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Treating Groundwater Salinity using Magnetic Field Technology

Yassien H. Owaied AL-Juboory [1], Aseel H. Mahdi[2]

1Biology Department, College of Education for Women, Tikrit University, Tikrit, Iraq
[2]Biology Department, College of Science, Kirkuk University, KiKuk, Iraq
Email: aseel19811975@gmail.com

ABSTRACT

This study was conducted in Kirkuk city-Iraq for the purpose of evaluating the effectiveness of the magnetic field in treating the salinity of groundwater wells, and for the period extending from April 2020 to August 2020, where the study focused on designing a treatment unit using magnetic fields of different intensity by exposing the water to permanent magnetic fields of Neodymium. The intensity of its magnetic flux is 5000 gauss (0.5 Tesla), 7000 gauss (0.7 Tesla), and 10,000 gauss (1 Tesla) with a stable water passage time of 15 minutes, then the water was passed with a magnetic field of constant intensity of 10,000 (1 Tesla) with the change of the water passing time from 5, 10 ,15 minutes. The study showed the effect of magnetic treatment in decreasing the values of total soluble solids, electrical conductivity, total hardness, calcium and magnesium hardness, chloride and sodium ion, high pH, high potassium ion concentrations, and increasing the readiness of nutrients for soil and plants.

Keywords: magnetic techniques, saltwater magnetization, groundwater

Correspondence:
Aseel H. Mahdi
Biology Department, College of Science, Kirkuk University, KiKuk, Iraq
Email: aseel19811975@gmail.com

INTRODUCTION

Groundwater is defined as water that is present in ground and is stored in pores of rocks or cracks through its infiltration through the soil and rocks to the lower layers of the earth's surface forming groundwater, which represents the largest proportion of fresh water after the frozen water and is considered an important water resource in desert areas, which They are found in the ground at different depths and change from one site to another according to the geological formation of the area [1]. Groundwater is the second main source of water for humans all over the world, and its importance increases, especially in dry and semi-arid regions. Groundwater reaches the surface of the earth by drilling wells, and where people benefit from this water for drinking and other uses [2]. Groundwater contains different concentrations of salts, most of which are calcium and magnesium salts, and they may be in high concentrations, which make the water hard, especially geological formations with structures containing ions, as well as salts transferred to them and suspended and dissolved materials [3].

In order to find out the percentage of these concentrations in the groundwater, many analyzes were made of the physical and chemical properties, and the magnetic field water treatment technique is an effective way to improve the water properties for drinking, agriculture, industry and other uses [4]. Also, the magnetic field works to cause changes in the structural properties of water and bring about a set of changes in the physical and chemical properties of water [5]. The magnetic field water treatment technology increases the readiness of soil and plant nutrients compared to untreated water with magnetic fields, It was found that the water exposed to the magnetic field works on arranging the water molecules and moving at the same time by the force of Lorentz, which leads to the reduction of collisions between the oxygen molecules and the calcium particles and thus prevents the formation of calcium carbonate, which is one of the main components of sediments [6]. Just as exposing the water to the magnetic field leads to a decrease in the concentration of chloride and sodium ion, and it works to dissolve different types of salts [7]. As noted by the researcher [8], a decrease in the electrical conductivity values with an increase in the intensity and time of the magnetic field and the proportions of this decrease to the fact that the water treated with the strength of the magnetic field contains colloidal particles that are in constant motion similar to the cold motion, and these particles have the ability to precipitate, which leads to a decrease in the conduction value. Electrophoresis.

In order to study the effect of the magnetic field on the properties of water, he designed a device consisting of

1. Neodymium permanent magnets.
2. Three polyethylene packages where magnets are placed.
3. Four bottles of polyethylene, one for inlet water, and three bottles for outside water.
4. Seven water valves.
5. High purity polyethylene connection pipes.

Where permanent magnetic fields of different strengths were used

1. The magnetic field is 5000 gausses (0.5 Tesla).
2. The magnetic field is 7000 gausses (0.7 Tesla).
3. The magnetic field is 10,000 gausses (1 Tesla).

