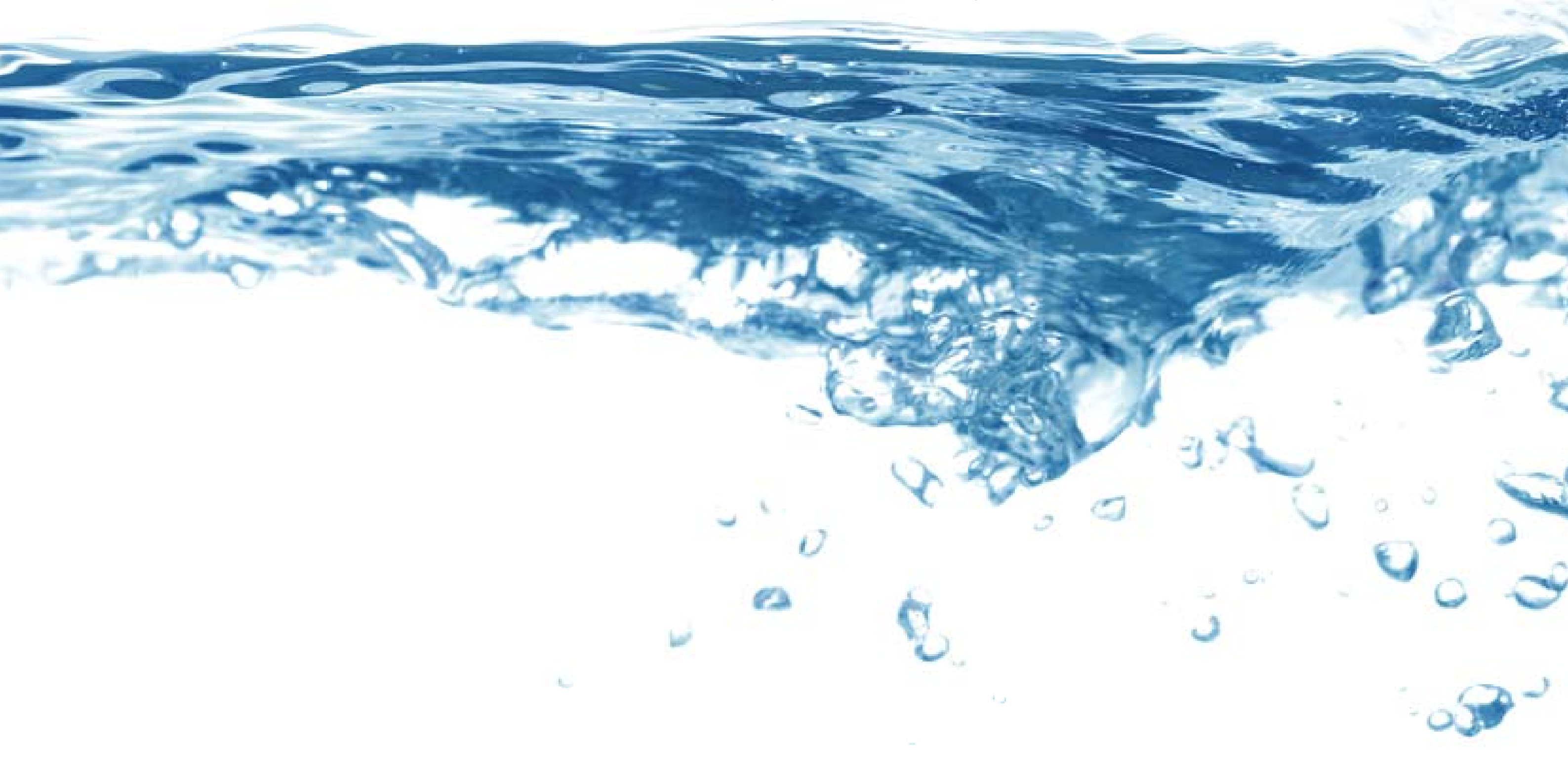
COLLOID-A-TRON

Non Chemical Catalytic Scale Prevention Units

Environmentally Friendly Water



Fluid Dynamics

Hard water solutions since 1973

Contents

COLLOID-A-TRON

Non Chemical Catalytic Scale Prevention Units

Fluid Dynamics International Ltd is a U.K based company with over 35 years experience manufacturing and supplying successful non-chemical water treatment solutions around the world.

Colloid-A-Tron is Fluid Dynamics leading scale prevention range designed for use in industrial applications catering for equipment protection to large pipe-line scale prevention.

All Colloid-A-Tron equipment is certified and approved by many water authorities in U.K, Europe and the Middle East.

Colloid-A-Tron operates totally non-chemically, does not add anything to the water and is even approved safe for use in drinking water systems

Colloid-A-Tron requires no power, no maintenance and can be installed in remote locations, in gravity feed systems and will constantly treat water without the need for backwashing.

