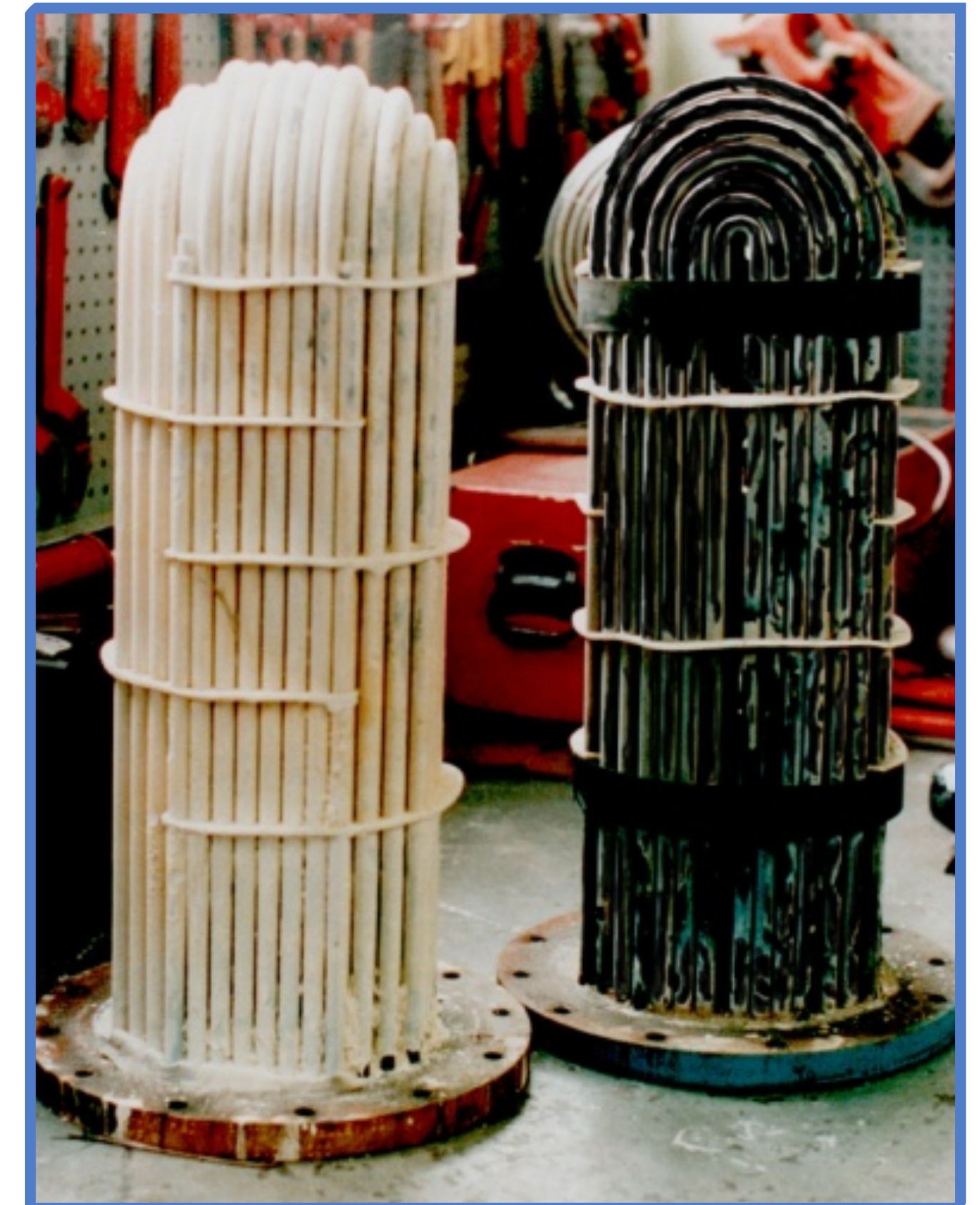
# BOILERS

- ✓ No more fouling
- ✓ Bacteriological assistance
- ✓ Reduced scaling
- ✓ Enhanced cleaning
- ✓ Reduction in chemical uses



# HEAT EXCHANGERS

- ✓ Reduced calcite
- ✓ Reduced scaling
- ✓ Enhanced thermal heat transfer
- ✓ Fouling elimination



# DRINKING WATER

✓ No bacteria    ✓ No impurities    ✓ Less chlorine

Even distilled, bottled water you purchase will eventually have some CO<sub>2</sub> from the air dissolved in it, forming a weak acid (carbonic acid)

Calcium and Magnesium are considered undesirable contaminants for forming scale inside water pipes

In the USA in 1994-5, there were 3,641 water purification utilities that reportedly violated the federal health standards for feral bacteria contamination



# AGRICULTURAL

“Wetter water” penetrates soil better and faster, and the salt and scale-dissolving properties of treated water increase its ability for leaching away excess salinity accumulated in the soil

- ✓ Healthier and stronger plants
- ✓ Faster growing plants without genetic modification





