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The Effect of Magnetic Field on The Solubility of NaCl and $CaCl_2.2H_2O$ at Different Temperature and pH Values

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Abstract. The electrical conductivity (E.C.) changes of a certain concentration (1000ppm) of aqueous sodium chloride and calcium chloride dihydrate solutions as a function to the solubility with and without applying a multiple constant magnetic field at different temperature and pH values were studied. A magnetic funnel with a magnetic field power of 450 gauss was used to prepare the magnetic water by passing the later 1, 5 and 10 times with flow rate of 41.66 mL/sec, before dissolving the sodium chloride and calcium chloride dihydrate salts. There was a proportional relationship between the solubility of sodium chloride and calcium chloride dihydrate and the number of water exposure to the magnetic field. There was also a proportional relationship between the electrical conductivity records and the increasing in temperature and pH values. It was found that the increasing in pH value is more effective as compared with the elevation in temperature degree. In general, the magnetic solutions of sodium chloride and calcium chloride dihydrate showed highly electrical conductivity values as compared with non-magnetic solutions. It was clear, that the advantages from using magnetized solutions of these two salts will be useful in the biological and physiological systems.

Key words: magnetic field, NaCl and $CaCl_2.2H_{2O}$ solubility.

Introduction

A very large part of everyday chemistry is concerned with aqueous solutions containing ionic substances; after all, most of the earth's surface and most of the mass of our bodies consist of such solutions. It is therefore worth taking some time to consider some of the properties of water that make it such a good solvent for ionic substances, and look briefly at some of the special properties of aqueous ionic solutions. The most important of these properties are its dipole moment and dielectric constant, these, in turn, derive from the composition and shape of the water molecule (16). Water is an unusual substance, mostly due to it 3D network of hydrogen bond in the molecule. Its properties allow it to act as a solvent, reactant, a molecule with cohesive properties and as a temperature stabilizer. Liquid water is affected by the magnetic fields (14 & 2). Water is a diamagnetic and may be levitated in very high magnetic fields (10T) (6). Lower magnetic fields (0.2T) have been shown to increase the tetrahedrality at the time. Other studies show that, the increase in cluster size in liquid water is caused by magnetic fields (2). Salt mobility is enhanced in strong magnetic fields (1-10T) causing some disruption to the hydrogen bonding (3). A tetrahedral cavity in puckered water dodecahedra may be used by H_3O^+ and NH_4^+ to form magic number cluster ions. The octahedral cavity could be occupied by any of the many mono atomic cations and anions that are normally found in contact with six water molecules in their (inner) hydration shell (for example, Na^+, K^+, Cs^+, Ca^{+2}, Cl^-, Br^-), Whilst allowing a fully hydrogen-bonded second shell. Such a structure for $Na^+ (H_2O)_{20}$ has been obtained (15). A reduction in hydrogen bonding net shown at high salt concentrations, whereas at lower concentrations (for example 1M NaCl) the increase in water hydrogen bonding in the presence of such high magnetic fields more than compensates for this effect (3). Weak magnetic field (15mT) has also been shown to decrease the evaporation rate (4) and increase refractive index due to increase in hydrogen bond strength (5). Static magnetic effects have been shown to cause strengthened hydrogen bonding (17) and increase the ordered structure of water formed around hydrophobic molecules and colloids (13). The phenomenon of water treatment with an applied magnetic field has been known for many years and reported as being effective in numerous instances (10 & 1). The vitalizing and healing properties of magnetized water are believed to be intimately tied in with its "memory". Fresh, uncontaminated water from a mountain stream is full of vitality especially if it has flowed over volcanic rock which is highly paramagnetic. During its passage through contaminated soil, miles of iron or plastic pipe, and treatment plants where it is exposed to toxic chemicals it gradually loses its vitality. By the time it comes out of the tap it is essentially lifeless (9). Fortunately, recent research has shown that it is possible to regenerate water to its original healthy state by magnetizing it. It has been reported that the preliminary magnetic water treatment can enhance the growth rate of plants (19 & 7) and animals, accelerate the healing of broken bones and tissues, inhibit scaling of metallic surfaces and improve the compressive strength of the cement (11). The effect of a constant magnetic field on the electrical conductivity of water and dissolution rate into water of some minerals is found to be significantly accelerated these two properties (8). The present study is dealing with the solubility of sodium chloride and calcium chloride dihydrate in their magnetic and non-magnetic aqueous solutions through the measurements of electrical conductivity at different temperature and pH values, which, in turn, reflect the behavior of aqueous solutions and availability of these salts for the biological and physiological systems.

