Leaching, purification and extraction of uranium from salcrete deposits - Egypt

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ABSTRACT

In this work chemical process for the elaboration of uranium concentrate from uranium ore has been studied. This process is composed of successive units operations: collecting ores, crushing, milling, acidic leaching, filtration-washing, purification-concentration by solvent extraction and uranium precipitation. In last few years, organophosphorus compounds have found wide application in nuclear establishments for the extraction; enrichment and reprocessing of uranium. The acid leaching operating conditions allow obtaining a recovery uranium rate of 84.62%. The uranium concentration of the pregnant solution is approximately of 202 ppm after washing the tailing with distilled water. This value justifies the use of solvent extraction technique to the concentration-purification of the pregnant solution. To avoid the precipitation of uranium, the pH has been fixed at 2.24. We have obtained at this condition good extraction efficiency. The extraction efficiency of uranium from the pregnant solution by using DEHPA and TBP as modifier in kerosene was found to be about 98 %. We have also recovered or stripped 100 % of the uranium loaded on the organic solvent using a solution of 4 % Na_2CO_3.   © 2013 Trade Science Inc. - INDIA

INTRODUCTION

Uranium ore processing is an important and vital step in the nuclear combustible cycle. The extraction of uranium from its ores has been the subject of a considerable amount of research effort since the inception of nuclear power generation and is carried out mainly by chemical process, consisting of successive selective operations[1]. There are many processes have been proposed for uranium extraction from its ores. Chemical precipitation[2], membrane processes[3], ion exchange[7, 8], adsorption[4-6] and solvent extraction[14] are the most commonly used methods. A large body of work exists on separation techniques for uranium which largely relies on liquid–liquid extraction techniques; commonly known as solvent extraction (SX)[9].

Di-(2-ethylhexyl) phosphoric acid (DEHPA) is an organophosphorus compound with the formula $(C_8H_{17}O)_2PO_2H$. It is used in the solvent extraction of uranium as well as the rare earth metals[12]. DEHPA is used in the solvent extraction of uranium salts from solutions containing the sulfate, chloride, or perchlorate anions. This extraction is known as the "Dapex procedure". DEHPA generally exists as a hydrogen-bonded dimer in the non-polar organic solvents. For practical applications, the solvent, often called diluents is typi-

cally kerosene[13]. A complex is formed from two equivalents of the conjugate base of DEHPA and one uranyl ion[14]. Complexes of the formula $(UO_2)_2[(O_2P(OR)_2]_4$ also form, and at high concentrations of uranium, polymeric complexes may form[13]. The extractability of Fe^{3+} is similar to that of uranium, so it must be reduced to Fe^{2+} before the extraction[13]. The uranium is then stripped from the DEHPA/kerosene solution with hydrochloric acid, hydrofluoric acid, or carbonate solutions. Sodium carbonate solutions effectively strip uranium from the organic layer, but the sodium salt of DEHPA is somewhat soluble in water, which can lead to loss of the extractant[15]. The extractive capabilities of DEHPA can be increased through synergistic effects by the addition of other organophosphorus compounds. Tributyl phosphate is often used, as well as dibutyl-, diamyl-, and dihexyl phosphonates. The synergistic effects are thought to occur by the addition of the trialkylphosphate to the uranyl-DEHPA complex by hydrogen bonding. The synergistic additive may also react with the DEHPA, competing with the uranyl extraction, resulting in a decrease in extraction efficiency past a concentration specific to the compound[16].

In this work, Chemical processes for the elaboration of uranium concentrates, from Egyptian uranium ore (Salcrete deposits) which located at North Western desert have been studied. It mainly consists of secondary uranium minerals. The chemical composition is indicated below in TABLE 1. Batch experiments were carried out to choose the optimum leaching, extraction and stripping conditions. Uranium efficiency was taken as a function of the following parameters: contact time, temperature, phase ratio, settling time and grain size.

EXPERIMENTAL

Reagents

All reagents were of analytical reagent grade and all solutions were prepared in calibrated flasks with distilled water. Sulphuric acid (Riedel-de Haen 96%), Sodium Hydroxide (Riedel-de Haen), Na_2CO_3 (Riedel-de Haen), Di-ethylhexyl-phosphoric acid (DEHPA) (Merck) and Tri-butyl phosphate (Merck).

Physical treatment of uranium ore

After the representation, the ore sample was crushed at a size of -60 mesh.

TABLE 1 : Chemical composition of the working uranium ore.

Major Oxides	Content (%)	Minor (Traces)	Content (ppm)
SiO_2	53.82	UO_2	1300
Al_2O_3	0.8	Cr	111
MgO	0.81	Ni	18
CaO	16.83	Cu	10
Fe_2O_3	1.2	Zn	102
Na_2O	1.68	Zr	42
K_2O	0.16	Rb	u.d.l.
P_2O_5	3.7	Y	24
SO_4^{2-}	11.5	Ba	73
Loss of Ignition at 1000 °C	9.09	Pb	66
		Sr	u.d.l.
u.d.l. = under detection limit		Ga	21
ppm = part per million		V	7
		Nb	7

Experimental of acidic leaching

5 g-gram from the crushed ore was leached in a glass beaker after filling the beaker with the ore, we started the addition of calculated amount of distilled water with agitation and then added the rest amount of sulfuric acid to complete the volume to 5 ml-milliliter, where ($V_{H2O} + V_{H2SO4} = 5$ ml) i.e. 1/1 phase ratio (S/A), to utilize the heat evolved from the exothermic reaction between sulfuric acid and water in warming the mixture and so decreasing the costs of leaching. The leaching of uranium is governed by several factors such as: the type of leaching acid, concentration of leaching acid, phase ratio (S/A), contact time or leaching time, leaching temperature and grain size were studied.

