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Iron (II) Adsorption from Groundwater by Natural Peat Soil at its in-Situ Conditions

Moharram Fouad, Mohamed I. Gad, Mahmoud H. Mustafa and Enas E. Ali*

KEYWORDS:

Adsorption technique, peat soil, adsorption removal efficiency, Adsorption capacity, pollutants

Abstract— Contamination of groundwater with heavy metals may have harmful effects on the lives of people who depend on groundwater for drinking and other life purposes. Several techniques were used to remove the pollutants from the water, such as chemical precipitation, ion exchange, coagulation, electrochemical treatment, and adsorption. The last method is preferred due to its simplicity, easy recovery, and high effectiveness. Chemical analysis of the natural peat soil and the Fe (II) aqueous solution were performed. The characteristics of the soil were identified using X-ray diffraction (XRD), scanning electron microscope (SEM), and X-ray fluorescence (XRF).

Furthermore, experimental work was carried out to investigate the effect of operational parameters on the removal efficiency% and adsorption capacity of natural peat to remove pollutants from aqueous solution. The operating parameters were the contact time, Fe initial concentration, adsorbent thickness, and adsorbent dose. The results explained that the natural peat soil was very effective for pollutant removal from an aqueous solution.

INTRODUCTION

GENERALLY, groundwater pollution with high concentrations of iron (Fe (II)) may cause serious harm to humans, plants, and animals because of its [1-3]. High concentration of Fe (II) inside groundwater comes from several sources, such as industrial activities [4-5], agriculture activities [6], mining [7-8], fertilizers [9], and oxidation ponds seepage [10-11].

Fe (II) high concentration may cause breathing rate, coughing, and severe health problems such as abdominal pain,

vomiting, and nausea [12]. So, the maximum acceptable concentration of Fe (II) ions for drinking water must not exceed 0.3 mg/l [13]. Consequently, the removal of Fe (II) ions from groundwater inside or outside the soil are necessary and an urgent need. Several actions have a significant effect on the reduction of Fe (II) ions inside the soil, such as ion exchange [14], reduction precipitation [15-20], coagulation and flocculation [21], and adsorption [22-24].

Several researchers have confirmed that natural adsorption can occur inside soil, reducing the concentration of some metals [25-27]. Various materials that exist inside soil have adsorbent action such as clay [28], kaolinite [29-30], vermiculite [31-32], bentonite [33], soil [34], perlite [35], calcite [36], zeolite [37], activated carbon [38-39], and peat [8, 40].

In [24], a highly efficient and low-cost sludge from a drinking water treatment plant is used as an adsorbent material to remove copper ions. The results indicated that the initial concentration of the copper ions is directly proportional to the sorption capacity of the sludge. On the other hand, the adsorbent dosage has an inverse relation with the sorption capacity of the sludge. Furthermore, the removal efficiency and the sorption capacity are high when pH is 6.6, and the temperature is 60°C. In [41], oil shell rock is used to remove

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metal ions (Pb (II) from an aqueous solution. The clay of kaolinite adsorbs Pb (II) greater than the other metals. The pH greatly affects the kaolinite's adsorption capacity. The experimental results explained that the removal efficiency was influenced by pH, initial concentration of ions, contact time, and adsorbent concentration. The removal % of Pb (II) using Kaolinite/Smectite reached 75 % at 120 min. In [42], indicated that US/PS/Fe₃O₄ process can effectively and efficiently aid the surface adsorption of CIP-F from aqueous solutions with 98.3% of removal efficiency percentage at pH = 5, CIP-F concentration = 200 mg/L, PS concentration = 0.15 mol/L and Fe₃O₄ concentration = 0.01 g/L at a resident time of 45 min.

In the present study, a natural peat soil acts as a protecting layer of groundwater aquifer in the north Delta. It was collected from digging pipelines in Dakahlia Governorate's villages, as shown in Figure 1. It has high adsorption properties and is called coaled organic soil. It was used as natural adsorbent material, which was considered commercial, inexpensive, and available. It had organic matter content of 2.49% and pH values of 6.51. The natural peat was characterized using XRD, XRF, and SEM to determine its constituents, size, and phase of its compounds. Experimental works were conducted to study the change of the water properties when passing through this adsorbent material. The effect of some parameters such as the contact time, initial concentration, adsorbent thickness, and adsorbent dose on the removal efficiency (%) and adsorption capacity was also investigated.



Fig. 1. Different types of the collected adsorbent material.

