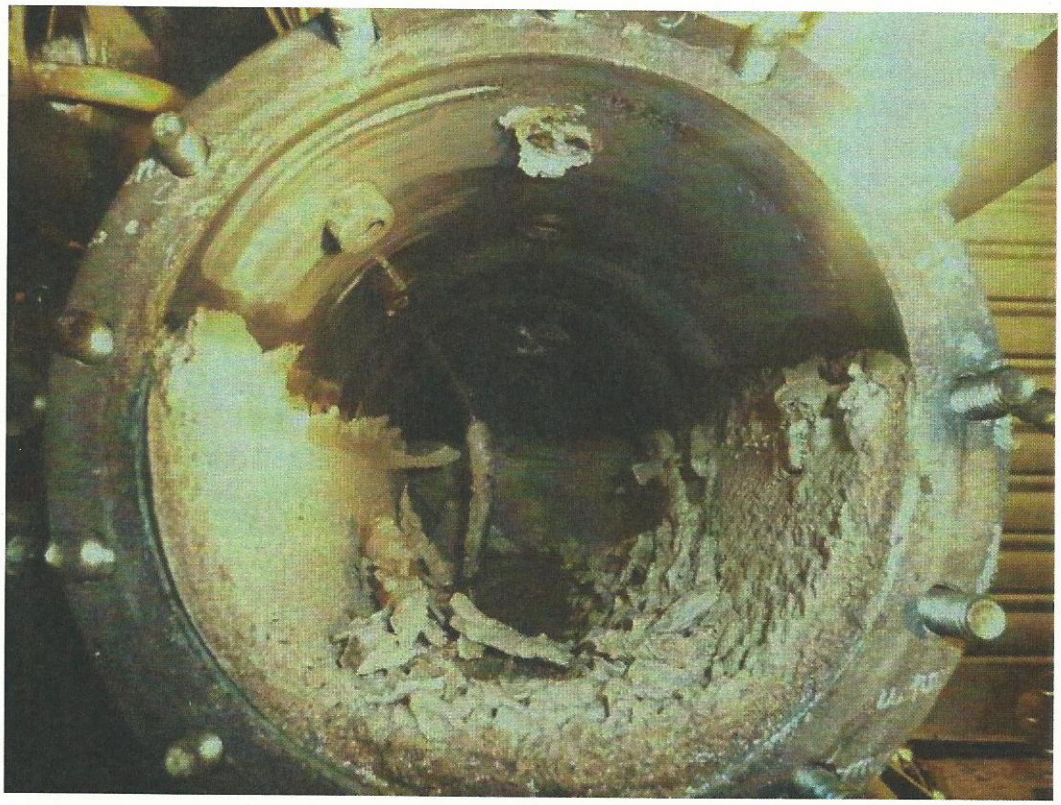
Magnetic Technologies solution to

Scaling within Pipes, Boilers & Water Infrastructure



Industrial Boilers
Domestic Appliances
Pipes, Faucets and Drip Feeds

2014

v4

Introduction to Scaling within Pipes, Boilers and Water Infrastructure:

There are several concerns associated with mineral scale in for example agriculture. Economic impacts to the grower include clogged plumbing and regulators, pressure loss, and nipple drinkers sticking or leaking. Labour Over time, this is a substantial cost when one considers the time and money of replacement. Pretreated water (i.e. filtered or softened water), is a cost effective means of reducing/preventing future problems, but this has traditionally required chemicals or complex filters.

Scale has a rough surface that contains pitting, cracks, and crevices which in consumable water systems can harbor microorganisms. Disinfectants such as chlorine and iodine simply pass over these cracks and crevices and the microorganisms will continue to flourish. Therefore, additional treatment measures must be used. Again traditional methods are often unhealthy long term unusually 100% effective. Normally to remove the scale, the pH of the water must be reduced by adding an acid to dissolve the mineral scale. However, the biofilm has to be removed first. An acid can not fully penetrate and will not hydrolyze the biofilm and thus can not dissolve the scale. Therefore, the influent pH of the water should also be considered. Consequently to date industry has to rely upon acids and chemicals to address both the biofilm and scaling, resulting to long term health risks and remains unlikely to solve the scaling 100%

There is a common misconception that chlorinated water does not require any maintenance and lines do not have to be flushed. This is absolutely false. Public water, treated well or surface water may reduce the severity of contamination in the lines. However, the lines still remain susceptible to biofilm formation and we also know that research has established that chlorine has an adverse affect upon consumers who either drink or use within industry.