Experimental of purification and concentration of uranium using DEHPA

All the experiments were performed on the leach liquor, a mixture of 10 ml of the leach liquor (202ppm-part per million of (UO_2^{+2})) and 10 ml of [3% DEHPA+ 1% TBP as modifier in kerosene] to keep phase ratio at (1/1) was stirred vigorously in 50 ml beaker using magnetic stirrer and at room temperature. Then, the mixture was transferred to a separating funnel and al-

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lowed to be settled down for 5 min-minutes. The aqueous and organic phases were separated and the aqueous samples were analyzed. In the present work we used DEHPA to purify and concentrate uranium from the previously prepared leach liquor. The factors which control the extraction process were studied in details which were; the effect of DEHPA concentration, contact time, diluents used, phase ratio (O/A) v/v, settling time and percent of modifier added.

Experimental of stripping of uranium from the loaded organic "DEHPA"

All the experiments were performed on the pregnant organic solution DEHPA, a mixture of 10 ml of the loaded organic (194 ppm of UO_2^{+2}) and 10 ml of the stripping agent at phase ratio (1/1) was stirred vigorously in 50 ml beaker using magnetic stirrer and at room temperature. Then, the mixture was transferred to a separating funnel and allowed to be settled down for 5 minutes. The aqueous and organic phases were separated and the aqueous samples were analyzed. The factors controlling the stripping process were studied as, the effect of the type of stripping agent, the effect of the concentration of the stripping agent, the effect of contact time, the effect of phase ratio (V_O/V_A) and the effect of settling time.

Uranium was analyzed in all the different working aqueous phases using Arsenazo III method[10]. Absorbance of the formed uranium Arsenazo III complex was measured at 650 nm-nanometer against proper standard solutions using a Lambda 3 UV/VIS spectrophotometer (Perkin- Elmer, USA).

RESULTS AND DISCUSSION

Results of acidic leaching

The effect of the type of leaching acid

To study this effect a series of experiments were performed using three different mineral acids, H_2SO_4, HCl and HNO_3 at the same leaching conditions; room temperature, (1mol/l- molar concentration) acid concentration, phase ratio (S/A) (1/1) and leaching time 30 minutes. It was found that sulfuric acid is the best one with extraction efficiency 60 %. This result can be shown in TABLE 2 and illustrated in Figure 1.

TABLE 2 : Effect of the type of leaching acid.

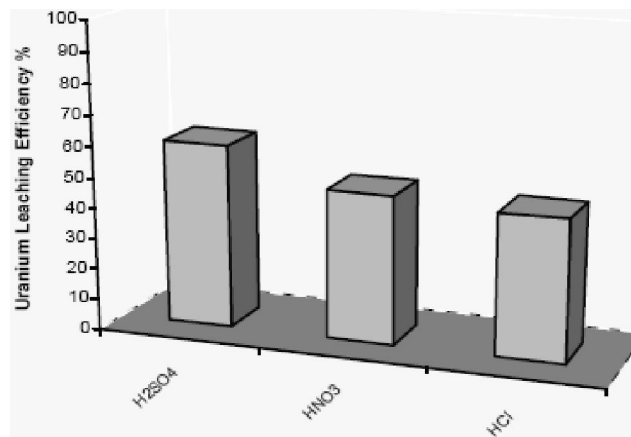| Acid type	Leaching Efficiency (%)
H_2SO_4	60.00
HNO_3	48.46
HCl	46.15

Figure 1 : Effect of type of acid on uranium leaching efficiency

The effect of H_2SO_4 concentration on uranium leaching efficiency

A series of experiments were carried out to study the effect of sulfuric acid concentration on the leaching efficiency of uranium. The concentration of H_2SO_4 was varied from 0.25 mol/l to 8 mol/l at the leaching conditions: phase ratio (S/A) 1/1, leaching time 30 minutes and at room temperature. The results are shown below in TABLE 3 and illustrated by Figure 2. It is clear that the leaching efficiency increases from 0.25 mol/l till we reach 0.5 mol/l and after 0.5 mol/l it decreases this is may be due to decreasing in pH or increasing acidity.
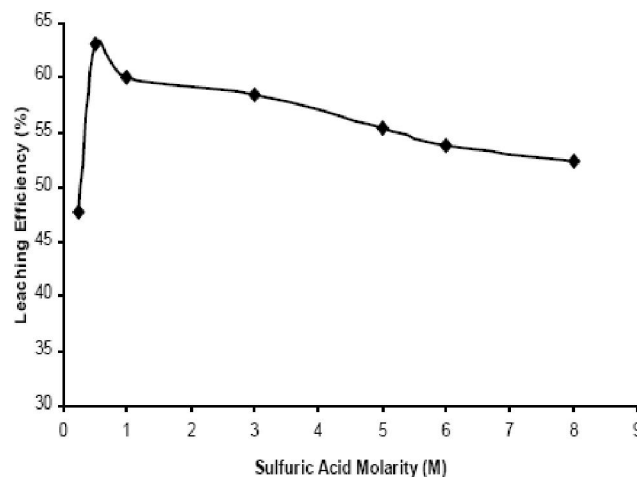

Figure 2 : Effect of H_2SO_4 concentration on uranium leaching efficiency

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**TABLE 3 : Effect of H_2SO_4 concentration on uranium leaching efficiency**

Acid Molarity, (M)	Leaching Efficiency (%)
0.25	47.69
0.50	63.10
1.00	60.00
3.00	58.46
5.00	55.38
6.00	53.85
8.00	52.31

The effect of phase ratio (S/A) on uranium leaching efficiency

To study this effect a series of experiments were performed by variation of phase ratio (S/A) from (1/1) to (1/5) at the leaching conditions: room temperature, H_2SO_4 concentration 0.5 mol/l and contact time 30 minutes. The results are shown below in TABLE 4 and illustrated by Figure 3. It is clear that the leaching efficiency remains constant while increasing phase ratio.