Materials and Methods

Analar NaCl and $CaCl_2.2H_2O$ of BHD Company, distilled water, magnetic funnel of 450 gauss magnetic field produced by Magnetic Technologies LLC Dubai, UAE, Beckman zeromatic ^{R} SS-3 pH meter, and electrical conductivity device type MARTINI MI 170 Bench Meter have been used in this study. Sodium chloride and calcium chloride dihydrate solutions of 1000 ppm concentration were prepared by using normal distilled water (non-magnetized) and magnetized water passing through the magnetic funnel 1, 5 and 10 times with a flow rate of 41.66 mL/sec. The electrical conductivities of NaCl and $CaCl_2.2H_2O$ solutions with normal and magnetized water were recorded at 7.2, 7.4, 7.6, 7.8 and 8.0 pH values under 20, 30, 40 and 50^o C. At the same time the electrical conductivities of blank solutions (without salt) of normal and magnetized water at the same conditions were subtracted from the obtained results from the both salt solutions.

Results and Discussion

In the present study, we have used a static magnetic field within a magnetic power, that always recommended for human uses, so we have used a magnetic funnel of 450 guass magnetic power to dissolve two kinds of salts, NaCl and $CaCl_2.2H_2O$ just to practically know, what have happen if the magnetized solution of these salts will used in the biological and physiological systems As shown in Fig. 1 and 2, N, refer to the normal solutions of NaCl and $CaCl_2.2H_2O$, which were not subjected to the magnetic field. 1, 5 and 10 refer to how many times do the water passing through the magnetic funnel before used to dissolve these two kinds of salts.

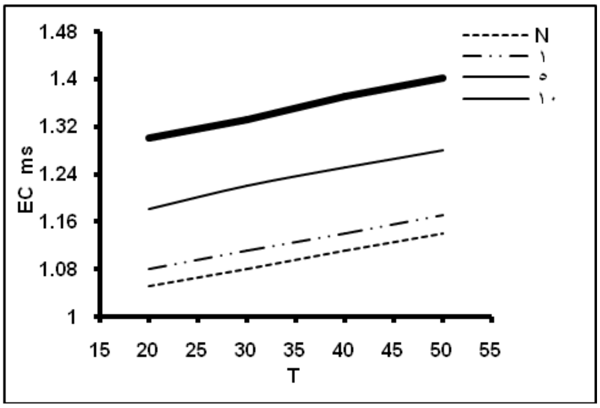

Fig. (1): The effect of 450 guass static magnetic field on the electrical conductivity of 1000 ppm NaCl solution at pH 7.2.

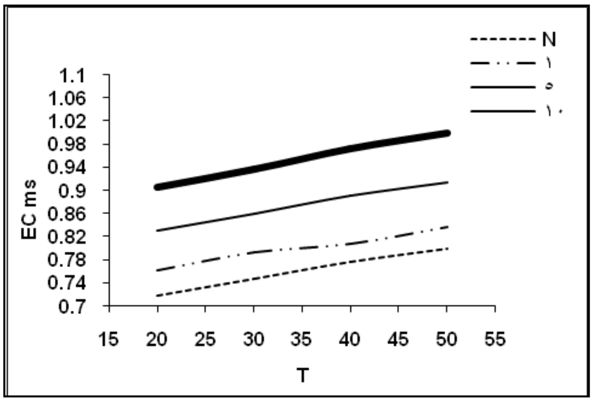

Fig. (2): The effect of 450 guass static magnetic field on electrical conductivity of 1000 ppm $CaCl_2.2H_2O$ solution at pH 7.2.

The electrical conductivity of any ionization salt can be used as a function for its solubility (20), therefore, the salt solutions which are subjected to a magnetic field become more soluble (8). As shown, there were proportional relationships between the number of magnetic treatments (1, 5 and 10) and the electrical conductivities of NaCl and $CaCl_2.2H_2O$ solutions at the same concentration and pH values. The proportional relationship also has been found between the temperature elevation and the electrical conductivity for both magnetic and non-magnetic salt solutions. The electrical current can flow through a solution of an electrolyte, and is carried by electrons. The characteristics of current flow in electrolyte in these respects are different. The current is carried by ions; chemical changes occur in the solution and an increase in temperature decrease the resistance. Electrical conductivity is a measure of the ability of water to conduct an electric current and depended on concentration of ions, specific nature of the ions and on the temperature of solution (high temperature, high E.C.). As shown in Fig. 1 & 2, a high electrical conductivity (1.4mS) of NaCl solution was record at 50^{o}C for water passing 10 times through the magnetic funnel as compared with that of $CaCl_2.2H_2O$ solution (1.0mS). The results are not confirm, that NaCl as electrolyte developed the E.C. more than $CaCl_2.2H_2O$, because we are dealing here with anhydrous salt (NaCl) and the hydrated form of $CaCl_2$ ($CaCl_2.2H_2O$). The anhydrous $CaCl_2$ giving a higher E.C. than NaCl according to the number of liberated ions (two ions by NaCl versus three ions by $CaCl_2$). Fig. 3 and 4, show the effect of pH value (7.4) at the electrical conductivities of salt solutions. As compared with Fig. 1 and 2, the electrical conductivity of NaCl solution rises from 1.4mS to 1.48mS for

