

Effect of Magnetic Treatment of Water on Corrosion Rate

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Abstract

The present study aims to investigate the effect of magnetic water treatment on the reduction of corrosion rate in the pipes. In this study, tap water was used by passed it in magnetic field in three magnetic strengths (three intensities) and three different flow rates in continuous treatment process. Corrosion rate of samples were measured before and after magnetic treatment every 60 minutes for two hours.

After comparing the results obtained before and after the magnetic treatment, it was found that the highest change occurred in the results at the magnetic intensity (5000 G) and flow rate (0.025 l/s) and the highest decrease in corrosion rate was found 88.9%.

Keywords: magnetic field, magnetic water treatment, corrosion rate.

I. INTRODUCTION

Water molecule contains one oxygen and two Hydrogen atoms covalently bounded, the molecule resulting is stable, does not carry a net electrical charge, has no unpaired electrons [1], figure (1) shows the molecule of water.

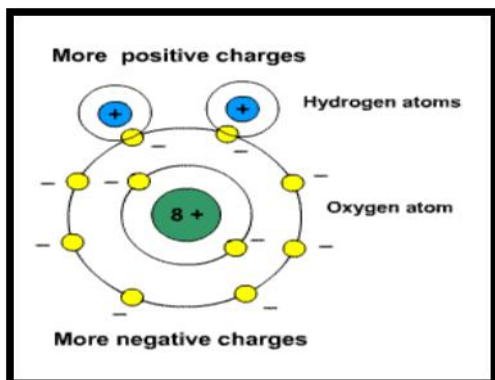


Fig 1: Molecule of H₂O

The molecule possesses a positive charge on one end and a negative charge on the other. Because of the two hydrogen atoms sharing electrons on one end. The dipole moment is a vector quantity and is

responsible for solubility which is one of the most important properties of water. Figure (2) shows how the dipole moment of a water molecule is similar to a magnet.

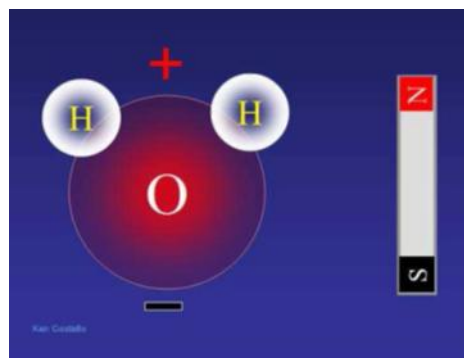


Fig 2: Water molecules, Dipole moment of a molecule

When using magnetic field for water treatment, the covalent bounded will be broken and this lead to absorbed more energy, thus reducing the boundary between the water molecules and increasing electrical decay which effected crystal decay [2].

The molecules of water could be either not polar or polar. Under influence of the magnetic field, we can change the molecules of water from non-polar to polar and a non-polar molecule becomes polarized they will be charges, this charge will pulling them together [3]. Magnet also reduces the bond angle between hydrogen-oxygen within the water molecule from 104.45° to 103° [4], figure (3) shows the water molecules before and after magnetic treatment. Many researchers confirm total fruit yield like tomatoes [5], or increase the health of human body, or the effect on weight and number of sunflower plant [6] are due to magnetic field. Constant magnetic field's effect was studied of direct impact on properties of wastewater modification [2].

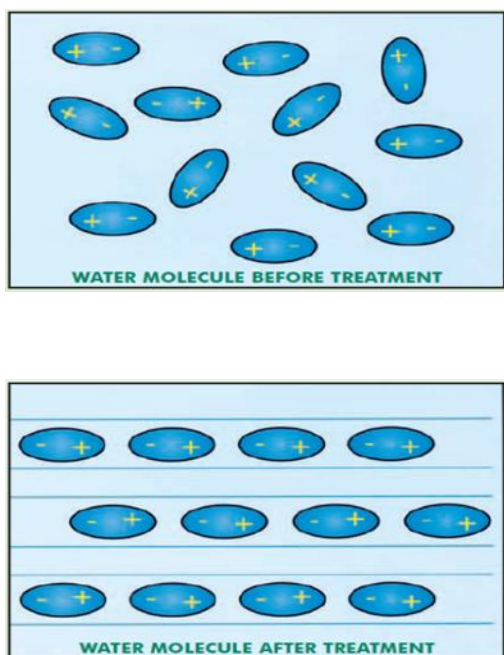


fig. 3 Water Molecules Before and After Magnetic Treatment [7]

According to [1] due to the magnetic field influence, different orientation was attained for polar molecules. Dipole numbers are greater in the direction of field is affected to the stronger the magnetic field.