MATERIALS AND METHODOLOGY

In this study, column experiments were performed to study Fe (II) 's adsorption behavior in groundwater through natural peat soil. The adsorbent material was broken into small sizes and put into graduated cylinders (1000 ml in size and 5 cm in inner diameter), as shown in Figure 2. The standard synthetic Fe (II) solutions 1000 (mg/L) was prepared by dissolving an appropriate amount of Fe (OH)₂. The solution was diluted to the required concentrations before being utilized. 12.5, 25, 50, and 100 mg/L as Fe initial concentration in water were used. A Ferose F medical tablet is the source of Fe (100 mg Ferric Hydroxide Polymaltose complex).

Experiments were conducted in glass columns packed with 50, 95, 175, and 210 g of dry adsorbent material to investigate the influence of different doses on Fe's adsorption from an aqueous solution. Fe aqueous solution was observed periodically, and chemical analysis after 5, 10, 15, and 20 hrs was done, as shown in Figure 2. There is mixing made in these durations to react with the ferrous solution, but Figure 2A, B, C, D began before mixing.

A series of laboratory experiments were conducted to investigate operational conditions Fe initial concentration, contact time, and adsorbent dose on the removal efficiency and adsorption capacity. The Fe initial concentration was increased from 12.5 to 100 mg/L, the adsorbent dose was changed from 50 to 210 g (50, 95, 175, and 210 g), and the contact time varied from 5 to 20 hrs. The aqueous solution temperature was a room temperature (25 °C). The pH value of the aqueous solution was measured as 7.4. The change of pH and temperature were being neglected, and all experiments were carried out at room temperature (25 °C).

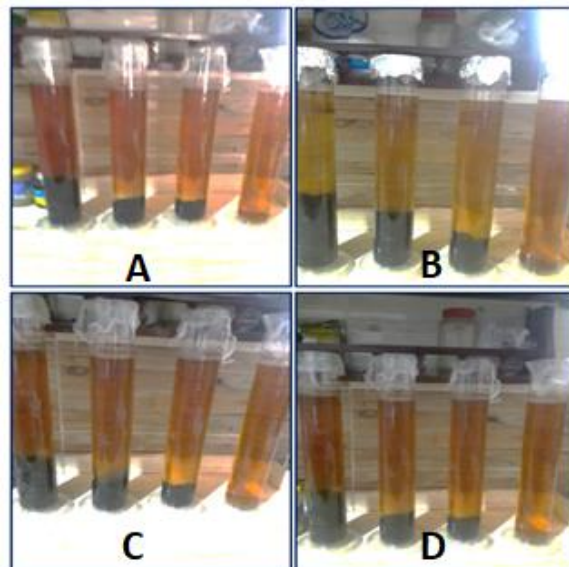


Fig. 2. The Fe (II) aqueous solution with different weights of the adsorbent material.

The aqueous solution and soil peat samples were analyzed for various physical methods and chemical parameters according to the standard for examining water (EPA, 2008). Water pH was determined using bench-top pH/ISE meter,

ORION model 710A. Electric conductivity (EC) of water samples was measured at 25°C as standard temperature using ATC Bench Electric Conductivity Meters, HANNA, model HI 8820. The total dissolved solids (TDS) in the water samples were determined gravimetrically. Major anions were determined using ion chromatography (IC) Model DX-ICS 5000, USA. Essential cations and heavy metals were determined using the Inductively Coupled Plasma-Emission spectrometry (ICP-OES) with Ultra Sonic Nebulizer (USN) (model Perkin Elmer optima 5300, USA).

Soil pH was determined by a glass electrode in distilled water suspensions at the soil to water ratio, 1:2.5. Electrical conductivity (EC) was measured using a conduct-meter in filtrates from soil/water suspensions, 1:2. The concentrations of heavy metals were determined in microwave-assisted digests (Multiwave Perkin Elmer 3000) of soil samples added with suprapure HNO₃/H₂O/HCl, 5:1:1 v/v. The concentrations (mg/kg) of heavy metals in acid-digested extracts were determined using inductively coupled plasma-optical emission spectrometry (ICP-OES).

CHARACTERIZATION OF THE ADSORBENT MATERIAL

The adsorbent material was characterized using XRD, XRF, and SEM to determine its constituents, size, and phase of its compounds.

X-ray Diffraction (XRD)

The phase compositions and structures of the tested sample were characterized by X-ray diffraction (XRD). A Broker axis D8 diffract meter using Cu-K α (λ 1.5406) radiation and secondary monochromatic in the range of 2 θ from 10° to 80° was used to analyze the tested sample where 2 θ is the angle between the beam and detector.

The tested sample phases were determined by matching the experimental pattern with the standard compiled by the Joint Committee on Powder Diffraction Standards (JCPDS).