10 times magnetic treatment by increasing the pH value from 7.2 to 7.4. The same changing associated with $CaCl_2.2H_2O$ solution (1.0 to 1.08 mS).

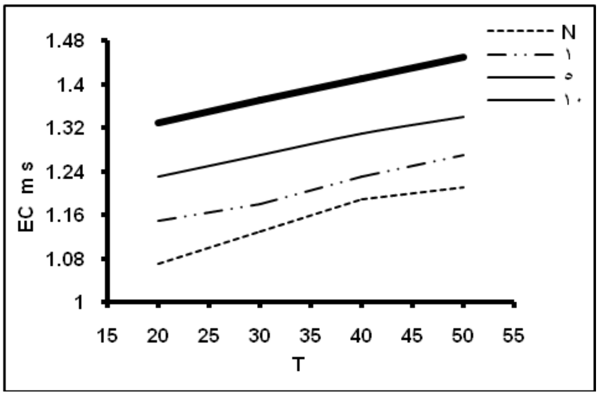

Fig. (3): The effect of 450 guass static magnetic field in the magnetic field on the electrical conductivity of 1000 ppm NaCl solution ppm $CaCl_2.2H_2O$ at pH 7.4.

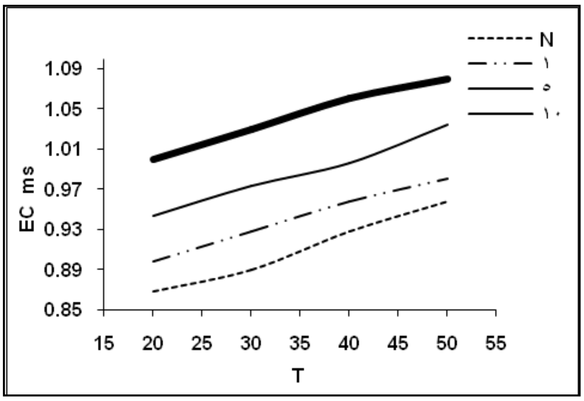

Fig.(4): The effect of 450 guass static electrical conductivity of 1000 solution at pH 7.4.

As shown in Fig. 3 and 4,, the same alteration in electrical conductivity by rising the pH value from 7.2 to 7.4 is associated with 1 and 5 times magnetic treatment and with the normal solutions of both NaCl and $CaCl_2.2H_2O$.

The results in fig. 5 and 6 also confirm that the higher electrical conductivities associated with higher pH values. It is clearly now, that the ionization of both salts increases by elevating the pH value. One can conclude that the minerals become more available for the plants, animals and human at pH closer to the basic.

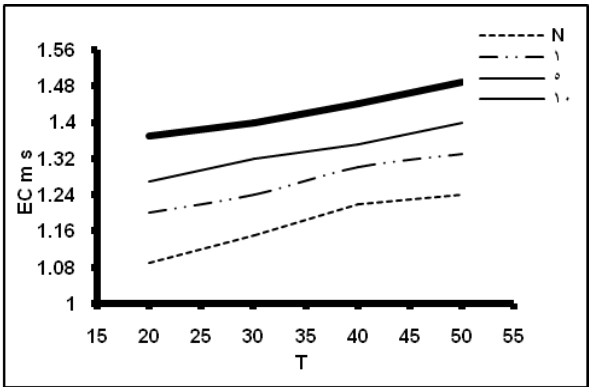

Fig.(5): The effect of 450 guass static magnetic field on the electrical conductivity of 1000 ppm NaCl solution $CaCl_2.2H_2O$ at pH 7.6.

