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A REVIEW ON FEASIBILITY OF MAGNETIC WATER TECHNOLOGY IN WATER RESOURCES MANAGEMENT

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Abstract:

Background and Objective: *Magnetic or magnetized water technology (MWT) has been recently introduced as promising approach for water resources management in agricultural, environmental, and industrial processes. Despite controversial findings of the recent studies, MWT seems one of the future technologies for efficient water management. This study aims to review the feasibility and perspectives of MWT in water resources management.*

Method: *The databases of Web of Sciences (1980–2016), EMBASE (1980–2016), and Google Scholar (1980–2016) were searched using the search terms of "Magnetic water" or "magnetized water" and "water resources management" and "treatment" and "agriculture" or "irrigation" or "industrial processes" to find the relevant papers. After reviewing the title and abstract, the papers were selected for selected for further review. The main focus of this review was the efficacy and feasibility of magnetized water technology in efficient management of water resources.*

Results: *Scale prevention or elimination, plant growth and crop yield enhancement, soil enhancement, desalination, antibacterial feature and wastewater treatment are the main features of MWT approach. Using appropriate set up of MWT in agricultural and environmental applications can result in water consumption saving. Magnetized water possesses strong antitoxic features and cannot enter the MW structure.*

Conclusion: *Although the modern MWT is in its early stage, the general consensus highlights its beneficial effects in agriculture, industrial applications and even for drinking water.*

Keywords: *Magnetic water treatment, Water resources management.*

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INTRODUCTION:

Water with H_2O formula and 18.01 gr/mol molar mass is introduced as a magical substance with special chemical properties. Water has a density of 1 gr/m^3 and a high surface tension. The world economy is largely dependent on water. It is used as a solvent for a wide variety of chemical substances, agriculture, industrial consumption and transportation Industry (1-6). Chemical properties of water such as PH, Iron, Total Hardness, Alkalinity, Fluoride, Arsenic, Total and Free Chlorine have a decisive role in its numerous applications. Electromagnetic fields change the momentum of charged particles and cause redistribution of flow energy (2). Several studies have shown that electromagnetic fields can change the molecular makeup of water and on a smaller scale change the critical radius of nucleation. In addition, numerical results have shown that electromagnetic fields are effective in reduction or elimination of water contaminants with influence on the zeta potential and size distribution of the particles formed in solution (1-3, 7, 8). Despite this method is viewed with much skepticism, but its effectiveness has been shown in various studies and countless occasions. The anti-scale effects of magnetic water treatment was used for reduction and transformation of calcium carbonate ($CaCO_3$) scale (1). Results of several studies have shown that treatment of water by EMFs results in formation of $CaCO_3$ particles and accelerates crystal growth (3, 9-11). According to diamagnetic property of water molecules, the efficiency of the magnetic treatment can be improved using a high gradient magnetic field to induce a strong force between ions and water molecules (12). Magnetic treatment can induce antibacterial and antimicrobial features on water which has been used in food processing as well as an approach for wastewater treatment (13-15). MWT has been recently developed and used as promising approach for water resources management in agricultural, environmental, and industrial processes. Although the initial findings of the studies were controversial, MWT seems one of the future technologies for efficient water management. This study was aimed to comprehensively review the recent advances of MWT and its feasibility and perspectives in water resources management.

Household Consumption

Several studies showed magnetic treatments cause to the formation of calcium carbonate particles. This technique can use in household consumption by eliminate with removing or filtering the resulting calcareous mud and avoid of sediment on the wall of pipes and other equipment (3, 16-18). Therefore, magnetic field effect on the precipitation or deposition of calcium carbonate and these particles can filter in the water flow. The results have shown that magnetic field decreasing the ionic calcium content of scaling waters by trapped a part of the ionic calcium and lead to inactive of ionic calcium content for scaling (3). The measurements rate of the calcium carbonate deposits under controlled physico-chemical conditions showed that scaling is dependent the system temperature, pH and degree of supersaturation (8). Studies have shown that electromagnetic fields because of intrinsic characteristics like antimicrobial and antibacterial properties have promising and beneficial potentials in wastewater treatment (4-6, 19). Several studies were reported that magnetic fields are effective on activity of activated sludge in wastewater treatment. They are also reported that using alternating current magnetic field has shown better results compared with pulsed DC magnetic field and DC form (4, 20, 21).