Colloid-A-Tron equipment is widely used around the world offering a range of non-chemical treatment to key industries from whole town protection to seawater treatment to manufacturing plants, oil production and much more.

Established Since 1973, Fluid Dynamics the world's oldest catalytic water treatment company, offers unrivalled experience in the supply of scale prevention equipment without the use of chemicals.

The Colloid-A-Tron scale preventers are operating in more than 26 countries Our track record speaks for itself:

- over 250,000 units installed Worldwide.
- our client base includes companies such as:
  - Guinness
  - Carlsberg
  - Nestle
  - Ford Motor Company
  - Coca-Cola
  - Rhone Poulec
  - UK Royal Air Force
  - Kellogg's
  - Akzo Nobel
  - Renault
  - Pirelli

And many more who have literally saved thousands of pounds/dollars since introducing Colloid-A-Tron scale preventers.

The Colloid-A-Tron scale preventers core is a mixture of precious metals that create an electrolytic current through the water, nothing is added or taken away from the water during treatment Colloid-A-Tron anti-scaling operation is performed while water is flowing on the surface of the very special alloy used in the unit. The required turbulence, pressure changes are caused by the special design of the unit.

The Colloid-A-Tron scale preventer operates as a catalyst using the Ph rise generated by the alloy to trigger precipitation of calcium carbonate in the bulk of the water in the form of stable aragonite crystals.

Existing scaling is also dissolved and previously deposited scale can be cleared over a period of time.

Benefits of installing Colloid-A-Trons

- Colloid-A-Tron scale preventers. a**re environmentally friendly – NO chemicals and salt are required.**
- Colloid-A-Tron scale preventers **do not use power**: CATs work under an electrolytic action which is effected utilising the principle of different metals in the galvanic series generating electricity between the phases in a manner similar to a battery.
- Colloid-A-Tron scale preventers advantage becomes evident when scale prevention is required in remote locations where delivery of power and chemicals and labor makes conventional water softening un-practical and extremely expensive.
- Colloid-A-Tron scale preventers **are maintenance free.**
- Water treated by Colloid-A-Tron scale preventers **is safe to drink and harmless to plant life**, CATs are WRAS certified as safe to use in domestic supplies.

Colloid-A-Tron scale preventers typical applications:

Below are some examples of systems treated by Colloid-A-Tron:

- Domestic hot and cold water supply pipes in buildings
- Heat Exchangers
- Injection Moulding Machines
- Air Conditioning Systems
- Vacuum Pumps
- Condensers
- Hot Water Heaters
- Sea Water Cooling Circuits
- Refrigeration Systems
- General Cooling Circuits
- Cooling Towers
- Mixing Valves
- Evaporators Nozzles & Humidifier sprays
- Ice making machines
- Washing machines
- Dish washers
- Shower systems