Figure 3 showed the XRD patterns for two tested samples of the adsorbent materials (clay 1 and clay 2), where they treated for 2 hours which, illustrated that the dominant materials of the first tested sample (clay 1) are Kaolinite (Al₂Si₂O₅(OH)₄), Montmorillonite (NaMgAlSi₂O₂(OH)₂H₂O) and Quartz (SiO₂). It is the sample used in the experimental work. On the other hand, the second tested sample's dominant materials (clay 2) were Kaolinite, Quartz, and Pyrite (FeS₂).

Scanning Electron Microscope (SEM)

The shape and size of the tested sample compounds (clay 1) were determined using a scanning electron microscope (SEM). The SEM was utilized to create an image by scanning the surface with a focused electron beam. This beam electron interacts with the tested sample and developing several signals, which were used to give information about the surface topography, morphology, and composition. The SEM instrument is JSM-6390 with an accelerating voltage of 20kV.

Different areas with different magnifications were considered to show the tested sample's important structure (clay 1). SEM with different magnification was done on a

dried soil sample to specify the morphological features, as shown in Figure 4.

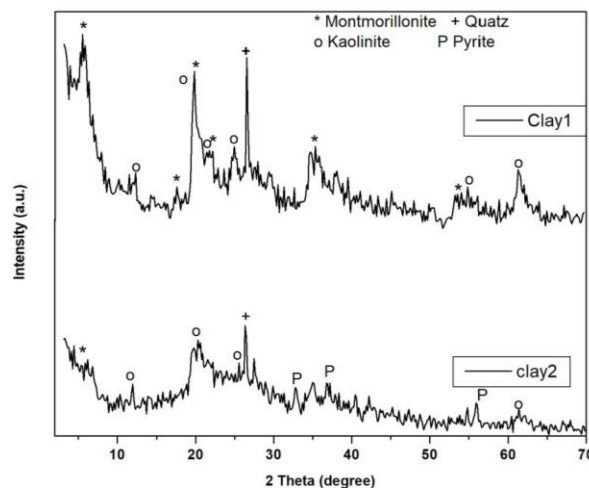


Fig. 3. XRD patterns of clay 1 and clay 2 samples.

X-ray fluorescence (XRF)

The tested sample's chemical properties for clay 2 were determined with X-ray fluorescence (XRF) using a wavelength dispersed X-ray fluorescence spectrophotometer that identifies the elemental composition of the materials. This technique is based on measuring the fluorescent X-ray emitted from the tested sample when it is excited by the primary X-ray source. ARLTM QUANT'X EDXRF (Energy Dispersive X-ray fluorescence) was used to provide major, minor, and trace element quantification across the sample. Each compound and element was identified by the mass percent concentration (m/m%), which indicates the mass of the component or solute divided by the compound's mass or solute.

RESULTS AND DISCUSSION

Figures 4A, B, C, and D for soil sample (clay 1) illustrated that there is no specified formation (irregular shape) of the particles of the tested sample using SEM. Figures 4A, B, C, and D were obtained for the soil sample at different reduction factors, ranging from 1 μ m to 50 μ m. Moreover, great spaces were observed between the sample granules, referring to filling these spaces with other materials like the polluted particle.

Study the adsorption behavior of Fe in aqueous solution through natural peat soil is mainly based on the chemical analyses of the peat soil and Fe aqueous solution samples. The experiments were repeated several times, and average results were obtained for the effect of the experiment variables to ensure the quality of the data.

The chemical compositions of the sample used as adsorbent material using XRF analysis are presented in Table I. The results of this analysis indicated that the tested sample adsorbed the Fe minerals in the solution significantly where the soil adsorbs the Fe pollutant; therefore, the mass percent of Fe in the soil is 54.22 % of the total mass of the soil sample. It

enhanced its use in reducing the transfer of pollutants from oxidation ponds to groundwater when lining the bottom of ponds with this peat soil material. Moreover, the results showed that the tested sample tends to absorb the Fe compound from the solution where the Fe's mass percent in the sample was found as 54.22.

Complete chemical analyses of samples were carried out in the National Research Center laboratory to clarify the effectiveness of adsorbent material onto Fe.

