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Recovery of Copper from Copper Slag by Hydrometallurgy Method, from Iraqi Factories Waste

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Abstract

In this research, the recovery of copper from copper slag is investigated using hydrometallurgy method. Slag samples were taken from Al-Shaheed State Company. The results of the chemical analysis showed that the slag contained 11.4% of copper.

The recovery process included two stages; the first stage is leaching using diluted sulfuric acid. The most important variables that effect on the leaching process was studied, such as acid concentration, hydrogen peroxide adding, particle size, liquid to solid, stirring speed and leaching time by changing the condition and the stabilizing of other factors at room temperature.

The second stage is precipitation of copper from leaching solution by zinc powder with different weights and times, at room temperature and 1.5 PH value.

The results of the first stage manifested that about 99.7% of the copper have been dissolved at the following operational conditions: 50% acid concentration, 5 ml hydrogen peroxide adding, particle size (-75+53) micron, 1:10 liquid to solid, 500 rpm stirring speed and 25 min of leaching time. The highest percentage of copper precipitation in the second stage was 99.8% when added 3gm zinc powder at 20 min.

The XRD result revealed that the predominant phase was pure copper. The results of EDS exhibited that a few percentage of oxygen appeared with copper powder. The final of copper recovery ratio was 99.3% with 99.2% purity.

Introduction

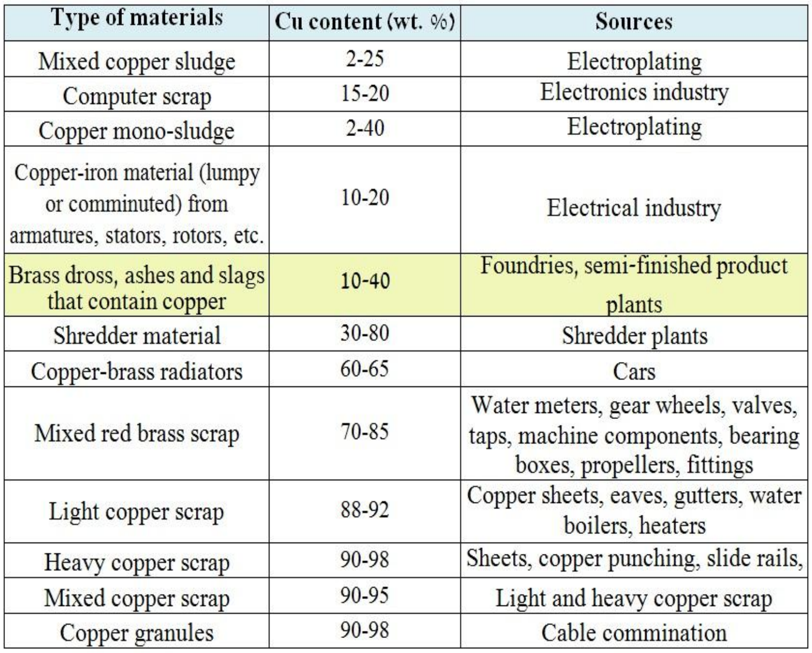
The expansion of many different engineering industries has led to consumption of many of the raw materials, which are the main source of materials engineering and they have produced tons of associated industrial wastes that have formed a clear environmental threat and occupied large tracts of land in various parts of the world [1].

Copper is one of the important metals that are indispensable for modern industries in various fields. Therefore, the process of recovery of copper from industrial waste has great economic and environmental benefits [2].

The recovery of copper from the industrial waste process included extensive and multiple Fields extended to include all spheres starting from the major mining operations and ending to the youngest industrial product that can be recycled after consumption [3].

The most important secondary sources for the recovery of copper and their estimated copper ratio is illustrates in (Table 1). The fifth field represents the area that matches this search.

Table 1: The secondary sources for the recovery of copper according [4].



Type of materials	Cu content (wt. %)	Sources
Mixed copper sludge	2-25	Electroplating
Computer scrap	15-20	Electronics industry
Copper mono-sludge	2-40	Electroplating
Copper-iron material (lumpy or comminuted) from armatures, stators, rotors, etc.	10-20	Electrical industry
Brass dross, ashes and slags that contain copper	10-40	Foundries, semi-finished product plants
Shredder material	30-80	Shredder plants
Copper-brass radiators	60-65	Cars
Mixed red brass scrap	70-85	Water meters, gear wheels, valves, taps, machine components, bearing boxes, propellers, fittings
Light copper scrap	88-92	Copper sheets, eaves, gutters, water boilers, heaters
Heavy copper scrap	90-98	Sheets, copper punching, slide rails,
Mixed copper scrap	90-95	Light and heavy copper scrap
Copper granules	90-98	Cable commination

Copper slag is a by-product of the smelting process, usually consisting of a mixture of oxides and silica. The slag floats on the molten surface because of the lightness of the oxides and can contain metal sulphates and some basic minerals [5]. Basically, copper can be recovered from slag by three methods: physical separation method such as flotation, pyrometallurgical method such as roasting and hydrometallurgical method such as leaching [6]. Hydrometallurgical processes are commonly found much more environmentally friendly and economical. It's more efficient than pyrometallurgical process, and emissions of solid particles comparatively are nonexistent. This method is suitable for recovery of copper from copper products factories' slag because of its ability to recover copper economically from the slag which contains a small percentage of copper [7].

leaching of copper, from copper converter slag by sulphuric acid and potassium dichromate addition was studied by [8]. It is reported that the percentage of copper recovery was increased to 81.15% when added potassium dichromate.

Recovery of copper by electrochemical technique from dross scrap of the state Company for Electrical Industries was studied by [9]. After many chemical process he was recovered 43.75% Cu from dross scrap with purity 99.9967%. Hydrometallurgical method to recovery copper, zinc and cobalt, from copper smelter slag in the presence of sulfuric acid with amount from sodium chlorides was developed by [10]. It is found that the percentage of recovery of copper increased when increased time, temperature and sodium chlorides addition.

The recovery of copper from copper smelter slag flotation tailings and copper smelter slag by sulphuric acid, with two different additions: ferric sulphate and hydrogen peroxide studied by [11]. It was noted that the extraction of copper increases with the increase of hydrogen peroxide addition, and the comparison between the extraction of copper with and without of stirring showed the stirring beneficial effect on copper extractions.