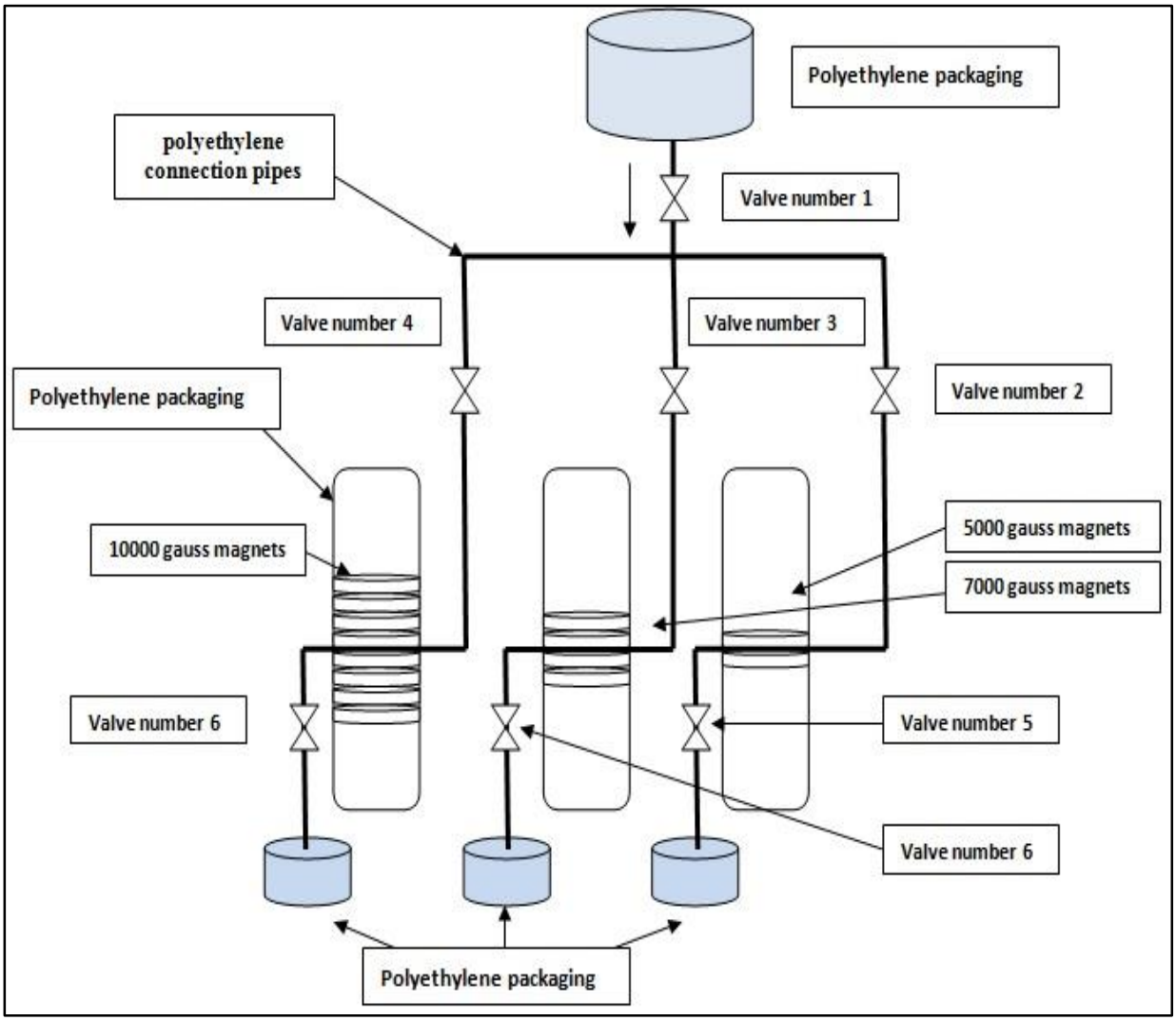

Figure 1. Schematic showing the magnetic treatment unit for wells water

Material and Methods

The following steps were taken to treat saline well water

1. Raw water (well water) passed through the input tank and through valve No. 1, then the water passed through the pipes through valves 2, 3, and 4 to the first treatment unit with a magnetic field of 5000 gauss (0.5) Tesla.
2. The raw, untreated water was passed to the second treatment unit with a magnetic field of 7000 gauss (0.7) Tesla.
3. The raw water was passed to the third treatment unit with a magnetic field of 10,000 gauss (1) Tesla in parallel and through valves (5, 6, 7), then the exposure time to the magnetic field and the speed of water passage were controlled, and then the treated water was out put out of the unit. The treated water is collected in polyethylene containers.