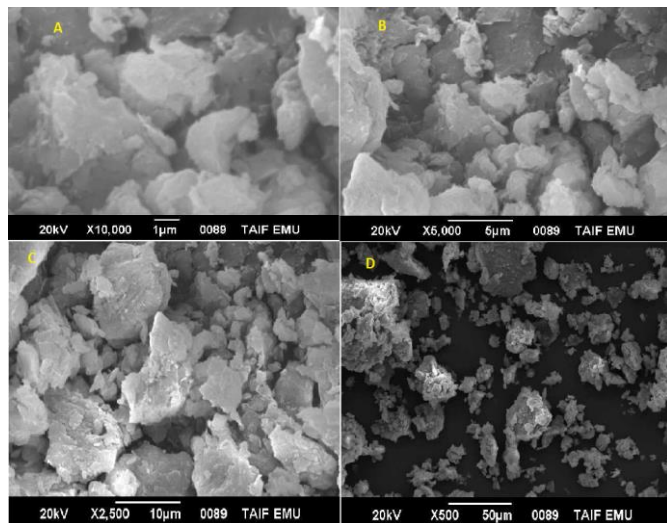


Fig. 4. Scanning electron microscope (SEM) of dry natural peat soil (A), (B), (C), (D).

TABLE I
THE MASS PERCENT OF EACH COMPOUND AND ELEMENTS IN THE TESTED SOIL (CLAY 2) SAMPLE USING XRF ANALYSIS

Compound	Mass percent concentration (m/m%)	Element	Mass percent concentration (m/m%)
Fe_2O_3	77.53	Fe (Iron)	54.22
SiO_2	5.77	Si (Silicon)	2.7
CaO	5.39	Ca (calcium)	3.85
TiO_2	4.87	Ti (Titanium)	2.92
K_2O	2.08	K (Potassium)	1.72
SO_3	1.28	Sx (Unknown)	0.511
Al_2O_3	0.824	Al (Aluminum)	0.436
ZrO_2	0.777	Zr (Zirconium)	0.575
SrO	0.35	Sr (Strontium)	0.296
ZnO	0.214	Zn (Zinc)	0.172
MnO	0.174	Mn (manganese)	0.134
NiO	0.173	Ni (Nickel)	0.136
CuO	0.167	Cu (Copper)	0.134
Cr_2O_3	0.099	Cr (Chromium)	0.068
Y_2O_3	0.089	Y (Yttrium)	0.07
Rb_2O	0.088	Rb (Rubidium)	0.08
Nb_2O_5	0.076	Nb (Niobium)	0.0535
Ga_2O_3	0.0672	Ga (Gallium)	0.0426

TABLE II
PHYSICAL, MAJOR ELEMENTS, AND MINOR ELEMENTS FOR ANALYZED WATER SAMPLES (RETENTION TIME IS 5HR)

Element	unit	Before experiment	After experiment
pH	-----	7.81	7.35
Electrical conductivity (EC)	ds/m ⁻¹	3.950	0.095
Total dissolved solids (TDS)	mg/L	2528	61
Total alkalinity	mg/L	117	52
Nitrite (NO ₂)	mg/L	<0.2	<0.2
Nitrate (NO ₃)	mg/L	0.41	<0.2
Phosphate (PO ₄)	mg/L	5.28	<0.2
Sulfate (SO ₄)	mg/L	960.38	2.007
Sodium (Na)	mg/L	575	17
Chloride (Cl)	mg/L	835.3	0.073
Carbonate (CO ₃)	mg/L	0	0

Based on the contents of minor ions and acceptable pollutant levels, it is clear from Table II that: The ions' concentration of nitrate and phosphate were decreased from 0.41 (mg/L) before experiment to < 0.2 (mg/L) after experiment for nitrate and from 5.28 (mg/L) before experiment to <0.2 (mg/L) after experiment for phosphate. All the results were expressed in milligrams per liter (mg/L). Also, it is seen from Table II that the sodium (Na), chloride (Cl), and bicarbonate (HCO₃) concentrations (mg/L) decrease after the experiment. Therefore, the peat soil adsorbs incredible amounts of these substances from an aqueous solution.

Based on Table III results, Aluminum ion concentration in the analyzed water samples decreased from 0.18 (mg/L) before the experiment to 0.040 (mg/L) after the experiment. Barium ion concentration in the analyzed water samples decreased from 0.032 (mg/L) before the experiment to 0.011 (mg/L) after the experiment. Chromium ion concentration in the analyzed water samples decreased from 0.003 (mg/L) before experiment to 0.002 (mg/L) after experiment. Cobalt ion concentration in the analyzed water samples decreased from 0.034 (mg/L) before the experiment to 0.014 (mg/L) after the experiment. Copper ion concentration in the analyzed water samples decreased from 0.019 (mg/L) before the experiment to 0.018 (mg/L) after the experiment. Iron ion concentration in the analyzed water samples decreased from 33.31 (mg/L) before the experiment to 22.04 (mg/L) after the experiment. Manganese ion concentration in the analyzed water samples decreased from 1.42 (mg/L) before the experiment to 0.038 (mg/L) after the experiment. Nickel ion concentration in the analyzed water samples decreased from 0.029 (mg/L) before the experiment to 0.026 (mg/L) after the experiment, and Zinc ion concentration in the analyzed water samples decreased from 0.022 (mg/L) before the experiment to 0.013 (mg/L) after the experiment. It is clear that the concentration of most heavy metals' elements was decreased after the experiment by passing the polluted water in a column contains the used material due to the effectiveness of peat soil adsorbent. It is observed that iron and all minor and trace elements were influenced and removed from the aqueous solution.