Brewery

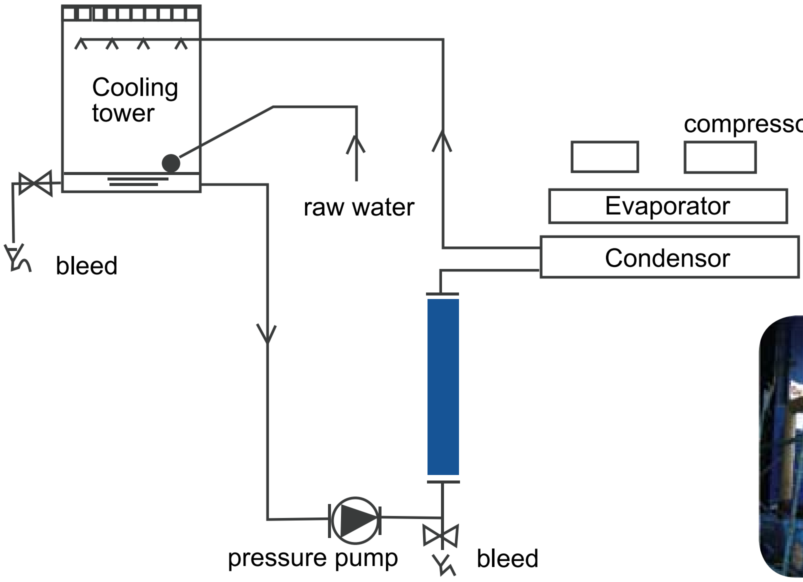
Hot water services

16" Diameter C-A-T

Before Colloid-A-Tron

After Colloid-A-Tron

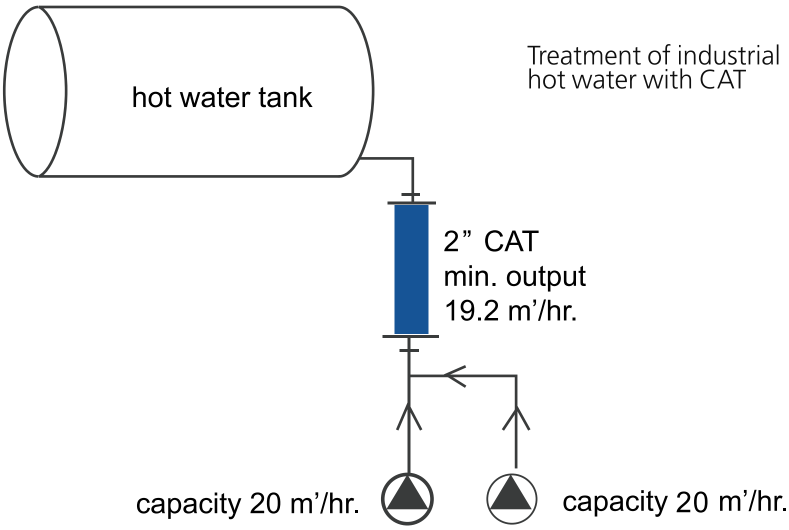
Installation



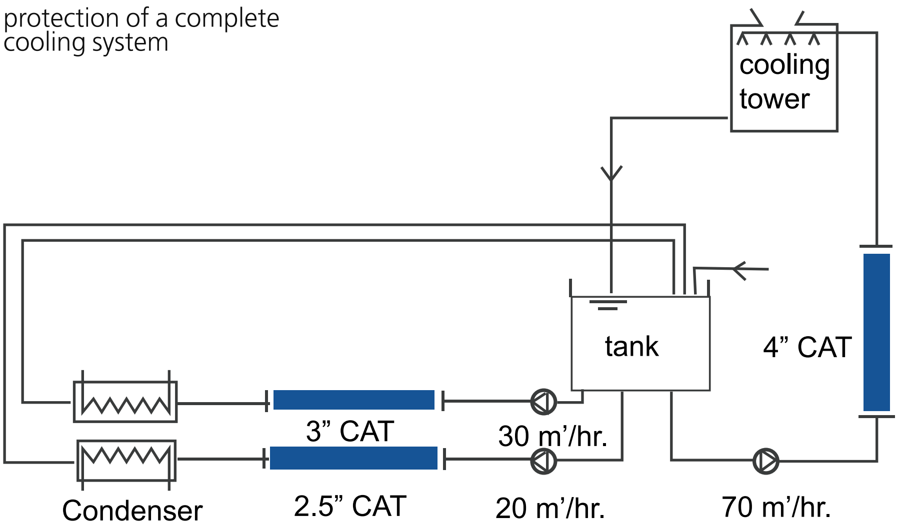

Cooling tower

Example of installation in practice

Treatment of industrial hot water with CAT



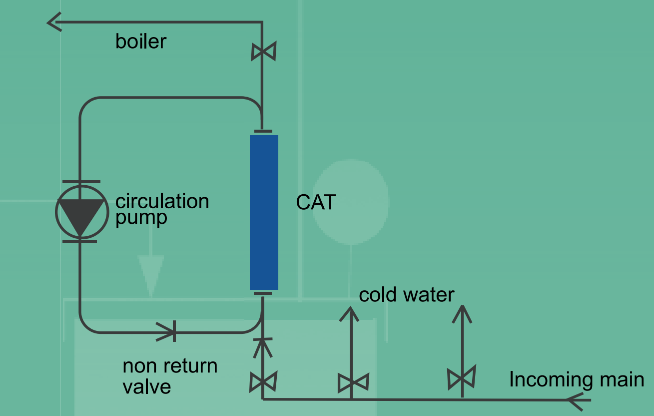
protection of a complete cooling system