Where permanent magnetic fields with magnetic flux (5000, 7000, 10000) gauss were used with a fixed time period of 15 minutes of water passing. As the magnetic treatment process is done by passing water through the magnetic field, and physical and chemical tests were performed before and after the treatment.

The electrical conductivity, the electrical conductivity was measured using the field device and the device by Lovibond and the pH using the field pH meter and the total dissolved solids in the HANNA device. As for the rest of the factors, the total hardness was measured according to the method shown in [9]. After adding 1-2 ml of ammonia buffer solution to raise the PH value, then adding Erichrom Black –T reagent, then crushing with EDTA-2Na solution until the color turns blue and calculated according to the following equation

$$\text{Total Hardness} = \frac{\text{V } Na_2EDTA \text{x } 1000 \text{x M.Was } CaCO_3}{V Sample}$$

V = volume

N = Normality

M.W = molecular weight

The same method was followed to measure calcium hardness by correcting it with EDTA-2Na solution and adding a standard hydroxide sodium solution at a concentration of (2.5N), then adding drops of Calcium Murexide until the color changed to blue, then the magnesium ion concentration was calculated by subtracting the calcium ion concentration From total hardness [9]. Then the sodium and potassium ion were estimated using the Atomic Absorption Spectrometer made by England [10]. Then the chloride ion was measured by following the method described in [11], according to the following equation

$$CL^{-} \text{ mg /L} = \frac{(A-B) x N AgNO_3 x\ 3540}{V \text{ حجم العينة}}$$

Where A = the volume of the silver nitrate solution used for the patch

B = Volume of the silver nitrate solution used for distilled water scrubbing
N = silver nitrate titrates ($AgNO_3$)
V = sample size

Results and discussion

The results of the current study, as shown in Table No. (1), showed the effect of changing the magnetic field strength on the values of total dissolved solids of well water after magnetic treatment using different magnetic field strengths: 5000 gauss (0.5) Tesla, 7000 gauss (0.7) Tesla, 10000 gauss (1) Tesla with a constant time for the passage of water 15 minutes, where a decrease in the values of total dissolved solids was observed from (1244-1088) mg / liter, i.e. by 13% when the magnetic field strength was 10,000 gauss (1) Tesla, and it decreased by 11% when the magnetic field strength was 7000 gauss (0.7). Tesla decreased by 4% when the magnetic field strength was 5000 gauss (0.5) Tesla, and the results of the current study showed as in Table (2) the effect of changing the time of water passing into well water during magnetic treatment using a different holding period (5, 10, 15) minutes At the strength of the static magnetic field 10,000 gauss (1 Tesla), where it decreased by 12%, when the magnetic field strength was 10,000 gauss(1Tesla) and the passage time of water was 10 minutes. Whereas it was noticed that increasing the time for the passage of water had an effect on reducing the values of total dissolved solids, and the results of the current study agreed with its findings [12]. Where he observed a decrease in the concentrations of total dissolved solids by 25% at the magnetic field strength of130 gauss (0.013 Tesla) within 30 minutes.

Table 1. levels of some physical and chemical properties before and after magnetic treatment with constant water passage time.

Test	Raw water before processing	Water treated with a magnetic field of 5000	Removal percentage	Water treated with a magnetic field of 7000	Removal percentage	Water treated with a magnetic field of 10000 gauss in 15	Removal percentage
Total Dissolved Salts TDS	1244	1200	4%	1112	11%	1088	13%
Electrical Conductivity (EC)	1918	1917	0%	1891	1%	1711	11%
PH ↑	7.5	7.6	1%	7.7	3%	8	7%
Total hardness	784	746	5%	730	7%	700	11%
Calcium hardness	120	115	4%	111	8%	100	17%
Magnesium hardness	118	111	6%	110	7%	99	16%
Chloride	46	41	11%	40	13%	33	28%
Potassium ↑	3.5	3.6	3%	4.0	14%	4.5	27%
Sodium	48	45	6%	42	13%	32	33%

Table 2. levels of some physical and chemical properties before and after magnetic treatment, with the difference in the time of water passing.

