

Prevention of Pipe Walls from Scale Deposition by using Magnetic Field Treatment

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Abstract— A home-made magnetic device was built with permanent magnets for treating scaling waters. Its efficiency was evaluated by measuring the remaining ionic calcium at the output of the device by means of an ion selective electrode. The scaling power of the treated water was estimated through an electrochemical scaling test. Chronoamperometric curves and chrono-electrogravimetric curves were plotted to obtain the scaling time and the nucleation time of the scale deposition. The variation of the efficiency of the magnetic treatment was studied when the length of treatment, the flow velocity of the scaling water in the device, the material of the pipe where the scaling water flowed were changed. Magnetic water treatment does not change the chemistry of water but it alters the structure of water. Lorentz force is exerted on water ions the redirection of particles increases the frequency of collision between ions and opposite sides combining to form a mineral precipitate or in soluble compound scale deposits by natural waters often lead to numerous technical and economic problems in industrial plants and domestic equipment by blocking the flow of water in pipes or limiting heat transfer in heat exchange.

Key words: Electrochemical Scaling Test, Magnetic Field Treatment, Hydration, MWT

I. INTRODUCTION

Mineral salts play an extremely important role in the metabolism of all organic matter, which forms the basis of all biological processes. From the ground, the dissolved minerals are later transported by water in our pipes and installations. Metallic ducts offer possibilities of higher chemical bonds than water, and attract these minerals, which are recrystallized in the form of tartar [1]. When soluble calcium bicarbonate, $\text{Ca}(\text{HCO}_3)_2$, turns into CaCO_3 tartar, the result is doubly harmful, as water loses its mineralization and deposits damage the installations causing an extra energy consumption (up to 25%) and a high maintenance cost [2]. The below chemical equation describes the decomposition of calcium bicarbonate into calcium carbonate:



Scale composed mainly from calcium carbonate is soft and is the main cause of scale formation. In order to remove scaling, industrials often resort to chemical treatment which attacks scales deposit and clean pipes. Unfortunately, this method has a number of drawbacks: it is costly in money and time and presents health hazards. As an alternative, magnetic treatment offers an economical, more efficient and less dangerous solution: it modifies the physical properties without affecting the chemical structure of water.

In this work, we investigate the effect of permanent magnet on the characteristics of water and show how a strong magnetic field helps to remove lime scale deposits by

increasing the aragonite: calcite ratio in the mixture from a 20:80 before the magnetic conditioning of water to an optimal ratio of 80:20 afterwards [3]. (Figure 1 indicates the difference between the two calcium carbonate polymorphs: calcite as a hard scale and aragonite as a soft scale). Thus, the magnetic water treatment accelerates the crystallization of mineral deposits preventing them from adhering to the piping [4].

MWT has been used in water treatment for different uses. Liburkin et al. (1986)[14] discovered that gypsum particles were found to be larger and more regularly oriented in magnetized water compared to ordinary water. In addition, MWT also significantly reduced a number of pathogenic bacteria such as E.coli, harmful viruses, and algae (Newman and Watson, 1999; Ramon et al., 1987)[19]. Petruska and Perumpral (1978)[16] found that magnetic field efficiently reduced color content, total suspended solid (TSS), chemical oxygen demand (COD) and turbidity in sewage. Furthermore, the use of magnetic device was used to improve the textile laundering process. It was found that the MWT remarkably modified the detergency and mineral fouling that eventually enhanced the whiteness of cotton (Lipus et al., 2013)[17]. MWT was also used for plant irrigation to produce good quality crops with higher yield.

