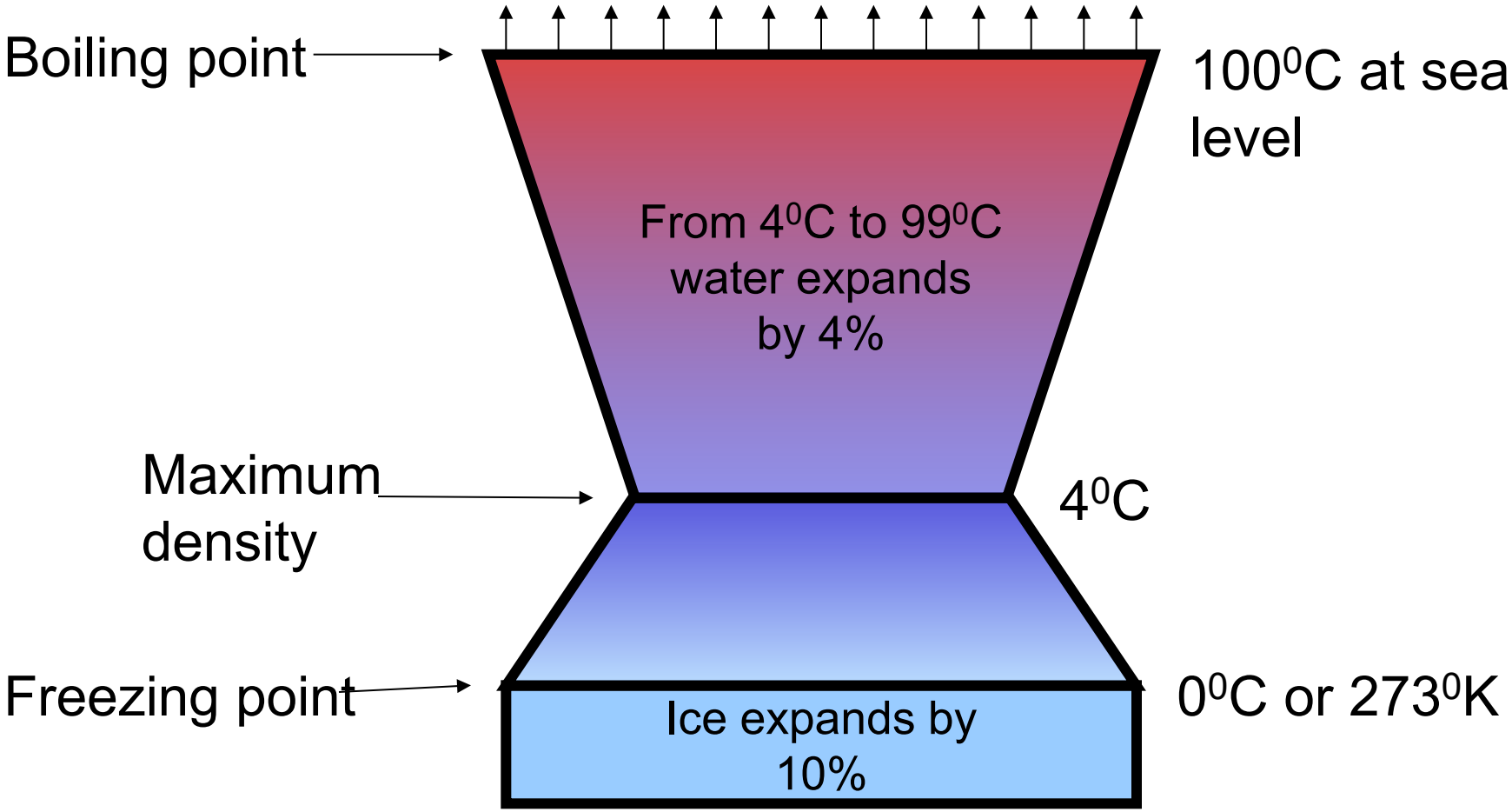
Unit 203: Scientific principles for domestic, industrial and commercial plumbing

Outcome 2
Scientific properties and principles of water

Water

Steam expands 1,600 times



Water

When water is heated it expands. For temperatures up to 100ºC, this expansion is usually up to 4% of the system contents at cold start up.

