Charge characteristics of clay separates in some soils of Egypt

By

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Abstract

Fine (<1.0 u) and coarse (2.0-1.0 u) clay separates were obtained from alluvial (Aswan, El-Menia, Fayium, Tanta and Kafr El-Sheikh), sandy loam (Belbeis) and calcareous soils (Nubareya). Their chemical properties and amorphous material content were determined. Clay separates either with or without amorphous materials were subjected to potentiometric titration against acid or base solutions. The adsorbed H/OH ions was calculated and depicted vs. pH and the obtained curves were used to find out different parameters of charge characteristics. Kaolinite and bentonite were used as reference clays.

The data showed that increasing the ionic strength of the background solution significantly decreased point of zero net proton charge (PZNPC). Generally, PZNPC – values for fine clays (with higher surface activity) were higher than that for coarse clays due to the silanolic nature of the surfaces of the fine clay separates. Removal of amorphous materials was associated with an increase of PZNPC at 0.01 M ionic strength for alluvial soils, while it was decreased for sandy (Belbeis) and calcareous (Nubareyia) soils. Total charge was higher for fine clay (43.2 – 95.6 Cmol/kg) than for coarse clay (37.2 – 54.4 Cmol/kg) in all the investigated soils. Total charge was generally decreased by the removal of amorphous material by higher percent in fine clay fraction.

The percent of permanent charge for fine clay (44 – 66%) was lower than that of coarse clay (53 – 72 %). The value point of zero net charge (PZNC) was obtained at the intercept of the adsorption curves of both sodium and chloride ions at increased pH values. The PZNC values were not sensitive as PZNPC for the variations in both fine and coarse clays or for amorphous materials. However, highly significant correlations were obtained between total charge and adorbed-Na for fine clay either with or without amorphous materials (r= 0.723** and 0.984**, respectively).

The results suggest that the use of potentiometric titration methods alone may be insufficient for thorough surface charge characterization, particularly at low and high pH. Proton titrations should be coupled with concurrent ion adsorption measurements to confirm surface charge development.

Key words: point of zero net proton charge (PZNPC.), point of zero net charge (PZNC), potentiometric titration, adsorbed H/OH, clay fractions, soils of Egypt

Introduction

Surface charge on soil minerals can develop in three principal ways: (a) as a result of proton or other ion complexation at the particle surface, (b) from lattice imperfections at the particle surface, and (c) isomorphous substitution within the crystal structure [Stumm,1992 and Stumm and Morgan, 1996]. With regard to amorphous materials, surface complexation reactions are expected to be the dominant source of surface charge. Net total particle surface-charge, **σP**,is defined quantitatively as the sum of four components [Sposito, 1981 and Sposito and Schindler, 1986]:

$$\sigma_P = \sigma_O + \sigma_H + \sigma_{IS} + \sigma_{OS} \quad (1)$$

Where:

σO =is the net permanent structural-charge density due to isomorphic substitutions;

σ H = is the net proton surface-charge density created by the difference between the moles of protons and hydroxide ions complexed by surface functional groups;

σIS = is the net inner-sphere complex surface-charge density resulting from net total charge of ions (excluding H and OH) bounded into inner-sphere surface coordination; and

σOS = is the net outer-sphere complex surface-charge density resulting from net total charge of ions (excluding H and OH) bounded into outer-sphere surface coordination.

All of the surface charge components except **σO** can be influenced by the pH value of the soil solution. This fact gives rise to the concept of points of zero charge, which are pH values associated with specific conditions imposed on one or more of surface charge type (Sposito and Schindler, 1986). Points of zero charge are traditionally defined as pH values where one or more components of surface charge vanish at a specified temperature, pressure, and aqueous solution composition. Different types of zero charge points were suggested by Sposito and Schindler (1986) which could be summarized as followed:

Symbol	Name	Defining Condition
PZC	Point of zero charge	$\sigma_P = 0$
PZNPC	Point of zero net proton charge	$\sigma_H = 0$
PZNC	Point of zero net charge	$q^+ = q^-$
PZSE	Point of zero salt effect	$\Delta\sigma_H / \Delta I$

q^+ = moles of sorbed cation charge per unit mass
q^- = moles of sorbed anion charge per unit mass
I = ionic strength of swamping background electrolyte.

Of the listed points of zero charge, the PZNC and PZNPC are perhaps the most useful in characterizing the colloid-soil solution interface (Sposito, 1989 and 1992).

Surface charge in these systems depends on activities of potential-determining ions (H^+ and OH^-) and electrolyte concentrations (ionic strength, I) (Van Olphen, 1977). Depending on soil pH, these surfaces can bear net negative, or positive, or no charge. The pH where the net total particle charge is zero is called the point of zero charge (PZC), which is one of the most important parameters used to describe variable-charge surfaces (Morais et al., 1976). If the pH of a soil is above its PZNC the soil surface will have a net negative charge and predominantly exhibit an ability to exchange cations, while the soil will mainly retain anions (electrostatically) if its pH is below its PZNC.

Several methods have been proposed for determination of the point of zero charge in soils and other materials dominated by variable surface-charge colloids. In soils, researchers have generally relied on potentiometric titration, which assesses changes in surface potential with changes in the activities of H^+ and OH^-, to determine the point of zero salt effect (PZSE) or point of zero net proton charge (PZNPC). They have also used non-specific ion adsorption, which measures changes in the electrostaticadsorption of a cation and anion with changes in the activities of H^+ and OH^-, to find point of zero net charge (PZNC) (van Raij and Peech, 1972; Parker et al., 1979; Marcano-Martinez and McBride, 1989).

The aim of the present work is to assess the changes in surface potential of clay fractions of main soil types of Egypt with the changes in the activities of H^+ and OH^-, to determine the point of zero net proton charge (PZNPC) or point of zero salt effect (PZSE). Point of zero net charge (PZNC) was also investigated for the studied clay fractions and compared with the other points of zero charge.

Materials and Methods

Surface soil samples (0-30 cm) were collected from (Aswan, Elminia, Fayoum, Tanta and Kafr El-Sheikh), alluvial (Belbeis) sandy loam and (Nubaria) calcareous soils. The general characteristics were determined using standard methods (Sparks 1998) and presented in Table (1). Fine (<1mu) and coarse (2-1mu) clay fractions were separated after soil dispersion using sedimentation method (Jackson, 1964) and subjected to determination of surface area using O-phenanthroline method (Black, 1982). Amorphous silica and alumina were extracted and determined according to Jackson (1964). Free iron oxides were extracted using Dithionite-Citrate-bicarbonate (DCB) method (Mehra and Jackson, 1960) and determined by atomic absorption.

Surface charge density was measured for each clay fraction before and after removal of amorphous materials as a function of pH at three fixed ionic strengths (I=0.01, 0.1 and 1.0 M) in a NaCl background solution. A discontinuous titration procedure was used, which permits simultaneous measurement of proton (H^+) and hydroxyl (OH^-) adsorption, (Marcano-Martinez

and McBride, 1989 and Zelazny et al., 1996). Clay fractions (0.2 g) were suspended in 20 ml background electrolyte solution of NaCl/HCl or NaCl/Na(OH). Mixtures of the background electrolyte, acid and base were prepared to reach equilibrium supernatant solutions with -log [H+] values ranging from 2 to 12. Blanks (without clay) were prepared with the same mixtures of background electrolyte, acid and base used for the adsorbent suspensions. All suspensions and blanks were prepared in duplicate.