TABLE 4 : The effect of phase ratio (S/A) on uranium leaching efficiency

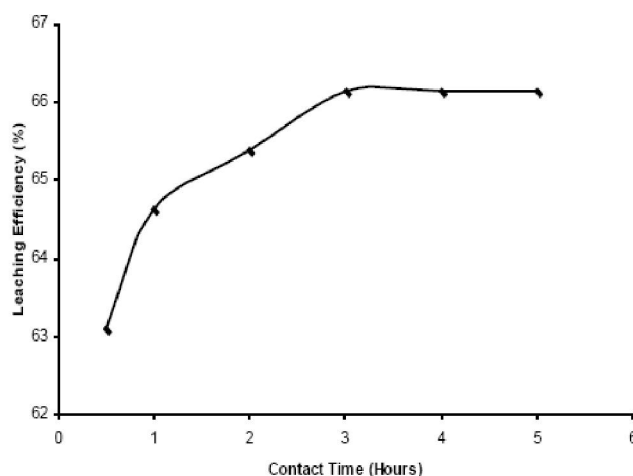| Phase ratio (S/A)	Leaching Efficiency (%)
1/1	63.1
½	63.1
1/3	63.1
¼	63.1
1/5	63.1
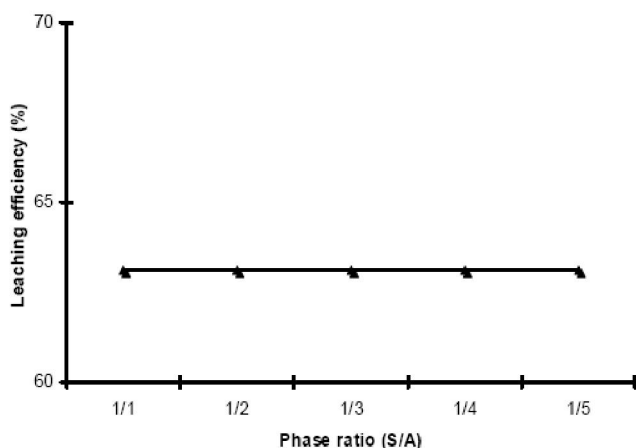
Figure 3 : The effect of phase ratio (S/A) on uranium leaching efficiency

The effect of contact (leaching) time on uranium leaching efficiency

A series of experiments were carried out to study the effect of leaching time on uranium leaching efficiency. The leaching time was varied from 1/2 hr-hour to 5 hr at the leaching conditions: phase ratio (S/A) 1/1, sulfuric acid concentration 0.5 mol/l and at room temperature. The results are shown below in TABLE 5 and illustrated by Figure 4. It is clear that the leaching efficiency increases from 1/2hr till we reach 3hr and after 3hr it remains constant.

TABLE 5 : Effect of leaching time on uranium leaching efficiency

Contact time (Hours)	Leaching efficiency (%)
0.5	63.10
1.0	64.62
2.0	65.38
3.0	66.15
4.0	66.15
5.0	66.15

Figure 4 : Effect of leaching time on uranium leaching efficiency

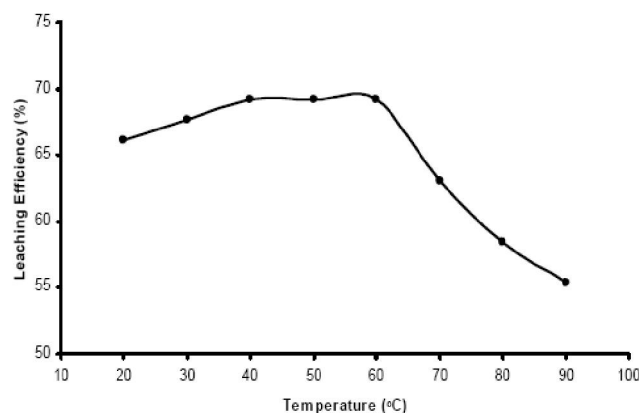## The effect of temperature on uranium leaching efficiency

To study the effect of temperature on uranium leaching efficiency a series of experiments were carried out by variation of temperature from room temperature about 20°C-degree centigrade to 90°C at the optimum leaching conditions previously determined: H_2SO_4 concentration 0.5 mol/l, contact time 3 hours and phase ratio (S/A) 1/1. These experiments were performed in a closed system to maintain the required temperature almost constant. In these experiments we added the weighted amount of the crushed ore (5 g) in a glass beaker after filling the beaker with the ore, we started

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the addition of calculated amount of distilled water with agitation and then added the rest amount of sulfuric acid to complete the volume to 5 ml, where $(V_{H2O} + V_{H2SO4} = 5\ ml)$ i.e. 1/1 phase ratio (S/A), to utilize the heat evolved from the exothermic reaction between sulfuric acid and water in warming the mixture and so decreasing the costs of leaching. The results are shown below in TABLE 6 and illustrated by Figure 5. It is clear that the leaching efficiency increases from room temperature till we reach 60°C, after that it started to decrease due to evaporation and semi dryness of the matrix.

