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**Uses of some Homoionic Aluminosilicate minerals to improve
irrigation water and some soil properties**

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Equilibrium, kinetic and thermodynamic studies of Na⁺ adsorption from aqueous solutions on homo-ionized K- and NH₄-kaolin

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Abstract

Egyptian kaolin clay (UnK) was homo-ionized with K⁺ and NH₄⁺ to obtain K-K and N-K, respectively. The analysis of the molar leaching solutions of KCl, NH₄Cl or HCl revealed an original cation exchange capacity of UnK up to 6.08 meq per 100 g. The adsorption parameters of Na⁺ on K-K and N-K were examined in aqueous solutions. The equilibrium adsorption data were evaluated using Langmuir, Freundlich adsorption and Dubinin–Radushkevich-Kaganer isotherm models. Freundlich model was the best that described the adsorption process and the maximum capacities (q_{max}) are found to be enhanced to 75.6 and 17.5 mg g⁻¹, respectively. The experimental data fitted well the pseudo-second-order kinetics model. The thermodynamic parameters such as standard Gibbs free energy (ΔG^{ads}), enthalpy (ΔH^{ads}) and entropy changes (ΔS^{ads}) for the adsorption process were calculated. The negative values of the Gibbs free energy confirm that the adsorption processes are spontaneous and thermodynamically favorable while the negative value of ΔH^{ads} supports the exothermic physicochemisorption of the adsorption process. Both homo-ionized kaolin samples are promising cheap adsorbents for lowering the sodicity of soil while gradually exchanging valuable nutrients for plants.

Keywords: Na⁺; Adsorption equilibrium; Kaolin; Thermodynamics; Kinetics.

1. Introduction

Salt-affected soils are found in arid and semi-arid climates in more than one hundred countries of the world, especially Egypt, where many regions are also affected by irrigation-induced salinization^[1]. This problem shall upsurge in the future by increasing the use of pretreated waste water in irrigation. Salinity becomes a problem when the total amount of salts which accumulate in the root zone is high enough to negatively affect plant growth depending on its type. Due to the accumulation of salt, water uptake by plant roots in the soil become difficult thus disturbing water balance, while high concentrations of salts in plant tissue were found to be toxic.

Sodicity refers to the sodium content of the irrigation water. Because of the relatively large size, single electrical charge, and hydration status of the sodium ion it particularly can cause soil dispersion. Sodic

soil conditions make it difficult for plants to become established, for roots to penetrate the soil, and for plants to receive sufficient nutrients and water. Overall, those effects have negative impacts on plant yield and survival^[2]. A soil is classified as sodic if exchangeable sodium percentage (ESP) exceeds 15%^[3]. Hence, it should be reduced below this percentage.

Nowadays, many desalination technologies are in use to produce freshwater from saline water. Electro-dialysis, vapor compression, multi-stage flash distillation, multiple-effect distillation, and reverse osmosis distillation have become standard desalination technology in the world at a recent decade^[4]. Indeed, these technologies can produce large amounts of freshwater but they are costly and cannot target sodium selectively.

Due to low operational costs as well as its friendly aspects to

CONTENTS

Subject	Page
Chapter One	
1. INTRODUCTION AND LITRATURE SURVEY	1
1.1. Introduction and aim of the work	1
1.2. Soil	2
1.2.1. Mean features of Soil	2
1.2.1.1. Soil composition	2
1.2.1.2. Soil texture	3
1.2.1.3. Soil structure	3
1.2.2. Soil Chemical Properties	4
1.2.2.1. pH	4
1.2.2.2. Ion Retention in Soils	4
1.2.2.3. Exchange Capacity	4
1.3. Essential nutrients for plant	5
1.3.1. Nitrogen	5
1.3.1.1. Sources of Nitrogen Compounds for Plant Growth	5
1.3.1.1.1. Nitrogen from the atmosphere	5
1.3.1.1.2. Commercial fertilizers	5
1.3.1.1.3. Animal manure	6
1.3.1.1.4. Crop residues	6
1.3.1.1.5. Soil organic matter	6
1.3.1.2. Forms of N found in the soil and plants	6
1.3.1.2.1. Nitrate	6
1.3.1.2.2. Ammonia	6
1.3.1.3. Functions of nitrogen	7
1.3.1.4. Nitrogen Deficiency in Plants	7
1.3.2. Potassium	7
1.3.2.1. Functions of potassium	7
1.3.2.1.1. Enzyme Activation	7