Problems caused by scale deposits within Industry are;

- Failure of boiler tubes due to overheating of the metal
- Corrosion of the metal surface under the deposit
- Increased boiler cleaning expenses to remove the deposit
- Energy implication (coal / fuel used for heating water) due to scale deposits is significant, as heat transfer efficiency to water is decreased as scale acts as an insulation.

Existing water pretreatment programmes (1. Clarification, 2. Filtration, 3. Softening, 4. Dealkalization, 5. Demineralization, 6. Deaeration, 7. Heating.) will be benefitted or can be avoided all together with **magnetic water** treatment.

Example – how even minute concentrations can cause scale deposits.

Consider a boiler plant running continuously at 10 Ton per hour (10,000 litres) with a feedwater hardness of 10ppm per liter of water. If one allowed this hardness to deposit in the boiler, then the scale build up would be almost <u>one ton over a one year period.</u>

(1 gm of dissolved or suspended mineral in 1 liter of water = 1000 mg or 1000 ppm)

Total hardness for 10,000 litres = 10 mg X 10,000 = 100,000 mg / 1000 mg = 100 gms

<u>For 24 hours</u> = 100 gms x 24 = 2.4 kg <u>For 365 days</u> it is : 2.4 kg X 365 = 876 kg's)

Magnetic Technology addresses all aspects of water scaling, biofilm and the need for additional treatment chemicals such as chlorine, without the need for increase energy use or any chemicals.

- The key factors of scale formation are supersaturation and crystallographic misfit.
- $CaCO_3$ supersaturation is growing with temperature increasing.
- MHD resonance initiates restructuring of liquid and as result its properties are changing.
- From magnetic treated water $CaCO_3$ basically would start crystallizing in aragonite modification.
- Aragonite would start crystallizing on Fe_2O_3 and $FeCO_3$ at supersaturation levels of, respectively, 15 and 2.7 times higher than calcite would.

Magnetic treated water has be proven to prevent scaling and even destroy existing scale deposit.

Importance of boilers:
The boiler house or steam generation facility within any given plant is frequently referred to as the heart. Boiler water refers to the water which is heated inside the boiler to produce steam. The boiler functions as a distillation unit, taking pure water out as steam. (leaving behind concentrated minerals and other contaminants in the boiler.)

The Steam Circuit
A typical steam circuit is described as follows. Water which enters the boiler is referred to as boiler feedwater. Make up water is raw water, which may be pre-treated for use in the boiler to remove specific impurities. Examples of pre-treatment are softener, demineraliser, reverse osmosis and de-alkaliser plants.

Return condensate is steam which has been condensed back to water through the process and is returned for further use in steam production. The impurities present in return condensate will differ from the make up water, depending on factors such as process, contaminants, materials etc.

Steam is generated for the following plant uses:

- Turbine drive for electric generating equipment, blowers and pumps
- Process for direct contact with products, direct contact sterilization and noncontact for processing temperatures
- Heating and air conditioning for comfort and equipment.

Water Impurities
Pure water does not exist in nature and impurities vary widely. Impurities may be classified into three types:

- Dissolved solids
- Dissolved gasses
- Suspended solids 3

While one may consider rain water to be pure but before this water has reached the earth's surface, it has absorbed pollutants, oxygen and carbon dioxide. Due to the high solvency of water, additional impurities are dissolved from the land surface. A few examples include:

- Calcium Carbonate (limestone)
- Magnesium Carbonate (dolomite)
- Calcium Sulphate (gypsum)
- Magnesium Sulphate (epsom salts)
- Silica (sand)
- Sodium Chloride (common salt)
- Iron

If all waters carried the same impurities, treatment could zero in on a nearly standard programme for each use. This is however not the case and water quality varies across the world depending on the type of ground material.