# CONCRETE & CEMENT MANUFACTURING

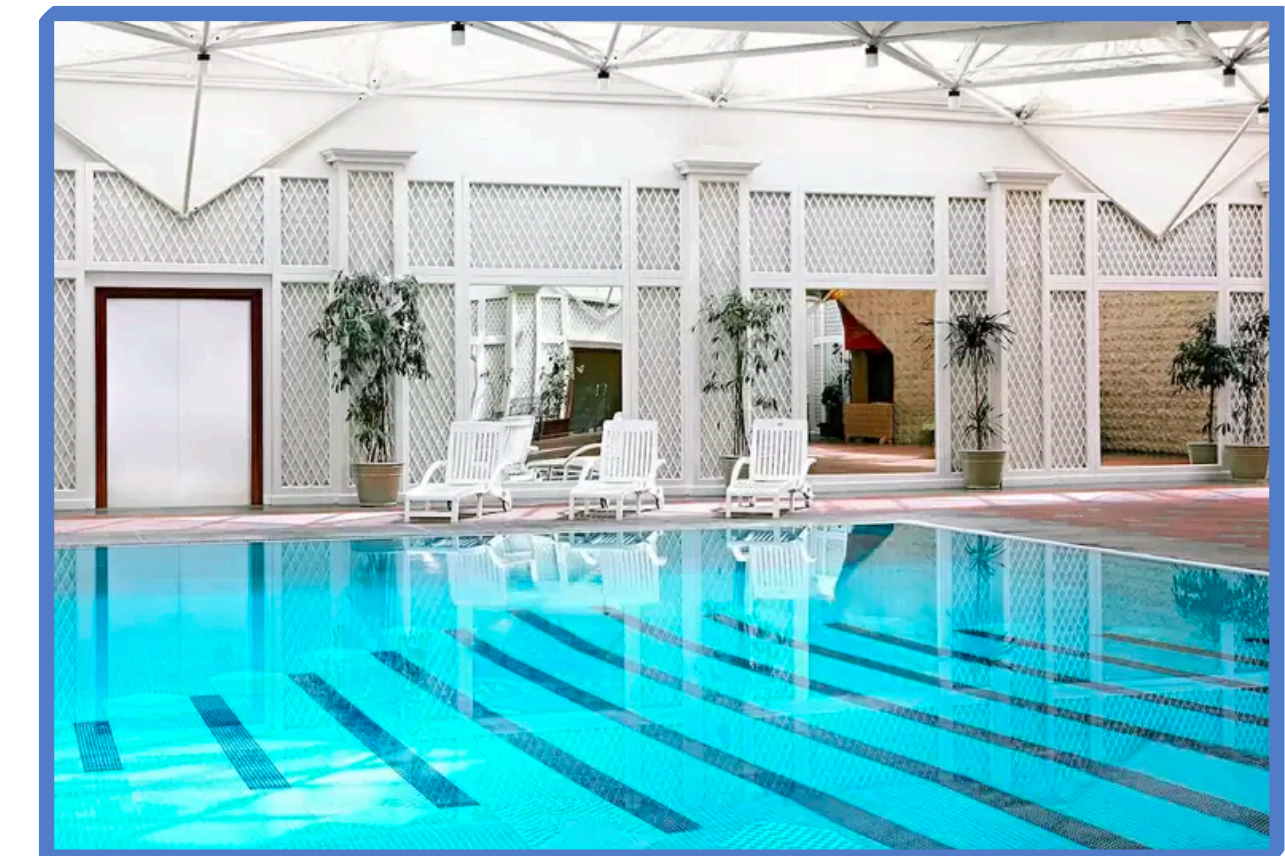
- ✓ Up to 12% stronger concrete
- ✓ Less water required
- ✓ Less shrinkage
- ✓ Less additives required
- ✓ Increase the consistence volume by 3-6cm



# SWIMMING POOLS

Three different areas of the Sheraton Hotel and Towers in Riyadh were fitted with anti-scale units: the main water supply to the guest rooms, kitchens, laundry etc; the calorifier room, and the swimming pool

- ✓ Overall water in pool improved
- ✓ Scum deposits removed from around pool edge
- ✓ Steel fittings return to former pristine condition
- ✓ Limescale removed from within swimming pool plant
- ✓ Stabilizers no longer required to correct pH balance
- ✓ Cleaner shower heads
- ✓ Less chlorine usage



# HUMIDIFIERS

Anstan Technologies in South Africa recommend the use of Carbon Care Solutions as a retro-fit to all their existing 5000+ customers, and have specified our solutions as a supplied option on their units



New scale eliminated, and existing scale removed:

1 week



2 weeks



3 weeks



# MARINE / NAVY VESSELS

- ✓ Works on calcium and sodium based salt scale
- ✓ Remove scale from pipework and calorifiers
- ✓ Reduce scale in desalinisation equipment and water-fed galley equipment
- ✓ Reduce scale build-up around baths, basins, sinks and shower heads
- ✓ Help maintain a constant water pressure
- ✓ Increase the life of capital equipment
- ✓ Reduce maintenance of seawater cooled diesel engines
- ✓ Reduce cleaning costs, chemicals and labour
- ✓ Short term payback

