



Optimization of phosphogypsumby-production using orthophosphoricacid as leaching solvent with different temperatures and leaching times

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phosphate and thus considerable calcium well remain in solution.

Keywords: Phosphogypsum; Jordan, Sulpheric acid; Orthophosphoric acid; P₂O₅extraction

I. Introduction

Jordan has huge reserves of phosphate deposits, the main deposits existed in the southern region of the country [1,2] (Bender, 1974; Khaled and Abed 1980). The concentrations of trace elements such as U, V, Cd, Cr, and As are increasing from south to north, for example, U ranged from 40-60 to 70-80 mg/kg)for samples from Esh-Al-Hisa Shidyia and mines. respectively [3. 41 (Jordanian Phosphate Mines Company (JPMC) 1998; Khaled et al. 1990). [5] Ghosheh and Dodeen (1993) had showed that other heavy metals and toxic elements in the Jordanian phosphate rocks are compared lower with several phosphate deposits from the world;[6] Al-Hwaiti et al. (2001). [7] Abed et al. 2008; found that potential toxic metals behaves as P and are enriched by a factor of more than 1.5 in the diammonium phosphate (DAP) compared with the input phosphorite. In addition, that the trace metal content in the PG is very low. However, U sticks to the mineral francoliteduring

Abstract-Phosphoric acid production generates unavoidable calcium sulfate byproduct (i.e. phosphogypsum (PG)) that is usually disposed either within a nearby-located gypsum stacking system. However nowadays this type of industry has been faced with two main problems, these are the formation of huge stockpiles ofphosphogypsum that affects the environment due to the presence of harmful radiations that is emitted from the uranium. In addition it contains P₂O₅>1.0 wt% and fluorine >0.18 wt%, which makes it not suitable for the cement industry. At the same time consuming large quantity of expensive sulphuric acid thatbecomea hazardous waste material too. The production rate of PG verses marketable P_2O_5 as acid in the world is high as much as 5 tons of PG are produced for each ton of P_2O_5 ; in Jordan the rate is around 5.0 - 5.3 ton of PG per ton of P₂O₅ produced depending on the phosphate rock composition. This means a huge amount of PG will accumulateat the fertilizer plant in Aqaba. The major advantage of using orthophosphoric leaching solvent isthe acid. as decreasing of the residual materials verses marketable P₂O₅to be589 kg /ton of P₂O₅ produced, compared with 5.0 - 5.3 ton ofdisposed PG/ton of P₂O₅produced through current practices. These results obtained by utilizing the wet agitation leaching technique; however, this alternative technique resulted in lowerP₂O₅ extraction, but decrease in bulk of the residue. The only disadvantage is the higher dissolution of calcium



acid and Hemilydrate phase (CaSO₄.1/2H₂O) [13] (EFMA 2000).

The most common technique used in the world for production of phosphoric acid from the phosphate rock comprises from reacting the phosphate rock with concentrated sulphuric acid solutions as in the following equation:

Ca₃ (PO₄)₂ + $3H_2SO_4$ + $2H_2O$ → 2H₃PO₄+ CaSO₄.2H₂O (gypsum)

Contaminated gypsum which also known as PG, CaSO₄.2H₂O that is coproduced formed as in the production of phosphoric acid by the wet- process. Unfortunately, the ratio of PG verses marketable P₂O₅ as much as 5 tons of PGproduced for each ton of P_2O_5 . The rate is controlled by the composition of the phosphate rock. In Jordan the ratio is around 5.0-5.3 ton of PG/1.0 ton P_2O_5 produced [13] (JPMC2008).