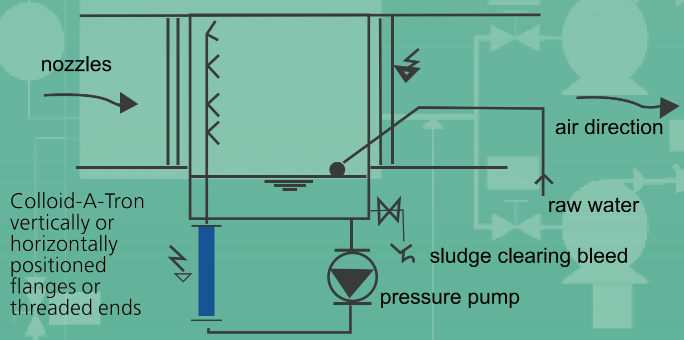

Heat Exchanger

Schematic Drawing Showing The Installation Of Colloid-A-Tron

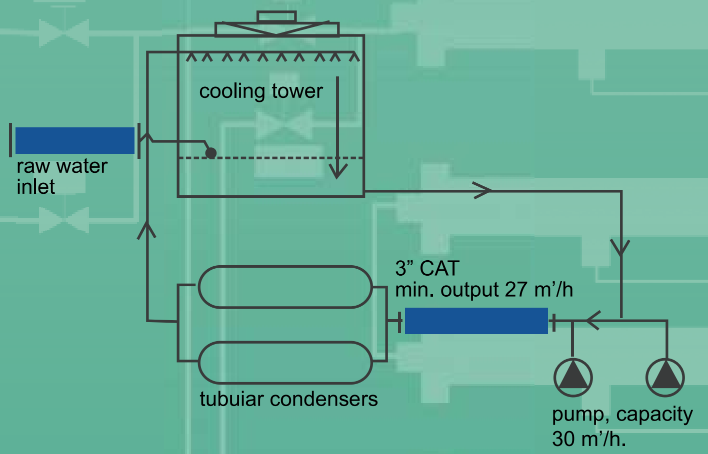
Hot Water Treatment With Colloid-A-Tron



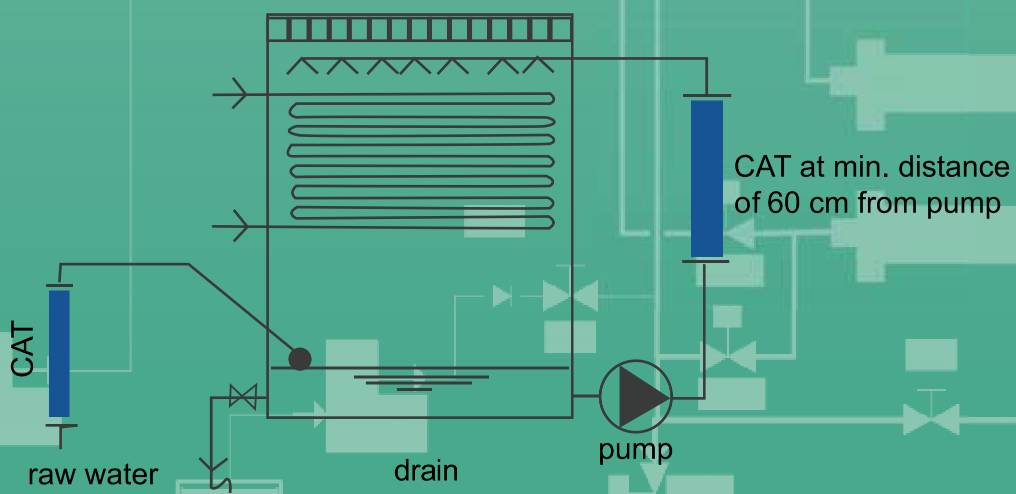
humidifier/air cleaner



Cooling tower with CAT



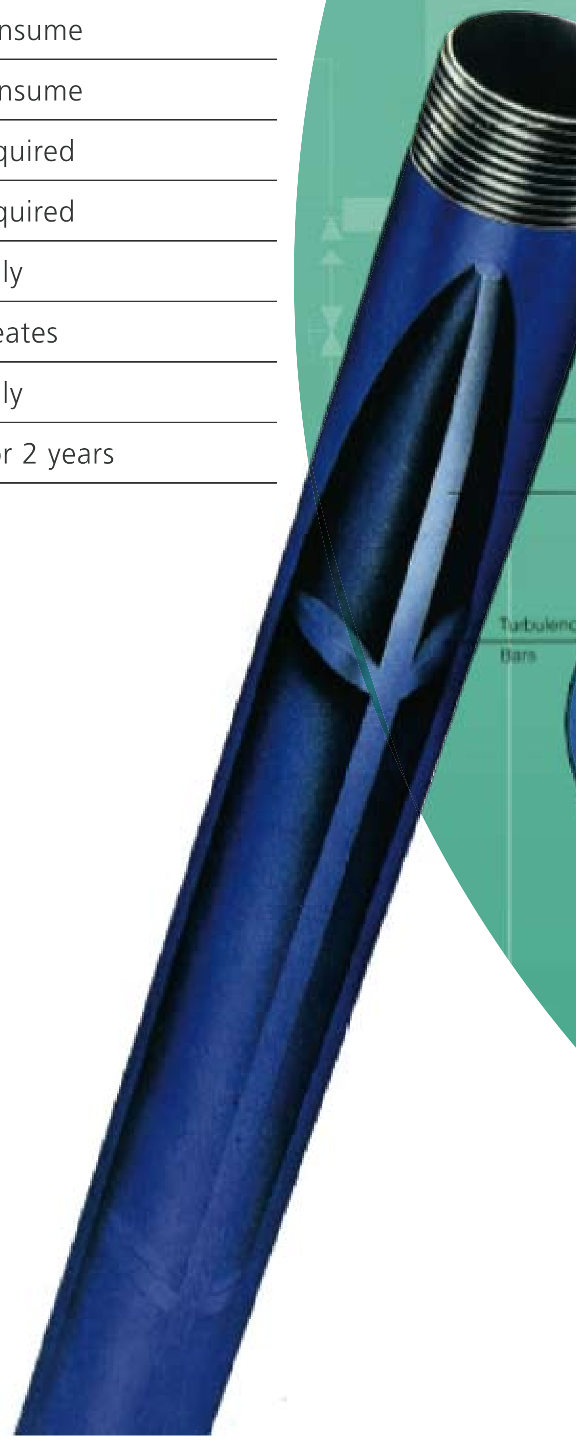
Closed Cooling Tower Evaporative Condenser

