Innovative Systems Design and Engineering
ISSN 2222-1727 (Paper) ISSN 2222-2871 (Online)
Vol.9, No.1, 2018
www.iiste.org

Leaching of Salt Affected Silty Loam Soil by using Magnetized Water

Liqaa Hussein A.Raheem
College of Engineering, Department Water Resources Engineering, University of Baghdad

Prof. Dr. Riyadh Z. Azzubaidi
College of Engineering, Department Water Resources Engineering, University of Baghdad

Abstract
Magnetized water is achieved by passing water through a field of magnet. Over the few past decades, many studies and researches have reported significant evidences that some properties of water can be changed as it passes through a magnetic field. The change in the physical properties of water can improves the use of water in different arias. It can have a promising potential of application especially in the fields of irrigation and drainage. However, the effects of magnetic field on properties of water are not yet being well developed and is still a challenging subject.In this research, magnetized water was used to leach salt affected silty loam soil. A laboratory test rig was designed and constructed for this purpose. The rig consists of a constant head reservoir, a variable intensity water magnetization device, soil columns, and drain collection tanks. Five different magnetic intensities and five different times of exposure were used in the treatment of water used for leaching soils. Leaching water drained form the soil samples were tested for EC and pH. EC is a general indicator for all anions and cations being leached. Results were analyzed and compared to the tests results of leaching of soil by using untreated water.The results showed that the efficiency of magnetized water in removing salts from the soil is more than the untreated water. As the magnetic intensity and the time of exposure are increased, the more salts were leached out of the soil.
Keywords: magnetized water, soil salinity, soil reclamation, salt affected soil, leaching of soil.

1. Introduction

Magnetizing of water is a new technique for treating water that can have a scientific basis. It has been introduced in many countries round the world and has many benefits at the same time [1]. Water is composed of atoms of hydrogen and oxygen, and its molecules are linked by hydrogen bonds. These bonds may be binary or multi-bonding. When the molecules of water are placed within a magnetic field, the hydrogen bonds between the molecules either change or disintegrate. This dissociation works to absorb energy and reduces the level of molecules. Water increases the susceptibility of electrolysis and affects the decomposition of crystals [3].

Magnetically treated water has more than three times the efficiency of the non-magnetized water in leaching salts out of soils, [4]. There is an increase in total dissolved solids and electrical conductivity of collected drained water after applying magnetized water to soil, [5]. Magnetized water helps to dissolve salts in a high rate compared to non-magnetized water, [6]. Magnetizing water directly before application gave better results than the use of water magnetized for 12*hr*, but both gave a good result in terms of reducing the time needed for the solubility process, [7]. Magnetized water makes it possible to provide a minimal quantity of water in reclamation of additional areas of saline soils or in irrigation so this a new technology is important especially in conditions of water scarcity, [8].

More studies are needed to investigate the effects of magnetized water on leaching of soils under different conditions of soil type, initial salt content of soil, salt type, magnetic intensity, time of exposer to magnet, and quality of water to be treated.

This research aimed at investigating the effect of water treated by different magnate intensities and time of exposer to magnet on the leaching of salt affected silty loam soil. A laboratory test rig was prepared for this purpose. It consists of a constant head water supply reservoir, a variable intensity magnetization device, columns of salt affected silty loam soil, and drain water collection tanks. Water was treated under five different magnetic intensities and five different time of exposure to magnet, represented by the flow velocity of the water flow passing through a tube within the magnetization device. Leached water from the soil samples were tested for EC and pH. EC is a general indicator for all anions and cations being leached.

2. Materials and methods

This section presents details of the experimental work that was carried out to investigate the effects of magnetized water on treatment of salt affected soils. These details include the description of the test rig, details of the use water and soil, magnetic treatment of water used in these experiments and the details of the experiments.