Suspensions and blanks were reacted on reciprocal shaker at room temperature for 12 h., and then occasionally stirred for 3 days. Suspensions were then subjected to the measurement of electromotive force (emf), calibrated to proton *concentration* using pH meter with semi-micro combination electrode. Calibration of the electrode was performed using standard buffer solutions with pH 3 and 10. Experimental proton concentrations are reported as -log [H⁺] in figures, but will be referred to as "pH" (for simplicity) hereafter in the text. This data was then used to construct titration curves. Surface charge was calculated using the following equation (Sakurai et al., 1988 and 1996):

$$\Delta H^+ = [(10^{-pH(b)} - 10^{-pH(s)})/ \gamma]x\ (0.02/W)$$

$$\Delta OH^- = [(10^{-[14-pH(b)]} - 10^{-[14-pH(s)]})/ \gamma]x\ (0.02/W)$$

Where:

ΔH^+ = the difference between the final H⁺ concentration of a suspension and that of the blank, at a given ionic strength and pH (cmol$_c$ /kg)

ΔOH^- = the difference between the final OH⁻ concentration of a suspension and that of the blank, at a given ionic strength and pH (cmol$_c$ /kg)

pH(b) = pH of the blank solution,

pH(s) = pH of the clay suspension,

14 = conditional dissociation product of water,

W = oven-dried sediment sample weight (g). and

γ = Single ion activity coefficient calculated from Debye-Huckel extended equation (Tan, 1998),

$$\log \gamma = -0.512 Z^2 \left(\frac{\sqrt{I}}{1 + \sqrt{I}} - 0.3I \right)$$

Where: Z= ion equivalence, I= ionic strength (M) calculated by Davis equation:

$$I = \frac{1}{2} C_i Z2$$

Where: Ci = molar concentration of ion (i)

The determination of point zero of net charge (PZNC) was done using the ion adsorption method (Sposito, 1998). 200 mg portions of clay samples were placed in 50-ml centrifuge tube, 20 ml 0.1 M NaCl was added with increasing volumes of 0.1 M of HCl or NaOH to obtain pH range from 2 to 12. The initial concentrations of both Na^+ and Cl^- at each pH were determined and considered as blank. Suspensions as well as blank were shacked for 12 h., then occasionally stirred for 3 days, then centrifuged for 30 min. and supernatant pH (equilibrium pH) was measured. Equilibrium concentrations of the Na^+ (determined by flame photometer) and Cl^- (found titrimetrically) in supernatants were subtracted from their original concentrations to produce the adsorbed ion concentration at each pH value, and used as measures of negative and positive charges.

Results and Discussion
Potentiometric titration curves: (a) Reference Clay minerals

Figure (1) represent potentiometric titration curves of bentonite and kaolinite reference materials obtained from Egyptian Authority of Geological Survey (EAGS). The point of zero net proton charge (PZNPC) is the pH at which ΔH^+ or ΔOH^- equal zero, while the point of zero salt effect (PZSE) was identified as the intersection of the suite of titration curves conducted at varying ionic strengths (Sposito and Schindler, 1986). Obtained PZNPC and PZSE data for bentonite and kaolinite are presented in Table (2).

The data (Table 2) showed that increasing the ionic strength of the background solution significantly decreased PZNPC values. This is consistent with the theory of the electric double layer (EDL) for variable-charge colloids, which states that increasing solution I yield an increase in the magnitude of the surface charge and decrease pH (Chorover and Sposito, 1995; Van Raij and Peech, 1972). Kaolinite (hydroxylic surface) had higher PZNPC values (3.06-4.55) than for bentonite (1.10-2.49) with dominant siloxanic surface. Sposito (1989) and Zhou and Gunter (1992) has reported PZNC of kaolinite to be between 4.0 –5.0 and synthetic goethite to be between 7.0 and 8.0.

Removal of amorphous materials significantly decreased both PZNPC and PZSE, which indicated that amorphous material, provides more hydroxylic surfaces (Hendershot and Lavkulich, 1983). The maximum total charge of kaolinite was much lower (9.09-10.3 $Cmol_c$/kg) than that of bentonite (92.02-93.90 $Cmol_c$/kg). The permanent charge component is much higher in bentonite compared to kaolinite due to higher isomorphous substitution.

(a) Soil clay fractions:

Figures (1-5) showed the Potentiometric titration curves of the investigated clay fractions. From these figures the values of PZNPC, PZSE,

total charge and permanent charge were extracted and presented in Table (3). Values of PZNPC were significantly decreased by increasing the ionic strength of the background solution due mainly to compression of EDL (Van Olphen, 1977). Generally, PZNPC values (at I=0.01 M) for fine clays (2.65-3.86) were higher than those for coarse clay (2.45 – 4.11) which indicated silanolic and aluminolic nature of fine clay surfaces (Sakurai et al., 1996). . It is possible, at lower pH values, that protons were partially consumed in mineral dissolution reactions instead of generating surface charge (Lewis-Russ, 1991). This would have the effect of narrowing the margin of difference between various electrolyte titration curves, which was evident in some clay separates. Removal of amorphous materials was associated with an increase in PZNPC values (at I=0.01 M) for coarse clay and decreased for fine clay in case of alluvial soils, while it was decreased in both fractions in sandy (Belbeis) and calcareous (Nubareyia) soils. This may attributed to the higher content of total amorphous materials (Gallez et al., 1976) in alluvial clays compared to that of sandy and calcareous soils (Table 4).

Regarding PZSE value, it showed the same trend as PZNPC except that the magnitude of change due to removal of amorphous materials was much less (.Schulthess and Sparks, 1986). PZSE values were much close to PZNPC values measured at I=0.01 M ionic strength. Highly significant correlation was recorded between them either for fine or coarse clay fractions (r=0.968** and 0.821**, respectively). As seen in Table (5), total negative charge (σ_T) of all the investigated clays increased by increasing background-pH. The maximum total charge (σ_T) was higher for fine clay fractions (43.2-95.6 Cmol/kg) than for coarse clays (37.2-54.4 Cmol/kg) in all the investigated soils. The highest total charge value was recorded in Kafr El-sheikh and the lowest was found in Aswasn soil, which could be attributed to the mineralogical differences (Shahin and Abdel-Hamid, 1994 and Shahin et al,1988). Removal of amorphous materials slightly increased total charge in both fine and coarse clay fractions. The magnitude of increase ($\Delta_{\sigma T}$) was significantly correlated (r=o.66*) (Table 4) to the percent of amorphous materials. The Y-intercept of PZSE was considered as permanent charge (σ_P) which was higher for fine clays (27.4-53.6 Cmol/kg) than for coarse clays (23.3-39.5 Cmol/kg). As percent of total charge, the variable charges (σ_T - σ_P) represent higher values for fine clays (34-56%) than for coarse clays (28-47%) due to higher surfaces with hydroxylic nature (Lindsay,1979).

Ion adsorption curves:

Figures (6-10) represent the adsorption curves for both sodium and chloride ions as a function of pH. The point (pH) where non-specific surface adsorption of anions and cations is equivalent defined as the PZNC. The value of point zero of net charge (PZNC) was obtained at the intercept of both Na and Cl adsorption curves. The values of PZNC, permanent cation exchange capacity

(**CEC$_P$**), and maximum cation and anion exchange capacities (**CEC$_{mx}$** and **AEC$_{mx}$**) are extracted from the previous figures and presented in Table (5). The values of PZNC were found to be much closer to PZSE values. Whoever, highly significant correlations were recorded between ZPNC and both PZSE and PZNPC (r=0.985** and 0.876**, respectively) for fine clays and also for coarse clays (r=0.993** and 0.888**, respectively). Lavardiere and Weaver (1977) found good agreement between PZSE and PZNC for several spodic horizons dominated by sesquioxides and organic matter. Permanent cation exchange capacity (CEC$_P$) was also correlated with permanent charge (σ_P) obtained from Potensiometric titration curves for both fine and coarse clay fractions (r= 0.911** and 0.843**, respectively). In addition, total negative charge (σ_T) - obtained from Potensiometric titration curves was significantly correlated with maximum cation exchange capacity (**CEC$_{mx}$**) for both fine and coarse clay fractions (r= 0.945** and 0.877**, respectively). Removal of amorphous material significantly increased (**CEC$_{mx}$**) in most of the investigated clay fractions (Shahin et al., 1982). However, highly significant correlations were obtained between total charge (σ_T) and maximum adorbed-Na (**CEC$_{mx}$**) for fine clay either with or without amorphous materials (R= 0.723** and 0.984**, respectively).

The results suggest that the use of titration methods alone may be insufficient for thorough surface charge characterization, particularly at low and high pH. Proton titrations should be coupled with concurrent ion adsorption measurements to confirm surface charge development.

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Table (1) Some characterstics of the investigated Soils.

