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The effect of electromagnetic field technique on wells water hardness reducing

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Abstract
This study was conducted on nine wells water within Kirkuk city for the period 1st July 2015 until 13th June 2016 to assess the electromagnetic field's effectiveness in groundwater purification, where the study focused on the design apparatus with different electromagnetic fields accomplished by exposing the water to electromagnetic fields while the water is passing through the device. Electromagnetic water treatment process consists of two phases, the first by using different electromagnetic fields 1.4,1.7,1.9 Tesla with the stability of the water passage time 20 minutes through electromagnetic field and the second phase is consists of fixed electromagnetic field intensity 1.9 Tesla with change water retention time 5, 10, 20 minutes during the electromagnetic field . Study showed the effect of electromagnetic treatment on wells water hardness. The total hardness decreases at a rate of 18% when the field intensity 1.4 Tesla and 31% when the field intensity1.7Tesla , while the total hardness value decrease at a rate of 48% when the field intensity 1.9. The total hardness decreased at a rate of 15% when retention time 5 minutes and to 30% when retention time 10 minutes , while the total hardness decreased at a rate of 57% when retention time 20 minutes.

Introduction
Water that permeates in the soil and below the rocks is known groundwater. They constitute 14% of the total volume of fresh water on the Earth's surface which is a second source of fresh water after rivers and glaciers. This water is undrinkable but important to the lives of animals and plants, industry and household uses. The main source of underground water is rainwater, where it moves to the scope of the underground water through the pores in the rocks and soil (1). All the chemical reactions that accompany the activities of water through water cycle since entering until they leave the ground as well as various human activities have an impact on the physical, chemical and biodiversity of water .as is it indicated by the Health and Environment Committee (CEOH).
The Changes in groundwater depends on the geographical location and the size of well and climate change. The existence and quality of groundwater depends on the quality of its load bearing rocks and rocks composition, density and permeability that result in variation in their ability to carry water. The cavities of rich areas with carbonate, such as Allamiston and dolomite rocks are more susceptibility to melt which is suitable for the formation and assembly of groundwater area .Also limestone rocks are suitable to carrying groundwater and make it hard water because of the melting of calcium and magnesium carbonate (2).However it is found that the quality of groundwater is affected by moving whenever the slow movement increased interaction between rock and water results an increase in the concentration of dissolved substances in water with time.
The groundwater in the course of their motion through the soil dissolves some of the constituent metals as well as some of the materials added as a result of human activity which is in contact with them. This means that the primary influence on groundwater quality is chemical composition of the rocks that water-bearing (3).
There is no doubt that this diversity of operations and factors affecting the chemical composition of the groundwater that makes all reservoir have their own chemical properties, and for all these reasons conducted detailed chemical analyzes are considered means and an essential tool to help in the interpretation and understanding the situation prevailing hydrogeological as the chemical composition of the groundwater is formed as a result of the impact of various natural conditions that determine the exact sources of the physico-chemical composition and processes that whereby the transfer of materials and re-distributed in the hydrogeological system(4) The magnetic water treatment technology is an effective way for conditioning the properties of fresh and salt water and improving the properties of this water for use in agriculture and other purposes (5) Virtually this technique is no longer modern but used in early researches between the years 1960 to 1980 for water treatment magnetically and conducted in Russian institutes and Europe countries and China. But now many of the concepts of water treatment magnetically has become indefensible facts (6) when water exposed to a magnetic field leads to bring about changes its structural characteristics (7). As well as the role of magnetic treatment to improve the water properties and using the magnetic treatment occur set of changes in chemical and physical properties of water including increases the proportion of dissolved oxygen and reduce the surface tension and increase the solubility of solids and increase the readiness of the soil food elements, and improve the permeability of the cell membrane and low viscosity compared to the use of untreated water.

Materials and methods
Preparation of the water treatment apparatus

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In order to study the effect of the magnetic field on water properties, it has designed apparatus composed of two parts:

-The first part of the device is used for the passage of water through the magnetic field and to control the amount of water, and consists of :

1- Container: Polyethylene bottle 2.5 liters capacity and used as a source to supply the device with water.