When water exceeds 100ºC it can turn to steam and expand to almost 1,600 times its original volume.

Video links:
http://www.youtube.com/watch?v=9bU-I2ZiML0
http://www.youtube.com/watch?v=68p4ngS-yME

Water

Water is a chemical compound of hydrogen and oxygen (H_2O).

It is very rare to get pure water (H_2O) and nothing else, as water is a very powerful solvent.

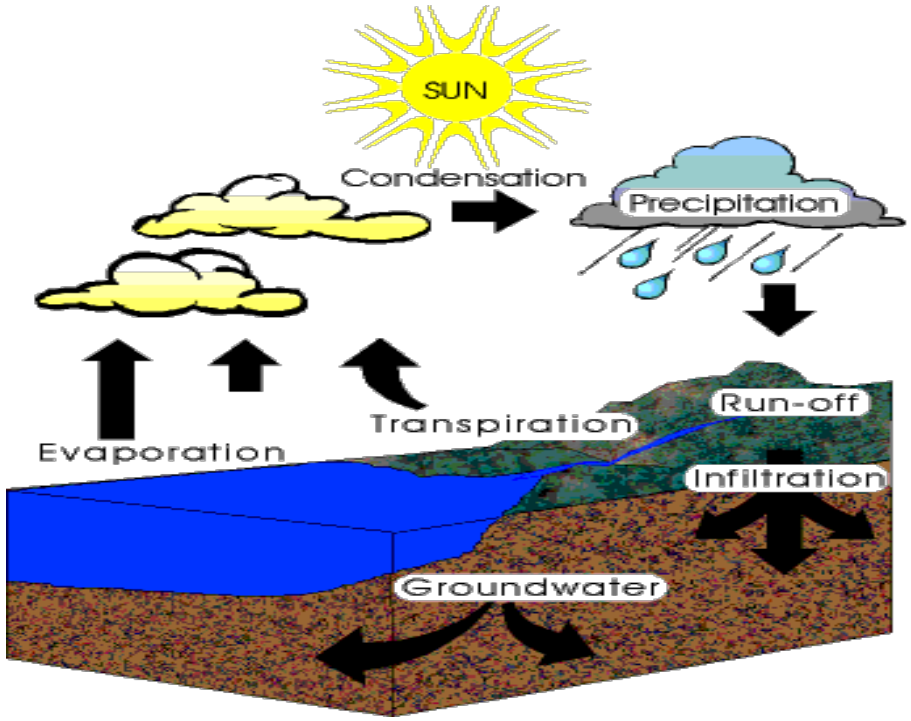
Given enough time it will**: erode**, **corrode**, **absorb** almost anything. Depending upon where water collects, it will absorb and contain a number of substances.