From Table IV, Aluminum ion concentration in the analyzed soil samples increased from 28712 (mg/L) before the

experiment to 36990 (mg/L) after the experiment. Barium ion concentration in the analyzed soil samples increased from 185.5 (mg/L) before the experiment to 299 mg/L after the experiment. Chromium ion concentration in the analyzed soil samples increased from 36.8 (mg/L) before the experiment to 87 (mg/L) after the experiment. Cobalt ion concentration in the analyzed soil samples increased from 12 (mg/L) before the experiment to 42 (mg/L) after the experiment. Copper ion concentration in the analyzed soil samples increased from 106.4 (mg/L) before the experiment to 464 (mg/L) after the experiment. Iron ion concentration in the analyzed soil samples increased from 19480 (mg/L) before the experiment to 63360 (mg/L) after the experiment. Lead ion concentration in the analyzed soil samples increased from 7.2 (mg/L) before the experiment to 113 (mg/L) after the experiment. Manganese ion concentration in the analyzed soil samples increased from 336 (mg/L) before the experiment to 1060 (mg/L) after the experiment. Nickel ion concentration in the analyzed soil samples increased from 43.6 (mg/L) before the experiment to 107 (mg/L) after the experiment, and Zinc ion concentration in the analyzed soil samples increased from 93.2 (mg/L) before the experiment to 283 (mg/L) after the experiment.

EFFECT OF SOME PARAMETERS ON THE REMOVAL EFFICIENCY (%) AND ADSORPTION CAPACITY

Several experimental works were carried out to investigate the performance of some parameters such as the contact time, the Fe initial concentration, and adsorbent dose on the Fe removal (%) and adsorption capacity.

In Figure 5, the relation between the Fe residual concentration (mg/L) and the contact time (hr.) with different Fe initial concentrations (mg/L) was investigated. The results showed that an increase in the contact time resulted in a decrease in the Fe residual concentration at the same Fe initial concentration. For example, at the same Fe initial concentration of 100 (mg/L), when the contact time was 5 (hrs.), the Fe residual concentration was 51 (mg/L) and decreased to 40 (mg/L) when the contact time increased to 20 (hrs.) since the adsorbent material can continuously absorb the Fe from the aqueous solution with increasing the contact time. On the other hand, when the Fe initial concentration increased, the Fe residual concentration increased simultaneously.

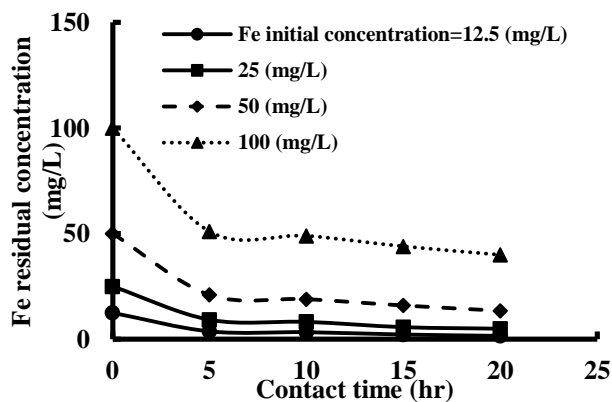


Fig. 5. Variation of the Fe residual concentration (mg/L) with the contact time at different Fe initial concentrations (adsorbent dose 175 (g), temperature 25°C, pH=7.4).

TABLE III
TRACE ELEMENT OF THE ANALYZED WATER SAMPLES
(RETENTION TIME IS 5HR)

Element	unit	Concentration before experiment	Concentration after experiment
Aluminum (Al)	mg/L	0.181	0.040
Antimony (Sb)	mg/L	<0.009	<0.009
Arsenic (As)	mg/L	<0.006	<0.006
Barium (Ba)	mg/L	0.032	0.011
Cadmium (Cd)	mg/L	<0.002	<0.002
Chromium (Cr)	mg/L	0.003	0.002
Cobalt (Co)	mg/L	0.034	0.014
Copper (Cu)	mg/L	0.018	0.019
Iron (Fe)	mg/L	33.31	22.04
Lead (Pb)	mg/L	<0.007	<0.007
Manganese Mn	mg/L	1.416	0.038
Nickel (Ni)	mg/L	0.029	0.026
Selenium (Se)	mg/L	<0.007	<0.007
Tin (Sn)	mg/L	<0.006	<0.006
Vanadium (V)	mg/L	<0.001	<0.001
Zinc (Zn)	mg/L	0.022	0.013