1.3.2.1.2. Stomatal Activity (Water Use)	7
1.3.2.1.3. Photosynthesis	8
1.3.2.1.4. Transport of Sugars	8
1.3.2.1.5. Water and Nutrient Transport	8
3.2.1.6. Protein Synthesis	8
1.3.2.1.7. Starch Synthesis	8
1.3.2.1.8. Crop Quality	9
1.3.3. Phosphorus	9
1.3.3.1. Phosphorus and Plant Growth	9
1.3.3.2. Symptoms of Phosphorus Deficiency in Plants.	9
1.4. Salinity	9
1.4.1. Measurements of Salinity in Soil	10
1.4.1.1. Total Soluble Salts (TSS)	10
1.4.1.2. Sodium Adsorption Ratio (SAR)	10
1.4.1.3. Exchangeable Sodium Percentage (ESP)	11
1.4.1.4. Electrical Conductivity (EC)	11
1.4.2. Causes of salinity	11
1.4.3. Effects of Salinity on Plant Growth	11
1.4.3.1. Crop tolerance to salinity	11
1.5. Soil sodicity	13
1.5.1. Types of Salt-Affected Soils	15
1.5.1.1. Saline soils	15
1.5.1.2. Sodic soils	15
1.5.1.3. Saline-sodic soils	16
1.5.2. Effects of Sodicity on Vegetation	16
1.6. Crops	16
1.6.1. Wheat	16
1.6.2. Bean	17
1.7. Reclaiming Salt-Affected Soils	17
1.7.1. Treatment techniques	17
1.7.1.1. Leaching	17

1.7.1.2. Chemical treatment	17
1.8. Adsorption	18
1.8.1. The advantages of adsorption process	18
1.8.2. Types of adsorption	18
1.8.2.1. Physisorption	18
1.8.2.2. Chemisorption	19
1.8.2.3. Electrostatic sorption (ion exchange)	19
1.8.3. Adsorption isotherms	20
1.9. Aluminosilicate minerals	20
1.9.1. Clay minerals	21
1.9.1.1. Clay mineral properties	23
1.9.1.2. Common clay minerals in soil	23
1.9.1.2.1. Kaolinite	23
1.9.1.2.2. Bentonite	24
1.9.2. Zeolite	26
1.9.2.1. Structure	27
1.9.2.2. Composite Building Units	27
1.9.2.3. The channel system and the pore size	28
1.9.2.4. Properties of zeolite structures	30
1.9.2.5. Ion-exchange behavior of zeolite	30
1.9.2.6. Modification of zeolite with a solution of inorganic salts	31
1.9.2.7. Zeolite classification	32
1.9.2.7.1. Natural zeolites	32
1.9.3.7.2. Synthetic zeolites	34
1.9.2.8. Applications	36
1.10. Removal of some inorganic cations from water on aluminosilicates	36
1.10.1. Kaolin	36
1.10.2. Bentonite	39
1.10.3. Natural zeolite (Clinoptilolite)	42
1.10.4. Synthetic zeolite (Faujasite)	45
1.11. Removal of sodium cations from water on various adsorbents	47

Chapter Two	
2. Experimental	49
2.1. Materials and reagents	49
2.1.1. Materials	49
2.1.1.1. Aluminosilicate minerals	49
2.1.2. Reagents	50
2.2. Equipments	51
2.2.1. Fourier transform infrared spectra (FTIR)	51
2.2.2. pH measurements	51
2.2.3. Powder X-Ray Diffraction spectra (XRD)	51
2.2.4. X-Ray florescence (XRF)	51
2.2.5. Flame atomic absorption spectrometry (FAAS)	52
2.3. Methodology	52
2.3.1. Homo-ionization technique	52
2.3.2. Analysis of metal concentration	53
2.4. Adsorption studies	53
2.4.1. Batch-mode adsorption technique	53
2.4.1.1. Effect of initial concentrations	53
2.4.1.2. Effect of contact time	53
2.4.1.3. Effect of temperature	53
2.4.2. Column-mode separation	54
2.4.2.1. Adsorption experiments	54
2.4.2.2. Regeneration experiments	54
2.5. Mathematical calculations	54
2.5.1. Adsorption isotherm model fitting	54
2.5.2. Fitting of kinetic models	56
2.5.3. Thermodynamic Parameters	56
2.6. Application	57
2.6.1. Column-mode separation	57
2.6.2. Pots experiment	57
2.6.2.1. Materials	57