A. Magnetic water treatment (MWT)

Magnetic water treatment is the process of exposing water for a magnetic field to induce some changes of chemical and physical properties of water, MWT is a type of water treatment that is used in many different fields like medical, environmental, industrial and agriculture [8].

The magnetic treatment method has been applied in water and wastewater systems of industrial and domestic to control the corrosion. Attention is paid to magnetic treatment during the last years. The objective for this study comes from the fact that such a simple technology has beneficial effect on many applications and impact on industries utilizing water. The technology of MTW is cheap, requires no energy to run, and creates no pollutants. Besides the method of magnetic treatment of water requires no chemical reagents, and is therefore environmentally friendly [9].

(MWT) is a relatively new technique in environmental management. When water is exposed to magnetic field, it will change the chemical and physical properties of water molecules resulting in unique characteristics. Magnetized water has shown different properties with applications used in various fields of environmental management. Scale prevention, plant growth, soil enhancement, water

saving, crop yield, and wastewater treatment are some of these applications. After the magnetic treatment of water, the structure of the water molecules will change into a small, uniform and hexagonally structured group that is easy to pass through the passages in plant and animal cell membranes. These features make MW a bio-friendly compound for human, animal and plant cells [6].

Magnetic water treatment results in changes in the transition character of the electrons in the water molecules due to the alteration of the polarization properties of the molecules and their distribution in magnetized water [10].

B. Corrosion

Corrosion is the chemical or electrochemical reaction between a material and its environments lead to a deterioration of the material and its properties, shows in figure (4) [11].

Corrosion of Iron in networks of water distribution is an important issue in industrial and drinking water for the large amount of unlined iron pipe. Pipes are destroyed by corrosion, disinfectants and consume oxidants in water, support growth of biofilm, causes scales that increase the energy required to water delivered, and suspensions are produced from particles of iron that give color of water a yellow, red or brown, or appearance of uncleaned [12].

1. Pipes corrosion causes

- i. **Water pH:** A pH effect under certain limits harms it and causes corrosion.
- ii. **Dissolved oxygen level in the water:** Oxygen effects on metals, gradually where it converts metal to rust. Or deposits of impurities are collected on the wall of pipes caused blockages and restrictions[13].
- iii. **Flow velocity and direction:** the high velocity or sudden change in direction can lead to corrosion in pipes because of the water turbulence[13].
- iv. **Water temperature:** water temperature influence many factors that directly affects corrosion rate such as dissolved oxygen, viscosity (which affect the water mobility), and electrochemical reaction which was reported to be increased with temperature increasing [14, 15].
- v. **Water's chemical makeup:** some chemical which increase water salinity would increase the corrosion rate, while some chemical that affect pH level may increase or decrease the corrosion rate [16].

2. Corrosion Effects

The cost of corrosion can be expensive, or effects on human's health. Consumption of water using toxic metals with high levels of resulting from corrosion such as lead and copper or others that lead to chronic and acute health problems [13].

Aesthetic quality is damaged of water and losing money like:

- i. Water heaters can be damaged causing them failure.
- ii. It can result in potential odors.
- iii. Plumbing systems and premature failure of fixtures are caused. [13]



Fig 4: Corrosion in pipes

II. EXPERIMENT METHOD

A. Magnetic Treatment Design

The design and configuration of the MTD to be used in these experiments consists of a main pipe which is divided into three branches where the water flows through them using water pump, each branch pipe (1, 2, 3) is fixed on magnet field with a certain strength (1000, 3000 and 5000 G), and each branch pipe contains a valve to control discharge of water passing through, as shown in figure (5).



Fig 5: Magnetic Treatment Design

B. Measured corrosion rate in water

Corrosion rates were measured by using samples of low carbon steel before and after using magnetic treatment of water in room temperature 23°C by using potentiostate device shown in figure (6) (7), applying Germly series (G300) which present in the computer, the experiment carried out by Tafel test.

Potentiostate device consisted of three electrodes: the first electrode is the starting test electrode the second electrode is graphite and it's used as an auxiliary electrode, and the third electrode is a saturated calomel electrode. The data and results appear on the screen monitor by Gamry software (program Echem) which shows corrosion rate data and curve.



Fig 6: potentiostate device



Fig 7: corrosion cell



Fig 8: samples of low carbon steel

III. RESULTS AND DISCUSSION OF CORROSION RATES

Figures (9) shows the decreasing in corrosion rate after using magnetic treatment of water, the maximum decrease shown in figures (9) (c) occur when ($Q=0.0251/s$) and (intensity=5000G).