2. Valves: Two valves were used in this device, the first valve is tied at the base of the bottle, the purpose of the first valve is to control water flow through filling the bottle with water, while the second valve is tied into the end of the metal tube which enter within the electromagnetic field, the purpose of it is to control the time and water quantity that pass through the electromagnetic field.

3. pipes: Two types of pipes were used : the first pipe is made of transparent rubber 0.5 meter length. This pipe tied between the polyethylene bottle and the metal tube by the first valve, while the other pipe (which is the most important part) is made from carbon steel material 40 cm length and insulated electrically by an insulating material on the sides of the tube which passes through the magnetic field.

-The second part of the apparatus: There are several magnetic structures around the world, which are used to improve water properties , most of these consist of permanent magnets pairs and are linked beside each other on the pipe(8). In the current study the used part was the fixed one (Astor) of the electric motor which consists of coil, this coil is a copper wire existing inside the electric motor, and when electric current passes through the coil it will generate electromagnetic field, this electromagnetic field is fed with electricity from an external source. The magnetic field intensity inside the electric motor dependent on two factors the number of the coil laps and on the intensity of electric current that passes in the coil.

Three different electromagnetic field coils are used:

1- Electromagnetic field 1.4 tesla is equal to 14000 gauss.

2- Electromagnetic field 1.7 tesla is equal to 17000 gauss**.**

3- Electromagnetic field 1.9 tesla is equal to 19000 gauss**.**

The following steps have been followed in the well water treatment

1−Using strong and different electromagnetic fields (1.4.1.7.1.9). Tesla these electromagnetic fields exceed all the magnetic fields used in previous studies with a fixed time of water passage 20 minutes. The electromagnetic treatment process is occurs by water passing through the electromagnetic field in all the fields intensity and then physical, chemical and bacteriological tests are carried out before and after treatment and treated water was used in irrigation the white sorghum plant.

2- Using fixed electromagnetic field intensity 1.9 Tesla with a different retention time (5,10,20) minutes. The treatment process occurs by passing water into the electromagnetic field and keeping it for periods (5,10,20) minutes under the influence of 1.9 Tesla field intensity, then Physical, chemical and biological tests are carried out before and after treatment.

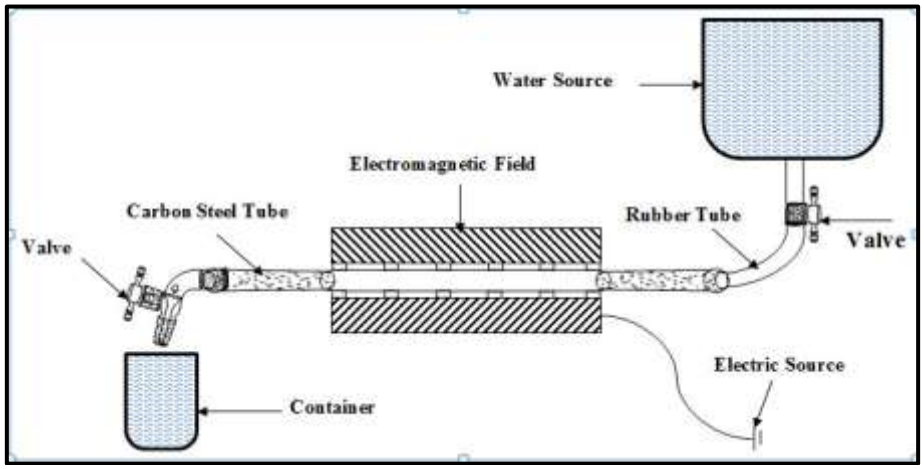

Figure (1) Schematic of the device used in the electromagnetic treatment of wells water

Total Hardness

Followed Lind way (1979) in the total hardness measuring by taking (5-10) ml of the water sample, then the volume was completed with distilled water to 50 ml and titrated with (Na2EDTA) solution (0.01) normality after raising the pH sample to 10 by adding 1 ml of ammonia regulator solution then adding a suitable amount of Erichrom Black-T powder as dry indicator until the color changed to blue and then the readings average was taken. The total hardness calculated according to the following equation:(9).