2.1 Description of the Test Rig

The test rig, shown in **Figure 1**, was designed and constructed to investigate the effects of magnetized water on treatment of salt affected soils. The rig consists of a reservoir that maintains constant head water flow to a magnetization device. Flow of water from the reservoir is controlled by using two valves. The water flow to the magnetization system through two rubber tubes of 0.5*cm* in diameter. Each end of the tubes is directed to a soil column. Soil sample to be leached is placed inside a 10*cm* in diameter plastic pipe of a length of 40*cm*. Its top is left is open and the bottom is closed by using a filter paper, which is fixed by using a reducer of 10 to 3*cm* at the bottom of the pipe. The filter allows drain water to flow and prevent the soil particles to be washed out. Excess water above a certain depth over the soil surface is drained out by using a 0.5*cm* in diameter rubber tube. Water drained from the soil columns is collected by using 1000cm^3 beakers.

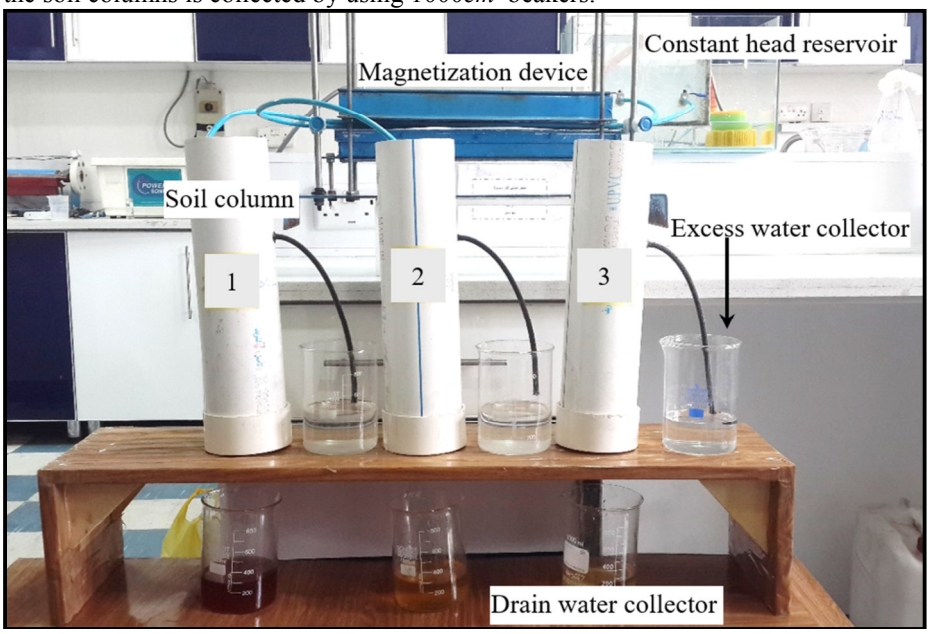

Figure 1. The test rig installed in the laboratory.

The variable intensity water magnetizing device, **Figure 2**, provides intensities that can be varied from 500 to 9000*gauss*. It consists of two 44*cm* long parallel steel plates used to fix the magnets. The plate on bottom is fixed and the upper plate can be move. Four magnets are placed over and below each of these two plates. The magnate intensity can be controlled to the desired intensity by changing the spacing between these two plates.

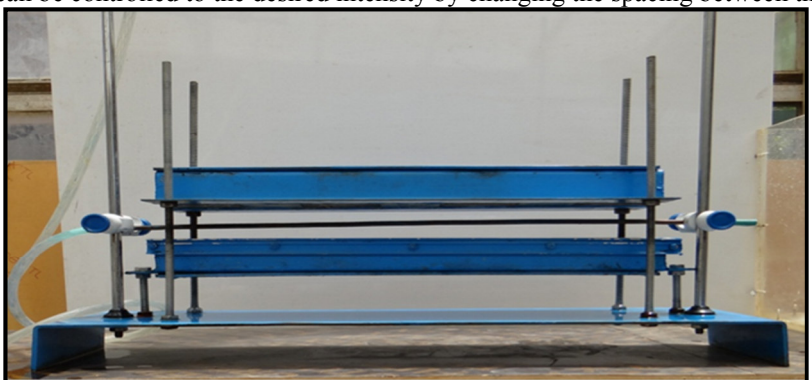

Figure 2. The variable intensity magnetization device.