II. MAGNETIC WATER TREATMENT TECHNOLOGY

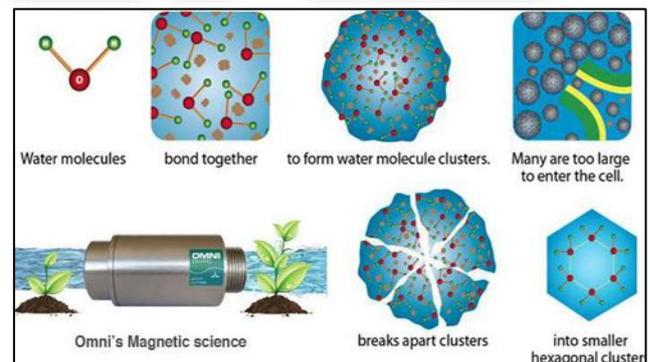


Fig. 1: Water Treatment Technology

Water is a colorless, odorless, tasteless liquid. It is a polar liquid, which means that it has a dipole moment defined as follows: In each molecule, the atoms with their electrons and nuclei are arranged so that one part of the molecule has a positive electrical charge while the other part is negatively charged. Such a molecule, therefore, becomes a small dipole. The change of the magnetic field causes the molecules to rotate, in one direction or the other, depending on the field load: taking a higher positive or negative potential. In the presence of a magnetic field, these molecules will react as a function of the net charge of the external force. The magnetic device brings a single positive (+) pole to the pipe [5].

This positive charge physically configures the fluid so that the negative poles of the molecules are attracted by the magnetic source. Therefore, a polarized and linear structural reorganization is created. The activated and amplified molecules (magnetized) react like small magnets. Because of Lorentz force which generates magneto-hydrodynamics effects [6] (Figure 2 explains this phenomenon).grid.

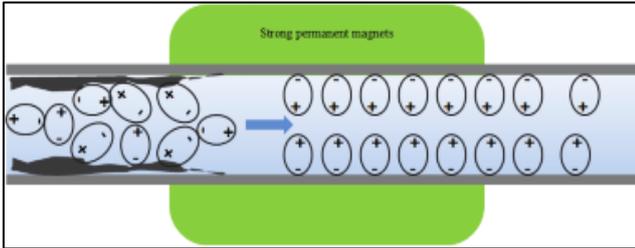


Fig. 2: Applied Magnetic Field Effect on Hard Waters

A water molecule consists of one oxygen and two hydrogen atoms. They form clusters with other water molecules, Clusters come in many sizes depends on water molecules involved [12]. Restructures the water molecules into very small water molecule clusters, each made up of six symmetrically organized molecules. Cluster is recognized by the cell as "bio friendly" the whole technology of magnetic water treatment shows in the figure [1]

III. WATER UNDER MAGNETIC FIELD

For the H_2O molecule, the bonds of the hydrogen and oxygen atoms are changed from a triangular structure to a linear structure. In a "linear" magnetized state, the more charged hydrogen (H_2) tend to attract the oxygen more negatively charged. As a result, the ionic field changes the net charge of water from negative (-) to positive (+). Thus, by treating a polar fluid with a correctly focused and sufficiently powerful magnetic field, we can control the orientation effect of atoms that affect molecular change. More precisely, the magnetic field increases the surface energy of small particles, and keeps them small and highly soluble. Their tendency to form a calcareous precipitate becomes considerably reduced. By treating the water with the appropriate magnetic field, crystallizations of calcium carbonate and hard relative minerals (limestone) will increase their water content. When tartar forms, it is in less hydrated form. In the case of calcium carbonate, the magnetic effect makes the crystals completely hydrated (saturated water) and change them into the aragonite form. The magnetic treatment increases the water content of this branched crystalline structure, thereby weakening it.

Finally, the limestone dissolves into aragonite formed of softer calcium carbonate, whereas the old limestone was hard and consequently hardly attached to the wall. This increased flocculation, i.e. a larger particle size, remains suspended in the water and therefore, depending on the equipment concerned (open or closed circuit), it must be removed by filtration or by rinsing.