TABLE 6 : The effect of temperature on uranium leaching efficiency

Temperature (°C)	Leaching Efficiency (%)
20	66.15
30	67.70
40	69.23
50	69.23
60	69.23
70	63.08
80	58.46
90	55.40

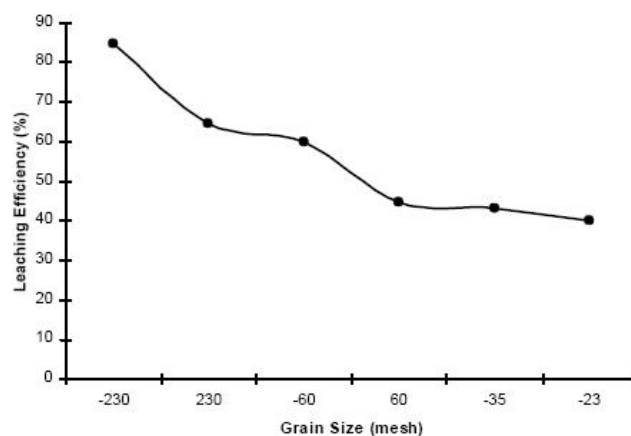**Figure 5 : The effect of temperature on uranium leaching efficiency**

The effect of grain size on uranium leaching efficiency

To study the effect of grain size on uranium leaching efficiency a series of experiments were carried out using different grades of the ore having grain size ranged from -0.063 mm-millimeter (-230 mesh) to 0.75mm (23 mesh) at the optimum leaching conditions previously determined: H_2SO_4 concentration 0.5 mol/l, and contact time 3 hours, phase ratio (S/A) 1/1 and temperature 40°C. The results are shown below in TABLE

7 and illustrated by Figure 6. It is clear that the leaching efficiency increases as grain size decreased due to increases of surface area.

TABLE 7 : The effect of grain size on uranium leaching efficiency

Grain Size, (mesh)	Leaching efficiency, (%)
-230	84.62
+230	64.62
- 60	60.00
+ 60	44.62
-35	43.00
-23	40.00

Figure 6 : The effect of grain size on uranium leaching efficiency

Results of neutralization of the obtained leach liquor at pH= 2.24

After preparation, then filtration of the leach liquor using the optimum leaching conditions previously studied. The pregnant solution should be neutralized using sodium hydroxide and sulfuric acid to maintain pH constant at 2.24 to prevent the precipitation of uranium during any stage of purification and concentration by solvent extraction technique using DEHPA.

Purification and concentration of uranium using DEHPA

Results of purification and concentration of uranium using DEHPA
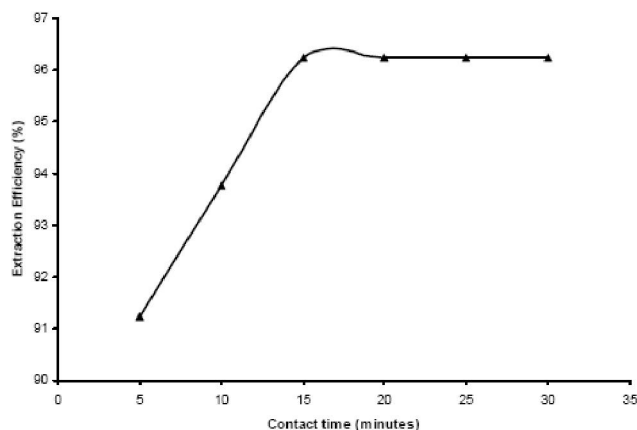
The effect of DEHPA concentration (%) on uranium extraction efficiency

To study this effect a series of experiments were carried out by varying the concentration of DEHPA from 1% to 20% by volume in kerosene diluent at room tem-

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perature, contact time 15 minutes, phase ratio (V_O/V_A) 1/1, settling time 5 minutes and using 1% TBP as modifier to prevent the formation of third phase. The results are shown below in TABLE 8 and represented on Figure 7. It is clear that the optimum DEHPA concentration is 3%.

TABLE 8 : The effect of DEHPA concentration (%) on uranium extraction efficiency

DEHPA Concentration (%)	Extraction Efficiency (%)
01	95.00
03	96.24
05	96.24
07	96.24
10	96.24
15	96.24
20	96.24

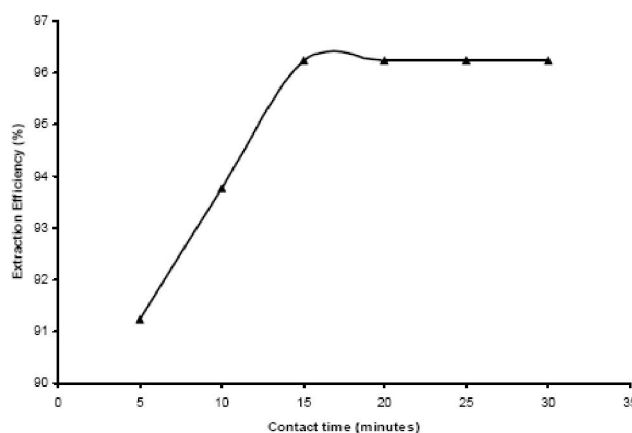**Figure 7 : The effect of DEHPA concentration (%) on uranium extraction efficiency**