2.2 Used Soils and water

Water used for leaching the soil was brought from the Tigris River. Soil samples used in the experiments was brought from a location known to have a highly saline soil. The soil was air dried at a room temperature, disaggregation with plastic hammer. The soil was sieved by using a 2*mm* sieve and then was stored in sealed plastic containers at ambient temperature to maintain same moisture content throughout the period of the laboratory work. The soil is a silty loam texture having 22% sand, 52% silt, and 26% clay. Results of some of tested physical and the chemical parameters of the used water and the soil are presented in **Table 1**.

Table 1. Results of the tests that carried out on the water and soil used in study

	EC *dS/m*	**pH**	**TDS** *ppm*	**K** *meq/l*	**Na** *meq/l*	**Ca** *meq/l*	**Mg** *meq/l*	**HCO_3** *meq/l*	**SO_4** *meq/l*	**Cl** *meq/l*
Water	1.12	7.00	717	0.45	11.20	14.60	9.67	2.00	5.04	8.76
Soil	40.53	7.11	25940	2.47	78.15	214.30	111.67	13.97	28.93	362.35

2.3 Preparing of soil columns

Soil sample is weighted to have 2000*g* in each experiment, Soil was added in layers of about 5*cm* by using a lab spatula to a depth of 25*cm*. Each added layer was shacked well to be distributed uniformly and gently pressed using a special plunger.

2.4 Magnetic treatment of water

Five different magnetic intensities were used to treat water, 1000, 3000, 5000, 7000, and 9000*gauss*. By changing the spacing between the two plates of magnetization device and by using a Gauss meter device the required magnate intensity can be achieved.

Five different time of exposing the flow of water to the magnetic field were used. This time of exposer is represented by the flow velocity of the water flow passing through a tube within the magnetization device these are 0.4, 0.6, 1.0, 1.4, and 2.0*m/s*. Water flow is controlled to the desired discharge by the valves at the outlets of the constant head reservoir.

2.5 Leaching Process

The treated water is applied to leach each soil column in three consecutive leaching processes. These consecutive leaching processes were coded as L_1, L_2, and L_3. Each leaching process is ended just when the collected drained water from the soil samples reaches 300*ml* than a new volume of drained water is collected or, in other words, a new leaching process is started. So that, the total drained water during each experiment is 900*ml*.

2.6 Design of the experimental runs

To investigate the effects magnetized water on treatment of salt affected soils, two variables were adopted in the magnetic treatment of water. These variables are the magnetic intensity and velocity of water flowing through the magnetization device. Five levels magnetic intensities were used to treat water, these are 1000, 3000, 5000, 7000, and 9000*gauss*. Five different velocities of water flow passing through the magnetization device were used, these velocities are 0.4, 0.6, 1.0, 1.4, and 2.0*cm/s*. A full combination of these two variables were used to treat water used in the leaching of soils. With five level of each variable then there will be a twenty-five-different combination. During each experiment, a water sample from each of the three 300*ml* drained water is collected to be tested for EC and pH.

2.7 Coding of experiments

Each experiment was coded. The code consists of three letters, M, V, and L and each letter has an extension subscript number, so that each the general experiment code is $M_xV_yL_z$. The letters refer to magnate intensity, water flow velocity, and leaching process, respectively. The extension number is an indicator to values of the magnetic intensity, the value of water flow velocity, and the sequence of the leaching process. So that M_1, M_3, M_5, M_7, and M_9 refer to the magnetic intensities that were used, that is 1000, 3000, 5000, 7000, and 9000*gauss*, respectively. V_1, V_2, V_3, V_4, V_5 are the flow velocities of 0.4, 0.6, 1.0, 1.4, 2.0*cm/s*, respectively. L_1, L_2, and L_3 refer to the first, second, and third leaching process carried out on each soil sample, respectively. Now, $M_3V_3L_3$ refers to the third leaching experiment that was carried out under magnetic intensity of 3000*gauss* and water flow velocity of 1*cm/s*.

3. Results and analysis

Figures 4 and **5** show variation of EC and pH of drained water of the experiments that were carried out with untreated water. The value of EC for the L_1 was 132.3*dS/m*. This value was reduced to 38.4*dS/m* and 15.0*dS/m* in the L_2 and L_3, respectively. It is clear that repeating the leaching of soil reduces the amount of salts and thus reduces the EC. The value of pH for the L_1 was 7.94, and it was reduced to 7.75 and 7.6 in L_2 and L_3, respectively.