Water

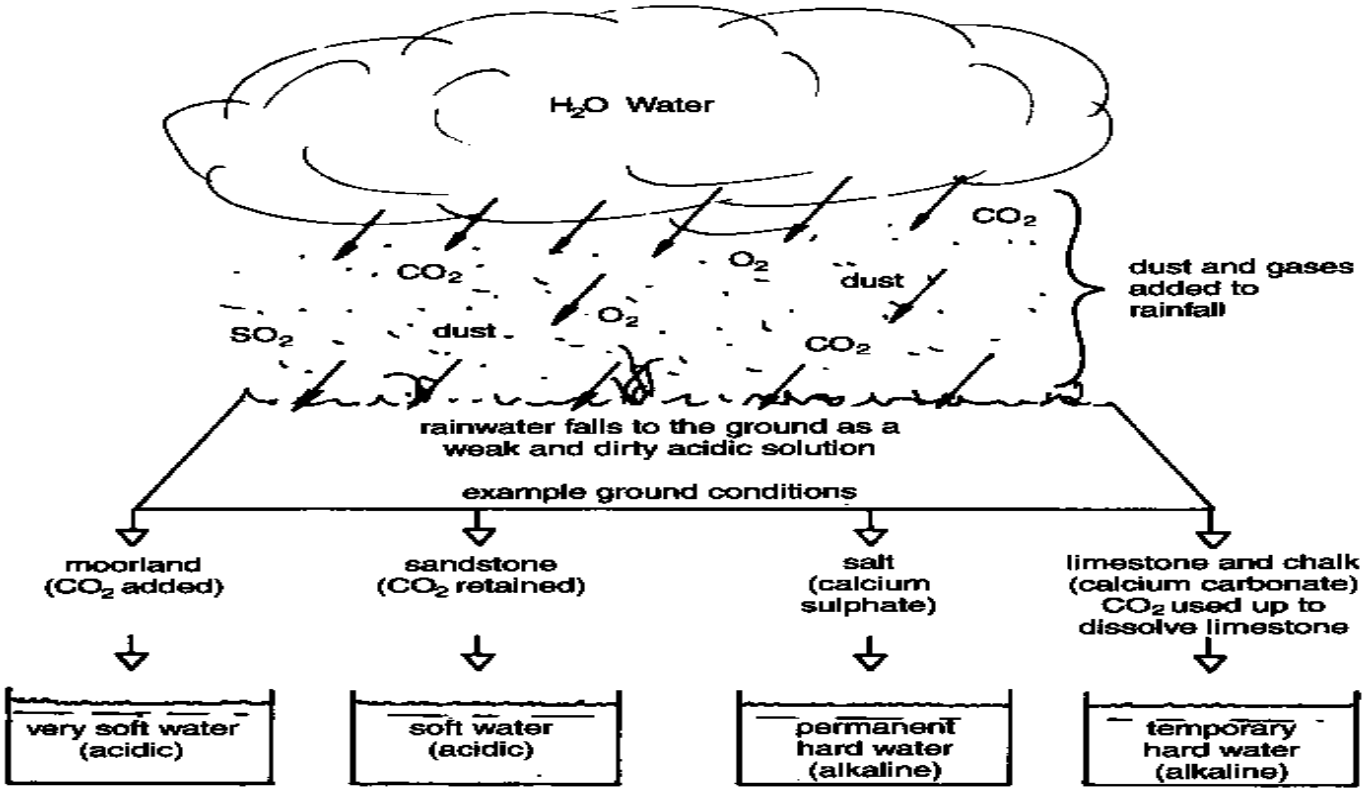
This gives the water the characteristics of:

hardness or **softness**

acid or **alkaline**



Water



Temporary hard water, if heated to 65^0C and above, will form limescale (calcium carbonate). This causes problems for appliances and the efficiency of appliances.

Water

Hardness in water is known as the **soap destroying factor**. The harder the water, the more soap is needed for a lather, and more sediment is produced. There are two types:

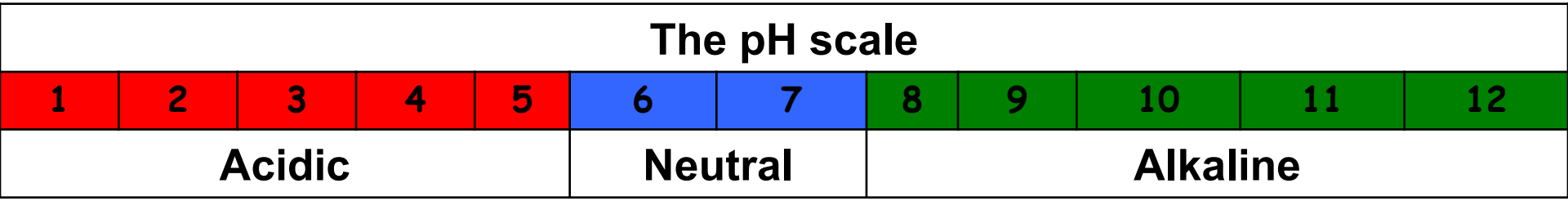
1.Temporary hardness
Contains **calcium carbonates** and can be removed by heating the water above 65^0C. The temporary hardness is released as scale.