The effect of contact time on uranium extraction efficiency

A series of experiments were performed to study the effect of contact time on the extraction efficiency of uranium from our leach liquor, a mixture of 10 ml of the leach liquor (202ppm of UO_2^{+2}) and 10 ml (of 3% DEHPA+ 1% TBP in kerosene) to keep phase ratio at (1/1) was stirred vigorously in 50 ml beaker using magnetic stirrer for various periods of time ranging from 5 – 30 minutes and at room temperature. Then, the mixture was transferred to a separating funnel and allowed to be settled down for 5 minutes. The aqueous and organic phases were separated and the aqueous samples were analyzed. The obtained results are shown in TABLE 9 and plotted on Figure 8. It is obvious that

after 10 minutes there is no considerable increase in uranium extraction could be regarded and so that 15 minutes could be the optimum contact time.

TABLE 9 : The effect of contact time on uranium extraction efficiency

Contact time (minutes)	Extraction Efficiency (%)
05	91.24
10	93.76
15	96.24
20	96.24
25	96.24
30	96.24

Figure 8 : The effect of contact time on uranium extraction efficiency

The effect of diluent used on uranium extraction efficiency

To study this effect a series of experiments were carried out by preparing 3% DEHPA + 1% TBP as modifier by volume in different diluents while the other conditions were kept constant as contact time 15 minutes, at room temperature, phase ratio (V_O/V_A) 1/1 and settling time 5 minutes. The results are shown below in TABLE 10 and plotted on Figure 9. It is clear that the optimum diluent is kerosene.

TABLE 10 : The effect of diluent used on uranium extraction efficiency

Type of diluents used	Extraction Efficiency (%)
Toluene	95.00
Xylene	93.75
Benzene	95.00
Kerosene	96.24
Diethyl-ether	93.75
Butanol	60.00

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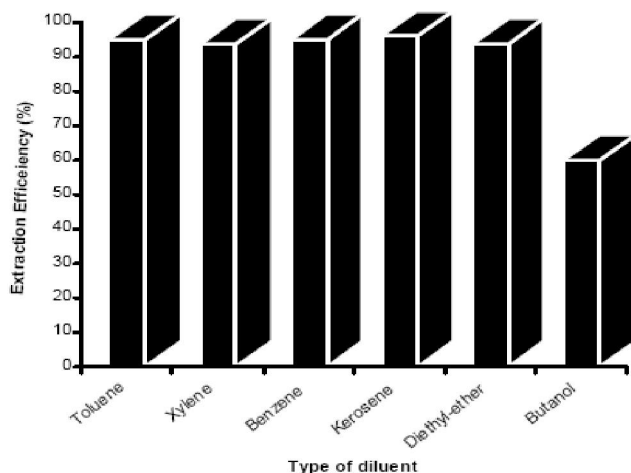**Figure 9 : The effect of diluent used on uranium extraction efficiency**

The effect of phase ratio (V_O/V_A) on uranium extraction efficiency

The effect of phase ratio was studied using different phase ratios (O_v/A_v) ranged from (5/1 to 1/3) at room temperature, contact time 15 minutes, settling time 5 minutes, DEHPA concentration of 3 % by volume in kerosene and in presence and absence of 1% TBP as modifier. The obtained results are shown in TABLE 11 and plotted on Figure 10. From these results, in the presence of 1% modifier it is clear that the extraction efficiency of uranium increases by increasing phase ratio (A/O) from 3/1 to 1/1, but increasing the organic solvent ratio cause decreasing in uranium extraction efficiency this may be due to dilution of modifier as organic solvent ratio increased. In absence of modifier it is clear that the extraction efficiency of uranium increases by increasing phase ratio (A/O) from 3/1 to 1/1 after that it remains almost constant and so the phase ratio of (1/1) (O/A) could be considered the most suitable case.

TABLE 11 : The effect of phase ratio (V_O/V_A) on uranium extraction efficiency

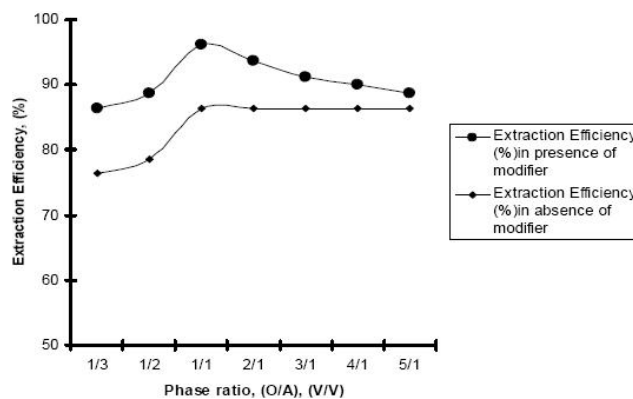| Phase ratio (v/v) [O/A]	Extraction Efficiency (%) in presence of modifier	Extraction Efficiency (%) in absence of modifier
1/3	86.33	76.33
½	88.75	78.60
1/1	96.24	86.30
2/1	93.75	86.35
3/1	91.24	86.38
4/1	90.00	86.40
5/1	88.75	86.38

Figure 10 : The effect of phase ratio (V_O/V_A) on uranium extraction efficiency

The effect of settling time on uranium extraction efficiency

The settling time is the minimum period of time required for the two phases to be separated. This effect was studied at an interval time of 1,3,5,7, and 10 minutes, while keeping the operating conditions constant as phase ratio (1/1), contact time 15 minutes, at room temperature and (3% DEHPA + 1% TBP in kerosene). From the obtained results given in TABLE 12 and represented in Figure 11, it is clear that settling time has no remarkable effect on uranium extraction efficiency. And so 5 minutes is quite reasonable.