Operational problems due to un-treated 'Boiler Feed Water'.
Impurities found in source water become an important consideration when used for steam generation. But when feedwater is not treated to remove impurities, the impurities precipitate out of the water directly on heat transfer surfaces and settle out on the metal as scale.

Scaling mechanism is the exceeding of the solubility limits of mineral substances, due to elevated temperature and solids concentration at the tube/water interface. Due to evaporation of water in the boiler, the concentration of dissolved impurities increases to the point where they precipitate out of solution and adhere to the heat transfer surfaces forming boiler scale

Certain minerals such as Calcium Carbonate experience inverse solubility, whereby the higher the temperature, the less soluble the material. For this reason these types of minerals will tend to exceed their solubility at the high temperature steel surfaces and form deposits while remaining soluble in the bulk water.

The deposition of crystalline precipitates on the walls of the boiler interferes with heat transfer and may cause hot spots, leading to local overheating. The less heat they conduct, the more dangerous they are. Some examples of boiler scale are-

- Calcium Carbonate
- Calcium sulphate
- calcium silicate.
- Calcium Phosphate
- Silica
- Iron

Boiler scale on water side

Before & after Magnetic treatment

Scale also results in energy waste, a one-sixteenth inch thickness of scalecan result in a 12.5% increase in fuel consumption. By controlling scaling deposition, carryover, and corrosion in the boiler system, the following benefits are obtained.

- Maximum life out of boilers, steam turbines, condensers, and pumps.
- Lower operational costs.
- Minimizes environmental pollution

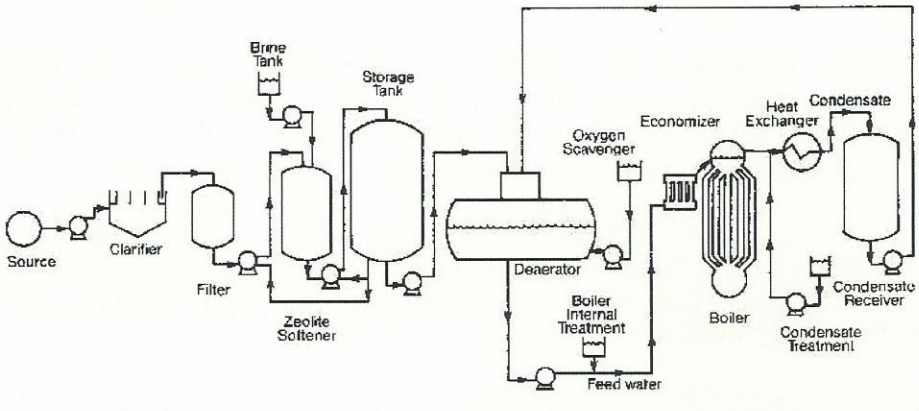
How good feed water quality is obtained.

External Treatment**:** External treatment, as the term is applied to water prepared for use as boiler feed water, usually refers to the chemical and mechanical treatment of the water source. The goal is to improve the quality of this source prior to its use as boiler feed water, external to the operating boiler itself.

Internal Treatment:

Even after the best and most appropriate external treatment of the water source, boiler feed water (including return condensate) still contains impurities that could adversely affect boiler operation. Internal boiler water treatment is then applied to minimize the potential problems and to avoid any catastrophic failure, regardless of external treatment malfunction.

(A flow diagram for a typical boiler plant.)