Soil location	pH	EC(ds/m)	CaCO3 %	Clay %	Texture
ASWAN	7.72	1.38	4.35	17.2	L
EL-Menia	7.94	3.32	4.55	20.28	L
Fayium	7.8	3.14	6.81	24.28	CL
Tanta	8.01	1.02	4.11	31.38	CL
Kafr El-Sheikh	7.94	2.8	4.52	33.34	CL
Belbeis	7.92	3.85	5.62	18.32	SL
Nubaryia	7.8	8.7	21.85	12.35	LS

L= Loamy   CL= Clay Loam
SL= Sandy Loam   LS= Loamy Sand

Table (2) Points of surface charge of bentonite and kaolinite

Standard Material	Amorphous material	PZNPC Ionic strength 1.0 N	0.01 N	PZSE	Total charge (mol/kg)	Permanent charge (mol/kg)
Kaolinite	With	3.4	4.55	5.00	-10.3	-5.20
	Without	3.06	3.90	4.76	-9.09	-4.40
Bentonite	With	1.40	2.49	2.45	-92.02	-60.0
	Without	1.10	2.28	2.40	-93.90	-62.4

Table (3) Charge characteristics of the investigated clay separates.

Soil location	Clay fraction	Amorphous material	PZNPC* Ionic strength		PZSE#	Permanent charge (molc/kg)	Total charge (molc/kg)
			1.0 N	0.01 N			
ASWAN	Fine	With	2.34	3.86	3.86	-27.4	-43.2
		Without	1.86	3.32	3.80	-28.1	-54.3
	Coarse	With	2.25	2.60	3.95	-23.3	-37.2
		Without	2.00	3.22	4.21	-27.8	-38.7
El-Menia	Fine	With	2.13	3.3	3.71	-33.0	-61.5
		Without	1.96	2.88	3.60	-33.9	-65.2
	Coarse	With	2.41	2.91	3.84	-27.2	-40.4
		Without	2.27	3.00	3.80	-28.0	-43.4
Fayium	Fine	With	2.11	2.65	3.67	-38.7	-68.0
		Without	2.20	3.09	3.52	-42.9	-70.2
	Coarse	With	1.55	2.45	3.73	-30.7	-42.6
		Without	1.98	3.36	3.71	-31.1	-46.2
Tanta	Fine	With	2.28	3.20	3.80	-44.5	-67.7
		Without	1.89	2.91	3.51	-43.6	-84.0
	Coarse	With	2.09	2.90	3.71	-31.3	-45.3
		Without	1.67	2.60	3.69	-32.6	-47.3
Kafr El-Sheikh	Fine	With	2.00	3.20	3.46	-42.3	-91.2
		Without	2.00	3.15	3.44	-45.4	-93.4
	Coarse	With	1.60	2.71	3.69	-33.8	-48.0
		Without	1.67	2.61	3.60	-35.2	-51.5
Belbeis	Fine	With	2.00	3.00	3.40	-50.8	-94.5
		Without	1.90	2.85	3.34	-53.6	-95.6
	Coarse	With	1.80	2.70	3.67	-36.5	-54.4
		Without	1.60	2.60	3.60	-39.5	-57.6
Nubaryia	Fine	With	2.60	3.84	4.40	-31.5	-71.1
		Without	2.60	3.49	4.20	-33.9	-73.2
	Coarse	With	2.80	4.11	4.60	-28.9	-53.9
		Without	1.75	2.90	4.55	-30.4	-50.4

 □   PZNPC= Point of zero net proton charge
 □   PZSE= Point of zero salt effect

Table (4) Amorphous materials (%) in the Studied Clays.

Soil location	Clay fraction	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	Total
ASWAN	Fine	11.98	4.73	2.2	19
	Coarse	9.63	4.44	1.63	15.71
El-Menia	Fine	12.63	4.35	2.51	19.5
	Coarse	9.42	3.21	2.23	14.86
Fayium	Fine	12.8	4.54	1.6	18.98
	Coarse	8.98	4.73	1.79	15.5
Tanta	Fine	10.91	6.33	2.39	19.7
	Coarse	9.63	3.97	2.39	15.99
Kafr El-Sheikh	Fine	10.84	5.48	2.15	18.47
	Coarse	8.13	4.35	2.01	14.59
Belbeis	Fine	10.1	4.35	2.1	16.5
	Coarse	4.71	3.21	1.63	9.56
Nubaryia	Fine	11.8	1.51	2.51	15.79
	Coarse	5.14	1.81	1.97	8.91
Kaolinite		3.21	0.66	0.063	3.94
Bentonite		3.64	1.82	1.39	6.85

Table (5) Charge characteristics of the investigated clay separates.

Soil location	Clay fraction	Amorphous material	Permenent Charge cmol/kg (σp)	CECp (cmol/ kg)	Total charge cmol/kg (σT)	CECmx (pH=10)	AECmx (pH=2)	AEC (pH=10
ASWAN	Fine	With	27.4	25.8	43.2	38.75	30.3	8.1
		Without	28.1	26	54.3	36.44	29.4	7.2
	Coarse	With	23.3	17.21	37.2	33.5	30.1	3.8
		Without	27.8	18.1	38.7	29.85	31.3	2.75
El-Menia	Fine	With	33	30	61.5	42.1	33.5	6.5
		Without	33.9	31.7	65.2	45.5	38.4	6.85
	Coarse	With	27.2	21.55	40.4	35.1	30	4.5
		Without	28.0	23.55	43.4	45.3	27.2	5.63
Fayium	Fine	With	38.7	31.5	68	45.2	40.2	4.6
		Without	42.9	38	70.2	51.1	46.3	6.88
	Coarse	With	30.7	22.12	42.6	44.3	29.3	3.5
		Without	31.1	22.5	46.2	38.1	31.5	4.1
Tanta	Fine	With	44.5	38.7	67.7	59.8	44	13.6
		Without	43.6	40	84	65.85)	45	13.2
	Coarse	With	31.3	21.48	45.3	49.1	33.5	5.2
		Without	32.6	25.5	47.3	51.3	37.4	6.35
Kafr El-Sheikh	Fine	With	42.3	42.6	91.2	68.5	51.2	7.3
		Without	45.4	45.5	93.4	77.4	55.4	3.3
	Coarse	With	33.8	26.34	48	48.5	37.3	6.5
		Without	35.2	26.8	51.5	49.2	38.2	7.5
Belbeis	Fine	With	50.8	46	94.5	72.3	56.5	10.3
		Without	53.6	50.8	95.6	76.4	65.5	7.6
	Coarse	With	36.5	27.2	54.4	46.8	38.4	7.95
		Without	39.5	28.0	57.6	44.1	35.4	8.9
Nubaryia	Fine	With	31.5	29.2	71.1	40.8	34.2	5.5
		Without	33.9	32.6/	73.2	48.1	37.2	6.8
	Coarse	With	28.9	17.1	53.9	31.85	32.2	4.5
		Without	30.4	18.6	50.4	33.2	33.5	4.8
Kaolinite		With	5.2	4.65	10.3	6.8	6.2	0.5
		Without	4.4	4.56	9.09	5.88	5.5	.28
Bentonite		With	60.0	50.7	92.02	66.5	51.2	6.45
		Without	62.4	52.2	93.9	78.33	52.4	8.65

