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Magneto hydro dynamics - the technology and practical application in cooling water treatment

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This paper is intended to provide a broad outline on the science of magneto hydro dynamics (used throughout this paper in the accepted shortform MHD) and how the science is being successfully applied in practice and used in heat transfer equipment for scale, algal and bacterial control. In particular, its application in replacing chemical treatment in water cooling systems is considered.

For those who wish to pursue the science further and research technical background some pertinent reference material is listed at the conclusion of this paper.

Magneto hydro dynamics (MHD)

The technology

Magneto hydro dynamics (MHD) is the science involving the passage of an electrically conducting fluid through a magnetic field. As the fluid flows through the field an electric current is induced in the fluid and can be "tapped off" and used to do useful work in some circumstances.

The name MHD is most often associated with its application in generating electricity by passing a plasma (a high temperature, ionised and therefore electrically conductive gas) through a magnetic field but it is important to realise that this is simply one example of the MHD effect.

Water containing electrolytes (substances which when dissolved form charged molecules, or ions, such as the normal salts commonly found in natural waters) will act as a conductor of electricity. When such a solution is passed through a magnetic field the MHD effect results in the generation of an electrical potential in the water owing to the Lorentz force acting upon the ions.

The Lorentz force is the force which is experienced by a charged particle at right angles to its direction of travel as it passes through a magnetic field.

When MHD is applied under certain conditions in water treatment there is an energy transfer, the consequence of which is an absorption of energy into the ions and the creation of dipoles in solution causing certain natural physical and chemical processes, which are thermodynamically

favoured, to be stimulated.

Typical processes that may be stimulated are crystallisation and oxidation. If the crystallisation process is stimulated to take place very rapidly the material is more likely to form a stable suspension than it is to form a hard scale on surfaces, and this is believed to be the process that prevents scaling.

The MHD stimulation causes crystals to grow rapidly from solution. It does not change their chemical nature; it simply changes the location and the rate where the reaction takes place.

This is the generally accepted explanation for the observed effects of magnetic water treatment processes where the characteristics of the water passed through the magnetic field are changed beneficially.

Practical use of the technology

The science has been put to practical use over the past 50 years throughout the world, particularly in what was the USSR where the use of MHD equipment is controlled by Government Acts.

Predominantly, MHD equipment has been developed over the years for control of scale in heat transfer equipment and for other many diverse uses, such as well documented use in bacterial control, algal control, effluent treatment, in mineral process slurry lines, in food process lines, and in agricultural production assistance to name just a few.

In Australia over the past 10 years the use of the MHD equipment has followed a similar pattern of usage and acceptance with many successful applications in the following areas:

- * Steam boiler scale and corrosion control [11].
- * Cooling system scale, algal and bacterial control.
- * Milk production lines for milk stone control.
- * Mineral process lines for gypsum scaling control.
- * Groundwater, for assistance in removal of iron by oxidation where high iron levels are present.
- * Development into effluent treatment.

Environmental impact

The use of MHD equipment can generally remove or reduce the necessity of chemical treatment methods in all areas covered under the heading

Practical use of the technology.

With the developing problems of chemicals usage and their impact on the environment, or in continually having the cost of disposing of possibly toxic chemicals after use, the use of MHD equipment often offers a very viable and cost effective alternative, which is also environmentally acceptable.

Discussions are currently being held with the NSW Health Department and with Water Authorities in that State, regarding the acceptance of waste water from MHD treated cooling systems being able to be dumped into the stormwater systems, in lieu of to sewer as with chemically treated water.

Cooling water treatment

The main concern of the building services industry and members of AIRAH, particularly those present who are from States in Australia where new Government legislation covering microbial control including Legionella species in cooling systems is either in place or under consideration, is to be able to comply at all times with the regulations.

These regulations, particularly in NSW, not only call for controlled levels of total bacteria count and Legionella levels in water cooling systems, but also extend into cleaning regimens and disposal of cooling system water whether chemically treated or not.

The result of new regulations has been the gradual moving away from chemical to non-chemical treatment methods including ozone, ultraviolet and magnetics.