2. Permanent hardness
Contains **calcium sulphates**; can only be removed by a **base exchange** method (water softener) – zeolite material.

All water contains temporary and permanent hardness, which gives the total hardness of water.

Water

Depending upon what has been absorbed, water will either be **acidic**, **neutral** or **alkaline**. The amount of absorption is registered on the pH scale (potential hydrogen), depending on what strata water falls through.



Acidic corrosion and pitting

Pure water is neutral

Limescale, blocking less efficient

Water

Water has the ability to dissolve lead; this is called:
Plumbosolvent

Water that is aggressive towards copper is called:
Cuprosolvent

Water is aggressive towards ferrous (iron) metals and, in any unprotected areas, will quickly form ferrous oxide (rust). Iron pipework, as we have covered, needs to be protected by painting the pipe with red oxide paint, zinc galvanising or denso.

Ferrous oxide can build up inside radiators on central heating systems, which in turn means the radiators need bleeding of hydrogen. A chemical inhibitor can be used to protect central heating pipework and components.

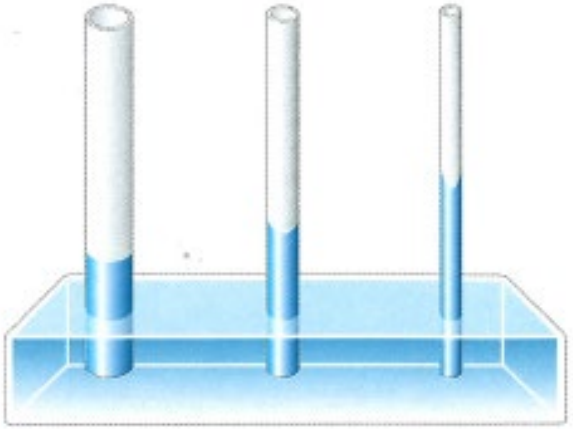
Water

Definitions

- Evaporate: when liquid turns into a gas (eg boiling at 100^0C).
- Freezing: when a liquid turns solid (eg water freezes at 0^0C).
- Condensation: when a gas turns into liquid – when it rains or when water droplets form on cold surfaces.

Water

Capillary action of water
This is when water can be drawn sideways or upwards between two close-fitting surfaces against gravity. The wider the gap, the less capillary action there is.



Water

Capillary action of water
Plumbers face this as a problem:

1. Water can be drawn up underneath the lead weathering on tiles, resulting in water leaking inside the property.
2. Water can be drawn up between lead weathering surfaces.
3. Loss of trap seal (S trap) under an appliance.

Discuss these points and see if you can find out how they can be overcome.

Water

Capillary action of water
Conversely plumbers can use this to their advantage:

To make soldered joints on fittings: the solder can be drawn between the two close-fitting surfaces of the copper tube and fitting.

Water

Properties of water

The water molecules have a **cohesive** nature in the way they stick together. This creates the surface tension on top of water.

The water molecules also have an **adhesive** nature and tend to stick to other materials they comes into contact with. This gives the water a curved appearance.

In a manometer, we have to read the water level from the bottom of the **meniscus** or curve.

Water

Solid (ice) – liquid (water) – gas (steam)

Chemical symbol for water	= H_2O
Boiling point of water	= 100^0C (at sea level)
Increase the pressure	= increase the boiling point of water
When boiling it expands by	= 1,600 times
Maximum density of water	= 4^0C
Water freezes at	= 0^0C or 273^0K
Add glycol (antifreeze) to water	= Reduces freezing point
When frozen, water expands by	= 10%
Relative density of water	= 1
Water heating from 10-90^0C expands by	= 4%

Water

Sensible heat
When heat is applied to water the temperature will rise, but it remains water. It can then be cooled (a change in temperature without a change in state).