Kaolinite

With

Without

Bentonite
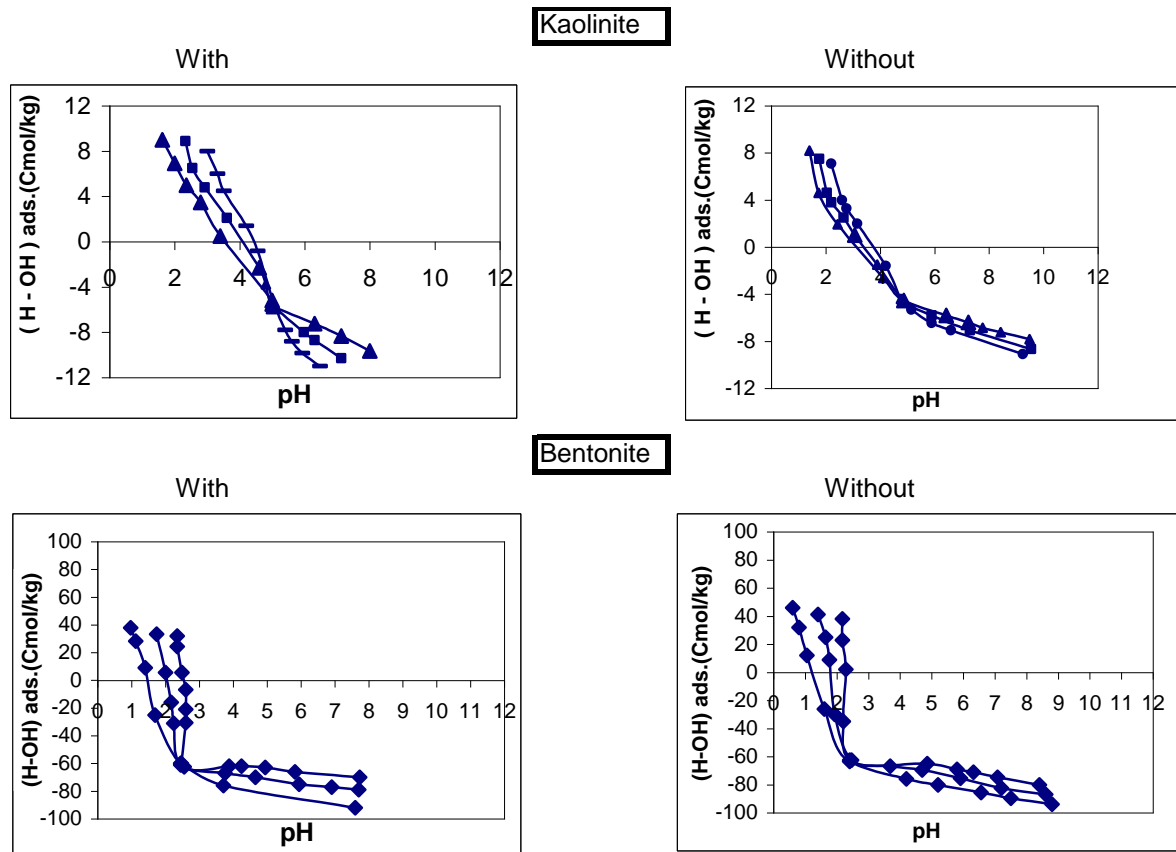
With

Without

Fig.(1) Potentiometric titration Curves for Kaolinite and Bentonite with and without amorphous

Aswan clay

Fine With

Coarse With

Fine Without

Coarse Without
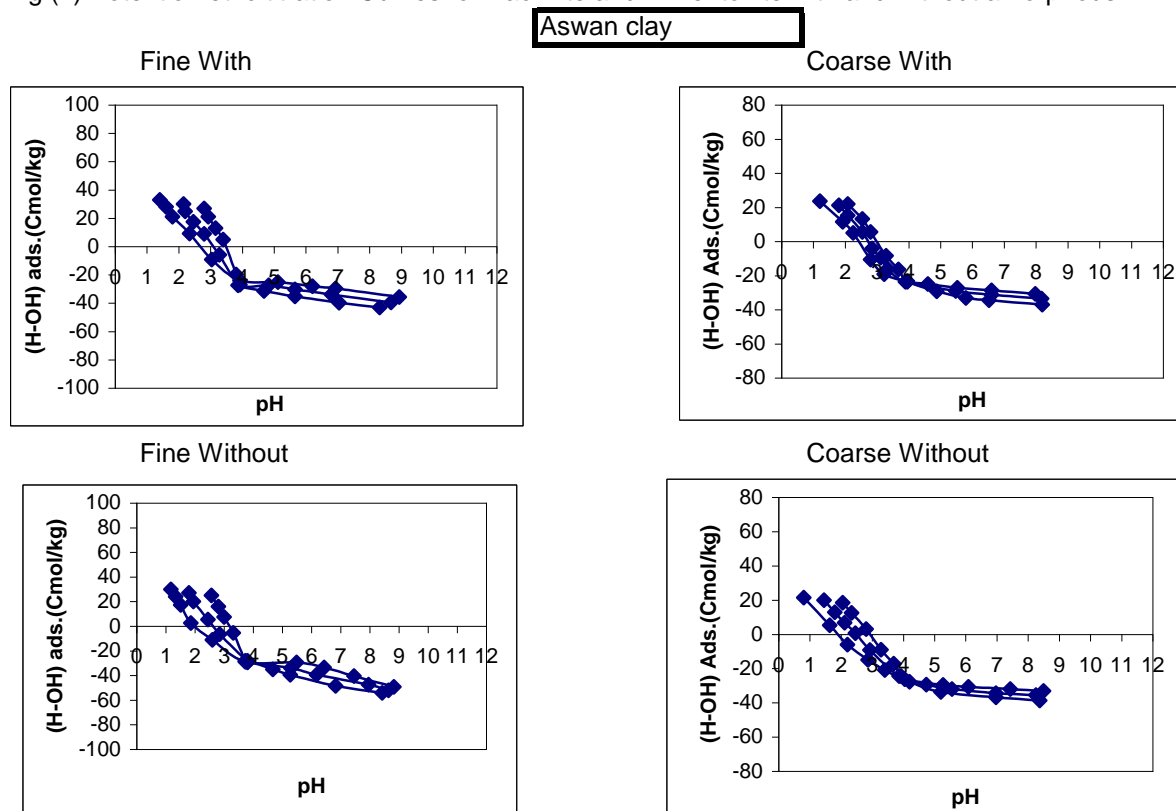
Fig. (2) Potentiometric titration Curves for Aswan fine clay with and without amorphous materials

El-Menia

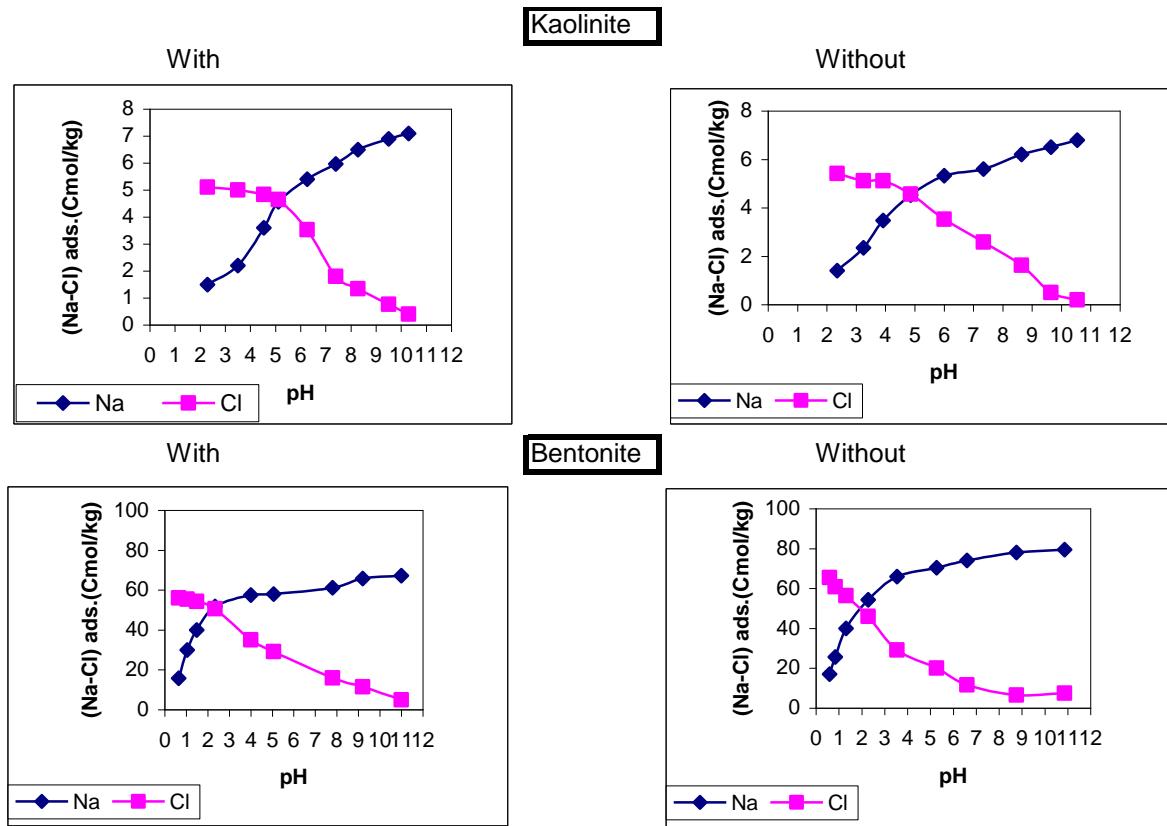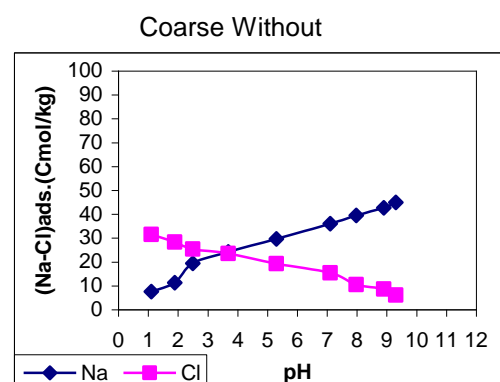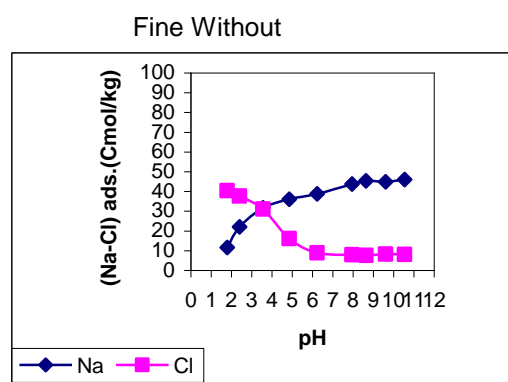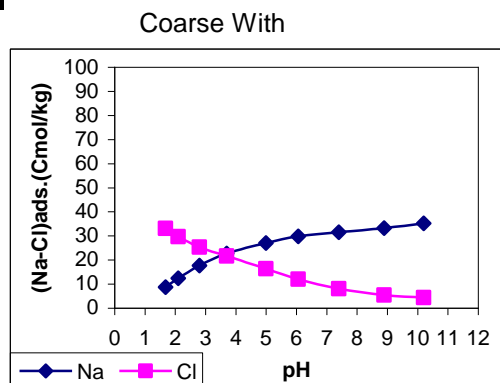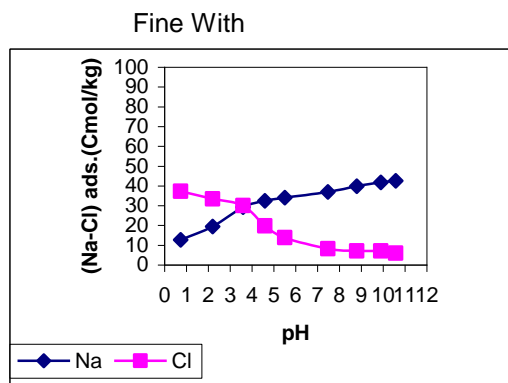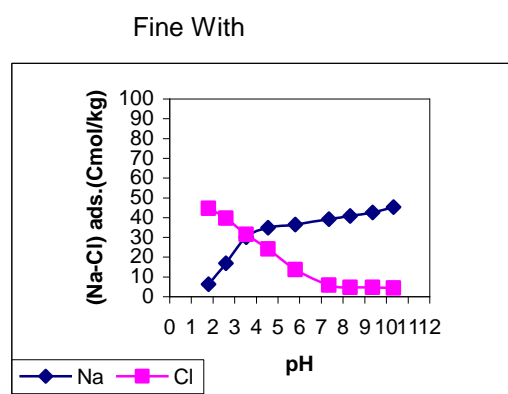Fine With