TABLE 12 : The effect of settling time on uranium extraction efficiency

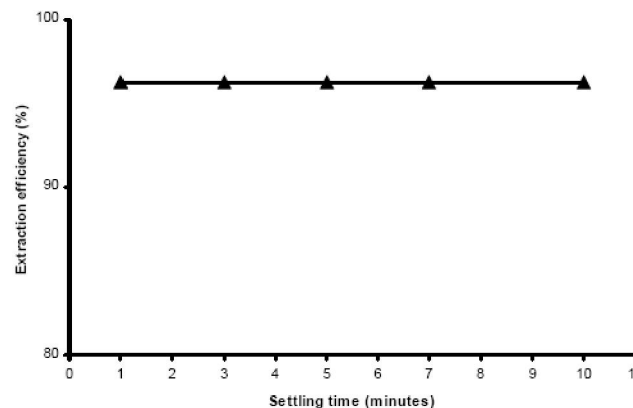| Settling time (minutes)	Extraction Efficiency (%)
01	96.24
03	96.24
05	96.24
07	96.24
10	96.24

Figure 11 : The effect of settling time on uranium extraction efficiency

The effect of percent of modifier on uranium extraction efficiency

The effect of percent of modifier used was studied using different volumes of TBP 0.1, 0.3, 0.5, 1, 1.5, 2 and 5 % by volume while the other conditions were kept constant as phase ratio 1:1 (v/v), at room temperature, settling time 5 minutes, 3 % DEHPA in kerosene and contact time 15 minutes. The obtained results are shown in TABLE 13 and represented on Figure 12, the results showed that the extraction efficiency is directly proportional to the percent of input TBP till 3 % TBP and after that it remains constant.

TABLE 13 : The effect of percent of modifier on uranium extraction efficiency

Vol. of modifier (TBP) (%)	Extraction Efficiency (%)
0.1	85.00
0.3	87.50
0.5	90.00
01	95.00
1.5	96.06
02	96.21
03	96.24
05	96.24
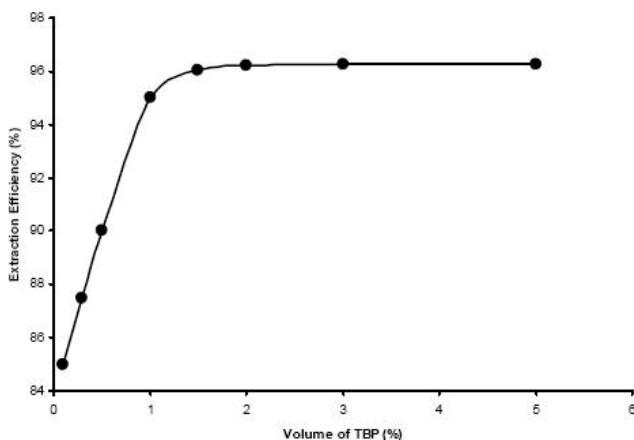
Figure 12 : The effect of percent of modifier on uranium extraction efficiency

Stripping or re-extraction of uranium from the loaded organic "DEHPA"

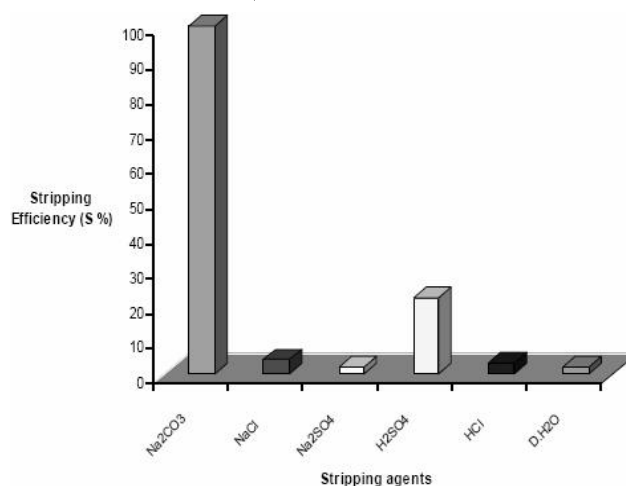### Results of stripping of uranium from the loaded organic "DEHPA"

The effect of the type of the stripping agent on the stripping efficiency of uranium

Six different stripping agents were used to study

this effect, at contact time 15 minutes; the concentration of the stripping agent was 10 % per volume and the previously described operating conditions. The results are given below in TABLE 14 and plotted on Figure 13. It is clear that the optimum stripping agent was Na_2CO_3.

TABLE 14 : The effect of the type of the stripping agent on the stripping efficiency of uranium

Stripping Agent	Stripping Efficiency (S %)
Na_2CO_3	100
NaCl	4.17
Na_2SO_4	2.08
H_2SO_4	21.88
HCl	3.13
$D.H_2O$	2.08

Figure 13 : The effect of the type of the stripping agent on the stripping efficiency of uranium

The effect of the concentration of the stripping agent "Na_2CO_3" on the stripping efficiency of uranium

The effect of the concentration of sodium carbonate was studied using different concentrations 2, 4, 6, 8, 10 and 12 % by weight while the other conditions were kept constant as phase ratio 1:1 (v/v), at room temperature, settling time 5 minutes and contact time 15 minutes. The obtained results are shown in TABLE 15 and represented on Figure 14; the results showed that the stripping efficiency increases from 2 % till we reach 4 % where we reach 100 % stripping of uranium.