Many environmental issues raised by such waste disposal problem, so it is estimated that over 40 million tons of PG was produced and accumulated in Aqaba area by Jordan Phosphate Mines Company Ltd., (JPMC) during the period 1982 – 2008. The JPMC annualdisposal isapproximately 2.2 million tons of dehydrate PG and 1.0 million tons of hemihydrate. The problem is accentuated by the fact that similar to Ca and $P_2O_5[8]$ (Abed 2011).

upgrading of the ores, and behaves

The phosphate industry is one of the most contaminating sources to the environment, which contributes to soil; water and air pollution [9] (Vandenhove, 2002).Al-Hisaphosphate mines are heavily affecting the particulate matter in the areas around the mines, [10] Hamaiedah and El-Hasan(2011). The utilization of effluent mine water from the Eshidiya phosphate mines in agricultural uses was investigated; it was categorized as C_4S_1 - C_4S_2 type which indicates that this water cannot be used for irrigation on any type of soil [11] (Al-Hwaiti et al. 2016).Similarly, [12] Jiries et al. (2004)has investigated the effluent water from Al-Hisa and Al-Abyad mines.Moreover, they found that it can be used for irrigation of salt-tolerant plants.

According to the European Fertilizer Manufacturing Association (EFMA), there are two phosphoric acid production processes; the first, at temperature 70 -80 °C that yields 26-32% P₂O₅, and gives acid and dehydrated phase (CaSO₄.2H₂O). The second, at temperature 90 - 110 °C, which yields 40-52% P₂O₅, and gives



which indicates that trace elements were not leached from the stacks in any significant amount.

An associated problem is the production of sludge produced in the neutralization of gypsum pond water by liming. The sludge produced is another solid waste, which is a mixture of complex compounds of phosphates and fluorides and is disposed of on the gypsum stacks.

Some technologies attempted at minimizing the pollutants in the PG. Nabulsi (1999) [23] used one of these attempts. He carried out several tests on specimens that were prepared from the PG in Jordan; the results showed that it could be used as a gypsum binder in the building industry. It can be also for producing precast units of low density and acceptable thermal insulation properties. However, the problem here is the radioactivity that still presents in the tested PG samples.

Other attempt was done by Industrial Chemistry Center in Royal Scientific Society. The team in the center prepared several samples from PG that brought from JPMC-Industrial Complex in Aqaba-Jordan and washing these samples up to five times using Tap water and sea water to employed in the wet-process production phosphoric of acid, of contains a number serious contaminants such as radioactivity due to the presence of uranium, fluoride, heavy metals besides sulphuric and phosphoric acids and their salts. The problem is further worsened by the large volume of PGpond water that is used in most plants for scrubbing pollutants. Whereas, [8] Abed (2011) suggested that Uranium is concentrated in the final phosphoric acid.

the PG, in most of the technologies

The PG is found to be radioactive due to the presence of naturally occurring uranium and radium in the phosphate ore [15] (Dippel, 2004). Thus, PG is classified as a hazardous waste and is currently being disposed and stockpiled on sandy soil [16 - 18] (Berish, 1990; Azouazi et al., 2001; Dueñas et al., 2007). There are various storage processes of PG wastes, such as ocean disposal [19] (Wissa, 2001), dry stacking on land, which is the common practice [20] (EPA 1999), and wet stacking on basins [21] (Anon, 1998), as well as the use of PG as mine backfill disposal as suggested by [15] (Dippel, 2004). [22] Al-Hwaiti et al. (2005) reported that trace elements in the PG stacks are stable with time,



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Other possibilities exist, but yet not

considered economically, for example the production of sulphuric acid from the PG or use it in cement clinker. At the same time, the expensive sulphuric acid raw material consumed will produce a large pile of waste material (e.g. PG) near the plant considered as another problem facing the production of phosphoric acid by using the sulphuric acid and phosphate ore. The estimated amount of sulphuric acid that consumed is about 2.7 ton /1.0 ton of P₂O₅ produced.Rabba (1993) [34] had carried out a metallurgical test work on the phosphate shale copper ore (Cambrian) atWadi Khalid, at northern Wadi Araba region. He concluded that the most sufficient and economic acid should be used for extraction the copper and P_2O_5 from the ore is the phosphoric acid to avoid the formation of PG.