Latent heat
If you keep heating water, it will change from water to steam; this is a change in state.

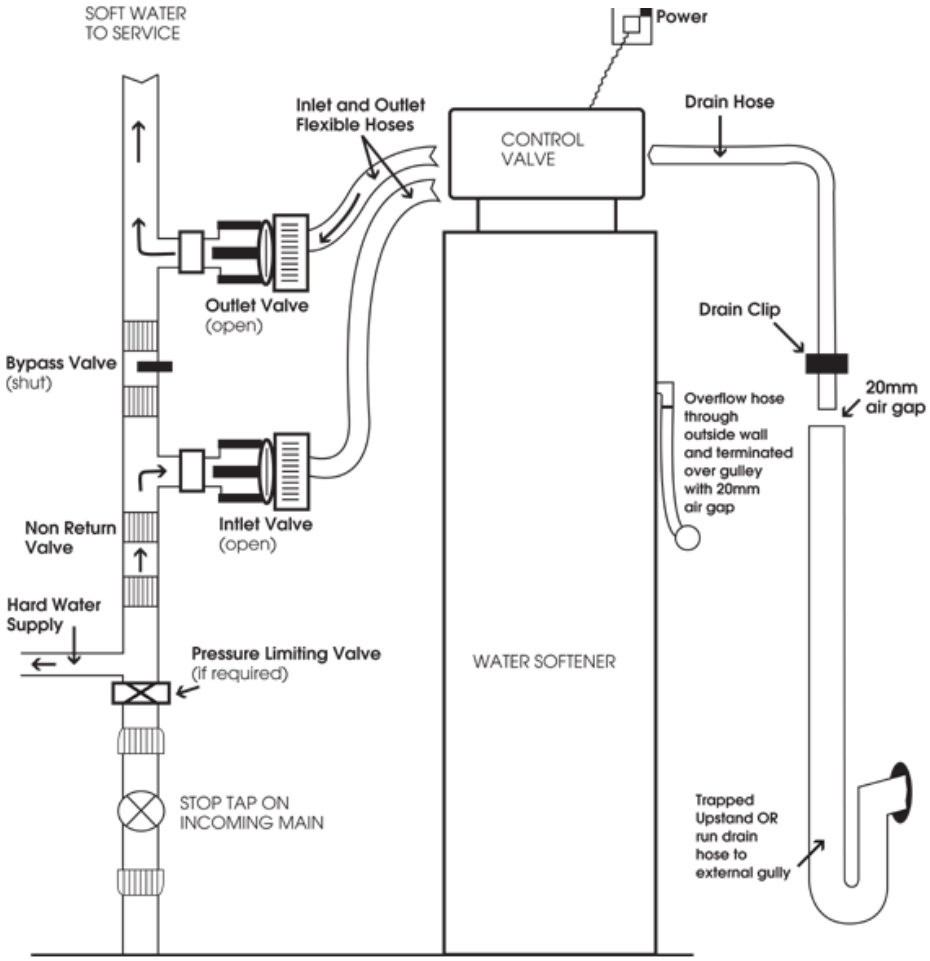
The heat required to raise the water temperature to 100^0C is **sensible** heat. The heat required to keep it boiling is **latent** heat.

Water

Water softener

The only way to fully remove hard water and prevent scale, scum and tide marks is to fit a water softener.