The effect of contact time on the stripping efficiency of uranium

This effect was studied at an interval time of 1, 3, 5,

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10, 15, 20, 25 and 30 minutes, while keeping the operating conditions constant as phase ratio (1/1), Na_2CO_3 concentration 4 %, settling time 5 minutes and at room temperature. From the obtained results given in TABLE 16 and represented on Figure 15, it is clear that contact time of 5 minutes is the optimum time for stripping uranium efficiently.

TABLE 15 : The effect of the concentration Na_2CO_3 on the stripping efficiency of uranium

Na_2CO_3 Concentration (%)	Stripping Efficiency (S%)
2	89.6
4	100
6	100
8	100
10	100
12	100
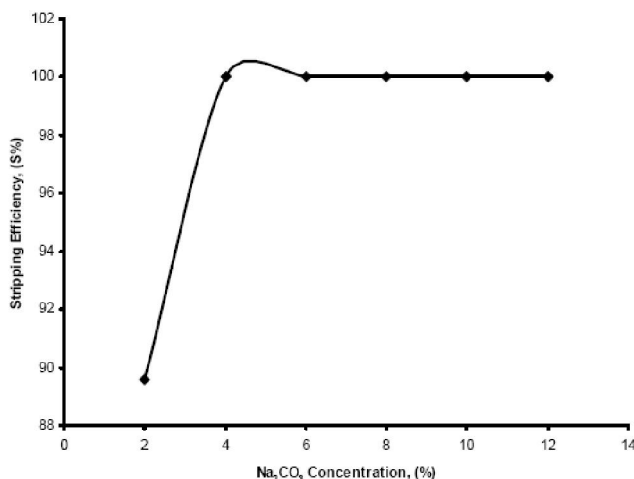
Figure 14 : The effect of the concentration Na_2CO_3 on the stripping efficiency of uranium
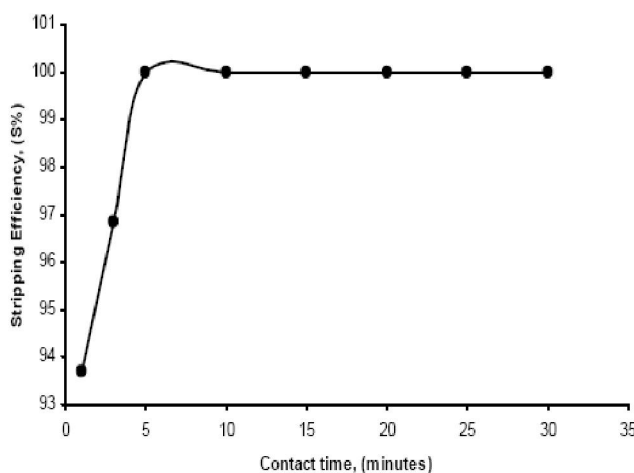
Figure 15 : The effect of contact time on the stripping efficiency of uranium

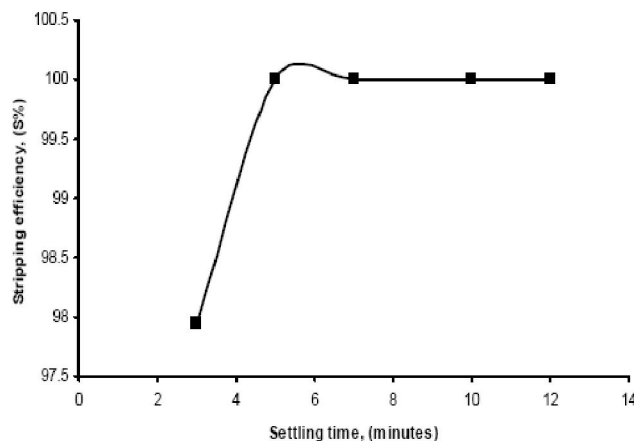**TABLE 16 : The effect of contact time on the stripping efficiency of uranium**

Contact time (minutes)	Stripping Efficiency (S %)
01	93.70
03	96.84
05	100.0
10	100.0
15	100.0
20	100.0
25	100.0
30	100.0

The effect of settling time on the stripping efficiency of uranium

This effect was studied at an interval time of 3, 5, 7, 10 and 12 minutes, while keeping the operating conditions constant as phase ratio (1/1), contact time 5 minutes, at room temperature and 4 % Na_2CO_3 concentration. From the obtained results given in TABLE 17 and represented in Figure 16, it is clear that settling time has no remarkable effect on uranium stripping efficiency. And so 5 minutes is quite reasonable. While studying this factor we have noticed that 1 minute is not sufficient for the phases to be separated.

TABLE 17 : The effect of settling time on the stripping efficiency of uranium

| settling time, (minutes)	Stripping efficiency, (S %)
03	97.94
05	100.0
07	100.0
10	100.0
12	100.0

Figure 16 : The effect of settling time on the stripping efficiency of uranium

The effect of phase ratio (V_O/V_A) on the stripping efficiency of uranium

The effect of phase ratio was studied using different phase ratios (O_V/A_V) ranged from (5/1 to 1/5) at room temperature, contact time 5 minutes, settling time 5 minutes and Na_2CO_3 concentration of 4 %. The obtained results are shown in TABLE 18 and plotted on Figure 17. From these results, it is clear that as (V_A) or the volume of Na_2CO_3 increases more than (V_O) or the volume of loaded DEHPA the amount of uranium stripped decreases due to dilution, on the contrary as (V_O) increases more than (V_A) the amount of stripped uranium increases until we reach 3/1 phase ratio (V_O/V_A) and so it considered the best.