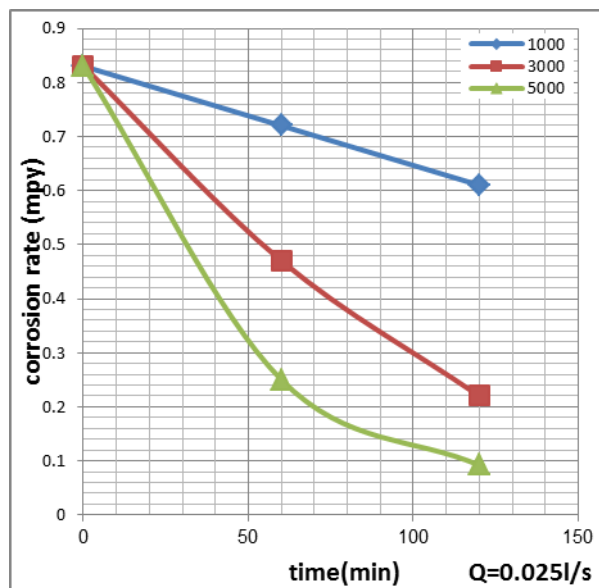
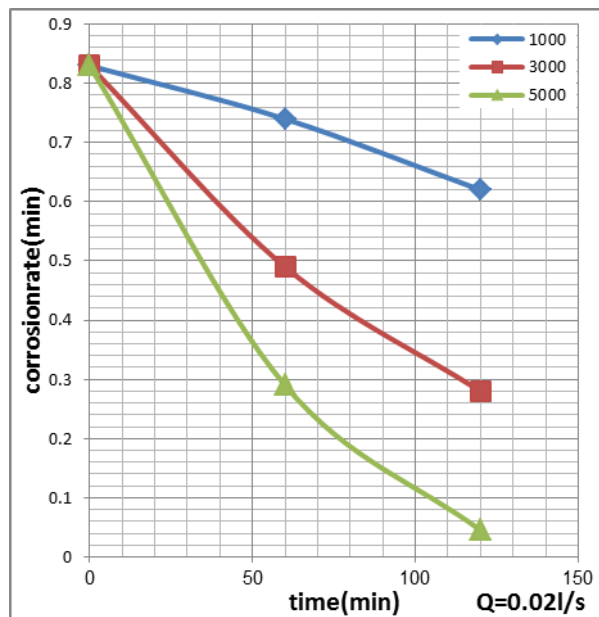
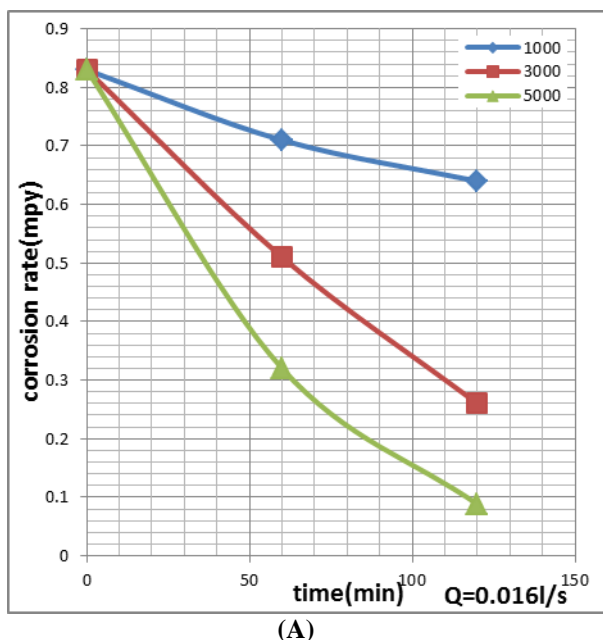


Fig 9: (A), (B), and (C): Relation between Corrosion rate and time at different flow rates

The reason of decrease is that the magnetic water restricts the movement of water molecules and ions that cause corrosion due the polarization resulting from the magnetic field, and enhance the bounds between O_2 and water molecules which result in reducing the reaction between O_2 and corrosive metals to the minimum level [17]. Many researchers refers that the magnetization of water would significantly increases the solubility of salts and hydration of ions and that is causes the changes in corrosion rates [18].

IV. CONCLUSION

The effect of magnetic treatment of water to reduce corrosion rate in pipes increase at the frequency of exposure to the magnetic field increased and the Magnetic intensity increased.

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