Industrial Consumption

Nowadays, many magnetic water treatment devices of different settings and capacities are used for the modified crystallization of scale-forming components and modified dispersion stability in industrial applications (22-24). One of the most common and costly problems in many industrial processes that use natural water is scale formation and ways of remove it. Among water conditioning methods, magnetic water treatment is an environmentally friendly and economic solution for scale control and amelioration of dispersion separations (25-27). One of the possible and controversial mechanisms on magnetic water treatment for scale control is based on the destabilization of nonmagnetic particles. This is an alternative method that is used in industrial water processing and improvement of dispersion separations for scale control (22). The main scale components include $CaCO_3$, $CaSO_4.2H_2O$, and SiO_2 are the main purpose in the water treatment. They are used in many industrial applications such as pigment, brightener filler, adsorbent and in different biomedical uses. On the other hand, scale depositions of them induce important damage in industrial installations using natural water (28-30). Among them, numerous studies have been focus on calcium carbonate precipitation because of its importance in several industrial processes. Results of studies confirmed that magnetic fields treatment enhanced $CaCO_3$ dispersion. The results showed that the flow velocity of dispersion increased by increasing the magnetic field density (31, 32). Alimi et al. (2009) investigated the effect of magnetic water treatment on calcium carbonate precipitation. They had used a magnetic field of 0.16 T for 15 min with different flow rates and PH of solutions. The results showed

that magnetic treatment affects $CaCO_3$ crystallization by increasing the total precipitate quantity. These results were observed strongly dependent on physico-chemical properties of solutions (33).

Agricultural Purposes

A large volume of water is used in agriculture. Water resources are limit and researchers are trying to find the ways and techniques to compensate of this deficiency with providing the possibility use of different types of water such as recycled water, low salinity water, and medium salinity water for irrigation in addition to the available water resources. One of the main problems in agriculture is the use of poor-quality irrigation water with high salinity. Results of several studies have shown that magnetized water can be used to reclaim soil and water and to reduce soil moisture stress (34-37). Magnetically treated water is changed in physical-chemical phases and these changes have shown the reclamation effect in agriculture applications (2, 38-40). Irrigation efficiency is appreciable increased with magnetic water treatment because of degassing of water and increase of permeability in soil (6, 41). Irrigation with magnetic water treatment increase the amount of CO_2 and H^+ in alkaline soils and also leads to convert insoluble carbonates into soluble bicarbonates in wet soil (41, 42). Results of studies reported improvement properties of alkaline soils and accelerates their leaching by virtue magnetized water irrigation (6, 43). After irrigation with magnetized water, the soil quality is increased because of improvement of permeability of irrigated water, leaching of superfluous salts and dissociation of mineral fertilizers (2, 6, 41, 43). Increasing soil quality also leads to less use of fertilizer and improvement the reclamation effect. Results of a study showed irrigation with magnetized water is most effective for soils with high soda content (2).

CONCLUSION:

The results were shown that magnetic methods are ecological purity, safety and simplicity among different physical and chemical methods of natural water treatments. These features encourage researchers to attract a special attention to this method (4-6). Magnetized water is used in industrial in order to avoid deposit of particles like calcium carbonate scale in the industrial installations using natural waters such as pipe blocking, membrane clogging, efficiency decay of heaters, etc (5, 22-24). Investigation the effects of magnetic treatment on irrigation water have been demonstrated improvement the quality of irrigation water with such physical-chemical changes in water such as the increase of the number of crystallization centers and the change of the free gas content (6, 41). Therefore, magnetic water treatments have shown cost-effective and practical methods and can expect further development and application of this method in many fields in the feature.

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