2.6.2.2. Experimental design	58
2.6.2.3. Seedling preparation	59
2.6.2.4. Soil Physical & Chemical Analysis	60
2.6.2.4.1. Mechanical Analysis of Soil Sample	60
2.6.2.4.2. Soil Chemical Analysis	64
2.6.2.5. Plant Analysis	71
Chapter Three	
3. Results and Discussion	74
3.1. Material Characterization	74
3.1.1. X-ray diffraction	74
3.1.2. X-ray fluorescence spectrometry	75
3.1.3. FTIR spectra	77
3.1.4. Evaluation of the ion exchange capacities of UnK, UnB, UnC and UnF	80
3.2. Adsorption studies	84
3.2.1. Batch-mode adsorption technique:	84
3.2.1.1. Effect of initial concentration	84
3.2.1.1.1. Fitting of adsorption isotherm models	87
3.2.1.2. Effect of shaking time	94
3.2.1.2.1. Examination of kinetic models	96
3.2.1.3. Effect of temperature	103
3.2.1.3.1. Determination of the thermodynamic parameters	108
3.2.2. Fixed bed column-mode adsorption study	113
3.3. Application	118
3.3.1. Application on irrigation water	118
3.3.2. Pots experiment	122
3.3.2.1. Analysis of irrigation water	122
3.3.2.2 Effect on Soil Properties	123
3.3.2.3. Effect on Plant Properties	127
3.3.2.3.1. Effect of Irrigation with Treated and Untreated Water on Na, N, P,	127
3.3.2.3.2. Effect of Irrigation with Treated and Untreated Water on dry weight of plants	131

References	132
Summary	142
Arabic summary	i

List of tables

Table	Title	Page
Chapter One		
Table (1.1)	The electrical conductivity expected to produce a specified percentage yield reduction for selected crops.	12
Table (1.2)	Featured symptoms associated with salinity	15
Chapter Two		
Table (2.1)	List of chemicals	49&50
Table (2.2)	Some chemical and physical properties of soil used for bean plants	62
Table (2.3)	Some chemical and physical properties of soil used for wheat plants	63
Chapter Three		
Table (3.1)	XRF analysis UnK, UnB, UnC, and UnF.	76
Table (3.2)	FTIR spectral band positions of the studied aluminosilicates	79
Table (3.3)	Analysis of Na ⁺ , K ⁺ , Mg ⁺⁺ and Ca ⁺⁺ in (UnK, UnB, UnC and UnF) and their homo-ionized products leached with 1M NH ₄ Cl, KCl or HCl.	83
Table (3.4)	Langmuir isotherm parameters and dimensionless equilibrium factors (R _L) for adsorption of Na ⁺ onto K-B, N-B, K-C, N-C, K-F and N-F adsorbents.	89
Table (3.5)	Freundlich isotherm parameters for adsorption of Na ⁺ onto K-K, N-K, K-B, N-B, K-C, N-C, K-F and N-F adsorbents	90

Table (3.6)	DRK isotherm parameters for adsorption of Na ⁺ onto K-K, N-K, K-B, N-B, K-C, N-C, K-F and N-F adsorbents	90
Table (3.7)	The pseudo 1 st order kinetic parameters for Na ⁺ adsorption onto (K-K, N-K, K-B, N-B, K-C, N-C, K-F and N-F) adsorbents, C ₀ = 100 mg L ⁻¹	97
Table (3.8)	The pseudo 2 nd order kinetic parameters for Na ⁺ adsorption onto (K-K, N-K, K-B, N-B, K-C, N-C, K-F and N-F) adsorbents, C ₀ = 100 mg L ⁻¹ .	99
Table (3.9)	The intraparticle diffusion rate constant for Na ⁺ adsorption onto (K-K, N-K, K-B, N-B, K-C, N-C, K-F and N-F) adsorbents, C ₀ = 100 mg L ⁻¹ .	101
Table (3.10)	Effect of temperature on removal efficiency of sodium ions onto K-B, N-B, K-C, N-C, K-F and N-F adsorbents, C ₀ = 50, 100, 200 mg L ⁻¹ .	104
Table (3.11)	Effect of temperature on adsorption capacity (q _e mg g ⁻¹) of sodium ions onto K-K, N-K, K-B, N-B, K-C, N-C, K-F and N-F adsorbents, C ₀ = 50, 100, 200 mg L ⁻¹ .	106
Table (3.12)	The thermodynamic parameters of sodium ions adsorption onto (K-K, N-K, K-B, N-B, K-C, N-C, K-F and N-F) adsorbents, C ₀ = 50,100,200 mg L ⁻¹ .	109
Table (3.13)	Comparison between the removal capacity of Na ⁺ using (K-K and N-K, K-B, N-B, K-C, N-C, K-F and N-F) with other adsorbents	112
Table (3.14)	Na ⁺ concentrations of NaCl solution determined at various inlet volumes	115
Table (3.15)	Na ⁺ concentrations of (SW) determined at various inlet volumes	116
Table (3.16)	Removal efficiency of Na ⁺ on K-F and N-F at various inlet volumes of NaCl solution	117
Table (3.17)	Removal efficiency of Na ⁺ on K-F and N-F at various inlet volumes of (SW)	117