In Iraq there are large quantities of copper slag produced in the production of copper and its alloys according to Ministry of Industry and Minerals Report (2009) [12]. The objective of this research is to benefit from the industrial waste by recovery of the metals from them and to rid the environment from the danger of accumulation that causing serious damage.

Material and Methods

Materials that used in the experimental work are included solid materials (Figure 1) as mentioned in Table 2, and their chemical solutions are listed in Table 3.

(a) (b) (c)

Figure 1: (a) Shaheed copper slag. (b) Zinc powder. (c) Sodium bicarbonate.

Table 2: Solid materials used with their specifications.

Materials	Details
Copper slag	11.4 % of copper with some elements, such as Zn, Si, Al, Fe, and others mostly in the form of oxides, gray color, irregular shape with different sizes from Shaheed State Company in Anbar Governorate , western Iraq
Zinc powder	99.9 % purity, practical size < 75 um, light gray color, product from Guangdong, China (Mainland).
Sodium bicarbonate	99% purity, practical size < 100 um, white color. PH: 8.6, product from Al-asi company, Iraq.

Table 3: Chemical solutions and their specifications.

Chemical Solutions	Details
Sulfuric Acid (H_2SO_4)	Central drag house, India Assay ~98%, Molecular Weight: 98.08 g/mol, colorless liquid
Hydrogen Peroxide (H_2O_2)	Applichem Gmbh, Germany Assay = 30%, at 20 °C, Molecular Weight: 34.01 g/mol, colorless liquid

The mineralogical and chemical analysis of copper slag is performed by X-ray diffraction**,** X-ray fluorescence, atomic absorption spectroscopy, energy dispersive spectroscopy and scanning electron microscope.

Methods

a. Sample Preparation

(5 Kg) of copper slag received from Shaheed State Company are comminuted by a laboratory jaw crusher and disk mill.

b. Mechanical Separation (sizing)

Mechanical separation was carried out by using auto sieve shaker (Impact, ISO 3310-1:2000, UK), Sieve sizes of (250, 150, 75 and 53 μm) opening.

c. Leaching Process

The leaching of copper slag by sulfuric acid was done in a leaching cell consisting of 500 ml 3-necked round bottom glass (Pyrex) with the refluxing condenser and thermometer placed on the magnetic stirrer heating mantle. The reaction solution in vessel was stirred by using a Teflon coated magnetic follower. The heating was not used in leaching cell, and the sample weight was kept constant at 5 gm in all leaching experiments. The leaching cell was shown in Figure 2.

Figure : The leaching cell

Leaching Experiments

The leaching experiments were conducted by changing a factor and stabilizing others. The effect of several parameters on the copper leaching process was studied which is summarized in the following list:

1- Acid concentrations: Different concentrations of sulfuric acid were used (20, 30, 40, 50 and 60 %).

2- Particles size: Different copper slag particles size were used (+250, -250+150, -150+75, -75+53 and -53 microns).

3- Liquid/ Solid ratio: The effect of this parameter was studied under the values of (5:1, 8:1, 10:1 15:1 and 20:1 v / wt).

4- Speed stirring: The speed stirring for reaction solution during leaching experiment was at (0, 100, 200, 500, 800 and 1000 rpm).

5- Leaching time: the leaching durations tested were, (5, 10, 15 and 20 minute).

6- Additions of (H_2O_2): The additions of (H_2O_2) during leaching experiment were (1 ml, 2 ml, 3 ml, 4 ml 5 ml and 6 ml) with its natural concentration of 30% (w/w) at 20 °C.

Sulfuric acid was used to leach the copper in the form of water copper sulphate slag. Sulfuric acid also dissolves other minerals in the form of sulphate such as Zn, Fe, Pb, etc. The insoluble composites of silica and alumina were separated by filtration, at the end of each leaching experiment. The filtrate (metals sulfate solution) was analyzed by Atomic absorption spectroscopy.

Leaching Efficiency for Copper

Leaching Efficiency for Copper (L.E.Cu) was calculated by the following relationship [13].

$$E\% = (C1 \times V)/(Co \times W) \times 100 \quad \text{.....................................} \quad (1)$$

Where:

E = Leaching Efficiency of copper (L.E.Cu).

- $C1$ denotes the concentration of a metal in solution in g/l.
- Co denotes the concentration of a metal in solid in wt%.
- V denotes the volume of leaching solution in l.

- W denotes the weight of solid sample in gm.

d. Filtration Process

The solution (metal sulfate) was filtrated by vacuum filtration, the filter cake after completion of the filtration was dried in drying oven, at 110 °C, for 30 min and sent to EDS analyses for the purpose of examination.

e. Recovery of Copper (Chemical Precipitation)

After determining the optimum conditions for leaching process , zinc powder was used to precipitate the dissolved copper in the leaching solution, According to the following equation [14]:

$\mathbf{CuSO_4\,(aq) + Zn(s) \rightarrow \quad ZnSO_4\,(aq) + Cu(s)}$ ....(a)

A displacement reaction between copper sulphate and zinc was occurred when adding zinc powder in the leaching solution, A more reactive metal (Zn) will displace a less reactive metal from a solution of one of its salts ($CuSO_4$). The amount of added zinc powder was estimated by the ratio of dissolved copper ions in the leach solution measured by Atomic absorption spectroscopy.

Precipitation Conditions

1. Leaching solution was done by leaching 25 gm of copper slag powder in 250 ml of diluted sulfuric acid with the optimal conditions of the leaching experiments.
2. All experiments were conducted at room temperature 27 ° C and PH 1.5. (when adding 10 gm of sodium bicarbonate to 250 ml of precipitation solution).
3. Amount of zinc powder: The different amounts of zinc powder added to the 200 ml precipitation solution were (2.7, 2.8, 2.9, 3) gm at 10 minute.
4. Precipitation time: The precipitation time used was (8, 10, 15, 20) minutes.

The value of ph was measured by a PH meter type (PH.mv.Temp) .

After obtaining the best result of process, the liquid was filtered leaving the copper powder on the filter paper, which was dried in the vacuum drying oven to 30 minutes at 90 ° C. Then this powder was sent to (XRD) to know the main phases and (EDS) to determine the percentage of copper and impurities in powder and finally sent to Atomic absorption spectroscopy to determine the final purity of copper powder. Figure 3 demonstrates the stages of precipitation.