TABLE IV
TRACE ELEMENTS OF THE ANALYZED PEAT SOIL SAMPLES
(RETENTION TIME IS 5HR)

Element	unit	Concentration before experiment	Concentration after experiment	
Aluminum (Al)	mg/L	28712	29550	36990
Antimony (Sb)	mg/L	DL	<0.009	<0.009
Arsenic (As)	mg/L	DL	<0.006	<0.006
Barium (Ba)	mg/L	185.2	197	299
Cadmium (Cd)	mg/L	DL	<0.002	<0.002
Chromium (Cr)	mg/L	36.8	77	87
Cobalt (Co)	mg/L	12	39	42
Copper (Cu)	mg/L	106.4	261	464
Iron (Fe)	mg/L	19480	52260	63360
Lead (Pb)	mg/L	7.2	87	113
Manganese (Mn)	mg/L	336	952	1060
Nickel (Ni)	mg/L	43.6	98	107
Selenium (Se)	mg/L	DL	<0.007	<0.007
Tin (Sn)	mg/L	DL	<0.006	<0.006
Vanadium (V)	mg/L	138.4	123	125
Zinc (Zn)	mg/L	93.2	240	283

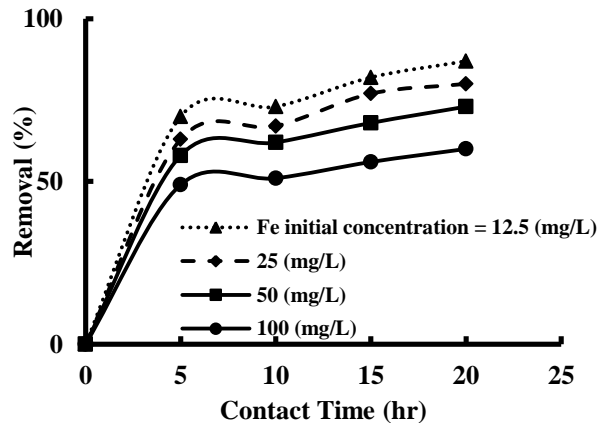


Fig. 6. Variation of the removal (%) with contact time (hr.) at different Fe initial concentrations (adsorbent dose 175 (g), temperature 25°C, pH=7.4).

The removal (%) can be computed as the difference between the Fe initial concentration and the Fe residual concentration at the specified time divided by the Fe initial concentration as follows,

$$\text{Removal (\%)} = \frac{C_0 - C_t}{C_0} * 100 \quad (1)$$

where C_0 is the Fe initial concentration (mg/L), and C_t is the Fe residual concentration (mg/L) at the specified time.

Figure 6 illustrated the relationship between the removal (%) and contact time at different Fe initial concentrations using Equation (1). The removal efficiency was investigated at various Fe initial concentrations from 12.5 to 100 (mg/L), adsorbent dose 175 (g), pH value 7.4, and a temperature of 25(°C). The effects of both C_0 and solution/adsorbent contact time C_t on the removal efficiency were showed. The removal efficiency is directly proportional to contact time at the same Fe initial concentration. An increase in the contact time increased the removal (%) at the same Fe initial concentration, for example, at the same Fe initial concentration 12.5 (mg/L), when the contact time was 5 (hr), the removal (%) was 70 (%). This value was 87 (%) at 20 (hr). The maximum removal (%) was 87 (%), at a high contact time of 20 (hr) and low Fe initial concentration of 12.5 (mg/L).

Figure 7 illustrated that an increase in the Fe initial concentration led to a reduction in the removal (%) at the same contact time since the term of the Fe initial concentration was in the denominator of Equation (1). The removal efficiency is computed based on Equation (1), where the C_t is the Fe's concentration in the solutions at a specified time t . If the contact time is increased, the removal efficiency % is also increased, reaching 87 % when the contact time 20 hrs. At 12.5 mg/L of Fe and this is obvious in Fig. 7. For another example, for 5 (hr) contact time, when the Fe initial concentration was 12.5 (mg/L), the removal (%) was 70 (%) and decreased to 49 (%) at 100 (mg/L).