$$\text{Total Hardness} = \frac{V_{Na2EDTA} \times N_{Na2EDTA} \times 1000 \times \text{M.W as CaCO3}}{V\ s_{ample}}$$

V = Volume
N = Normality
M.W = molecular weight

Results and Discussion

The results of the present study as table (1) showed the effect the changing of electromagnetic field intensity on the total hardness values of wells water after treatment by using different field intensity 1.4, 1.7,1.9 Tesla with a fixed time 20 minutes for the water passage through electromagnetic field. The total hardness decreases to 394 mg/l at a rate of 18% when the field intensity 1.4 Tesla and total hardness value decrease to 330 mg/l at a rate of 31% when the field intensity1.7Tesla , while the total hardness value decrease to 250 mg/l at a rate of 48% when the field intensity 1.9 Tesla compared to total hardness value before treatment 480mg/l in the well number one .Also the rate of total hardness values of the nine wells waters has decreased at the field intensity 1.4 Tesla to 340 mg/l at a rate of 20% and to 320 mg/l at a rate of 27% when the field intensity 1.7 Tesla ,while the total hardness values decrease to 254 mg / l at a rate of 40% when field intensity 1.9 Tesla compared to the total hardness 425 mg / l before treatment.

Table (1) Levels of total hardness mg/L in wells water before and after treatment by different electromagnetic fields

Wells	Before electromagnetic treatment	Water passage through electromagnetic field 1.4 tesla in 20 minutes	Percentage of Decrease	Water passage through electromagnetic field 1.7 tesla in 20 minutes	Percentage of decrease	Water passage through electromagnetic field 1.9 tesla in 20 minutes	Percentage of decrease
1	480	394	18%	330	31%	250	48%
2	500	405	19%	360	28%	281	44%
3	475	365	23%	340	28%	300	37%
4	470	382	19%	366	22%	290	38%
5	400	310	22%	285	29%	235	41%
6	347	275	21%	256	26%	214	38%
7	390	315	19%	289	26%	232	41%
8	370	308	17%	285	23%	240	35%
9	392	310	21%	288	27%	245	37%
The average	425	340	20%	311	27%	254	40%

Also the results of the current study as table (2) showed the effect of the changing a retention time on the total hardness of wells water during electromagnetic treatment using a variable retention time 5,10,20 minutes with constant electromagnetic field intensity1.9 Tesla, as the total hardness decreased to 334 at a rate of 15% when the retention time 5 minutes and to 275 mg/l at a rate of 30% when retention time 10 minutes while the total hardness decreased to 170 mg/l at a rate of 57% when retention time 20 minutes. The rate of the total hardness values for nine wells waters has decreased to 15% when retention time 5 minutes and to 30% when a retention time 10 minutes while the total hardness has decreased to 53% when retention time of 20 minutes.

Table (2) Levels of total hardness mg/L in wells water before and after electromagnetic field treatment by different retention time

Wells	Before electromagnetic treatment	Water retention time in electromagnetic field 1.9 tesla in 5 minutes	Percentage of decrease	Water retention time in electromagnetic field 1.9 tesla in 10 minute	Percentage of decrease	Water retention time in electromagnetic field 1.9 tesla in 20 minutes	Percentage of Decrease
1	480	406	15%	341	29%	232	52%
2	500	420	16%	339	32%	235	53%
3	475	403	15%	336	30%	223	53%
4	470	401	15%	335	29%	218	54%
5	400	339	15%	278	30%	184	54%
6	347	293	16%	240	31%	168	52%
7	390	330	15%	271	31%	199	49%
8	370	321	13%	263	29%	160	57%
9	392	334	15%	275	30%	170	57%
The average	425	361	15%	298	30%	199	53%