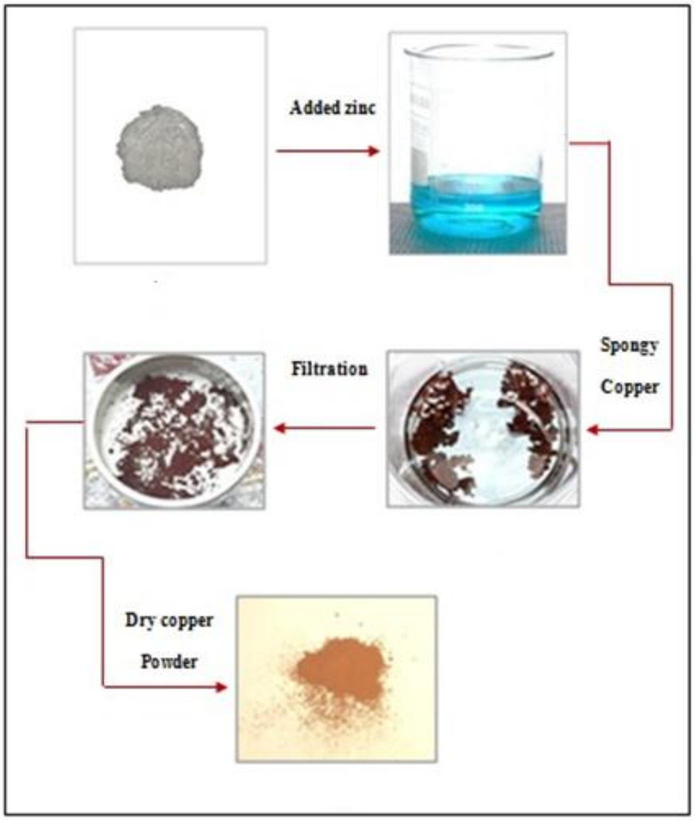


Figure 3: stages of Precipitation

f. Copper Recovery Ratio

After obtaining the copper powder at the optimum conditions of the precipitation process, the copper recovery ratio of the slag was calculated by the following law [15]:

Copper recovery ratio (R%)= (Mass of copper produced)/(Mass of copper in slag)× 100………(2)

Results and Discussion

1. Result of Chemical and Mineralogical Analysis

The chemical composition results that related to copper slag are displayed in Table (4). From this table, the percentage of copper is about 11.4%. The chemical analysis results also show that the copper sample contains high amounts of Si, Zn, Al, Fe and low amounts of Ca, S, K, Pb.

Table 4: Chemical composition analysis of Shaheed copper slag sample

Constituent	Zn	Si	Cu	Fe	Al	Ca	S	K	Pb	Other	L.O.I
Percentage%	14.7	19.1	11.4	5.5	8.4	2.9	2	1.5	1.5	١	32

X-Ray diffraction analysis of copper slag samples is shown in Figure 4, this result confirms that the copper is found in copper slag as two phases, CuO and Cu.

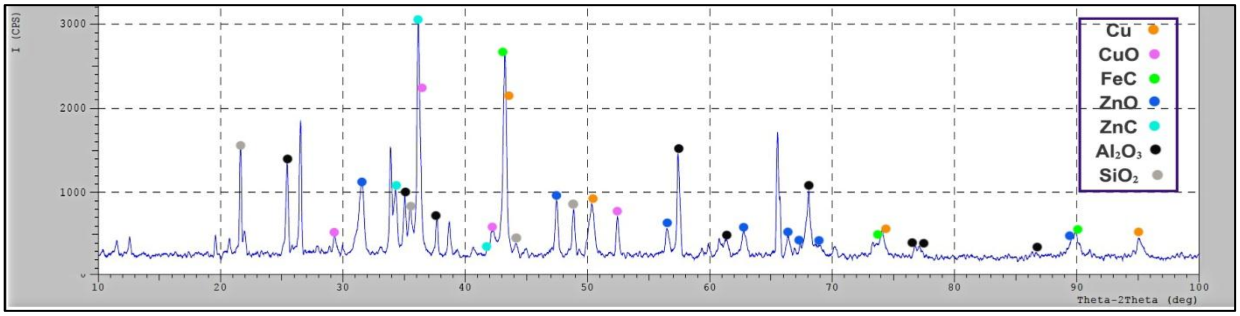


Figure 4: X-ray diffraction analysis of copper slag samples

2. Concentration by Sieving

The results of the volumetric gradient that performed on copper slag are illustrated in the table 5, it's shown that neither copper nor the other important impurities in slag were concentrated at specific sieve size.

Table 5: The weight distribution and chemical analyses for copper and important impurities of copper slag.

Sieve Size	**Sieve (μm)**	**Weight (g)**	**Weight (%)**	**Zn Wt.%**	**Si Wt.%**	**Cu Wt%**	**Fe Wt.%**	**Al Wt.%**
250	+ 250	77.25	31	15	19.3	11.6	5	8.3
150	-250 +150	91.78	36.7	11.3	19.1	11.4	7٥.	8.4
75	-150 +75	62.36	24.9	13.5	18.8	11.4	5.8	8.2
53	-75 +53	12.57	5	14.7	18.5	11.3	6	7
Pan	-53	4.31	1.7	15.2	19.2	7.8	5.9	٣.٨
Dust loss		1.7	0.7					
Total		250	100%					

3. Leaching of Copper

Effect of Acid Concentration

Five different concentrations are tested so as to establish the maximum leachibility of copper by sulfuric acid (H_2SO_4). The levels of these concentrations are: 20, 30, 40, 50 and 60 wt. %. The experiments are implemented under the conditions, 2 ml H_2O_2 added, particle size (-75+53µm), 8:1 v/wt liquid to solid ratio, speed stirrer 100 rpm and 20 min reaction time. The heating was not used in all experiments, and the operation was carried out at room temperature. The experimental results are plotted in Figure 5.

