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OVERVIEW OF RECENT MAGNETIC TREATMENT RESEARCH AT CRANFIELD UNIVERSITY

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1. Introduction

The build up of scale deposits is a common and costly problem in many industrial processes using natural water supplies. In Britain alone the formation of scales in industrial process plant where water is heated or used as a coolant is estimated to cost £1 billion per year[1]. Such costs can be attributed to the cleaning of the scaled surfaces or to the increase in operating costs due to the poor conductivity of scale. For example[2], a 2.0 mm scale layer can induce a 47% decrease in overall heat transfer for a heat exchanger with a heat transfer coefficient of 1000 $W.m^{-2}.°C^{-1}$. Moreover, scale deposits narrow the inner diameter of piping, increasing the amount of energy required to pump the cooling fluid through the system.

Scaling is defined as the deposition of sparingly soluble salts present in water. In the case of calcium carbonate ($CaCO_3$), the most common scalant in heated systems, this occurs as a result of temperature or pH changes, influencing the carbonate/bicarbonate chemistry. Other common scale-forming compounds include calcium sulphate, barium sulphate, calcium phosphate, magnesium hydroxide, zinc phosphate, iron hydroxides and silica, all of which occur naturally in raw water supplies.

Reported effects of magnetic conditioning of water have appeared in the literature since the late 1930's. These have usually related to antiscale magnetic treatment (AMT)[3], though there is some evidence that magnetism interacts directly with microorganisms. Reported effects appear to vary widely, possibly reflecting variations in water quality, and the apparent lack of their reproducibility has tended to undermine the credibility of the process.

The scientific literature is unable to explain why AMT works in some applications and not in others. This has lead to controversy over the application of AMT which is not helped by the paucity of systematic studies of the phenomenon, independent of AMT device manufacturers, and the lack of recorded design criteria have prevented acceptance of the method by process designers and plant engineers.

Cranfield University have been active in magnetic treatment research for the past 6 years and this paper will summarise some of the major findings during this time.

The objectives of the work over the past four years has been the identification and quantification of physicochemical parameters (principally magnetic field strength, solution chemistry and system hydrodynamics) governing:

semi-permanent change in the charge and potential at the boundary of the Stern layer. This mechanism is particularly interesting as it could explain both coagulation and crystallisation behaviour whilst offering a quantifiable performance parameter in the form of the zeta potential. What is does not explain is the effect magnetic treatment has on static systems.

5. Summary

- Magnetic treatment can reduce scaling under the correct conditions of temperature, pH, hardness and flow. There is no reproducible evidence that once through magnetic treatment can consistently reduce scaling.
- The type of scale formed during magnetic treatment is changed when compared to a reference.
- Results seen during static treatment require further evaluation.
- Electronic water conditioners can not soften water under the conditions tested here.
- Magnetic treatment increasing the coagulating tendency of the suspension by decreasing double-layer repulsion. This then keeps the crystals in solution rather than allowing them to crystallise on the pipe walls.

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