**TABLE 18 : The effect of phase ratio (VO/VA) on the stripping efficiency of uranium**

phase ratio, (v/v),O/A	Stripped U, (ppm)
1/5	38.784
1/4	48.480
1/3	64.640
1/2	96.960
1/1	194.00
2/1	387.84
3/1	581.76
4/1	581.76
5/1	581.76
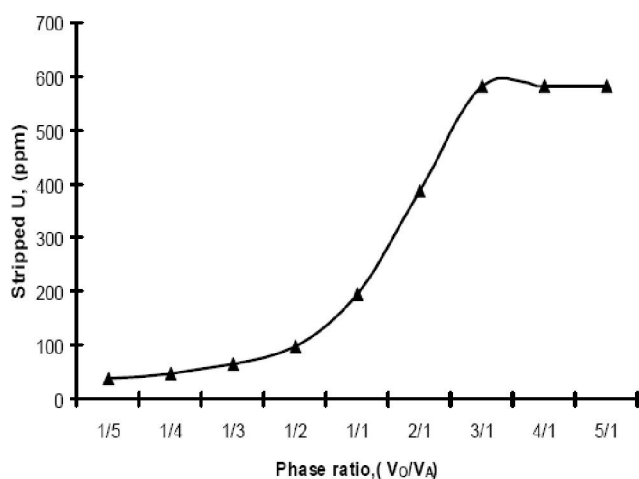
Figure 17 : The effect of phase ratio (V_O/V_A) on the stripping efficiency of uranium

The general flowsheet of uranium ore processing is composed by the following steps: exploration, collecting ore, crushing, screening, milling, alkaline or acid leaching, filtration-washing of the residue, uranium ex-

traction by solvent extraction or ion exchange resins, and chemical precipitation[1, 11]. It was found that this process is adapted to the specificity of uranium ore used and is carried out according to the flowsheet indicated below in Figure 18. The classical flowsheet of the uranium ore processing has been applied to the Egyptian uranium ore (Salcrete deposits). Adjustments have been effectuated to the stage of concentration - purification by solvent extraction, according to the specificity of uranium leaching solution obtained. To avoid the precipitation of uranium, the pH was adjusted to pH=2.24. We have obtained at this condition good extraction efficiency.
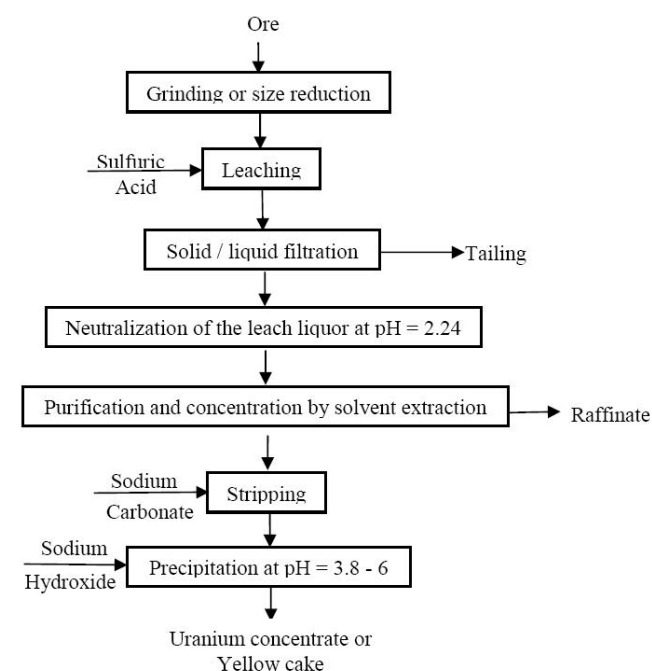
Figure 18 : The proposed flowsheet indicating the processing of the Egyptian uranium ore (Salcrete deposits)

CONCLUSIONS

The leaching of uranium from Salcrete deposits using acidic leaching was studied with respect to various factors. These factors were the type of leaching acid, concentration of leaching acid, phase ratio (S/A), contact time or leaching time, leaching temperature and grain size were studied. It was found that Sulfuric acid is the most suitable one, with concentration of 0.5 M, at phase ratio (1/1), after 3 hours at 40 °C and the grain size was -230 meshes.

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DEHPA was studied with respect to various factors. These factors were the effect of DEHPA concentration, contact time, diluents used, phase ratio (O/A) v/v, settling time and percent of modifier added. It was found that the optimum conditions for extraction of uranium from the leach liquor were [3% DEHPA + 3% TBP modifier] in kerosene; 15 minutes contact time, 5 minutes settling time, at phase ratio (1/1) and at room temperature.

The stripping or re-extraction of uranium from loaded DEHPA was studied with respect to various factors. These factors were the type of stripping agent, the effect of Na_2CO_3 concentration, contact time, phase ratio (O/A) v/v and settling time. It was found that the optimum conditions for re-extraction of uranium from the pregnant solution were Na_2CO_3 with concentration of 4 %, 5 minutes contact time, 5 minutes settling time, at phase ratio (A/O) (1/3) and at room temperature.

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