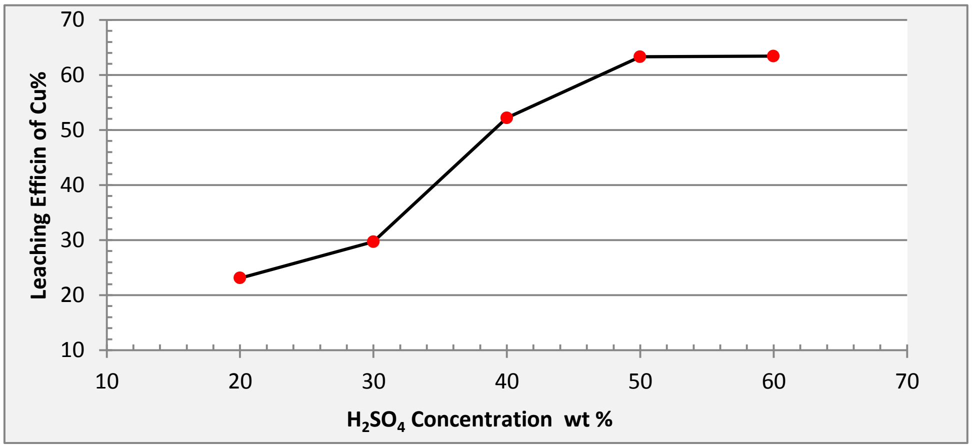


Figure 5: Effect of acid concentration on the (L.E.Cu) %.

From this figure, it can be concluded that the leaching efficiency of copper (L.E.Cu) increases as the acid concentration increases, where the highest percentage of (L.E.Cu) was 63.4% at 60% acid concentration, while the lowest (L.E.Cu) was 23.1% at 20% acid concentration. The increase in (L.E.Cu) is due to the increased concentration of hydrogen ions and active sulfates that degrade water and react with copper to give dissolved copper sulphate and water. This behavior is agreement with that recorded by [16]. The difference in the (L.E.Cu) is very low between the concentration 50% and 60% where 63.3% and 63.4% respectively, so the concentration of 50% is then used to reduce the amount of acid in the dissolved of copper.

Effect of H_2O_2 Addition

The best results that have been determined from the previous experiments, included the concentration of acid by 50%, particle size (-75+53µm), liquid to solid ratio 8:1 v/wt , speed stirrer 100 rpm and 20 min reaction time. The effect of the addition of

Hydrogen Peroxide (H_2O_2) has been studied on the leaching process at different rates: (1ml, 2ml, 3ml, 4ml, 5ml and 6ml). The results that obtained are displayed in Figure 6.

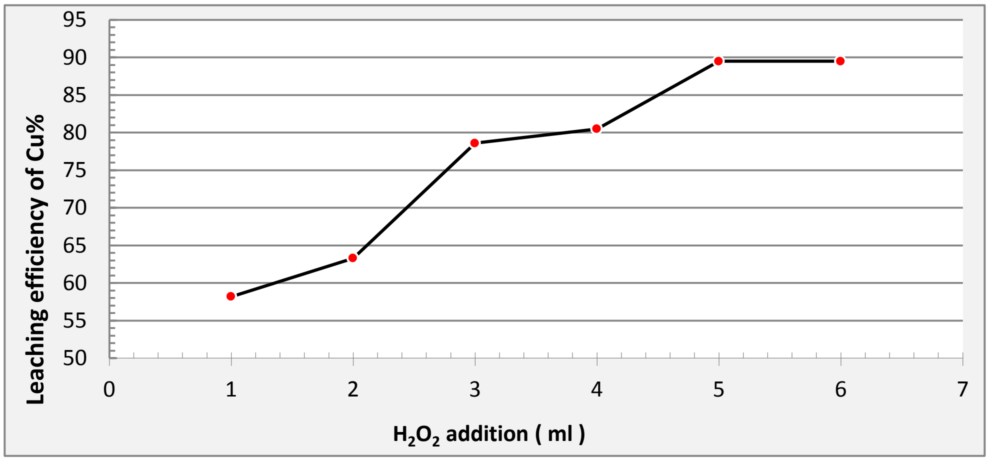


Figure 6: H_2O_2 addition (ml) on the (L.E.Cu) %

It can be noticed from this figure that the (L.E.Cu) increases as the H_2O_2 addition increases, where the highest percentage of (L.E.Cu) obtained was at 5ml of H_2O_2 addition and reached to 89.5%, while the lowest (L.E.Cu) reached to 58.2% at 1ml of H_2O_2 addition, so there was no significant increase in leaching after adding more than 5ml of H_2O_2.

The reason for increasing (L.E.Cu) is illustrated by the following points:

1- Hydrogen peroxide is a strong oxidizing agent.

2- The reaction of sulfuric acid with water is a heat-reactive reaction, where the temperature of the reaction is 120 ^{O} C. The high temperature with the presence of a strong oxidant factor leads to the acceleration in the process of copper oxidation and thus easy conversion into ion [17].

Effect of Particle Size

After selecting the optimal process leaching variables from the acid concentration 50% and 5 ml H_2O_2 addition, different experiments were carried out according to the size of the particles for the purpose of determining the best particle size can increase of (L.E.Cu). The following particle sizes were used (+250, -250 +150, -150 +75, -75 +53, -53), with the following constant conditions: (8:1 v/wt) liquid to solid ratio, speed stirrer (100 rpm) and (20 min) reaction time. The results obtained are presented in Figure 7.