The researchaims find to alternativetechnique by using the orthophosphoric acid for leaching the Jordanian phosphate ore instead of sulphuric acid. Therefore, themain objective of this study is to estimate the maximum extractable percent of P_2O_5 from the phosphate oreto determine the amount of insoluble minerals in the phosphate ore by using

decreased 13%, but the SO₄ increased

in the tested samples.

reduce the impurities that present in the

Abdelhadi et al. (2014) [24] ; demonstrated experimentally the use of raw PG without treatment (heating) in cement production, which will eliminate a serious environmental source of pollution; besides, decreases the cost of cement production.

Smadi et al. (1999)[25] studied the behavior of the compressive strength of cement with different replacement ratios of purified (PG) and calcined temperature up to 900 °C, he found an increasing in compressive trend strength which improved the initial and final setting time. Bhadauria&Thakare (2006) [26] utilized the PG wastes in cement additive as past or mortar in concrete; it was found that it is suitable for concrete in terms of workability and compressive strength. PG is also known worldwide for its applications as a binder or cement, [27 -33] (e.g. Gutt 1978; Ouyang et al. 1978; Ghafoori, 1986; Akın &Yesim, 2004; 2008; Degirmenci, Lysandrou&Pashalidis, 2008; and Yang et al., 2009).





each 1.0 ml of acid is equivalent to

1.75 g H₃PO₄ (90% Conc.). Two of them were performed at temperature of 30°C for 1.0 and 2.0 hours leaching time and the other two samples were treated at 50°C for 1.0 and 2.0 hours leaching times using magnetic stirrer for agitating the phosphate components. Employing acid an strength of 17.5 % phosphoric acid on a weight basis, the strength being equivalent to 10.0 ml of acid per 100ml of solvent used for leaching. The remaining four samples (IR-1, IR-2, IR-3 and IR-4) were leached with concentrated sulphuric acid(90% Conc.). Two of them were performed at temperature of 30°C for 1.0 and 2.0 hours leaching times. And the other two samples were treated at 50°C for 1.0 and 2.0 hours leaching times, utilizing an acid strength of 18.35 % sulphuric acid on a weight basis, the strength being equivalent to 10 ml of acid per 100ml of solvent used for leaching. It should be noted that each 1.0 ml of acid is equivalent to 1.835 gm H₂SO₄.

2.2 Agitation experiment

Twenty-nine representative samples (100g)have been prepared from the phosphate ore sample (Ph-1) were

investigate the release of P_2O_5 as a function of temperatures and leaching time using orthophosphoric acid as solvent. In addition, this work aimed to prevent the formation of huge amounts of PGand residue materials.

various acids/water ratios, and

II. Sampling and Analytical methodology

2.1 Leaching Test:

Nine representative samples prepared from the phosphate ore sample labeled as Ph-1, each of 10 g in weight, ground to -20 microns. One representative sample from the phosphate ore (Ph-1) was digested with concentrated mix of Nitric and Perchloric acidssolution. The digested filtratessolutions were analyzed using an A.A.S. technique using different standards contain increasing amount of P_2O_5 . This technique was performed in order to in P₂O₅production remove errors estimation of each samples due to dilution process. Eight representative samples from the phosphate ore (Ph-1), each of 10 g were ground to -20microns. Four samples (IR-5, IR-6, IR-7 and IR-8) were leached with orthophosphoric acid (90% concentration which contains 65.29% P_2O_5), it should be noted that





sample powder and 7.2 g of L2B4O7 in Au/Pt crucible using flexor machine (Leco 2000) for 3 – 4 minutes at 1200 °C. The melt was poured in a mold and left to cool to form a glass disc. The machine was calibrated with international standards, particularly the Geological Survey of Japan (GSJ) geochemical standards (i.e., Japanese slate JSI-1 and JSI-2). The analytical error was within 5%. Moreover, mineral constituents were determined using X-Ray Diffraction analysis. It executed using the machine was (XRD-Philips Expert MPD) at the labs Resources of Natural Authority (NRA), Amman. The samples were scanned between 2° and 65° 2 θ , using Ni-filtered Co K α radiation, 40 kV/40mA, divergent and scattering slits of 0.02°mm, a receiving slit of 0.15mm, with stepping of 0.01° and scanning speed of 3°/min.