Coarse With

Fine Without

Coarse Without

Fayium

Fine With

Coarse With

Fine Without

Coarse Without
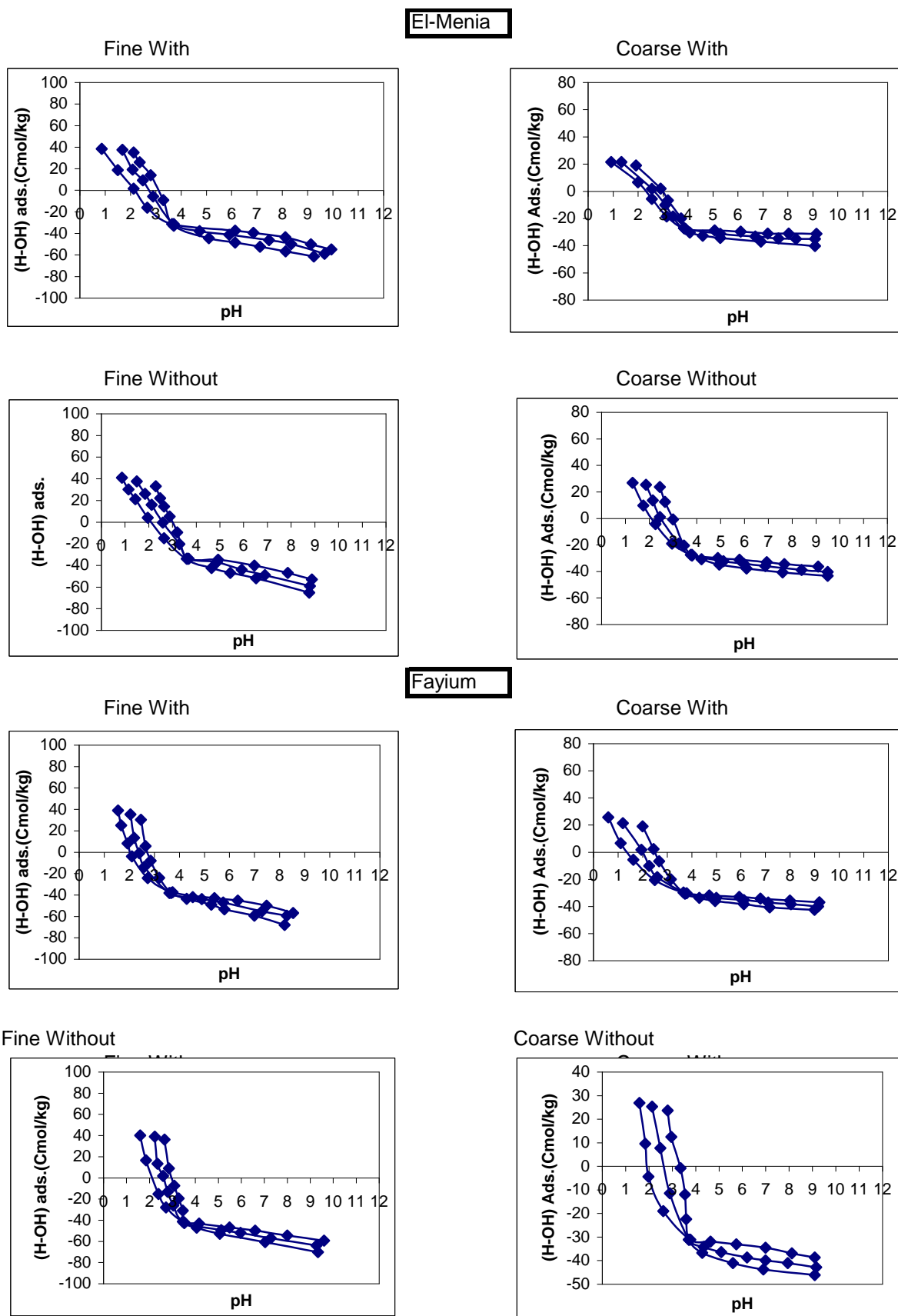
Fig.(3)Potentiometric titration Curves for El-Menia and Fayium with and without amorphou materials