Table (3.18)	Na ⁺ concentrations determined in effluents of 100 mL volume after each regeneration	119
Table (3.19)	Removal efficiency of Na ⁺ on K-F and N-F after each regeneration	120
Table (3.20)	EC, pH, SAR and concentration of cations and anions of irrigation water used in the pot experiment.	123
Table (3.21)	Soil chemical prosperities after harvesting bean plants.	124
Table (3.22)	Soil chemical prosperities after harvesting wheat plants.	124
Table (3.23)	Effect of treated and untreated irrigation water on Na, N, P and K uptake of bean plants.	129
Table(3.24)	Effect of treated and untreated irrigation water on Na, N, P and K uptake of wheat plants.	129
Table (3.25)	Effect of treated and untreated irrigation water on fresh weight and dry weight of plants.	131

LIST OF FIGURES

Figure	Title	Page
Chapter One		
Figure (1.1)	A soil texture diagram-soil types according to their clay, silt and sand composition	3
Figure (1.2)	Behavior of non sodic and sodic soils in water	14
Figure (1.3)	The Physisorption and chemisorption processes.	19
Figure (1.4)	(a) SiO ₄ tetrahedral units and silica 'T' layers (b) octahedral (XO ₆) units and the difference between brucite and gibbsite 'O' layers.	22
Figure (1.5)	Structure of kaolinite	24

Figure (1.6)	Structure of sodium montmorillonite	25
Figure (1.7)	A Combination of $(\text{SiO}_4)_4$ - PBUs to form SBUs, alignment of which results in a cage	27
Figure (1.8)	Development of a zeolite from (a) the PBUs, (b) the SBUs, (c) CBUs, and (d) zeolite structures	28
Figure (1.9)	The three channel systems: (a) the 1-D channel system of the AFI zeolite, (b) the 2-D channel system of Mordenite, (c) The 3-D channel system of Faujasite	29
Figure (1.10)	Schematic representation pore size distributions	30
Figure (1.11)	Zeolite particles in natural and modified zeolites (Na and Fe forms of clinoptilolite) and SEM image of zeolite surface after the implementation of chemical modification.	32
Figure (1.12)	The tetrahedral framework of Clinoptilolite	33
Figure (1.13)	Tetrahedral model of clinoptilolite, indicating 10-membered and 8-membered channels that are bridged with 8-membered channels	34
Figure (1.14)	The structure of faujasite	35
Figure (1.15)	XRD patterns for raw kaolin.	37
Figure (1.16)	XRD pattern of raw kaolin, sieved to -112 μm and its HCl-treated material, K = kaolinite, Q = quartz.	38
Figure (1.17)	SEM photos of raw kaolin (A) and its HCl-treated kaolin HK (B).	38
Figure (1.18)	Illustration of the interaction hydrogentetraoxochromate(VI) anion and protonated amine in the clay surface.	40
Figure (1.19)	SEM micrographs of the natural and modified bentonite samples.	40
Figure (1.20)	X-ray diffraction of Na-bentonite and HQ-bentonite.	41
Figure (1.21)	SEM images of (a) natural zeolite and (b) modified zeolite with 0.1 M H_2SO_4 .	43
Figure (1.22)	Illustration of the adsorption mechanism of salt ions onto zeolite surface	45