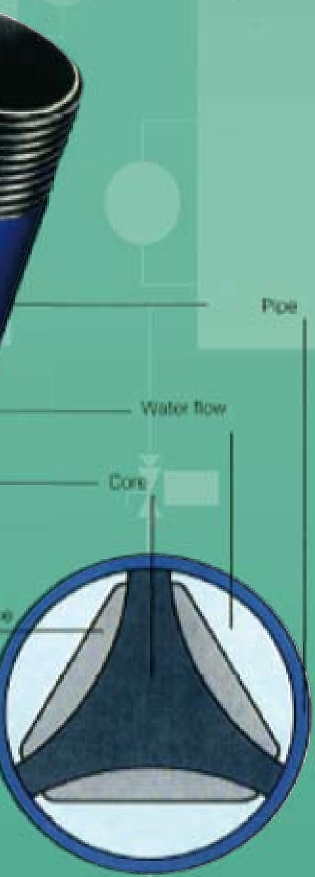


Collloid-A-Tron and Conventional Treatments Compared

Colloid-A-Tron scale preventers compared to conventional softening and chemical systems

	Colloid-A-Tron scale preventers	**Conventional** chemical system
Installation	Simple – 1 or 2 persons	Complicated – professional stuff
investment	One time	On-going running costs
Energy consumption	None	Consume
chemicals	None	Consume
storage for chemicals	None	Required
Spare parts	None	Required
Waste water	None	Daily
Environmental pollution	None	Creates
Maintenances	None	Daily
Guarantee	5 years	1 or 2 years
Handle variable water quality	Yes	No





Product Code	Length	Diameter	Flowrange
CAT 10	254mm	10mm (3/8”)	0.1-1.2m3/hr
CAT 15	254mm	15mm (1/2”)	1 - 1.6m3/hr
CAT 22	305mm	22mm (3/4”)	1.4 - 3.6m3/hr
CAT 28	305mm	28mm (1”)	3 - 5.2m3/hr
CAT 35	609mm	35mm (1.25”)	4.4 - 8.2m3/hr
CAT 42	609mm	42mm (1.5”)	6.8 - 13.5m3/hr
CAT 54	609mm	54mm (2”)	11.5 - 20m3/hr
CAT 65	913mm	65mm (2.5”)	18 - 29m3/hr
CAT 75	913mm	75mm (3”)	25 - 54m3/hr
CAT 100	913mm	100mm (4”)	45 - 80m3/hr
CAT 125	913mm	125mm (5”)	75 - 145m3/hr
CAT 150	913mm	150mm (6”)	120 - 270m3/hr
CAT 200	913mm	200mm (8”)	225 - 440m3/hr
CAT 250	913mm	250mm (10”)	360 - 650m3/hr
CAT 300	913mm	300mm (12”)	550 - 750m3/hr
CAT 350	913mm	350mm (14”)	650 - 1100m3/hr

LARGER SIZES AVAILABLE ON REQUEST

Benefits of installing Colloid-A-Trons

By Dr. D.M. Dawson

Colloid-A-Tron is a non-chemical water treatment system. It is operating effectively in preventing hard scale build-up in several thousand heat exchange plants around the world; a market that has been built-up over the last 15 years. This article describes the reasons for scale formation from hard waters and examines some recent research into the way Colloid-A-Tron modifies the scaling behavior of calcium carbonate. This research has provided clear, scientific evidence that the system has a significant effect on scale formation conditions in hard waters. The combination of field experience and basic scientific programs is generating more confidence in preventing scale "physically" rather than using chemical water-treatment systems.

Scaling and it's causes

Water is a very good solvent for minerals and many other materials it comes into contact with. Natural waters are essentially "ionic soups": all of the ionic species are trying to keep in a thermodynamic equilibrium with their environment, and they achieve this by combining together in clusters – perhaps growing to form crystals – or by breaking up into the free ions. All of these reactions are occurring all the time as local conditions change.