Tanta

Fine With

Coarse With

Fine Without

Coarse Without

Kafr El-Sheikh

Fine With

Coarse With

Fine Without

Coarse Without
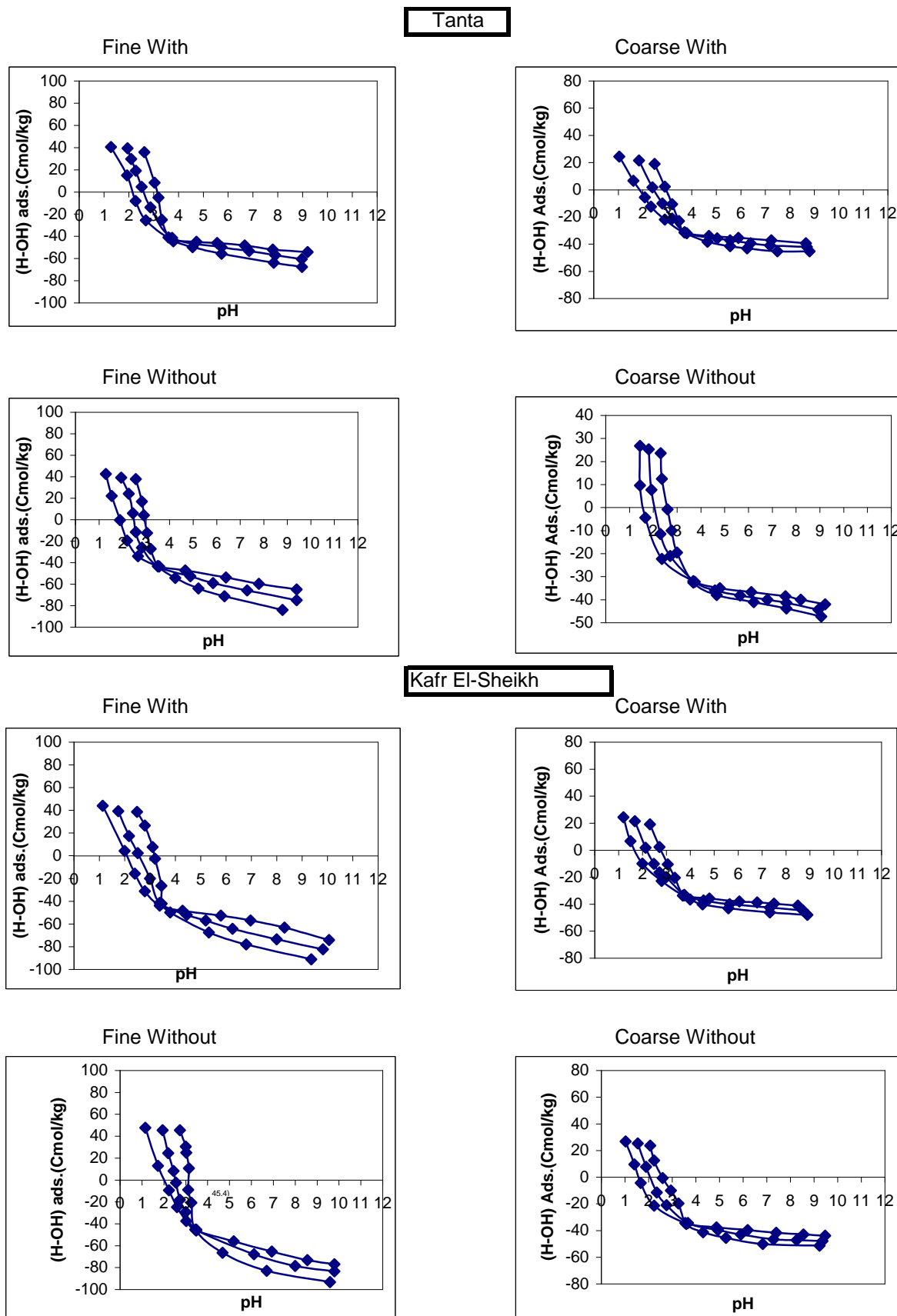
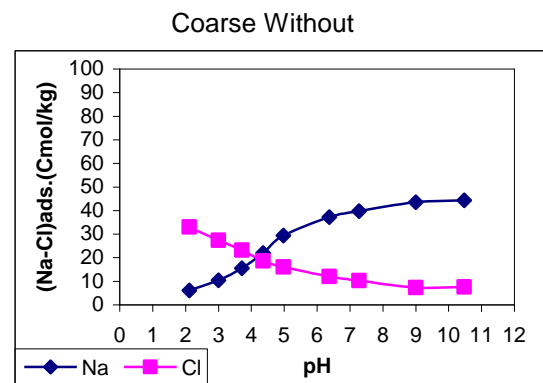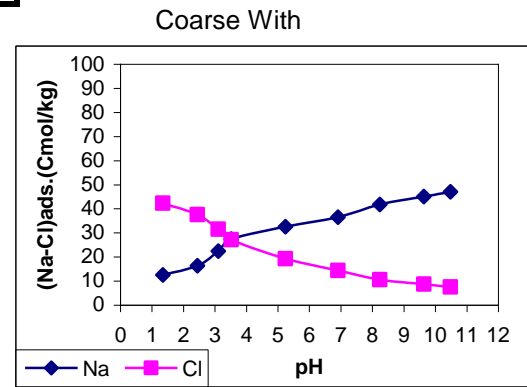fig.(4) potentiometric titration curves for Tanta and Kaf El-sheikh with and without amorphous materials
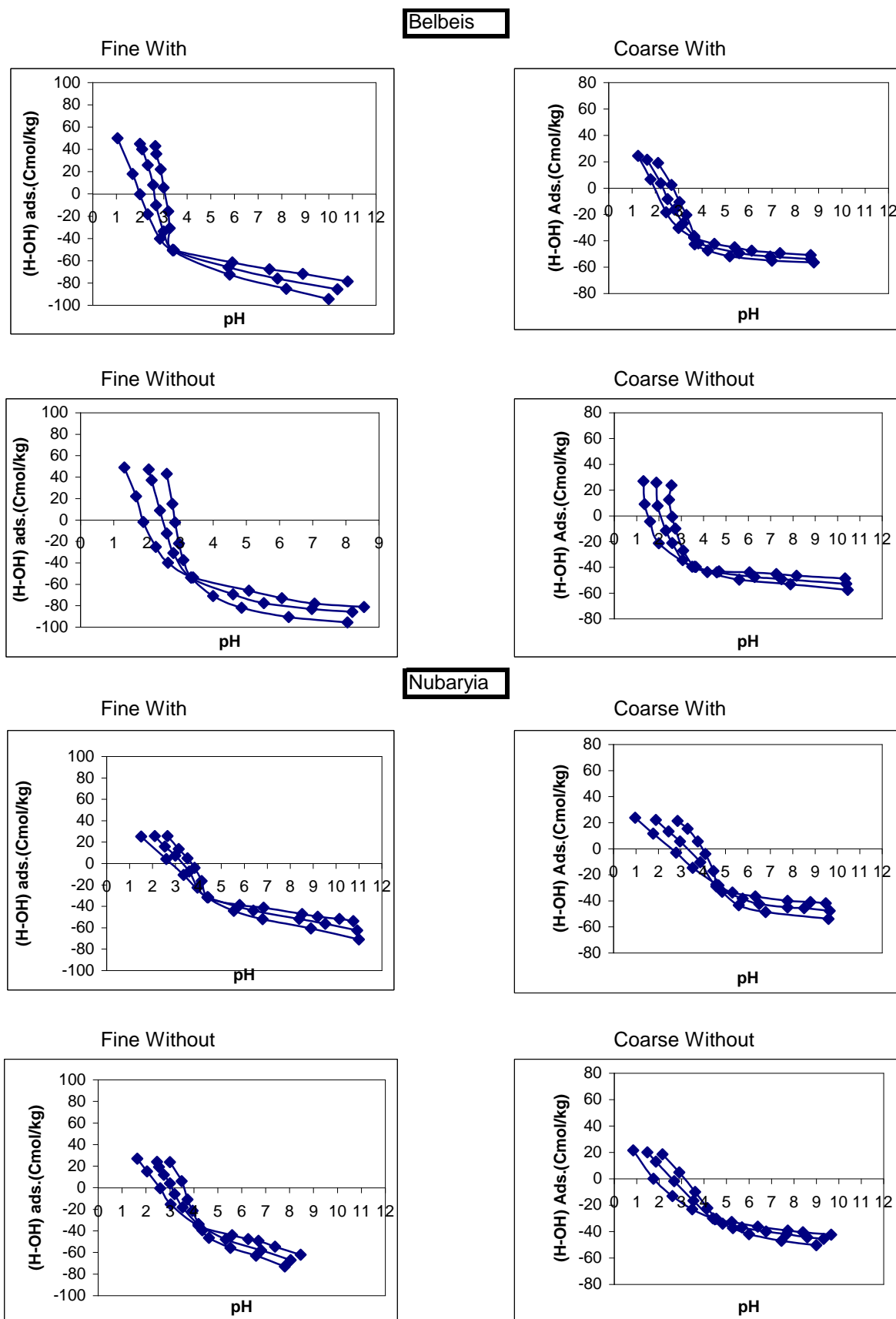
fig.(5) potentiometric titration curves for Belbeis and Nubaryia with and without amorphous materials

Kaolinite

With

Without

Bentonite

With

Without

fig.(6) Ion adsorption Curves for Kaolinite and Bentonite with and without amorphous materials