Pellets were made by fusing 0.8 g of

III. Results and Discussion:

3.1 Treatment of phosphate ore using concentrated H_2SO_4 and H_3PO_4 The results showed that the P_2O_5 extraction obtained from two samples that were treated at temperatures 30C° and 50C° was 89.6% and 93.05% in 1.0 hour of leaching time, with an acid treated using H₃PO₄ (90%conc.) acid strength of 100, 150, 200 and 300 ml of /1000 ml of solvent (i.e. Distilled Water (DW)). Nine samples leached for 1.0, 2.0 and 3.0 hours, at temperature of 30C°, 50C° and 80C°; using an acid strength of 100 ml of H₃PO₄ (90% conc.) /1000 ml of (DW). Other nine samples were leached under similar conditions but with different acid strengths; 150 ml of H₃PO₄ (90%conc.) /1000 ml of (DW). Six of the remaining nine samples were treated using similar conditions but employing an acid strength of 200 ml of H₃PO₄ (90% conc.) /1000 ml of (DW) and employed leaching time of 1.0 and 2.0 hours. The last three samples were leached for one hour at a temperature of 30C°, 50C° and 80C° using an acid strength of 300 ml of H_3PO_4 /1000 ml of (DW). The leached residue after each interval was analyzed by X.R.F and Calcimeter for P_2O_5 , CaO, other extractable elements.

The chemical composition of PG was investigated through X-Ray Fluorescence analysis. It was done using the machine (XRF-Pioneer F4), manufactured by Broker at the Natural Resources Authority (NRA)labs, Amman. The machine comes with an attached 72-position sample changer.



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respectively, these figures equivalent to 15.85 g with 23% loss of ignition and 15.59 g weight with 21% loss of weight respectively. It should be noted that the original ore samples used in the tests were 10 g weight each, the increase in weight being due to the formation of gypsum in the residual materials. The complete results of these tests are present in Table 1.

Table 1

3.2 Treatment of phosphate ore using 10.0 ml of concentrated H₃PO₄ / 90 ml distilled water

Leaching results have showed that P_2O_5 is released from phosphate ore using dilute orthophosphoric acid. The P₂O₅ extraction results obtained range from 62.0% using 10.0 ml of H₃PO₄ (99.5% Conc.) /100 ml of solvent (DW) after 1.0 hour leaching to 69.53% using the same acid strength after 2.0 hours leaching at 30C° Table 2.

maximum The P_2O_5 extraction obtained from phosphate ore samples after 2.0 hours leaching time at 50°C with orthophosphoric acid was 72.91%. This was produced using acid solution of 10.0 ml H₃PO₄ (90%

consumption of 851 and 877 kg H₂SO₄/ton of ore respectively. The calculated amounts of H₂SO₄ that consumed to produce 1.0 ton of H_3PO_4 (concentration 99.5%) were 2.29 and 2.26 tons respectively. The chemical results obtained for the residue from X.R.F. analysis showed that it contained 30.0, 29.94 wt% CaO, and 42.54, 43.26 wt%SO₃, using these figures the amount of gypsum precipitated in leach residue (PG) was estimated to be 91.37 % and 92.97 % of the residue weight which are equivalent to 16.33 and 16.37 g respectively, while the original weights of the ore samples that used in the tests were 10.0g each, this increase in weight being due to the formation of gypsum in the residual materials.