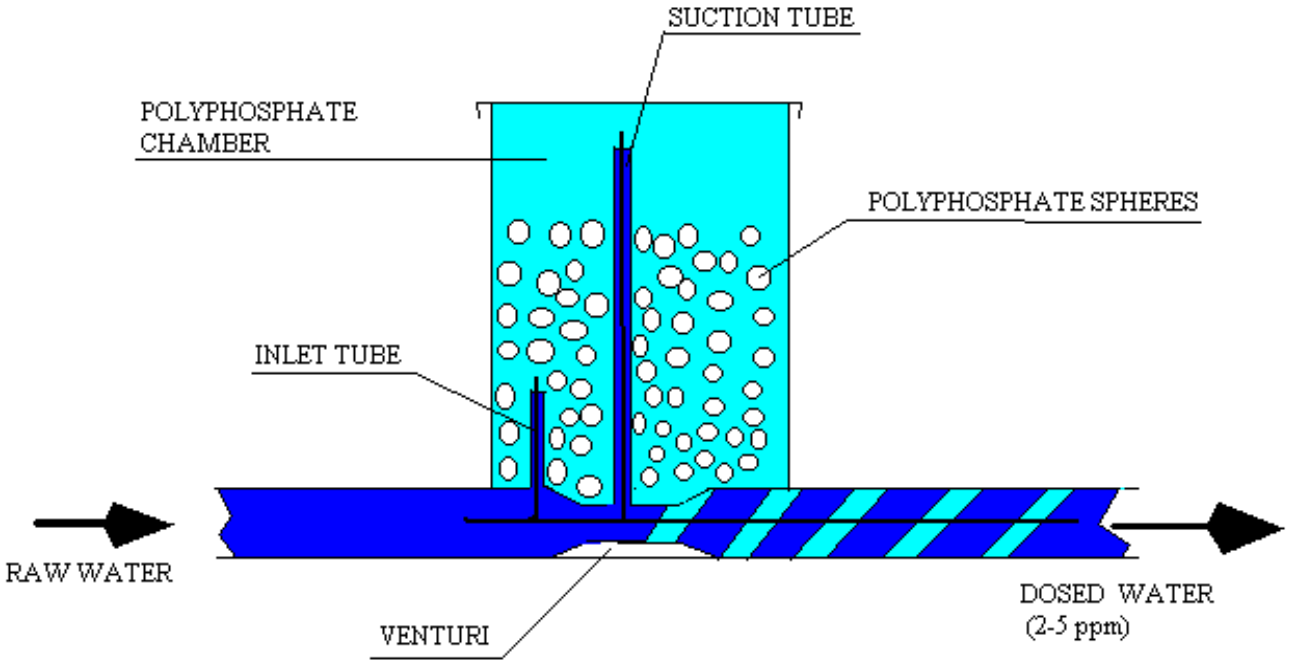
Water is taken through a zeolite or resin bed then flows out of the top of the vessel to the tap. The resin holds the calcium and magnesium in the filter. The unit is then back-washed by a brine solution (salt or sodium chloride).