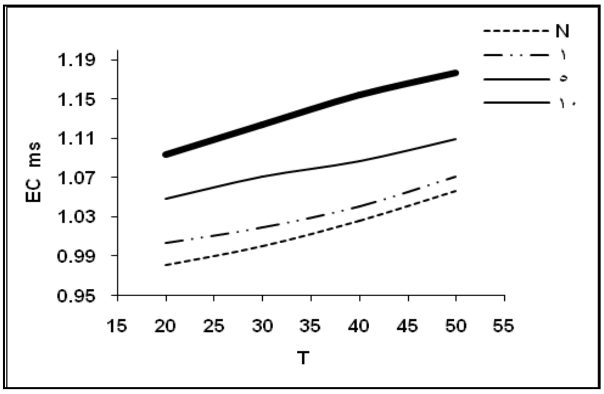

Fig. (6): The effect of 450 guass static magnetic field on the electrical conductivity of 1000 ppm solution at pH 7.6.

Figs. 7, 8, 9 and 10 show the electrical conductivities of both salts (NaCl and $CaCl_2.2H_2O$) solutions at 7.8 and 8.0 pH values. The E.C. as a function to the solubility shows a direct proportional relationship with the increasing in pH values, because more hydroxyl (OH^-) groups are created. It is these molecules that help reduce the acidity in magnetized water. Normal tap water has a pH level of about 7.0, whereas magnetized water can reach 7.8 pH after exposure to a high magnetic field. Cancer cells do not survive in an alkaline environment (18). It was observed that magnetized water helps in dissolving minerals and acids by a higher rate than non-magnetized water and increasing the speed of chemical reactions (12).

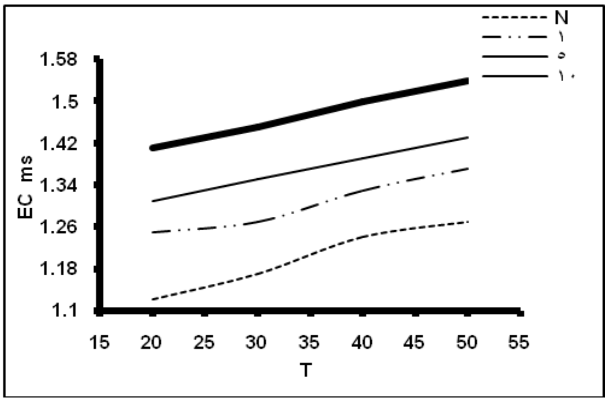

Fig. (7): The effect of 450 guass static magnetic field on the on the electrical conductivity of 1000 ppm NaCl solution pH 7.8.

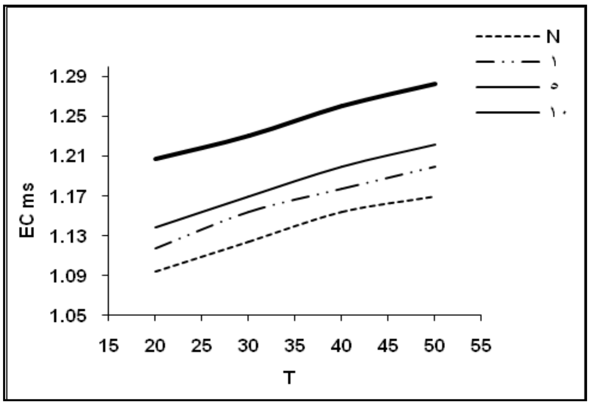

Fig. (8): The effect of 450 guass static magnetic ield electrical conductivity of 1000 ppm $CaCl_2.2H_2O$ at solution at pH 7.8.

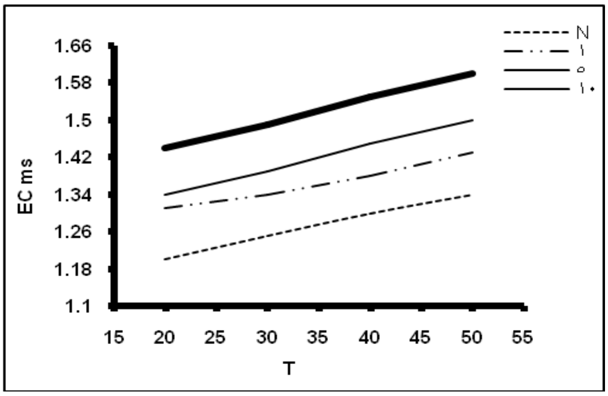

Fig. (9): The effect of 450 guass static magnetic field on the on the electrical conductivity of 1000 ppm NaCl solution $CaCl_2.2H_2O$ at pH 8.0.