The results of the present study showed according to F-test there were significant differences at the significance level 0.01 between the total hardness before and after electromagnetic treatment, where the results showed the effect of increasing electromagnetic field strength in decreasing the total hardness and it has noted the highest impact at electromagnetic field intensity1.9 Tesla on total hardness decreases. Whereas no significant differences appeared in decreases the total hardness values between field intensity 1,4 and 1,7 Tesla .While the results showed significant differences in the total hardness values after the electromagnetic treatment, an increase was observed in retention time leads to a clear effect in decreases the total hardness values during the magnetic treatment . I think that the decrease in total hardness values through electromagnetic treatment attributed to decrease the numbers of ions constituent by the large attraction force generated by the electromagnetic field ,or may be attributed the decrease in the total hardness value to the exposure of the water to the electromagnetic field intensity that leads to decreases the surface tension which helps in the dissolution of Calcium carbonate (10).The results of the current study agreed with the results that obtained by Banejad & Abo Salihi (11) when studiing the effect of the magnetic field intensity on the water hardness by using different magnetic fields (zero, 0.05, 0.075 ,0 0.1) Tesla ,where they noted a decrease in the total hardness values reached to 99%. The results showed that the magnetic field intensity zero Tesla did not affect as compared with the magnetic field intensity 0.1 Tesla as noted through the results that the magnetic field is effective in the reduction of total hardness values increased with increasing magnetic field intensity. Also he noted through the results that increased water velocity through the magnetic field decrease the total hardness value and he attributed it to the speed of the water passing into the magnetic field increases of the water turbulence and thus reduces the production calcium carbonate, but these results does not agree with the results of current study. Also the results that obtained by (12) agreed with the results of the current study, where they noted decrease the total hardness at a rate of 17% and attributed to the fact that exposure the water to a magnetic field will be affected by the Lorentz force that acting in arrangement water molecules and movement in one direction and this leads to reduce collisions between oxygen and calcium molecules and prevents the formation of calcium carbonate, and the magnetic field attracts ions with electric charges. Also, the results obtained by Jaafar and Majdi (13) agreed with the results of the current study, where they noted decrease the total hardness by magnetic treated through using different field intensity 1000,3000.6000gauss by magnetization device that attached to the water tube where they noted the decrease of the total hardness values with increasing magnetic field intensity at a rate of 38% at magnetic field intensity 1000 gauss and 45% when the field intensity 3,000 gauss while the rate of decrease has reached 53% at a magnetic field intensity 6000 gauss. It is also noted through the results, the increase in the time of water exposure to a magnetic field with Shedding a magnetic field intensity 6.000 Gauss increases the proportion of total hardness decrease to 55%. The results obtained by Elid, (14) contradicted to the results of the current study, despite of using different magnetic fields intensity 0.025, 0.047, 0.068 Tesla but he had not noticed any clear decrease in the ions values that causing total hardness.

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تاثير تقنية الحقل الكهرومغناطيسي في تقليل عسرة مياه الابار

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الملخص

أجريت الدراسة على مياه تسعة آبـار ضمن مدينة كركوك للفترة 7/1 /2015 ولغاية 13/ 6/ 2016 لتقييم فعالية المجال الكهرومغناطيسي في معالجة المياه الجوفية حيث ركزت الدراسة على تصميم جهاز بمجالات مختلفة يتم فيه تعريض الماء إلى مجالات كهرومغناطيسية أثناء تمرير الماء خلال الجهاز. تضمنت عملية المعالجة الكهرومغناطيسية للمياه مرحلتين الأولى باستخدام مجالات كهرومغناطيسية مختلفة 1.4,1.7,1.9 تسلا مع ثبات زمن مرور الماء 20 دقيقة خلال المجال الكهرومغناطيسي والمرحلة الثانية هي ثبوت شدة المجال الكهرومغناطيسي 1.9 تسلا مع تغيير زمن استبقاء الماء 5, 10, 20 دقيقة خلال المجال. اظهرت الدراسة تاثير المجال الكهرومغناطيسي في انخفاض تركيز العسرة الكلية لمياه الابار اذ انخفضت العسرة الكلية بنسبة 18% عند شدة مجال كهرومغناطيسي 1.4 تسلا و 31% عند شدة مجال 1.7 تسلا في حين انخفضت بنسبة 48% عند شدة مجال كهرومغناطيسي 1.9 تسلا. كما كان انخفاض العسرة الكلية بنسبة 15% عند زمن استبقاء 5 دقائق و 30% عند زمن استبقاء 20 دقيقة في حين انخفض تركيز العسرة الكلية بنسبة57% عند زمن استبقاء 20 دقيقة.