Forming part of this "soup" are the ions calcium and carbonate. And they can form calcium carbonate – the principle scaling salt found in hard waters. We need to understand the equilibrium of these species in water, and having done so we will know whether scaling can occur, or not. If we can, in some way, change the equilibrium with Colloid-A-Tron, we can modify the scaling behavior of hard water.

The equilibrium solubility product for calcium carbonate is a thermodynamically defined value for a given pressure and temperature. It is the concentrations of calcium and carbonate free ions in equilibrium with large crystal of calcium carbonate suspended in water. Equation (1) is the standard way of showing this equilibrium.

$$[Ca^{++}] + [CO_3^{--}] \rightarrow [CaCO_3] \qquad [1]$$

It is this equilibrium point that all waters will try and reach, either by crystal growth or dissolution. At this equilibrium point, the crystal will be growing and dissolving at the same rate.

Most waters will be at equilibrium if given time, but changes in the environment, such as bore-hole, water emerging to the surface or the temperature and pressure changes in heat-exchange plant, will disturb this equilibrium. This then forces changes to the water composition. If the concentration of calcium and carbonate is greater than the equilibrium requirements, then the water attempts to reduce these concentrations and it does this by precipitations and growth of scale crystals. Equally, the water may be under saturated with respect to calcium carbonate, and this will increase the free ion concentrations by dissolving scale crystals.

The term super saturation ratio (Sr) is used as a shorthand description of the equation that determines whether the water can scale:

$$Sr = \frac{[Ca{+}{+}]a\ [CO3{-}{-}]a}{[Ca{+}{+}]eqm\ [CO3{-}{-}]eqm}$$

The square brackets refer to the in concentrations (mole/liter) of the free calcium and free carbonate, the 'a' refers to actual concentrations prevalent in the water, and 'eqm' to the equilibrium concentrations as defined above.

If Sr > 1, scaling can occur; if Sr < 1, scaling cannot occur, but dissolution can.

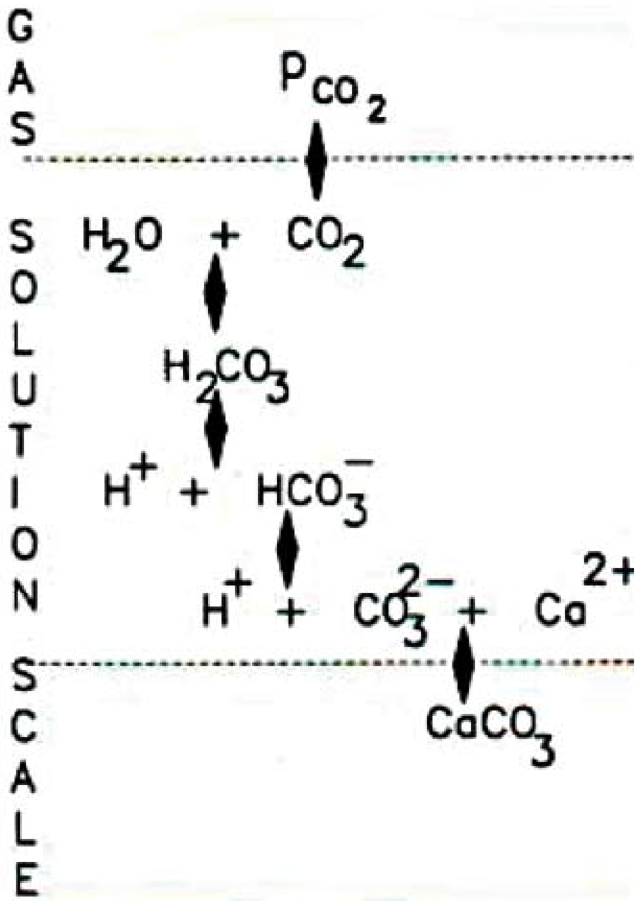
This is a fundamental thermodynamic requirement for scale formation or dissolution – from it we can see that scaling is controlled by the equilibrium concentrations of Ca++ and CO3 ions – defined by pressure and temperature – and by the actual free ion concentrations of these in any water.