1. Science behind magnetic treatment of water

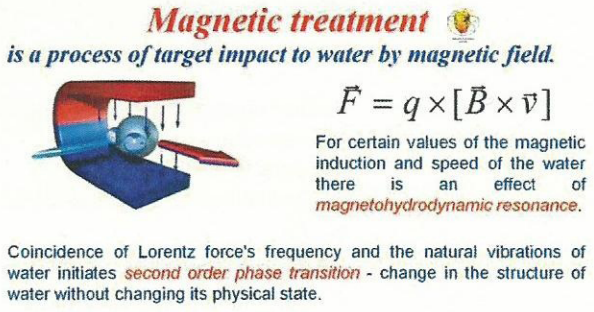
Alterations of physical and chemical properties of water-dispersed systems in the mode of magnetic treatment, imply a certain influence of magnetic field on the structure of water and aqueous solutions alike. Hydration of salt ions and other impurities minimises and improves technological characteristics of the water treated by magnetic field, i.e. better salt solubility, kinetic changes in salt crystallization, accelerated coagulation, etc.

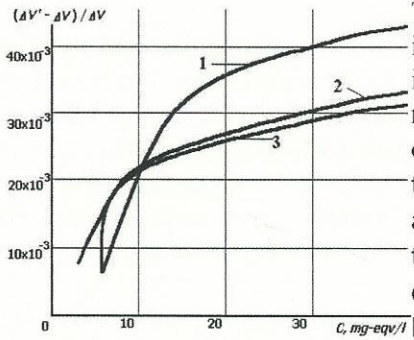
The research has revealed the evidence that all structural changes of water dispersed systems treated by magnetic field have to do with the ions of substances present in the water, colloidal[1] particles of considerable magnetic susceptibility and water changes, to boot. Thus, magnetic field affects the ions making their way through it and brings about the Lorentz forces, which can be calculated by way of the following equation:

$F = K \cdot q \cdot v \cdot H \cdot \sin a$, (1)
given that,
K - coefficient of proportionality;
q - ion charge;
v - ion velocity;
H-Magnetic field strength;:
a – Angle of magnetic field direction with ion flow.

[1] A colloid is one of the three primary types of mixtures, with the other two being a solution and suspension. A colloid is a solution that has particles ranging between 1 and 1000 nanometers in diameter, yet are still able to remain evenly distributed throughout the solution. These are also known as colloidal dispersions because the substances remain dispersed and do not settle to the bottom of the container.

According to the theory of MHDR (Magneto Hydro-Dynamic Resonance), the lorentz force, resulting from a liquid travelling across magnetic lines of force, can bring about restructuring (entropy change) when it comes to resonance with the inherent oscillations of electrically charged particles present in the liquid, such as molecules, solid dust particles, ions & free radicals.





The equation (1) shows that the Lorentz forces intensify with the growth of ion charge, magnetic field strength, flow velocity and perpendicularity of ions crossing magnetic field lines. The Lorentz forces act on positively and negatively charged ions (cations and anions) and make them diverge in opposite directions. whilst not changing its energy) Due to these influences, the energy of hydrogen bonding undergoes changes. The bonds are "bent" and partially broken which causes re-alignment of molecules and, therefore, alterations of water structure. This also brings about changes in density, surface tension, viscosity and other water properties when treated by magnetic field.

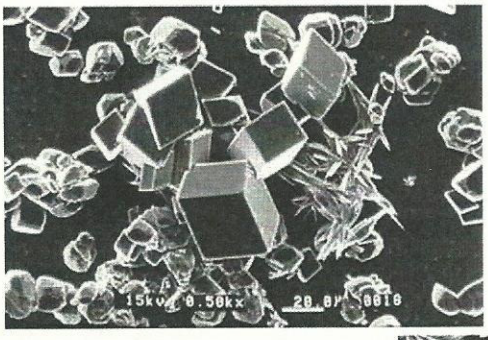
2. Anti-scaling properties of Magnetized Water

The driving force of crystallization (leading to scaling formation) due to hardness causing mineral salts are super saturation levels of the liquid media. By increasing the super saturation levels of this media, we stop or delay the crystallization process. Crystallization consists of two stages. Formation of crystal nuclei and their subsequent growth to visible dimensions.

Therefore rate of crystallization is in general, limited by the rate of nucleation. (Rate of nucleation is higher by as much as 1000 to 100,000 times in non-magnetized water). We can vary the kinetics of crystallization process by changing the entropy (structure) of liquid through magnetic hydrodynamic resonance (MHDR).