Figure (1.23)	SEM of the synthesized zeolites. A: Na-LTA. B: Na-FAU.	46
Figure (1.24)	Scanning electron micrographs of CM (left), GT (right)	48
Chapter 2		
Figure (2.1)	Experimental design	58
Chapter 3		
Figure (3.1)	XRD patterns of the aluminosilicate samples; kaolinite (K), quartz (Q), feldspar (*), montmorillonite (M), clinoptilolite (C), cowlesite (+) and faujasite (F).	75
Figure (3.2)	FTIR spectra of different aluminosilicate samples	78
Figure (3.3)	Released ion exchangeable metal ions during the homo-ionization process using 1M KCl (plain) or 1M NH ₄ Cl (shadowed) from (a) UnK, (b) UnB, (C) UnC and (d) UnF adsorbents.	81
Figure (3.4)	Adsorption isotherms of Na ⁺ on (a) K-K and N-K, (b) K-B and N-B, (C) K-C and (d) N-C and K-F and N-F adsorbents.	85
Figure (3.5)	Effect of initial concentration on removal efficiency of Na ⁺ on (a) K-B and N-B, (b) K-C and N-C and (c) K-F and N-F adsorbents.	86
Figure (3.6)	Langmuir adsorption isotherm of Na ⁺ onto (a) K-B and N-B, (b) K-C and N-C and (c) K-F and N-F adsorbents plot.	91
Figure (3.7)	Freundlich isotherm adsorption of Na ⁺ onto (a) K-K and N-K, (b) K-B and N-B, (C) K-C and N-C and (d) K-F and N-F adsorbents plot.	92
Figure (3.8)	DRK isotherm adsorption of Na ⁺ onto (a) K-K and N-K, (b) K-B and N-B, (C) K-C and N-C and (d) K-F and N-F adsorbents plot.	93
Figure (3.9)	Effect of shaking time on removal efficiency of Na ⁺ ions onto (a) K-K and N-K, (b) K-B and N-B, (C) K-C and N-C and (d) K-F and N-F adsorbents. C ₀ =100 mg L ⁻¹ .	95

Figure (3.10)	The fitting data of the pseudo 1 st order for sodium ions adsorption onto (a) K-K and N-K, (b) K-B and N-B, (C) K-C and N-C and (d) K-F and N-F adsorbents.	98
Figure (3.11)	The fitting data of the pseudo 2 nd order for sodium ions adsorption onto (a) K-K and N-K, (b) K-B and N-B, (C) K-C and N-C and (d) K-F and N-F adsorbents.	100
Figure (3.12)	The fitting data of the intraparticle diffusion model for sodium ions adsorption onto (a) K-K and N-K, (b) K-B and N-B, (C) K-C and N-C and (d) K-F and N-F adsorbents, $C_0 = 100 \text{ mg L}^{-1}$.	102
Figure (3.13)	Effect of temperature on removal efficiency of sodium ions onto (a) K-B and N-B, (b) K-C and N-C and (c) K-F and N-F adsorbents, $C_0 = 50, 100, 200 \text{ mg L}^{-1}$.	105
Figure (3.14)	Effect of temperature on adsorption capacity ($q_e \text{ mg g}^{-1}$) of Na ions onto (a) K-K and N-K, (b) K-B and N-B, (c) K-C and N-C and (d) K-F and N-F adsorbents, $C_0 = 50, 100, 200 \text{ mg L}^{-1}$.	107
Figure (3.15)	Effect of temperature on ΔG_{ads} of K-K (down) and N-K (up) towards Na^+ .	110
Figure (3.16)	Effect of temperature on ΔG_{ads} of (a) K-B and N-B, (b) K-C and N-C and (c) K-F and N-F adsorbents towards Na^+ .	111
Figure (3.17)	Linear plot of Thomas equation.	114
Figure (3.18)	Column separation of (a) 300 mg/L Na^+ and (b) 1000 mg/L Na^+ on 1g K-F and N-F packed in mini columns.	116
Figure (3.19)	Removal efficiency of Na^+ on K-F and N-F at various inlet volumes of (a) (SW) and (b) NaCl solution.	118
Figure (3.20)	Na^+ concentrations determined in effluents of 100 mL volume after column separation on regenerated adsorbents.	124
Figure (3.21)	Removal efficiency of Na^+ determined in effluents of 100 mL volume after column separation on regenerated K-F and N-F.	121
Figure (3.22)	Concentrations of soluble cations after harvesting bean plants	126

	(plain) or wheat plants (shadowed).	
Figure (3.23)	Concentrations of available nitrogen and available phosphorus after harvesting bean plants (plain) or wheat plants (shadowed).	126
Figure (3.24)	Concentrations of available potassium after harvesting bean plants or wheat plants.	127
Figure (3.25)	Effect of treated and untreated irrigation water on Na, N, P and K uptake of bean plants.	130
Figure (3.26)	Effect of treated and untreated irrigation water on Na, N, P and K uptake of Wheat plants.	130