All of these control factors can be modified to some degree for a given water and heat exchange plant. The one that is most readily, and economically, variable is the CO3-- ion concentration. Fig.1a illustrates the overall carbonate equilibrium reaction path available in hard water. Each reaction and ionic species demands its own equilibrium concentration. If the temperature is increased, the bicarbonate ion thermally decomposes, forming carbonate, thereby increasing the super saturation ratio and providing the conditions for scale formation. It is this reaction that causes the scaling of hot surfaces – whether the surface is a kettle element or a large heat exchanger. If the pH increases, the water tries to produce free H+ions so as to achieve the H+/HO-H2O equilibrium. One of the easiest ways it can do this is to decompose carbonic acid, and bicarbonate the ion – again producing carbonate ions and increasing the super saturation ratio, Increasing pH has a much greater effect on Sr than an increase in temperature, as illustrated in Fig1.b. A temperature change of 80oC takes a water that is close to saturated at 10oC to a super saturation ratio of between 3 and 4. This will be enough to cause severe scaling. But a change of one pH unit, from 7 to 8, increases Sr to around 15. Scaling is around five times as rapid – or five times as likely to occur – than under the temperature increase shown above.

pH and temperature are the factors that most affect the CO3-- concentration, and in turn affect Sr and consequently scale formation; pH is the most dominant.

Can we then use these factors to propose, and demonstrate, a feasible explanation for the Colloid-A-Tron water treatment? The answer is yes.

Fig.1a. The alkalinity equilibrium chain



Water treatment

The Colloid-A-Tron unit (Figs 2 and 3), never more than 1m long, is plumbed into the system it is meant to protect. The standard unit is an apparently-simple device: water is made to flow past a special alloy insert in a length of pipe.

If the unit is to work, it must change the water as it flows past. It must, in some way, reduce the super saturation ratio of the water, i.e the free Ca++ and free CO3-- ions must be reduced. The most obvious way would be by precipitating them as calcium carbonate – much like lime softening techniques.

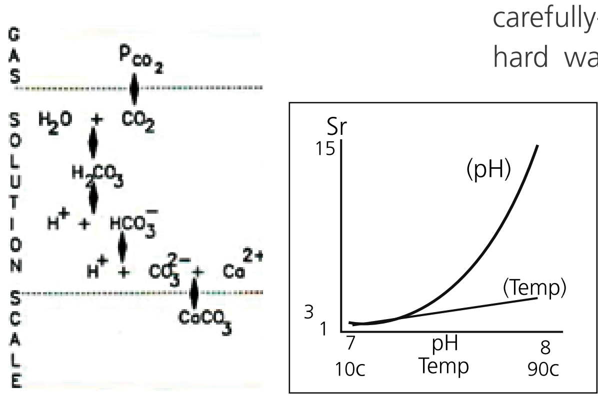


Fig.1b. Increased temperature and pH effects

Because of the composition of the unit, there are only two ways in which it can work. Firstly, the special alloy could either adsorb ions from the solution or corrode. Either event could increase the pH locally, increase the Sr locally, and cause precipitation of calcium carbonate, thus providing the desired result that downstream of the Colloid-A-Tron the water is part-softened and carries suspended calcium carbonate crystals. Secondly, the shape of the unit promotes turbulence; the associated pressure differences could cause dissolution of CO2 gas, which may get stripped from the water when it becomes open to the atmosphere, in a cooling tower for example, and therefore reduce the total carbonic species in the water.

The second method is independent of alloy composition, but copper or zinc inserts, for example, do not work in practice. We are therefore drawn to the first, the special alloy, effect mechanism.

A research programmed at the UKAEA Harwell laboratory was commissioned to study the behavior of a number of synthetic hard waters, simulating typical waters experienced in practice, under carefully-controlled conditions. Waters 1 and 2 were hard waters (350ppm as CaCO3) at different pH levels, 3 was less-hard water (250ppm as CaCO3 and 4) was simulated sea water.

1) Does Colloid-A-Tron alloy give rise to increases in pH of the water?

Colloid-A-Tron alloy granules were washed in distilled water, and were air dried and 35g samples were added to 500ml of synthetic water. The flasks were stoppered, shaken from time to time and the pH monitored. Fig.4 shows the results for each of the waters.

Fig.2. Standard Colloid-A-Torn unit has a static triangular alloy core.

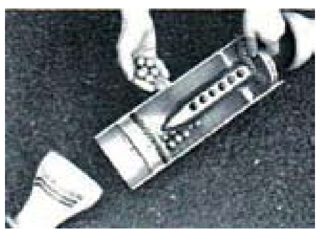


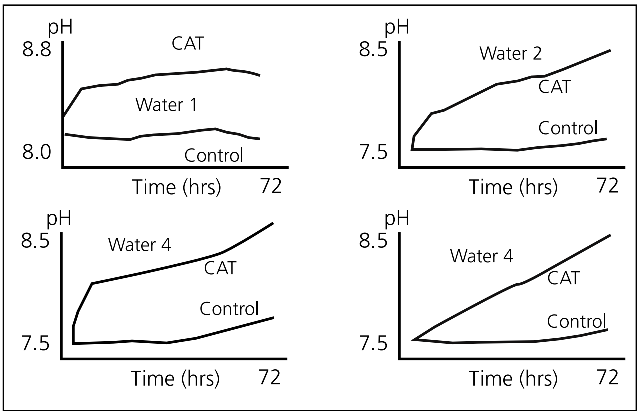
Fig.3. The 2000 unit, showing the alloy sphers used to keep the core clean.