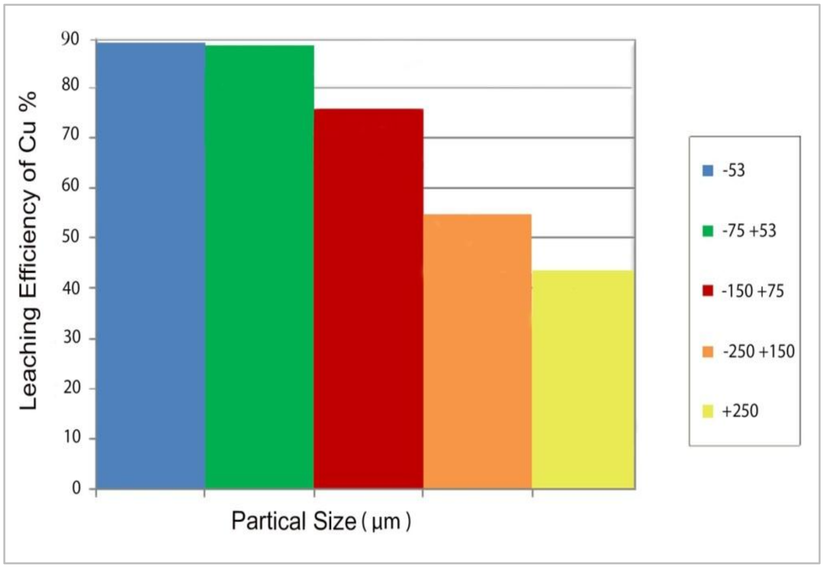


Figure 7: Effect of particles size on the (L.E.Cu) %

It can be seen that the (L.E.Cu) increased as the particles size was decreased, the highest percentage of (L.E.Cu) obtained was at -53µm and reached to 89.6%, while the lowest (L.E.Cu) was 47.3% at +250µm particle size. The difference in the (L.E.Cu) is very low between the (-75+53µm) and (-53µm) where it reached 89.5% and 89.6%, respectively, so the partial size of (-75+53µm) is then used. The reason for increasing the (L.E.Cu) with the decrease in particle size is due to increasing of the surface area exposed to acid, the rate of transmission of materials is large and thus increases the reaction rate.

Effect of Liquid to Solid Ratio

After adoption the partial size (-75+53µm) of previous experiments as the best partial size suitable for solubility and 50% concentration of acid with the 5ml of H_2O_2 addition, several experiments were conducted to study the effect of liquid to solid ratio on the (L.E.Cu). The following liquid to solid ratios were used: (5:1, 8:1, 10:1, 15:1 and 20:1 v/wt), with the constant conditions: speed stirrer 100 rpm and 20 min reaction time.

The results of these experiments are illustrated in table 6. It can be conclude that the (L.E.Cu) increases as the liquid to solid ratio increases, where the highest percentage of (L.E.Cu) obtained was at 15:1 and 20:1 v/wt and reached to 92.5%, while the lowest (L.E.Cu) reached to 73.8 % at 5:1 v/wt. The increase in L.E.Cu was due to diffusion of slag particles within the solution when liquid to solid ratio was increased. This process helps to prevent aggregations and the ease of mixing the solution with the slag particles, thus increasing the reaction rate. This behavior is in a close agreement with that recorded by [18]. There is no significant difference in the (L.E.Cu) at liquid to solid ratio of (10:1, 15:1 and 20:1 v/wt) since it was 92.4%, 92.5% and 92.5% sequentially, suggesting that the ratio between solid and liquid (10:1) can be considered as an optimal ratio.

Table 6: Effect of liquid to solid ratio on the (L.E.Cu)

Liquid to Solid ratio Wt/v	Leaching efficiency of Cu %
5:1	73.8
8:1	75.7
10:1	92.4
15:1	92.5
20:1	92.5

Effect of Stirring Rate

Effect of stirring speed at dissolution rates for the copper was studied at different stirring speed (0, 200, 500, 800 and 1000 rpm). The experiments were conducted at 50% concentration of acid, 5 ml of H_2O_2 addition, the partial size (-75+53μm), 10:1 liquid to solid ratio and 20 min leaching time. The results of these experiments are depicted in Figure 8.

It is noted that increasing the speed up to 500 rpm leads to increase in (L.E.Cu), where the maximum (L.E.Cu) is 95.1% at the stirring rate 500 rpm. But, when increasing the speed for more than 500 rpm, the (L.E.Cu) is decreasing, where the (L.E.Cu) was 79.5% and 70.2% at speed 800 and 1000 rpm, respectively.

The reason for this decrease is due to the rapid decomposition of hydrogen peroxide, and hence the lack of control over the propagation process during the reaction. Therefore, the time is not sufficient for the copper oxidation process to be correct. The behavior of decrease in (L.E.Cu) with high speed stirring is in agreement with that recorded by [19].

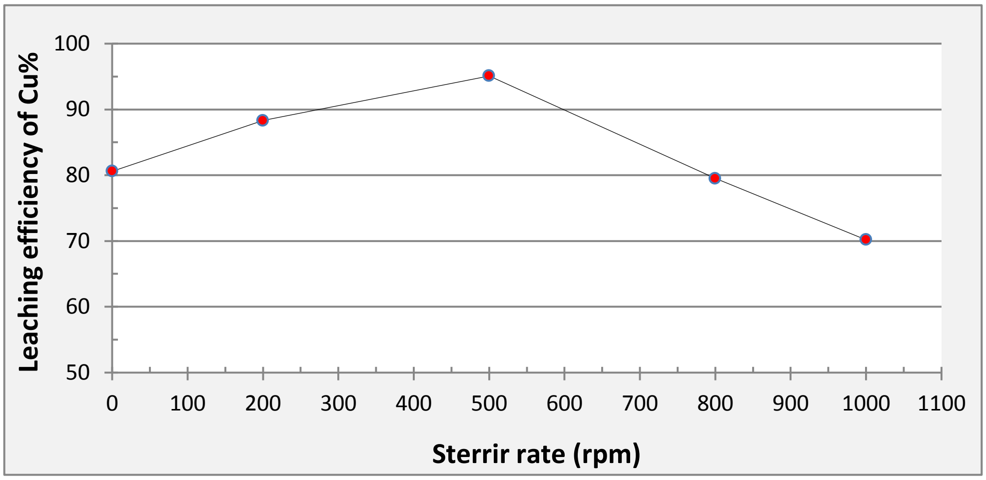


Figure 8: Effect of Stirring Rate (rpm) on the (L.E.Cu) %

Effect of Leaching Time

Leaching time is the last variable that has been studied in the process of leaching, and it was selected as (10, 15, 25 and 30 min) with the following conditions obtained from the previous experiences: (the acid concentration 50%, 5 ml H_2O_2 added, particle size (-75+53µm), 10:1 v/wt liquid to solid ratio and speed stirrer 500 rpm). The results of the effect of leaching time on the (L.E.Cu) are represents in Figure 9.