The P_2O_5 extraction obtained from the other two samples that were treated at temperatures 30C° and 50C° was 100 % for both tested samples in 2.0 hours of leaching time, with an acid consumption of 896 and 897 kg H_2SO_4 /ton of ore respectively. The calculated amounts of H₂SO₄ that consumed to produce 1.0 ton of H_3PO_4 (concentration 99.5%) were 2.15 and 2.16 tons respectively. From the analysis of the leach residue for CaO and SO₃ that was 94.63 and 95.07 wt%



ranging from 61.5 to 68.0 % at 30C° and 50C° respectively after 2.0 hours leaching. The summary of the results of residue production, acid consumption and extracted P_2O_5 % by using the two acids are presented in Tables 2. Although the use of H_3PO_4 resulted in lower P_2O_5 extraction, but also reduces the residue weight Figure 1.

Table 2

Figure 1

3.3. Results obtained using differentOrthophosphoricAcid/Tap Water.

A total of 29 samples with weight 100 were treated with different gr orthophosphoric $acid(H_3PO_4)$. Four acid/tap water ratios were performed (i.e. 100ml/900ml; 150/850; 200/800 and 300/700 respectively). Each mixture was investigated with variable temperature (30C°, 50C° and 80C°) and leaching time (1, 2 and 3 hours). The results obtained are summarized in Tables (3 &4).

Table 3

Figure 2

Table 4

IV. Discussion

from this material dropped to 68.04% with decreasing the leaching time. Similarly, CaO extraction amount from the phosphate ore was also leaching time dependent. The CaO and P_2O_5 extraction values obtained matched each other closely; indicating that all components of the apatite in the samples were leached into solution. The calculated amounts of H₃PO₄ that generated from the tested samples after 2.0 hours leaching at 30°C and 50°C were 289.1 and 303.14 kg respectively under acid concentration (100%)/1.0ton of phosphate. While the generated phosphoric acid from the tested samples after 1.0 hour leaching time at 30°C and 50°C were257.8 and 282.9 kg/ ton of ore respectively.

Conc.) /100 ml of solvent. Extraction

No precipitation was observed from the leaching solutions once they were filtered, indicating that CaO and P₂O₅ were stable in the leached solutions. The residues weight loss for the four samples was tested. These weight lossesof the leached samples arecorrelated to apatite and calcite content of the ore samples and the used leaching time. They varied from 50.70 % at 30C° to 60.0 % at 50C° after 1.0 hour leaching, while weight losses in the remaining two samples were





Aqaba/Jordan. Furthermore, washing the precipitate with diluted sulphuric acid at a temperature of 40 °Cfor 10minutes agitation will raise the gypsum mineral to more than 99.5% with 0.00% P_2O_5 content. No impurities such as uranium and fluoride were recorded in the new product. This shows that quality of the PG produced are more commercial and suitable for cement industry and at the same time reduce the costs of washing the product by diluted sulphuric acid.

4.2 Results of the agitation leaching with orthophosphoric acid

The presence of apatite (Ca₅ (PO₄)₃.OH,F) in the Jordanian phosphate ore and its dissolution in the orthophosphoric acid solutions resulted in the presence of phosphor in solution. The major reactions, which occur during phosphate ore leaching, are illustrated by the following equations:

Ca₅ (PO₄)₃ (OH) F+ H₃PO₄ + 5H₂O \rightarrow 5CaO + 4H₃PO₄ +H₂O+ F

Ca₅ (PO₄)₃ (OH) F + Phosphoric Acid +Water \rightarrow Calcium oxide + Phosphoric Acid

4.1 Results of the agitation leaching

with sulphuric acid

The calcium phosphate that might be dissolved during the leaching of phosphate ore with orthophosphoric acid is not necessarily a problem. The calcium can be co-precipitated by adding of stoichiometric amounts of sulphuric acid and this correspondingly results in the increase of phosphoric acid in the leaching solutions. The produced calcium sulphate is of excellent quality and itself represents a possible commercial product.