Test	Raw water before processing	Water treated with a magnetic field of 10000	Removal percentage	Water treated with a magnetic field of 10000	Removal percentage	Water treated with a magnetic field of 10000 gauss in 15	Removal percentage
Total Dissolved Salts TDS	1244	1108	11%	1100	12%	1088	13%
Electrical Conductivity (EC)	1918	1898	1%	1817	5%	1711	11%
PH ↑	7.5	7.7	3%	7.8	4%	8	7%
Total hardness	784	754	4%	750	4%	700	11%
Calcium hardness	120	116	3%	110	8%	100	17%
Magnesium hardness	118	113	4%	112	5%	99	16%

Chloride	46	40	13%	36	22%	33	28%
Potassium ↑	3.5	4	14%	4.2	20%	4.5	27%
Sodium	48	38	20%	37	23%	32	33%

PH

The results of the current study, as shown in Table (1), showed that the pH value of well water increased after treating the water with the magnetic field, and the percentage of increase was 7% when the magnetic field strength was 10,000 gauss (1) Tesla and the lapse time of 15 minutes, and by 3% at the magnetic field strength. 7000 gauss (0.7) Tesla and a lapse of 15 minutes, with a percentage of 1.3% at the strength of the magnetic field 5000 gauss (0.5) Tesla and a lapse of 15 minutes. The reason for the increase in the pH is the breaking of the hydrogen bonds and the formation of some alkaline substances [8]. And as the results of the current study agreed with the results of the study [13], which indicate an increase in the pH by 1%, the highest value was 9.81 when the magnetic field strength was 0.15 Tesla.

Electrical conductivity

The results of the current study as shown in Table (1) indicated a decrease in the electrical conductivity values by 11% when the magnetic field strength was 10,000 gauss (1) Tesla and the lapse time of 15 minutes, as for the magnetic field strength of 5000 gauss (0.5) Tesla, the decrease was Zero% and the lapse time 15 minutes , The reason for the decrease in the electrical conductivity values is the decrease in the number of ions' charges due to the large force of magnetic attraction, which is generated by the strength of the magnetic fields [4]. The results of the current study agree with the results of [14]. which observed a decrease in the values of electrical conductivity with an increase in the intensity of the magnetic field.

Total hardness

The results of the current study as shown in Table (1) indicated a decrease in the total hardness values of well water at the magnetic field strength of 10,000 gauss (1) Tesla and the lapse time of 15 minutes, where the decrease rate was 11% and the percentage decrease was 7% when the magnetic field strength was 7000 gauss (0.7). Tesla and the water passage time is 15 minutes, while the percentage of decrease at the magnetic field strength of 5000 gauss (0.5) Tesla was 5% when the water passage time is 15 minutes. The results of the current study showed in Table (2) the effect of changing the water passage time on treating the salinity of well water, where the percentage of The decrease is 4% when the magnetic field strength is 10,000 gauss (1) Tesla, and the decrease is 3% when the magnetic field strength is 10,000 gauss and the elapsing time is 5 minutes, and the reason for the decrease in total hardness is due to the decrease in the values and concentrations of calcium and magnesium ions, as they are in normal water due to adhesion to each other At the molecular level, they become large clusters, which leads to their exit from the solution and their sedimentation into tubes or pores. When treating water, it prevents random adhesion of these particles and keeps them inside the solution [7]. The exposure of water to the magnetic field will be affected by the force of Lorentz, which works on arranging water molecules, thus reducing collisions between oxygen molecules and calcium particles and preventing the formation of calcium carbonate [15].