Clearly the alloy produces a significant increase in the bulk pH of the waters. Its effect on the water close to the unit's surface may well be even more marked. Is this a sufficient change to produce significant bulk crystallization of calcium carbonate and reduce the Sr of the treated water?

2) Does Colloid-A-Tron alloy cause precipitation in hard waters?

To answer this, Harwell conducted a series of simple experiments in which a metal spinner or impeller was rotated in hard water made metastable by injecting CO2 gas (Fig.5 illustrates the arrangement). The flask was open to air and as the CO2 was lost, the pH increased, until eventually crystal precipitation occurred and the pH decreased with the associated CO2 formation – this is very similar to threshold tests carried out by chemical water treatment companies.

Fig.4. The effect on pH



The same four synthetic waters were tested and spinners of copper (considered to be material that was inert – e.g a control), zinc (to represent a material that will be corroding fairly rapidly), and Colloid-A-Tron alloy were used. The pH was monitored continuously and a typical example of the change in pH over time is also shown in Fig.5.

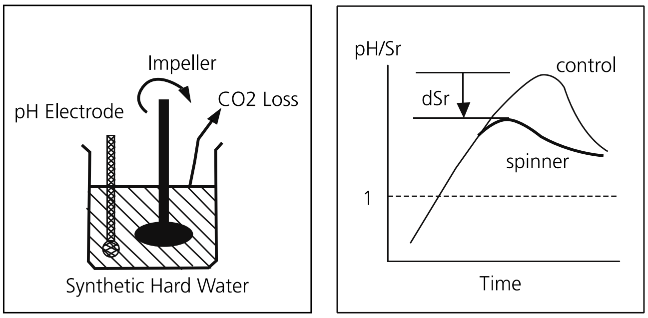


Fig.5. The effect on scale precipitation

The value of Sr – the difference between the Sr at which the control system precipitates and that at which the test impeller precipitates – is a measure of the effectiveness of the spinner at promoting the production of scale crystals.

The larger this value, the greater the effectiveness of the test alloy.

The results of these tests, as shown in Table 1, are the definitive proof that the special alloy causes a significant change in scale crystal precipitation from hard waters. In hard waters (1 and 2), less hard waters (3) and in sea water (4), Colloid-A-Tron has caused precipitation to occur at Sr values well below both the control values and those observed for a rapidly-corroding metal.

Table 1. Changes to scale precipitation conditions

Water	Impeller metal	Sr(mar)	dSr
1/2 (hard)	copper	15.7	0
	zinc	12.6	3.1
	C-A-T	3.2	12.5
3 (Less hard)	copper	17.6	0
	zinc	11.5	6.1
	C-A-T	4.7	12.9
4 (sea)	copper	4.8	0
	zinc	3.4	1.4
	C-A-T	2.2	2.6

The combination of the results of these carefully-controlled experiments, and recent interpretation – in the light of the research results – of several years of successes and failures in real industrial applications, allows the following mechanism of action to be proposed:

The special alloy – by either adsorption and/or corrosion processes – produces an increase in pH in water close to its surface, which is sufficient to cause $CaCO_3$ crystal precipitation. The turbulence in the device minimizes the scale build-up on the surface, and any CO_2 dissolution will assist in the stabilization of the crystals. Hard water is therefore part-softened, and carries the crystals around the circuit harmlessly.

It must be stressed that the unit has not changed the total Ca and CO_3 content of the water – it has merely tied up a proportion of the free ions as stable $CaCO_3$ crystals which get carried round the circuit. These crystals will act as scale growth sites in preference to heat exchange surfaces, where conditions favor crystal growth, and so they may have positive benefits to keep surfaces scale-free.

The suspended solids will settle out in low flow rate areas such as cooling tower sumps, and they can be removed during blow-down as required.

Summary

Scale formation is controlled by the thermodynamic equilibrium of the reaction:
[Ca++] + [CO3--] -> [CaCO3]
Colloid-A-Tron exploits this equilibrium by manipulating the local CO3 concentration and, thus, causes scale formation in the water near to the unit's surface. The resulting crystals get carried harmlessly round the treated circuit.
Water treated in this way can be considered as part softened and the heat-exchanger surfaces are, as a consequence, less at risk of scaling.

This effect is becoming increasingly predictable through a combination of field experience and basic research programmers. The effect has now been built into the Fluid Dynamics water models which are incorporated in a specialist computerized prediction system which has resulted in significant improvements in the selection of appropriate installations and running conditions.

Fluid Dynamics
Hard water solutions since 1973