Figure 8 explained the effect of the adsorbent thickness variation on the removal (%) at different contact times and constant Fe initial concentration 12.5 (mg/L). It is shown from Figure 4 that an increase in the adsorbent thickness in aqueous solution resulted in a rise in the removal (%) at the same contact time and Fe initial concentration 12.5 (mg/L) which, mean that removal efficiency is directly proportional to adsorbent thickness at the same contact time. When no soil in an aqueous solution, there is NO removal of Fe from the aqueous solution, and when the adsorbent thickness was 1 (cm), the removal (%) was 42 (%) at 5 (hr) contact time. The removal (%) increased to 70 (%) when the adsorbent thickness became 4 (cm). An increase in the contact time indicated an increase in the removal (%) when the adsorbent thickness was constant. The maximum removal (%) was 90 % occurred at high adsorbent dose 210 (g), high adsorbent thickness 5 (cm), and high contact time 20 (hr).

Figure 9 explained the effect of the adsorbent weight (g) on the removal (%) at different contact times and constant Fe initial concentration 12.5 (mg/L), pH value of 7.4, and a temperature of 25(°C). The adsorbent weight was increased from 50 to 210 (g). Its effect is the same as the adsorbent

thickness. An increase in the adsorbent thickness led to a rise in the adsorbent weight. It indicates that as the adsorbent weight increases, Fe's available adsorption sites increase, helping to achieve higher removal efficiency.

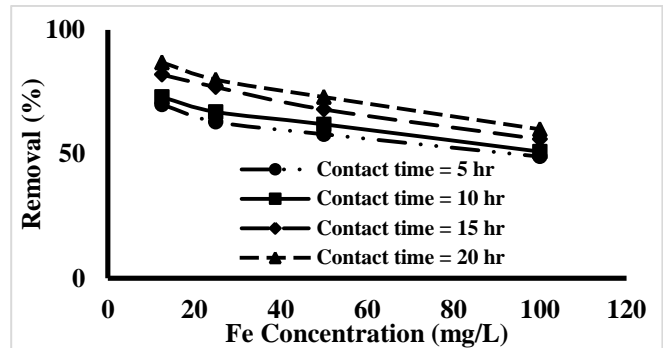


Figure 7. Variation of the removal (%) with the Fe initial concentration (mg/L) at different contact time (adsorbent dose 175 (g), temperature 25°C, pH=7.4).

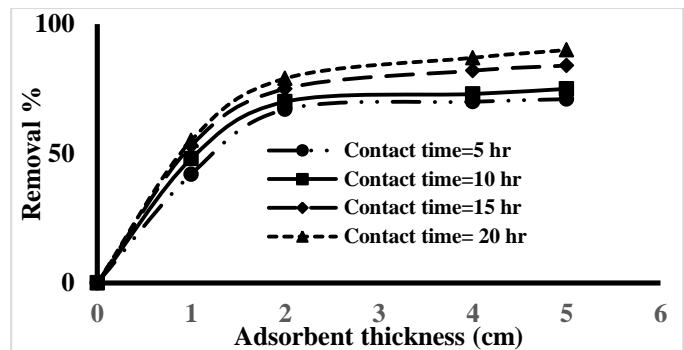


Fig. 8. Variation of the removal (%) with the adsorbent thickness (cm) at different contact times (Fe initial concentration 12.5 mg/L, temperature 25°C, pH=7.4).

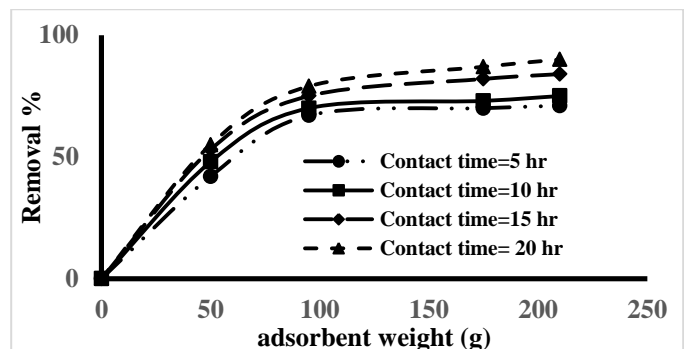


Figure 9. Variation of the removal (%) with the adsorbent weight (g) at different contact time (Fe initial concentration 12.5 (mg/L), temperature 25°C, pH 7.4).

The adsorbent weight (g) effect on the adsorption capacity (mg/g) was discussed. The adsorption capacity (A) in (mg/g) can be determined as

$$A = \frac{C_0 - C_t}{m} V \quad (\text{mg/g}) \quad (2)$$

where C_0 is the Fe initial concentration (mg/L), C_t is the Fe residual concentration in aqueous solution (mg/L), m is the adsorbent mass (g), and V is the solution volume (L).