Fine With

Aswan clay

Coarse With

Fine With

Coarse With
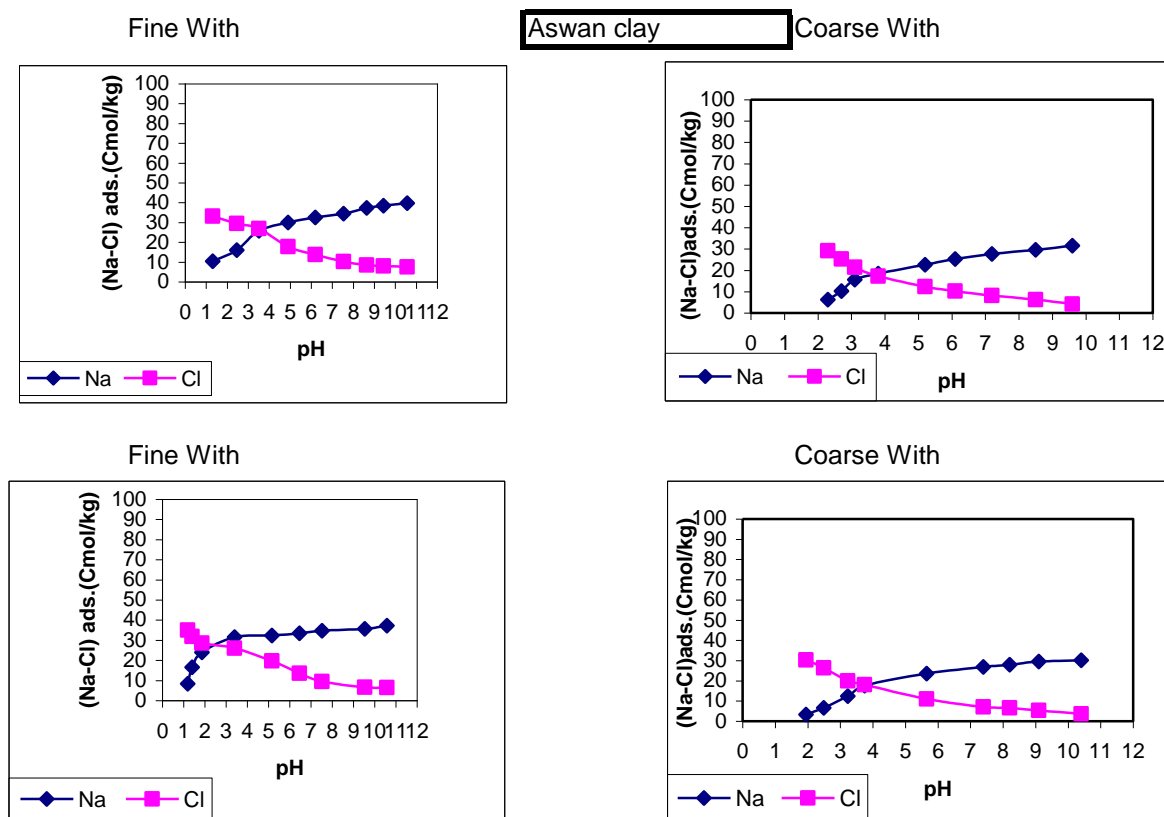
Fig. (7)Ion adsorption Curves for Aswan fine clay with and without amorphous materials

El-Menia

Fine With

Coarse With

Fine Without

Coarse Without

Fayium

Fine With

Coarse With

Fine Without

Coarse Without
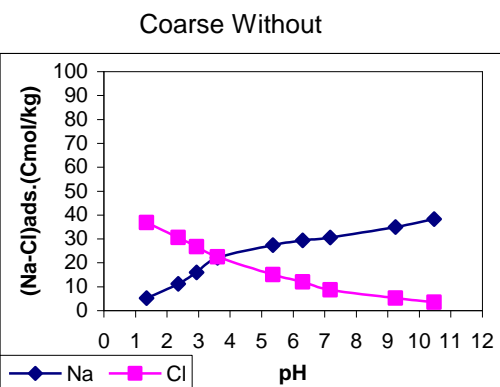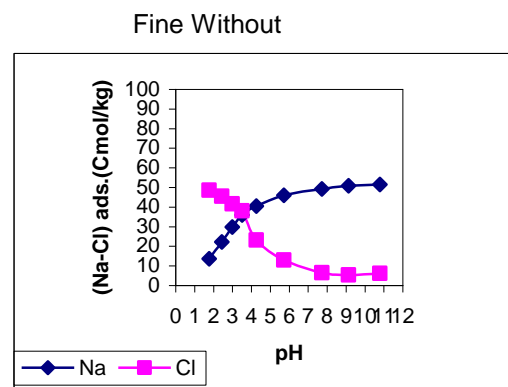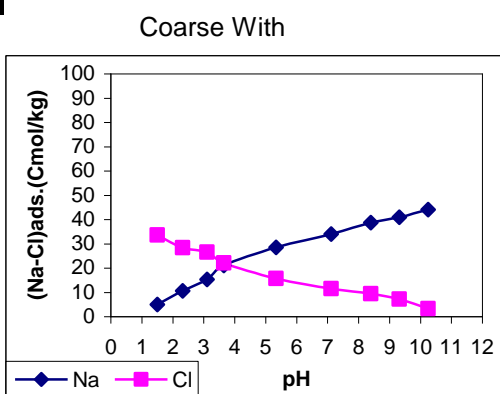
Fig.(8)Ion adsorption Curves for El-Menia and Fayium with and without amorphou materials

Tanta

Fine With

Coarse With

Fine Without

Coarse Without

Kafr El-Sheikh

Fine With

Coarse With

Fine Without

Coarse Without
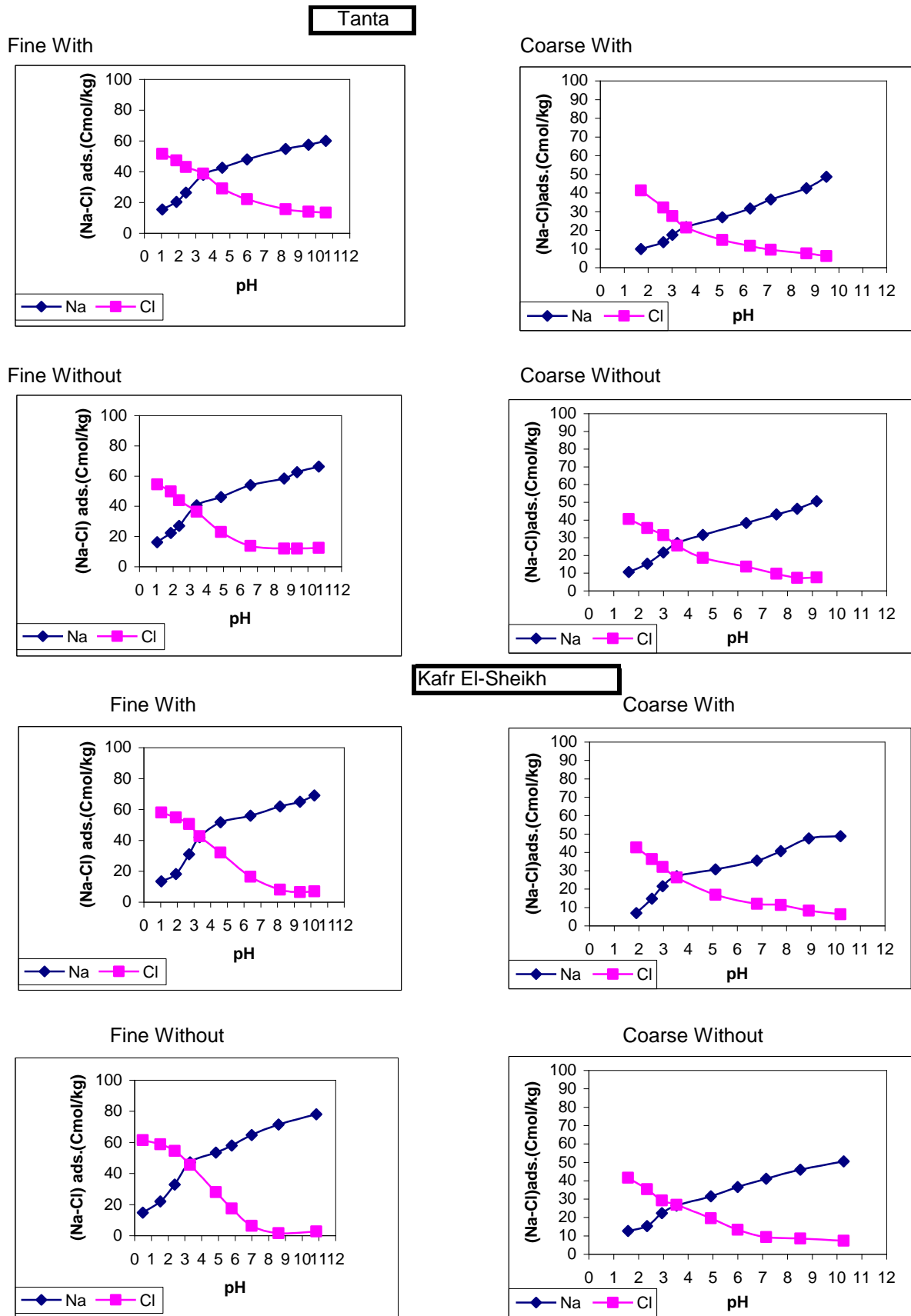
Fig.(9)Ion adsorption Curves forTanta and KafrEl-sheikh with and without amorphous materials