According to Table2each 1.0 ton P_2O_5 produced needs 3.52 ton of phosphate ore to produce 4.30 ton of precipitate with gypsum content about 98%, this quantity of the produced gypsum will consume 1.96 ton of concentrated sulphuric acid as shown in Figure 1.

The estimated amount of residue (PG) for each 1.0ton of P_2O_5 produced was 0.626ton, compared with 4.5-5.0 ton of PG residue produced by current practice on JPMC-IND COMPLEX in Aqaba/Jordan. The whiteness of the precipitated sample was measured; the results revealed that the whiteness was 97.5%.Compared with 56.5 the whiteness of the PG that usually produced by JPMC-IND COMPLEX





Extraction of the P₂O₅ that obtained

from this material dropped to 80.82%using a temperature of $80C^{\circ}$ and 54.85% at a temperature of $50C^{\circ}$ when the lowest acid strength (100ml of H₃PO₄/900 ml of Tap water) was employed, Table 3.

Dissolution of the calcium phosphate content of the phosphate ore orthophosphoric with acid was characterized by weight loss of the leaching residue. This ranged from 46.0-88.20 % depending on the leaching time, acidconcentration and temperature used in leaching process.

Usingleaching temperature at 80°C for the phosphate ore and 1.0 and 2.0 hour leaching time, the weight loss recorded was lower compared with the previous tests that used temperatures of 30°C and 50°C. This difference may be related to the amount of phosphate mineral formed in the residues of the leached samples that treated at 80°C only. The extraction of P₂O₅ did not increase further even though the test was running for one hour more. However, residue weight continued to rise after 1.0-hour leaching time. The result suggests that the extraction of P₂O₅ may be limited after 1.0 hour leaching at temperature of 80°Cand the

(H₂PO₄)₂ (Mono-Calcium phosphate) Liquid

 H_3PO_4

Apatite + H3PO4 + SiO2 +Fluorine (F) \rightarrow H3PO4 + (Mono-Calcium phosphate) + HF (v)

 $HF(v) + SiO2 \rightarrow Si F4(v)$

 $5CaO + 4H_3PO_4 + H_2O$

Si F4 (v) + Scrubbing by water \rightarrow H2SiF6 (Liq.) Floro-silicic Acid

The other minor reactions that may be formed and resulted in formations of solid materials associated with the cake of residue samples. These reactions are:

- Reaction between Na₂O and SiO₂ to produce Sodium silicates (Na₂SiO₃)
- Reaction between CaO and SiO₂ to produce Calcium silicates Ca₂SiO₃
- 3. Reaction between CaO and F to produce Calcium fluoride CaF₂ Employing 10% ratio of solid to solution the leaching results have shown that P_2O_5 is released from phosphate ore samples using orthophosphoric concentrated acid (300ml of H₃PO₄/1000 ml of Tap water). The highest P_2O_5 extraction result obtained was 98.72% in 1.0 hour leaching time using a temperature of 80C°, comparing with 98.0% when employing a temperature of 50C°.





to some extent between higher extraction of P_2O_5 and F; Table 3. The decreases in extraction of fluoride may be due to the increase of fluorite mineral (CaF2) formation in the residue sample, which is estimated to be about 44.5% of the residue, as shown in Table 3 and Figure (3).

Employing 10% ratio of solid:solution the leaching results have shown that P_2O_5 is readily released from phosphate ore samples using diluted orthophosphoric acid (200ml of $H_3PO_4/800$ ml of tap water). The highest P_2O_5 extraction results obtained was 95.04% after 3.0 hours leaching time at temperature of 30C°, comparing with 94.5% when at temperature of 30C° and 2.0 hours leaching time. Consequently, we can conclude that employing a leaching temperature of 30C° for 2.0 hours leaching time with acid strength 20% for leaching the phosphate ore, the extraction of P₂O₅ was 95.04% and this will remain constant even though anextra hour of leaching was added. This might be attributed to the fact that carbonate minerals (apatite and calcite minerals) in the phosphate ore sample were completely dissolved. This was confirmed by the absence of CO_2 contents in the residue, Table 4. The

acid strength less than 30% is not capable of dissolving further P_2O_5 from the ore or even preventing the formation of calcium phosphate hydrate from the leach solutions at this temperature, Figure 2.