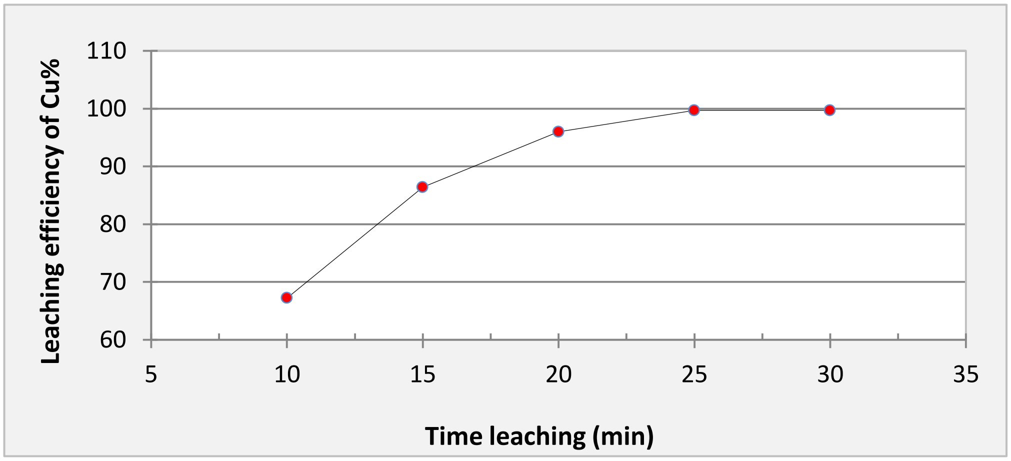


Figure 9: Effect of leaching time (min) on the (L.E.Cu) %

According to Figure 9, it is clear that the increase of leaching time leads to increase (L.E.Cu). The

best (L.E.Cu) was 99.7% obtained at 25 min, while the lowest (L.E.Cu) was 67.6 at 10 min of leaching time. The percentage of (L.E.Cu) stabilized even after staying for more than 25 min. The reason for increasing the (L.E.Cu) with the increase in leaching time is due to that the increase in time increases the solubility of the solution by contacting with the solids, and giving sufficient time for the diffusion of the solution in the solids, thus increasing the reaction rate.

4. Recovery of Copper

Result of Precipitation of Copper

After determining the optimum conditions for leaching process using 250 gm of slag, copper precipitation process was performed using a pure zinc powder. The experiments were carried out at room temperature and 1.5 PH value. Different amounts of zinc powder were used at 10 min, for the purpose of obtaining the best precipitation efficiency of copper. Then using different times to identifying the sufficient time to complete of replacement reaction between zinc and copper.

Effect of zinc powder addition

Results of the effect of zinc powder addition (2.7, 2.8, 2.9, 3, 3.1 gm) at 10 min on the precipitation efficiency of copper are shown in Figure 10.

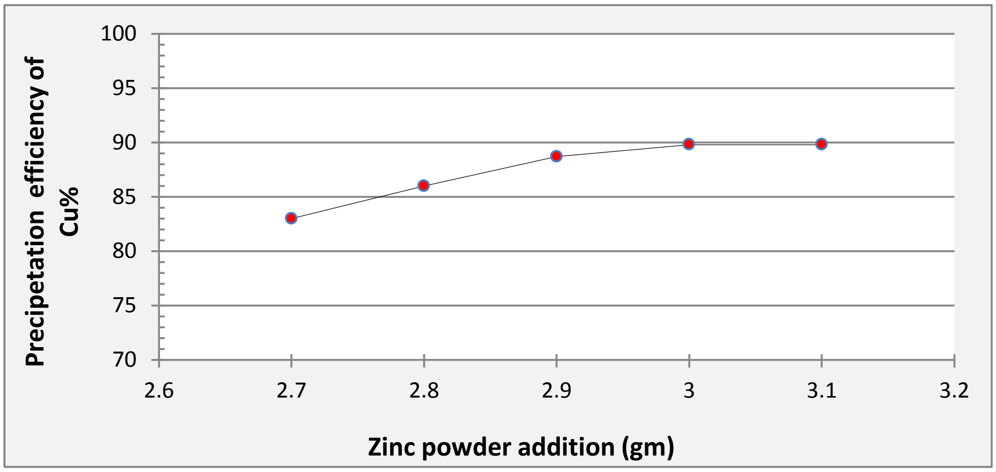
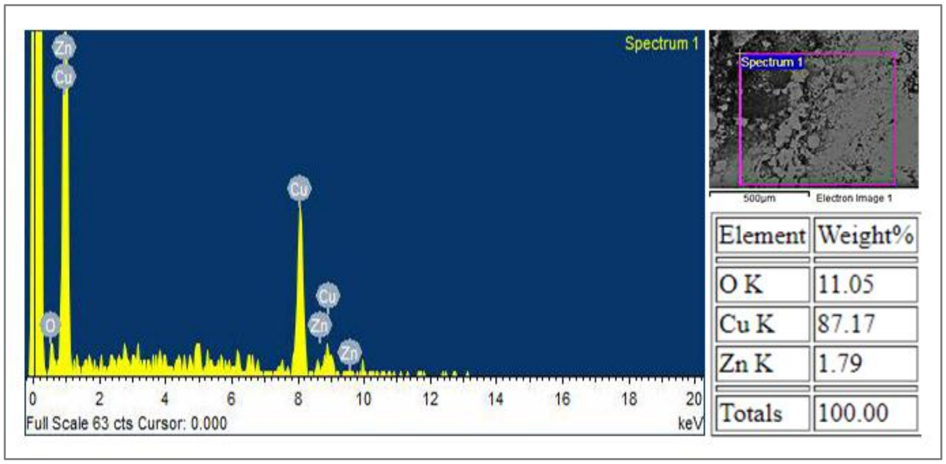


Figure 10: Effect of zinc powder addition on precipitation efficiency of copper at room temperature, 1.5 PH and 10 min reaction time.

It can be seen that the best percentage of precipitation efficiency of copper obtained was 89.8 % when adding 3gm of Zn powder, while the lowest percentage of precipitation efficiency of copper was 83 % when adding 2.7 gm of Zn powder. There was no significant increase in precipitation efficiency of copper after adding more than 3 gm of zinc powder. After the determination of the best weight of zinc addition, which was 3 gm, copper powder was filtered and dried in oven for 30 min at 120°C. According to EDS test that shown in Figure 11.



Element	Weight%
O K	11.05
Cu K	87.17
Zn K	1.79
Totals	100.00

Figure 11: Pattern for copper precipitate at 10 min

There was a few percentage of zinc metal with pure copper and oxide copper, while in the X-ray diffraction results that shown in Figure 12, only pure copper and copper oxides phases were appeared. The explanation for the presence of zinc in Cu powder by EDX is because there is not enough time to complete the reaction between copper and zinc. The presence of a percentage of copper oxide is due to the oxidation of copper in drying oven.