Magnetics - use in cooling systems

MHD equipment has been marketed in Australia on a regular ongoing basis for approximately 10 years. Initially the magnetic equipment was sold successfully for scale control in cooling towers and, importantly, for cooling tower usage in down-the-line scale control in their circulating

| PHENOMENON | ADVANTAGES |
|---|--|
| <p>Surface chemistry is modified</p> <p>Increases mobility of minerals into water</p> <p>Accelerates the processes of crystallisation in solutions</p> <p>Reduction in viscosity</p> <p>Bacterial/algal/fungal/attack</p> <p>Changes in the infra red spectra</p> | <p>Increase settlement rate. Decreases process times. Enhances water particle separation. Removes existing scale, prevents new scale formation. Reduced surface tension.</p> <p>Allows for rapid descaling.</p> <p>Promotes precipitation from unstable solution. Crystals form in the solution. Minimum adhesion to walls of vessels. Preponderance of small, non-coagulating scale.</p> <p>Improves heat transfer through lower surface temperature. Lowers power consumption in transporting piped slurries.</p> <p>Permits dramatic reduction in level and control of bacteria, algae and fungi.</p> <p>Confirmation of either a chemical or physical change in the water. Occurs in 3450 wave number region, changes up to 40 per cent.</p> |

controlling bacterial levels. These results, together with reports of MHD equipment in actual field operations throughout Australia now form part of a detailed submission to the NSW Health Department Legionella committee as to the suitability of MHD equipment, as tested, for use in the control of bacterial growth including Legionella species.[10]

How does MHD treatment work

Scale. MHD processing affects crystallisation, therefore since crystallisation processes are basically a solubility phenomenon of the material that is coming out of solution, then to increase the rate of removal from solution means that there will also be an increase in the rate of solubilisation of those materials already out of solution.

It is the consequence of this reverse reaction that causes scale that is already formed to degenerate into a sludge form which could be sluiced off in pipes or tubes in large lumps or pieces.

Beyond these crystallisation and solubility phenomena the following list summarises some of the additional phenomena observed when normal process water is subjected to a MHD field.

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systems.

In December 1987 the WA Health Department checked a number of cooling towers in Perth for Legionella infestation, following outbreaks in Wollongong, NSW.

One of the towers checked had MHD

equipment installed as the only treatment for scale, algae and bacterial control. Results achieved on this cooling tower [9] prompted the Health Department to proceed with further laboratory tests to prove the efficacy of the MHD equipment in

Bacterial/algal/fungal control. It has been a regularly observed phenomenon in practise when MHD equipment is used that certain conditions will be present in cooling towers.

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(i) Algal/fungal growth will be initially removed where in contact with MHD treated water, and will not regrow even in open sunlight conditions.

(ii) Bacterial levels will be maintained at very low acceptable levels 104 TPC or less).

(iii) Re-introduction of bacteria, including Legionella species, into a cooling system will be controlled by the ongoing MHD treatment.

(iv) The cooling tower sump water will remain clear and clean.

Obviously, with a clean, algal-free, scale-free circulating system, control of bacterial levels in the system is assisted greatly by the lack of available nutrients, and scaled areas for bacterial infestation to be present.

This, however, is only a contributing factor in bacterial control under the MHD treatment. From laboratory tests carried out in WA [10] an absolute kill was achieved on various bacterial and Legionella species.

The observed phenomenon, on inspection of the dead cells, was that rupture had occurred to the membranes of individual cells. This may be caused by the negative and positive areas of the cell membrane being induced to move in opposite directions by the Lorenz effect resulting in rupture, but there are many theories as to how the actual kill is achieved.

Conclusions

The weight of evidence is now available to prove the effectiveness of MHD equipment treatment in cooling water systems to be able to provide ongoing, continual ' and to some extent a residual control in the following areas:

- * Scale, slime, fungal and algal growth.
- * Bacterial including Legionella control.
- * General cleanliness.
- * Efficient maintenance to increase heat transfer surface efficiency, and therefore reduce fuel usage costs.
- * Cost effective when compared to other systems in providing total control.
- * Environmentally acceptable, with reduction in water usage, both by reductions in bleed-off rates and in dump and cleansing requirements.

It should be noted that this paper in recognising the general use of MHD equipment is based on case histories and research results achieved by the Turbocide range of equipment and should not be seen as an acceptance of all types of magnetic equipment being able to provide the same proven ability.

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