calcium and magnesium hardness

The results of the current study showed a decrease in the concentrations of calcium and magnesium ions upon exposure to the magnetic field strength of 10,000 gauss (1) Tesla and the passage time of 15 minutes, where the percentage of decrease was 12% and 11%, respectively, and the percentage of decrease was 4% when the magnetic field strength was 5000 gauss (0.5) Tesla. The water passage time is 15 minutes, the rate of decrease of 8% when the strength of the magnetic field is 7000 gausses, the passage time of 15 minutes. A lapse time of 10 minutes. As for the magnesium ion, the lowest percentage decrease of 6% was when the magnetic field strength was 5000 gauss and the elapse time of 15 minutes. The reason for the decrease in calcium and magnesium ions is due to the fact that the magnetic field changes the ionic state of the calcium and magnesium salts, as the calcium and magnesium ions in normal water tend to stick to each other at the molecular level, so they become large clusters that lead to their exit from the solution and their sedimentation inside the tubes. It prevents random sticking of these particles and keeps them in solution [7].

Chloride ion

The results of the current study, as shown in Table (1), showed a decrease in the chloride ion values, where the percentage decrease was 28% when the magnetic field strength was 10,000 gauss (1 Tesla), the passage time of 15 minutes, and the percentage decrease of 13% when the magnetic field strength was 7000 gas (0.7 Tesla), the lapse time of 15 minutes and the percentage 11% reduction over 5,000 GAS (0.5 Tesla) magnetic field strength and 15 min elapsing time. As shown by the results of the current study as shown in Table (2), the effect of changing the time of passage of water to well water during magnetic treatment using a different passage period (5, 10, 15) minutes at the strength of the static magnetic field 10,000 gauss, as it decreased by 13% at a time of 5 minutes and decreased. 22% when the lapse of 10 minutes. This decrease is due to the breakdown of the salts and the dissolution of the hydrogen bonds between the atoms, which increases the solubility of the salts by the attractive force created by the magnetic field, which leads to a decrease in the number of chloride ions [16]. The magnetic treatment affects the polarity of ions, which increases the permeability of chloride into the cellular membranes, which works to break down the salts and increases the readiness of the nutrients by breaking the salt crystals so that it penetrates the roots into the soil, which increases plant growth [17]. And these results were identical to his findings [13].

Potassium ion

The results of the current study, as shown in Table (1), showed an increase in the values and concentrations of the potassium ion after the magnetic treatment, and the percentage of increase in the potassium concentration

was 29% when the magnetic field strength was 10,000 gauss (1 Tesla) and the lapse time of 15 minutes, while the rate of increase in the potassium ion 14 % When the magnetic field strength is 7000 gauss and the lapse time of 15 minutes and the rate of increase by 2% when the magnetic field strength is 5000 gauss and the lapse time of 15 minutes. 5 minutes and a percentage increase of 20% at a constant field strength of 10,000 gauss and a lapse of 10 minutes. The reason for the increase in potassium ion is due to the increase in the readiness of nutrients for plant growth and the increase in potassium ion absorption, which leads to an increase in its stored content in plant parts [18].

Sodium ion

The results of the current study showed a decrease in the sodium ion concentrations, and the decrease was as shown in Table (1) by 33% when the magnetic field strength was 10,000 gauss, the passage time of 15 minutes, the percentage decrease of 13% when the magnetic field strength was 7000 gauss, the time of 15 minutes, and the percentage decrease of 6% when The intensity of the magnetic field is 5000 gauss and the lapse time of 15 minutes. As for Table No. (2), it showed the effect of changing the time of water passing through the magnetic field, where the percentage of decrease was 22% when the strength of the magnetic field was 10,000 gauss, the time of 10 minutes, and the rate of decrease of 20% at the time of 5 lapse. minutes. The reason for the low concentrations of sodium ion is attributed to the fact that exposing the water to mesetic fields leads to a decrease in the concentration of sodium ions, which helps in eliminating the negative effects of the rest of the ions as it works to dissolve various salts and minerals [7]. The magnetic treatment works to break the salts and separate the hydrogen bonds between the atoms, which increases the solubility of the salts and ions that attract the magnetic poles [14]. The results of the study were identical to the findings of the researcher [19]. Which showed that there is a decrease in the sodium ion concentration by 12% after magnetite treatment, and the results were identical to the study [20]. Which showed the decrease in the sodium ion concentration in wastewater after magnetic treatment from 101 ppm to 61.1 ppm.

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