IV. EXPERIMENTAL PROCEDURE

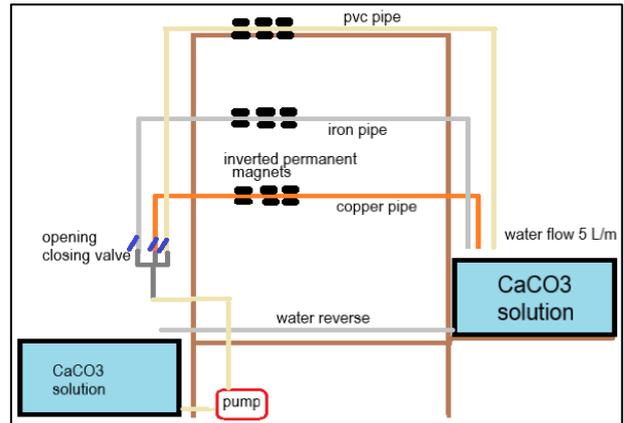


Fig. 3: Setup

Parameters of proposed method is as follows

- Pvc pipes of 0.5 inch dia 1.5 m length.
- Iron pipes of 0.5 inch dia 1.5 m length.
- Copper pipes of 0.5 inch dia 1.5 m length.
- Calcium carbonate as hardner 300mg/Lit.
- 45 Lit ionized water.
- 5 Lit/min flow velocity.
- 3800 gauss permanent ferrite black magnet.
- Scale formation time is 30 hr

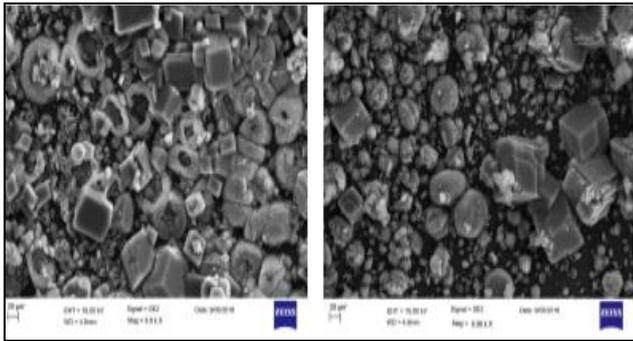
The home-made magnetic device It consisted of a series of pairs of permanent magnets with north and south poles facing each other, which can be associated alternately. The investigations were carried out using the experimental set-up shown in Fig (16) In this study, we used model water that was prepared following the method of Parsons who reported that the optimum concentration of Ca^{2+} ions for the best response to the magnetic treatment.



Fig. 4: Lab Setup

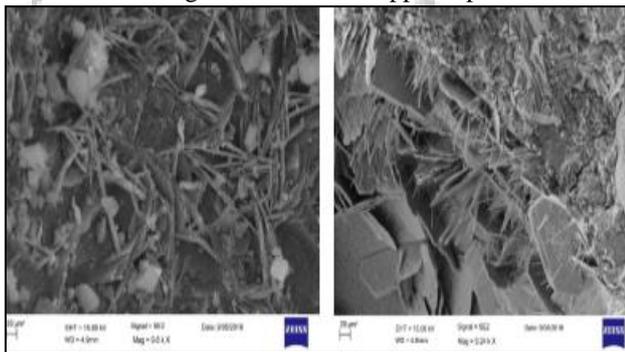
The magnetic treatment device (MTD) in a closed circulation system. Experiments were performed in parallel runs. One of the runs was treated with a magnetic field of 3800 gauss and the other was without magnetic field for the magnetic water treatment. The scaling water to be treated was circulated in a pipe through the gap by means of a centrifugal pump. The pipe, unless specified, was of copper, iron, PVC. The water velocity can be uniform with 5 lit/min. Each polar piece is the assembling of two rectangular permanent magnets

(40mm length, 25mm breath, 10mm thick). here the magnetic field was almost uniform in the gap (mean value 3800 gauss). The without magnetic water was treated for no memory effect that's why we were firstly circulate water in without magnetic field pipes up to 30 hours at a constant flow of 5lit/min and after that we close the valve of all three pipes of non-magnetic flow and after this process we were open the valve of magnetic field pipes which has the two pair of magnets which is bound around the pipe walls with the stick tape for creating a strong magnetic field of 3800 gauss and the hard water was start flow through the magnetized pipes and this flow of water is also flows up to 30 hours.