Figure 10 showed the influence of adsorbent weight on the adsorption capacity of the peat soil. The experiment was

conducted using the same Fe initial concentration 12.5 (mg/L).

In the above question, the initial concentration C_0 as 12.5 mg/L and final concentration (C_t) as 7.5 mg/L of Fe at a contact time of 5 hr is presented as an example. The volume is 1000 ml, and the amount of adsorbent used (peat soil) is 50 gm.

Now we use the formula to compute A

$A = [(12.5-7.5) \text{ mg/L} * 1 \text{ L}]/50 \text{ gm}$ or $A = [5 \text{ mg}/50 \text{ gm}]$ or $A=0.1 \text{ mg} / \text{ gm}$. Thus 0.1 mg of Fe ions are adsorbed by 1 gm of peat soil. The A value you have got for the contact time of 5 hr.

It was found that the adsorption capacity decreased from 0.1 to 0.04 (mg/g) with an adsorbent weight increased from 50 to 210 (g). As in Equation (2), the adsorption capacity depends on the mass of the adsorbent, the solution volume, and the Fe's initial concentration. The adsorption capacity was computed when the Fe's initial concentration was 12.5 mg/L, and the solution volume is considered 1 L. Therefore, the adsorption capacity is low, and when the initial concentration of Fe is increased, then the adsorption capacity will also be increased. It concludes that the percentage adsorbent area that adsorbs the polluted metals and occupied by adsorption ions reduced.

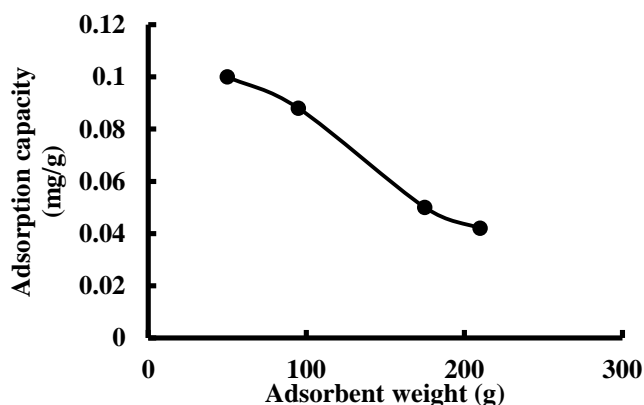


Fig. 10. Variation of the adsorption capacity (mg/g) with the adsorbent weight (g) (Fe initial concentration 12.5 mg/L, temperature 25°C, pH 7.4)

CONCLUSION AND RECOMMENDATION

Laboratory experiments confirmed that the organic soil layer extending down most of Egypt's delta lands acts as an adsorption medium, especially to remove the iron element from the groundwater.

Under normal conditions and without any activation, the organic layer acts as a slow adsorbent, and the adsorption capacity reaches up to 0.1 mg Fe for 50 mg from the adsorbent.

From the experimental results presented in this study, the efficacy of natural peat soil to adsorb the heavy metals from water has been ascertained widely concerning different parameters such as the material thickness, contact time, initial concentration of the heavy metals, and the adsorbent dose. Furthermore, this natural peat soil can cover the bottom surface of the oxidation ponds, streams, and canals to avoid contaminating the groundwater.

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Title Arabic:

سلوك الامتزاز لأيون الحديد من المياه الجوفية عبر تربة الخث الطبيعية

Arabic Abstract:

استخدمت عدة تقنيات لعزل (نزع) الملوثات من المياه مثل الترسيب الكيميائي والتبادل الأيوني والتخثر والمعالجة الكهروكيميائية والامتزاز. فضلت الطريقة الأخيرة لسهولة وسهولة الاسترداد والفاعلية العالية لها. تم عمل تحليل كيميائي لتربة الخث الطبيعية والمحلل المائي المحتوي على ايون الحديد ومن ثم بيان خصائص تربة الخث عن طريق حيود فلورة الأشعة السينية وأيضاً باستخدام المجهر الإلكتروني. تم عمل تجارب معملية لتقصي تأثير بعض المتغيرات على كفاءة عزل الملوثات وسعة أو قدرة الامتزاز للملوثات من المحلول المائي المحتوي على ايون الحديد باستخدام تربة الخث الطبيعية. ومن المتغيرات التي تم استقصاء تأثيرها زمن التلامس وتركيز الحديد الابتدائي وسمك وجرة المادة المازة (تربة الخث). وقد بينت النتائج أن تربة الخث الطبيعية لها فاعلية كبيرة في امتزاز الحديد وعزله من المحلول المائي.