Therefore a change in entropy, affects not only the rate of nucleation in the supersaturated salt solutions, but trigger crystallization of the salt in the form of the crystallographic modifications typical for that salt.

For example, when the changed structure of magnetic treated water acts on dissolved CaCo3, its crystals will start to grow when super saturation at many times more than in normal water.
The crystals of CaCo3 (calcium Carbonate), will grow mostly as '**aragonite'** instead as '**Calcite**'as in the case of normal water. The aragonite crystals compared to calcite crystals have less adhesion to surface of pipe or heat exchanger and less cohesion to each other. Aragonite deposit being softer is easily removed by the water flow.

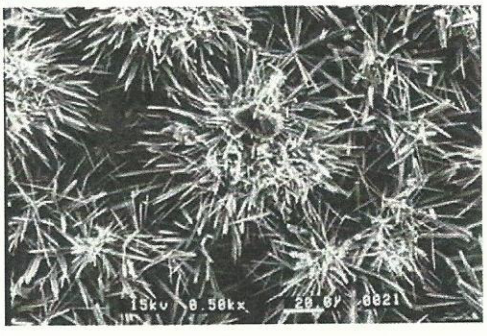


Calcite:

- adhesion to the material of the heat-exchange surface or the substrate is higher
- cohesion between the crystals is more strong
- δ ($FeCO_3$, Fe_2O_3) are lower

Aragonite:

- adhesion to the material of the heat-exchange surface or the substrate is lower
- cohesion between the crystals is poorer
- δ ($FeCO_3$, Fe_2O_3) are higher



<u>Specifically addressing scale deposits on a heat exchanger surface:</u>
First the basic substance forming crystal deposits on heat exchange surfaces of boiler and pipelines is CaCo3, practically always contained in water of natural sources. Scale deposits are formed not on all surfaces. Most frequently it occurs on steel surfaces. Formed on a steel surface, the film of oxides has a <u>crystal lattice</u> close to a <u>calcite lattice</u> and serves as a substrate for growth of calcite crystals.

Whereas, the crystal lattice of aragonite considerably does not correspond to parameters of a crystal lattice of iron or its chemical compound with oxygen or carbonic acid. Therefore scaling of aragonite on heat exchanger does not occur.
Second, for CaCo3, the inverse dependency of solubility on temperature is characteristic. That is with growth of temperature the solubility of CaCo3, does not grow. They tend to crystallize as calcite on heat exchange surface as scaling.
In conditions of magnetic hydrodynamic resonance, the structure of water varies so that crystallization of CaCo3 passes basically as Aragonite (in the ratio of 4:1). Aragonites barely adhere to each other and to heat exchange surface.

(There will be a gradual loosening of existing calcite scaling and gradual exfoliation of calcite pieces due to recrystallization in the changed structure of magnetic water).

Reducing energy expenditure incurred on heating.

In a liquid condition, water has casual quantity of intermolecular bonds, casual quantity of water molecule clusters in varying sizes. By heating water, we break off inter-molecular bonds to increase quantity of small and average clusters. But we incur high power expenses for heating water to achieve this

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But expenses incurred for destruction of bonds in water molecular clusters are avoided without consumption of external energy, through magnetic hydro dynamic resonance. It results in change extremely important for thermal power parameters such as

- Heat capacity
- Heat of evaporation.

Therefore, by increasing quantity of small structures and single molecules of water, water heat capacity is reduced. Thus during heating by way of reducing liquids heat capacity, we receive a real price in power expenses. Besides at the expense of change of structure of a liquid it is possible to lower its viscosity, hence to lower energy consumption of pump equipment.

One more source of energy saving is magnetic treatment of liquid fuel. The change of liquid fuel structure increases completeness of its combustion, reduces the contents CO and HC in the outgoing gases.

Capacity & Warranty

- 10 Years on magnetic strength
- Off the shelf we offer products that handles upto 1 million litres per hour and be customized to treat water to handle very high levels of hardness, pressure and temperature.

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