Examining the leaching residues after 1.0-hour treatment using different acid concentration revealed that the main chemical differences observed between them is the CaO content. As the acid strength increased, the CaO values decreased in the residues. This was evident from the decrease in the residue weightstoo as shown in Table 4 and Figure 2.

It is interesting to note that in case of using an acid concentration of 200ml H₃PO₄/800ml of tap water, the fluoride content in the leached ore sample treated at 30C° was 22.63% after 2.0 leaching time. However, the lowest fluoride extraction value 3.30 % was noticed at the 100ml H₃PO₄/900ml leached at 80 °C. Generally the fluoride extraction is increasing with increasing acid concentration, and decreasing with increasing temperatures of leaching process, thus 30 °C yields always higher fluoride in residue in the form of fluorite mineral. This may explain the positive





process as seen in the following equations:

 $Ca_5 (PO_4)_3 (OH) F+ H_3PO_4 + 5H_2O \rightarrow 5CaO$ $+ 4H_3PO_4 + H_2O + F$

Apatite + Phosphoric Acid + Water \rightarrow Calcium oxide + Phosphoric Acid

One of the assumed advantages in the use of orthophosphoric acid in leaching the phosphate ore would be pregnant solutions identical in acidic character. which could be combined together for further treatment. The data confirms that P_2O_5 can be extracted from the Jordanian phosphate ores utilizing orthophosphoric acid solutions, and revealed that the increase solubility of apatite in this solvent.The results show that dilute sulphuric acid was capable of leaching slightly more of all the elements measured under the leaching conditions employed at temperature.Dissolution low of the calcium phosphate of the content Jordanian phosphate ore with orthophosphoric acid caused a weight loss

be presented in the form of crystalline phosphoric acid. Thus, no need for further use of higher acid strength or longer leaching time.

remaining 5%P₂O₅ in the residue could

Dissolution of the calcium phosphate content of the phosphate ore with orthophosphoric acid was characterized by a weight loss of the leaching residue. This ranged from 82.0-84.84 % depending on the leach time used for leaching.

Figure 3

V. Conclusions

In this work, phosphoric acid has been investigated as a possible solvent for the recovery of P_2O_5 from Jordanian phosphate ores. The idea was initiated depending on bases that phosphoric acid composition is similar to the composition of the apatite phosphate mineral, so the acid will dissolve the apatite without any reaction dissolved between the components of the apatite and the phosphoric acid and no precipitations will be formed during the agitation leaching





and research found agencies.

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of the leaching residue ranged from 50.7

VI. Acknowledgment

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Prof. Tayel M. El-Hasan; a professor in geochemistry, he received his Ph. D. in Geochemistry Ore Deposits from Tsukuba University, Japan in 1999. He got his professorship on 2009. His activities was teaching undergraduate students geology & environmental courses. Besides conducting research on natural resources and environmental geochemistry fields. El-Hasan is a senior member of the national user's network of the Synchrotron radiation (SESAME). He was a visiting professor at Erlangen-Nornberg University, Helmholtz Centrum for Materials and Energy, University of Jordan and Taibah University. He has published more than 50 articles in international journals, participated in more than 35 international conferences, he supervised many master students, and he got many research and fellowships from (DFG, JICA, IAEA and JASSO). Beside he got several research grants from SRFS, Shouman Foundation, NATO, SRTD, ICTP and Mutah University Scientific Research Deanship fund. Prof. El-Hasan is an



phosphate mines in Central Jordan.

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