Water

Chemicals

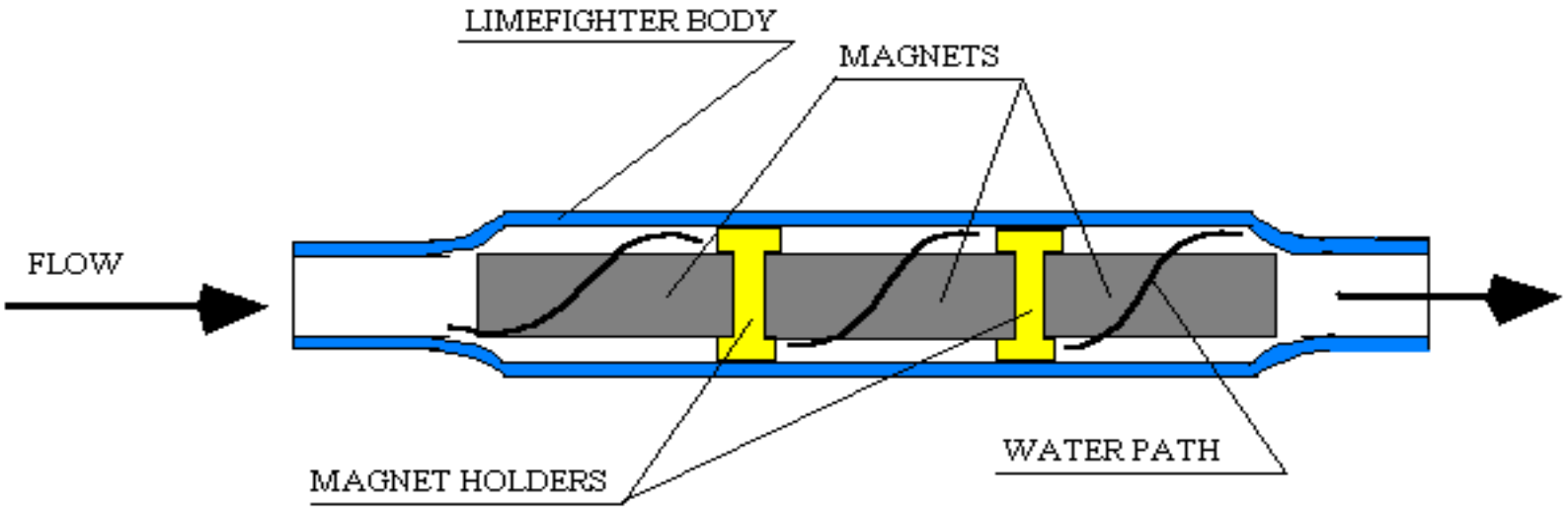
These do not soften the water; they stabilise the salts to prevent scale. Salt crystals tend to bind together to form hard scale. Polyphosphate chemicals form on the salt crystals, preventing them sticking together and getting caught in the cartridge filter. Used on combination boilers.



Water

Magnetic scale inhibitor

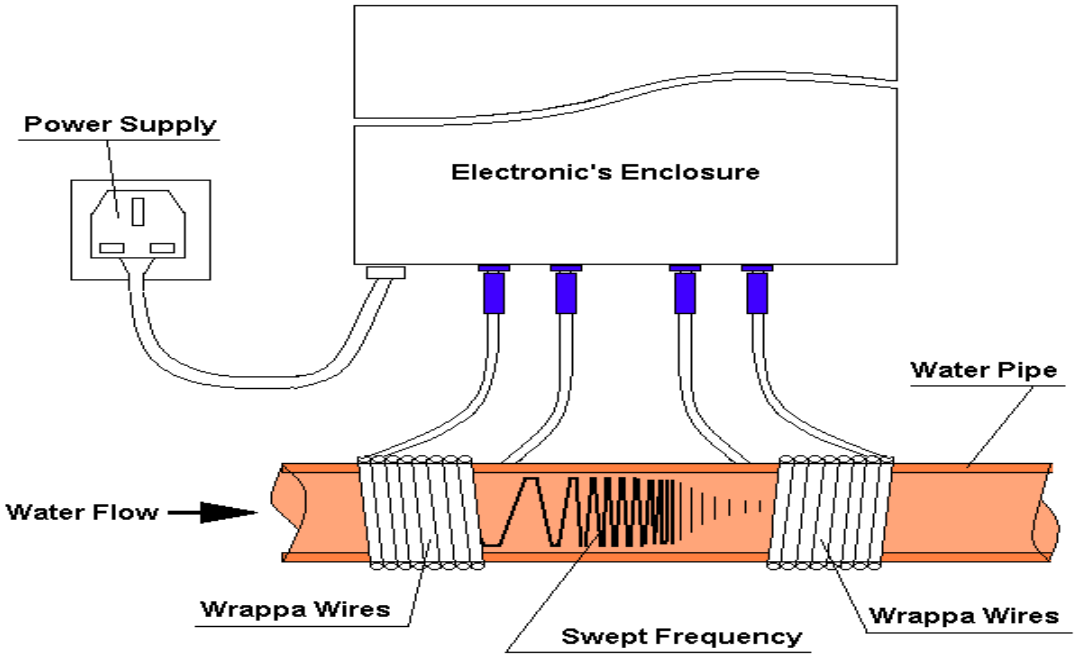
The water is passed through a strong magnetic field running across the water flow. This alters the physical nature of the water and breaks the salt crystals down into small pieces so they cannot stick together.