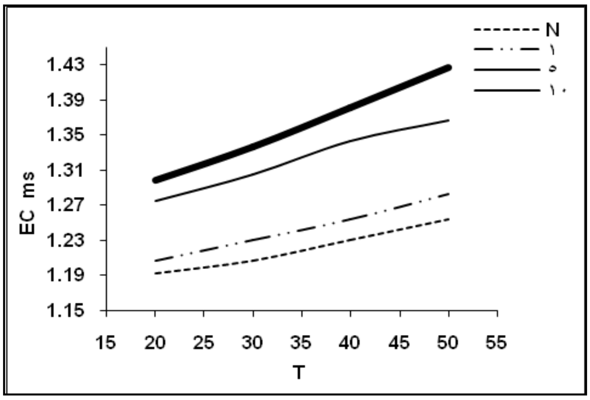

Fig. (10): The effect of 450 guass static magnetic field electrical conductivity of 1000 ppm solution at pH 8.0.

It has been reported that the dissolution rate into water of some minerals, e.g. oxygen and copper sulfate, is significantly accelerated by the presence of magnetic field, furthermore, the self - diffusion coefficient of water can also be altered under a magnetic field (8). We can find out from the previous figures and according to this study circumstances, that the pH factor affected the electrical conductivity (the solubility) of the both salt solutions more than the temperature factor, this fact will declare that the minerals are more available in basic soils (like the soil of Iraq) as compared with acidic soils.

Conclusions

The magnetized water helps in dissolving minerals by a higher rate than non-magnetized water**.** There were proportional relationships between the number of magnetic treatments and the electrical conductivities of NaCl and $CaCl_2.2H_2O$ solutions at the same concentration and pH values. The results also confirm that the higher electrical conductivities associated with higher pH values. The proportional relationship also has been found between the temperature elevation and the electrical conductivity for both magnetic and non-magnetic salt solutions. The pH factor affected the electrical conductivity (the solubility) of the both salt solutions more than the temperature factor.

Recommendations

1-Calcium chloride was added to processed milk to restore the natural balance between calcium and protein for the purposes of making cheese, so the magnetic field will improve calcium chloride characteristics. Also we think, that the passing of pasteurized milk through a magnetic funnel making the calcium ions more available for cheese making.

2-Since the osmotic pressure depends upon the solubility of salts, so using of magnetized water to prepare the osmotic solutions become more useful in such techniques as osmotic evaporation to concentrate fruit juices.

3-We have selected two kinds of salts which are available in our soil, so using of magnetized water for irrigation makes the minerals more available to be used by the plants, especially in Iraqi alkaline soil.

4-Using magnetized water to dissolve NaCl in normal saline solution (0.9% NaCl) and glucose in glucose solution, which always are used as medications in medicinal centers will improve their therapy characteristics.

5-Sodium chloride is used veterinary medicine as emesis causing agent. It is given as warm saturated solution, so using magnetized water to prepare the saturated solution of NaCl may go to be it for this operation.

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دراسة تأثير أستخدام الحقل المغناطيسي على ذوبانية ملحي NaCl و $CaCl_2.2H_2O$ في درجات حرارة وقيم pH مختلفة

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المستخلص. تمت دراسة التغيرات في قيم التوصيل الكهربائي (E.C.) لمحلول مائي تركيزه 1000 جزء بالمليون لملحي كلوريد الصوديوم وكلوريد الكالسيوم ثنائي التميؤ كدالة للذوبانية في حالة عدم وجود أو وجود حقل مغناطيسي ثابت وبتكررات معينة وتحت درجات حرارة وقيم أس هيدروجيني مختلفة. تم استخدام قمع مغناطيسي ذو قوة مغناطيسية مقدارها 450 غاوس لتحضير الماء الممغنط وذلك بامراره 1 ، 5 و 10 مرات خلال القمع المغناطيسي وبسرعة جريان 41.66 مل/ ثانية قبل أستخدامه في أذابة ملحي كلوريد الصوديوم وكلوريد الكالسيوم ثنائي التميؤ. تبين ان هنالك علاقة طردية بين ذوبان الملحين وعدد مرات تعرض الماء للمجال المغناطيسي، وظهرت العلاقة نفسها بين قيم التوصيل الكهربائي المسجلة وزيادة درجات الحرارة وقيم الأس الهيدروجيني. وجد في هذه الدراسة ان لزيادة قيم الأس الهيدروجيني تأثير أكثر مقارنة بارتفاع درجات الحرارة في زيادة التوصيل الكهربائي للملحين. لقد تبين ايضا أن المحاليل الملحية الممغنطة لكل من كلوريد الصوديوم وكلوريد الكالسيوم ثنائي التميؤ أعطت قيم توصيل كهربائي عالية مقارنة بالمحاليل الملحية غير الممغنطة للملحين المذكورين. يظهر مما سبق ان استخدام الماء الممغنط في اذابة الملحين اعلاه ستكون له فوائد مميزة عند استخدامه في الانظمة البايولوجية والفسيولوجية.