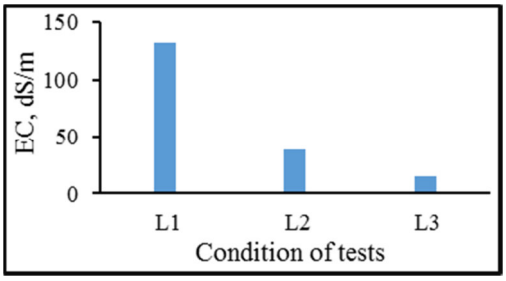

Figure 4. Variation of EC, untreated water.

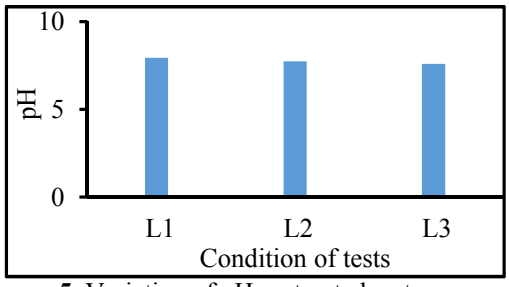

Figure 5. Variation of pH, untreated water.

Figures 6 and 7 show variation of EC and pH values of collected drained water during the experiments that were carried out with magnetized water. EC values of the drained water were increased by increasing the magnetic intensity and reducing the flow velocities and for all the leaching process in each experiment. All EC values obtained in the experiments carried out with magnetized water were higher compared to that obtained when using untreated water. The highest increase in EC values between the experiments carried with and without water treatment is achieved in the results of $M_9V_1L_1$ experiments, this increase was 73.8%. The highest percentage of increase in the EC values among all experiments carried out with magnetized water was achieved by comparing the results of $M_1V_5\ L_1$, and $M_9\ V_1\ L_1$ experiments. This increase reaches at a percentage of 57.8%. It is clear that the values of pH are slightly affected by the magnetized water. A maximum increase in the pH value of 8.7% when comparing the results of experiments carried out with and without magnetic treatment. Among all experiments carried out with magnetized water, the maximum increase in the pH value was 6.5%, which was obtained by comparing the results of the $M_1V_1L_1$ and $M_9V_5L_1$ experiments.

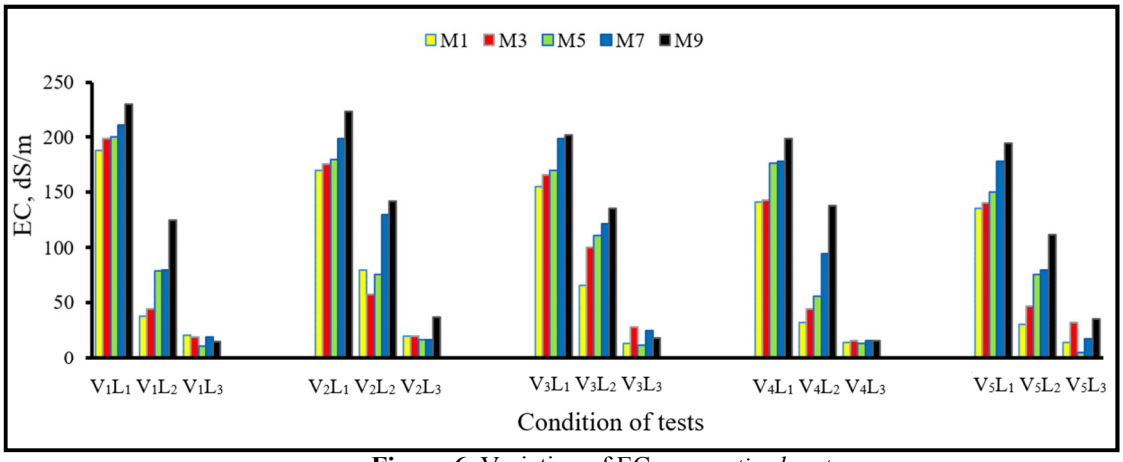

Figure 6. Variation of EC, *magnetized water*.