Belbeis

Fine With

Coarse With

Fine Without

Coarse Without
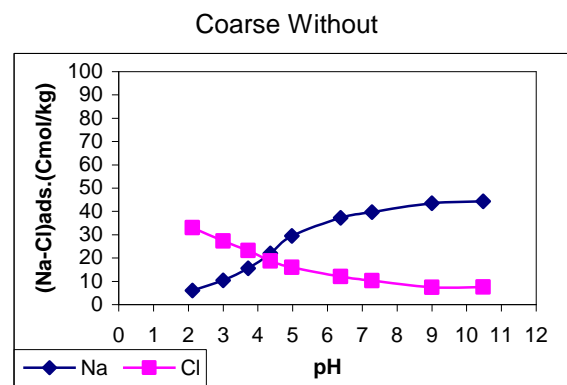
Nubaryia

Fine With
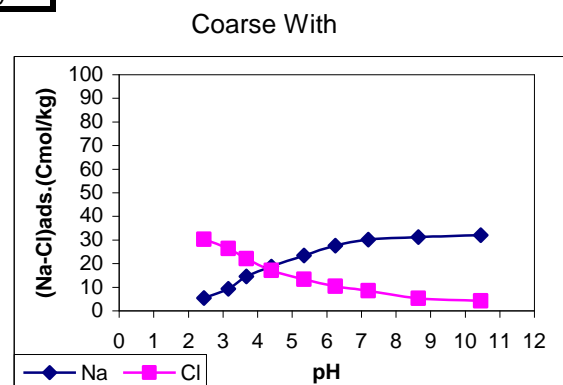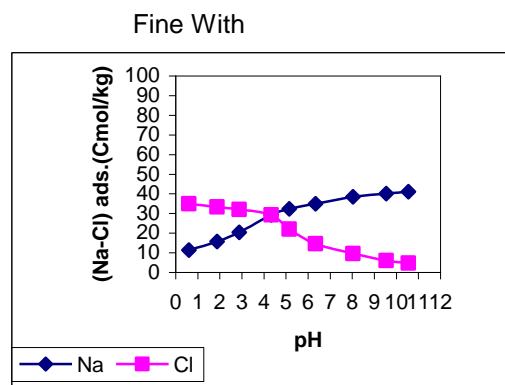
Coarse With

Fine Without

Coarse Without
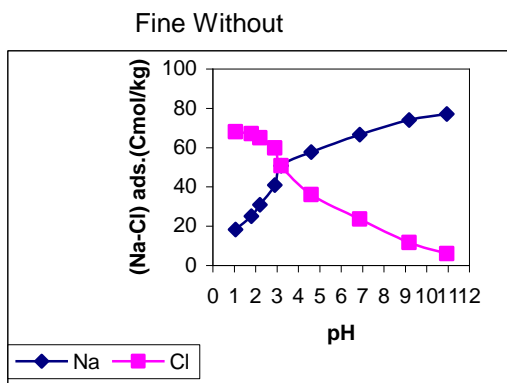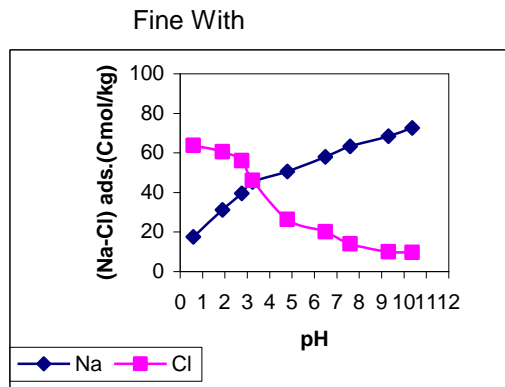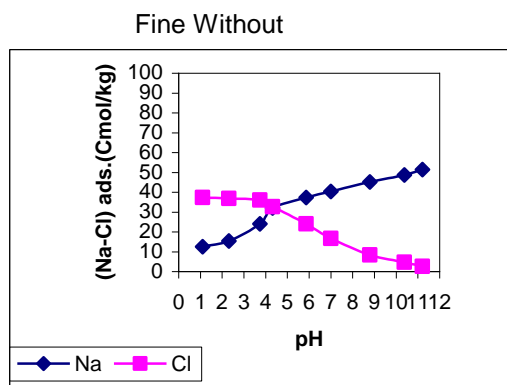
Fig.(10)Ion adsorption curves for Belbeis and Nubaria with and without amorphous materials

خصائص الشحنات لمفصولات الطين في بعض الأراضي المصرية

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قسم الأراضي, كلية الزراعة, جامعة القاهرة

جمعت مفصولات الطين الناعم (أقل من 1 ميكرون) والخشن (1-2 ميكرون) من أراضي رسوبية نهرية في أسوان والمنيا والفيوم وطنطا و كفر الشيخ وأرض طميية رملية من بلبيس وجيرية من النوبارية , وقدرت الخواص الكيميائية ونسبة المواد الأمورفية بها.

أجريت منحنيات تنقيط جهدية باستخدام محاليل حمض وقلوي عيارية لكل المفصولات الأصلية وبعد التخلص من المواد الأمورفية للحصول علي منحنيات تربط بين الأيدروجين والأيدروكسيل المدمص مع رقم الـ pH واستخدمت لحساب معاملات وصف الشحنات مع استخدام معدني الكاؤولينيت والبنتونيت كمعادن مرجعية.

أوضحت النتائج أن النقطة الصفرية لشحنة البروتون PZNPC تزداد بزيادة الجهد الأيوني للمحلول المستخدم, وتزداد قيمة PZNPC للطين الناعم أكبر منها للطين الخشن وذلك لطبيعة الأسطح السيلانولية لها. كما أن إزالة المواد الأمورفية أدت إلى قيم PZNPC عند جهد أيوني 0.01 مول للأراضي الرسوبية النهرية بينما أدت إلى انخفاضها في الأراضي الطميية الرملية و الجيرية . ولقد وجد أن الشحنة الكلية للطين الناعم (43.2-95.6 سنتيمول/كجم) أكبر منها للطين الخشن (37.2-54.4 سنتيمول/كجم) وتنخفض بإزالة المواد الأمورفية عموما بنسبة أكبر في الطين الناعم .

وأوضحت النتائج أيضا أن الشحنة الثابتة تمثل (44-66 %) في الطين الناعم من الشحنة الكلية, (53-72 %) في الطين الخشن. كما تم تقدير نقطة الشحنة الصفرية الصافية PZNC من نقطة تقاطع منحنيات ادمصاص أيونات الصوديوم والكلوريد علي أرقام pH متزايدة, أظهرت نقطة PZNC حساسية أقل للتغيرات في الطين الناعم والخشن عند نقطة PZNPC إلا أنها ارتبطت معنويا بها (= r^2 0.984** and 0.723**).

وأوضحت النتائج أن كلا من منحنيات ادمصاص البروتونات ومنحنيات ادمصاص الكلوريد والصوديوم تكمل بعضها في إعطاء صورة متكاملة عن خصائص الشحنات لمفصولات الطين المدروسة.