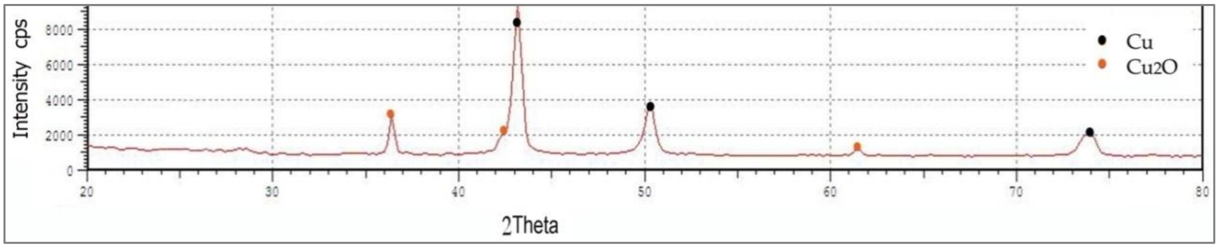


Figure 12: XRD pattern for copper precipitate at 10 min

Effect of reaction time

After determining the best addition of zinc 3gm from the previous experiments, and getting the precipitation efficiency of copper 89.8 % in 10 minutes, the effect of reaction time on the precipitation efficiency of copper was studied. Results of effect of reaction time was illustrated in Table 7, It can be seen that precipitation efficiency of copper was increased when time reaction increased. The best percentage of precipitation efficiency of copper obtained was 99.8 % at 20 min reaction time, while the lowest percentage of precipitation efficiency of copper was 92 % at 5 min reaction time. After 20 min the percentage of precipitation efficiency of copper was established.

Table 7: Effect of reaction time on the precipitation efficiency of copper

Zinc powder addition (gm)	**Reaction time (Min)**	**Precipitation efficiency of copper (%)**
3	5	65.7
3	15	94.5
3	20	99.8
3	25	99.8

The result of XRD that shown in figure 13 after the sample was filtered and dried in vacuum furnace revealed that the only predominant phase was pure copper . The results of EDS in Figure 14 of three different areas for same sample showed that the percentages of copper in spectrum 1, 2, and 3 were (98.98, 98.74, 100%) respectively and a few percentages of oxygen were recorded in spectrums 1 and 2 which were (1.02, 1.26%), respectively. This means that the zinc was removed due to increased reaction time, and the percentage of oxygen has been reduced in comparison to previous results due to the use of vacuum drying.. Figure 15 shows the SEM image of copper precipitate at 25 min. Purity of copper was 99.2 measured by Atomic absorption spectroscopy

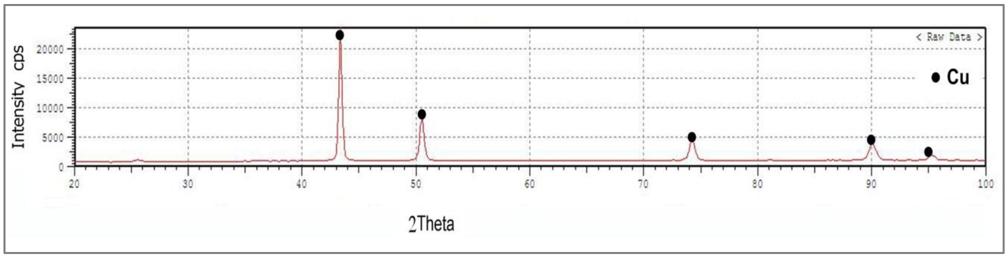
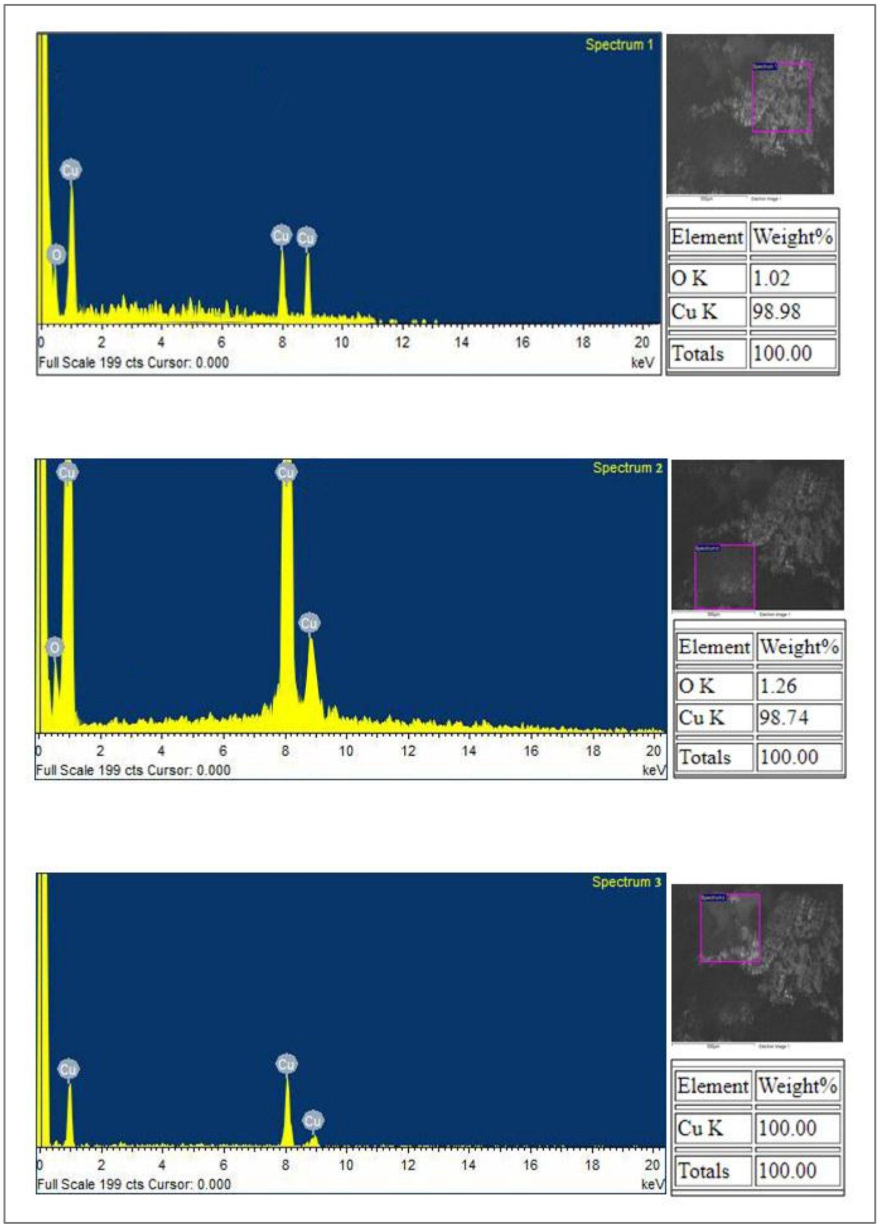