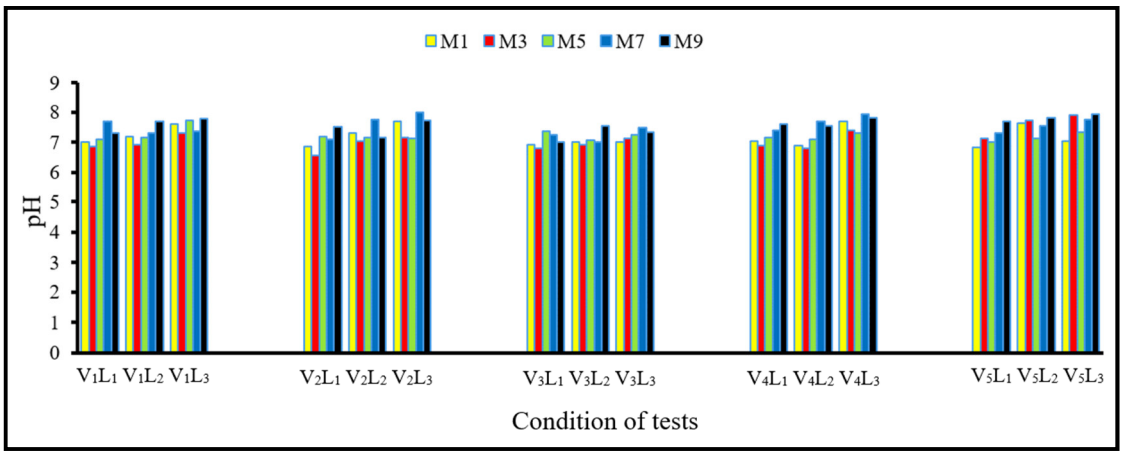

Figure 7. Variation of pH, *magnetized water*.

4. Conclusion

A test rig was designed and constructed to investigate leaching of salt affected silty loam soil by using magnetized water. Five different magnetic intensities and Five different time of exposing the flow of water to the

magnetic field were used were used to treat the used water. It was found that the magnetized water can positively affects leaching of soils. EC values of the drained water were increased by increasing the magnetic intensity and reducing the espouser to the magnetic field. The maximum increase in the value of EC of the drained water was 73.8%. It was found that the values of pH of the drained water is slightly affected by the magnetized water. The maximum increase in the pH values was 8.7%.

References

[1] Busch, K.W., Busch, M.A. Darling, R. E., Maggard, S., and Kubala. S. W. (1997), "Design of a test loop for the evaluation of magnetic water treatment devices". Process Safety and Environmental Protection. Transactions of the Institution of Chemical Engineers 75, part B.

[2] Spear, M. (1992), "The growing attraction of magnetic treatment". Process Engineering. May.

[3] Wasef, R. K. (1996), "Energy and Magnetic Power". Gulf Newspaper Issue 12. Faculty of Science, Cairo University. In Arabic language.

[4] Yasser, A. K. (2010), "The use of magnetized water technology in the leaching of soil affected by salts". Journal of Babylon University. Vol. 18. No.2. In Arabic language.

[5] Faris, A. S., Majeed, H. M., Alwan, A. K., Umran, N. J., Nadhim, Z. F., Khraibit, A. C., Jaafer, R. E., Muhammed, H. J., Rasheed, w. J., Abdlraheem, L. H., Abdlsadah, A. S. (2013), "The Effect of Magnetic Water Treatment on the Prevention of Calcium Carbonate Deposits ". Baghdad Journal of Science. Vol.10. No.1. In Arabic language.

[6] Mohamed, I. O., and Ebead, B. M. (2013), "Effects of Magnetic Treated Irrigation Water on Salt Removal from a Sandy Soil and on the Availability of Certain Nutrients". International Journal of Engineering and Applied Sciences. Vol. 2, No.2.

[7] Al-Hadidi, M. T., (2014), "A New Method to Increase the Ability of the Water for Dissolving Total Salts in Soil by Using the Magnetism". Engineering and Technology Journal, Vol.32, part A.

[8] Kadhim, R. J., (2010), "The use of magnetized water in reclamation of salt-affected soils". Journal of the Euphrates for Agricultural Sciences. 103-97: (2)2. In Arabic language.