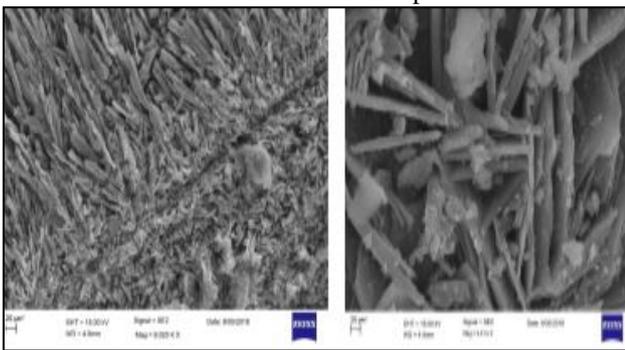
(A) (B)

Fig. 5 (A): SEM Image of Treated Copper Pipe (B) SEM Image of Untreated Copper Pipe



(A) (B)

Fig. 6 (A): SEM Image of Treated Iron Pipe (B) SEM Image of Untreated Iron Pipe



(A) (B)

Fig. 7(A): SEM Image of Treated PVC Pipe (B) SEM Image of Untreated PVC Pipe



Fig. 8: (A) Treated (B) Untreated

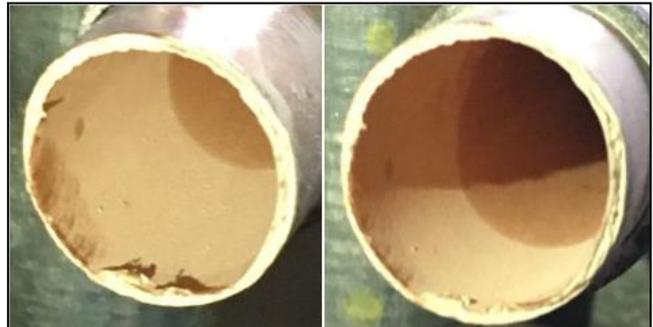


Fig. 9: (A) Treated (B) Untreated

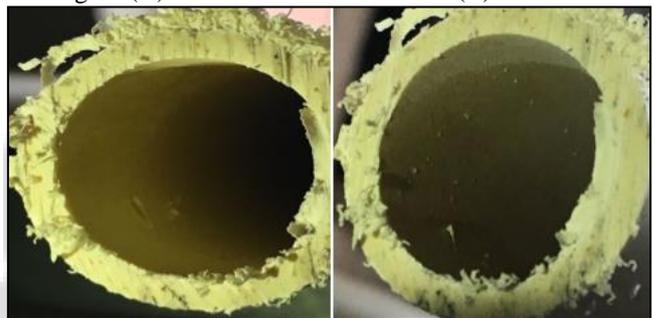


Fig. 9: (A) Treated (B) Untreated

Reading of final output reading with magnetize hard water
Are as follows

- 6.6
 - 4.5
 - 7.2
- Reading with un-magnetize hard water
- 7.0
 - 8.5
 - 10.5

V. CONCLUSION

In the proposed system, after treatment we found that in iron pipes the scale formation in 30 hr with magnetic treatment has less amount of scale deposition in comparison to the treated iron pipe, and the scale deposition in copper pipe and pvc pipe is less in comparison to the iron pipe. The factors of magnetic field intensity, situation of magnets setup, amount of enter water flow and enter water hardness has a significant effects on water hardness reducing. The strong influence of the applied magnetic field on the nucleation and further crystallization of calcium carbonate in hard water was confirmed. Although the benefits of the magnetic field in treating the water pollution, it has reduce the harmful effects of chemicals in environment. So, using the magnetic field with an intensity of 3800G is a safe method for treating water

pollution. Many studies must be done to reveal the benefits of magnetic field usage for water treatment in industries which has toxic waste.

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