Figure 13: XRD pattern for copper precipitate at 25 min

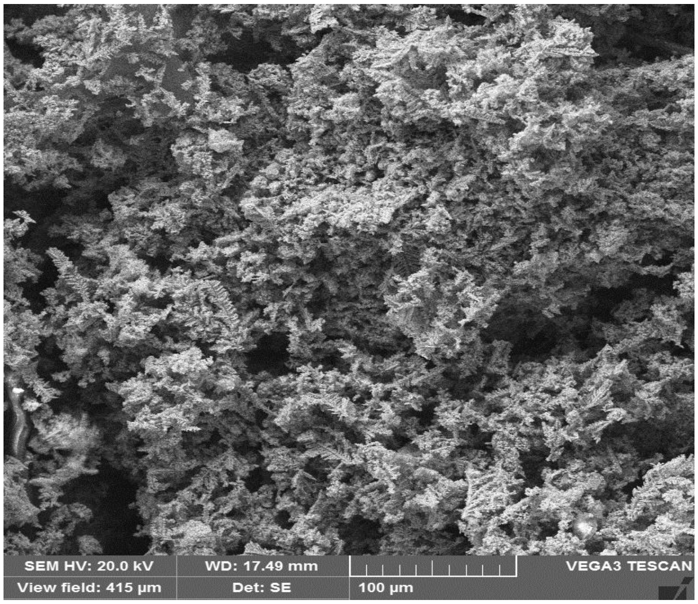


Element	Weight%
O K	1.02
Cu K	98.98
Totals	100.00

Element	Weight%
O K	1.26
Cu K	98.74
Totals	100.00

Element	Weight%
Cu K	100.00
Totals	100.00

Figure 14: EDX spectrums of copper precipitate at 25 min dried under vacuum in three different spots



Figurer 15: SEM of copper precipitate at 25 min

Conclusions

The conclusions of this research can be summarized as following:

1- Neither copper nor the other important impurities in slag were concentrated at specific sieve size.

2- Leaching of copper from slag can be used successfully with H_2SO_4.

3- 99.8 of copper leachibility was achieved under the flowing optimum conditions: (acid concentration 50%, speed stirrer 500 rpm, particle size -75+53µm, liquid to solid ratio 10:1 v/wt , H_2O_2 addition 5 ml and leaching time 25 min).

4- Leaching efficiency of copper increased as acid concentration, liquid to solid ratio, H_2O_2 addition and leaching time were increased while it decreased when particle size was increased.

5- Leaching efficiency of copper increased when speed stirrer was increased up to 500 rpm, after this value the leaching efficiency of copper was decreased.

6- 99.8 % of copper was precipitated by adding 3gm zinc powder at 20 min reaction time.

7- Copper recovery ratio was 99.3 %, and the purity of copper reached to 99.2 %.

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استرجاع النحاس من خبث النحاس بالطريقة المائية من مخلفات المصانع العراقية

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الخلاصة

في هذا البحث تم دراسة استرجاع النحاس من خبث النحاس باستخدام الطريقة المائية. تم جلب نماذج العينيات من شركة الشهيد العامة. اظهرت نتيجة التحليل الكيميائي للنموذج ان الخبث يحتوي على ١١.٤ % من معدن النحاس . ان عملية استرجاع النحاس تضمنت مرحلتين: المرحلة الاولى هي عملية النض باستخدام حامض الكبريتيك المخفف.

تم دراسة اهم العوامل المؤثرة على عملية النض مثلا : تركيز الحامض، تأثير اضافة بيروكسيد الهيدروجين، الحجم الحبيبي، نسبة السائل الى الصلب، سرعة التحريك ووقت عملية النض عن طريق تغير عامل مع تثبيت العوامل الاخرى عند درجة حرارة الغرفة.

المرحلة الثانية كانت عملية ترسيب النحاس من سائل النض النهائي بواسطة مسحوق الزنك باستخدام اوزان واوقات مختلفة عند درجة حرارة الغرفة ايضا، تم تثبيت درجة حامضية محلول بقيمة ١.٥.

نتائج تجارب المرحلة الاولى بينت ان اعلى نسبة اذابة للنحاس وصلت الى ٩٩.٧ % تحت الظروف المثالية التالية: (٥٠% تركيز الحامض، اضافة ٥ مل من بيروكسيد الهيدروجين، الحجم حبيبي (٥٣+٧٥–)، نسبة السائل الى الصلب ١:١٠ ، سرعة التحريك ٥٠٠ دورة بالدقيقة و بزمن مقداره ٢٥ دقيقة.

نتائج تجارب المرحة الثانية سجلت اعلى نسبة ترسيب النحاس والتي بلغت ٩٩.٨% بعد اضافة ٣ غرام من مسحوق الزنك في غضون ٢٠ دقيقة.

بينت نتائج الفحص بحيود الاشعة السينية (XRD) للمنتج النهائي ان الطور السائد هو طور النحاس النقي فقط اما نتائج الفحص بمطيافية تشتت طاقة الاشعة السينية (EDS) سجلت ظهور نسبة قليلة من الاوكسجين مع معدن النحاس المترسب. بلغت نسبة استرجاع النحاس النهائي ٩٩.٣% بنقاوة وصلت الى ٩٩.٢%.

الكلمات المفتاحية:– استرجاع، خبث النحاس، الطريقة المائية، النض، الترسيب.