Water

Electrical scale inhibitor

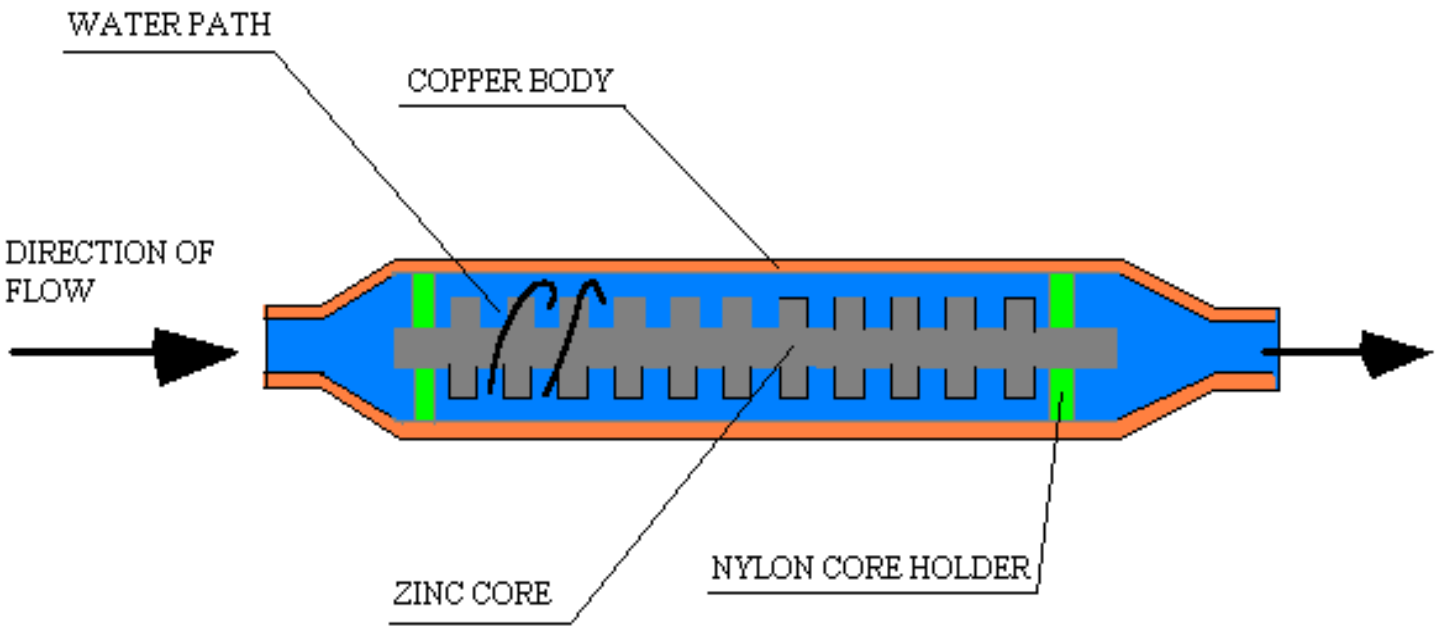
This works in a very similar way to the magnetic inhibitor except it uses a magnetic field to produce low level radio waves that pass through the water.



Water

Galvanic cell scale inhibitor

This uses a combination of zinc and copper to form an electron flow (zinc being the anode which will break down).



Water

Corrosion can reduce the life of pipework or components.

Limescale will block pipes and components so it reduces the flow. It will also coat components, thus reducing the efficiency of an appliance.

Soft water is acidic so will also affect the life of pipework.