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RESEARCH ARTICLE

EXPERIMENTAL STUDY OF LEACHING OF COPPER FROM COMPUTER ELECTRONIC WASTE

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ABSTRACT

This study aims to design a commercial process to leaching copper from electronic waste. The proposed leaching process has been sub-divided into two stages 1 physical separation 2 metal recoveries. Stage 1 involve s size reeducation to 3-4 mm, stage 2 involves the dissolution of metals in acid in different operating condition (time, temperature, concentration of acid, weight of sample).

Copper leaching and its affecting factors have been studied statistically. Statistical analysis of the data showed that the most influential factor on the process of leaching process are weight, concentration $H_2O_2$and Temperature, finally the results of experimental runs for the leaching of copper from the computer circuit boards shown High recovers for copper (>%80(Under suitable condition of weight 83.1 gm,concentration of H_2O_2 (0.86 gm/ l) and temperature 100 OC in 0.5 hr.

INTRODUCTION

E- waste recycling is economically motivated by the content in bases precious and special metal where no specific law regulates e-waste recycling yet, the existing system has developed organically from the pre-existent scrap industry traditionally dealing with scrap from ship breaking end-of –life vehicles or demolition waste (100).because and a lack of control and regulation of the recycling industry ,the poorest strata of the population find an economic benefit in recovering the valuable parts of e-waste with non-scientific methods while simply dumping the non-profitable and often hazardous fractions[1]

The recycling of E-waste engages two types of facilities according to the nature of the methods involved. In the first step in the recycling process is manual dismantling which allows the recovery of whole homogenous parts that may be reusable .Valuable or recyclable e.g. whole components metal plastic or glass parts and hazardous components that require further special treatment .Further liberation and size reduction of the recyclable materials e.g. PC-boards, is usually achieved by some kind of shredding or crushing process. After the size reduction, the materials are sorted into defined output fractions based on their specific physical characteristics .typical sorting processes used are screening magnetic separation of ferrous parts, eddy current separation (electric conductivity) of non-ferrous metals and density or gravity separation of plastics[2].

Further upgrading and refining of the metal containing fractions are performed by metallurgical processes .Both pyro metallurgical processes, in which the metals are melted and pyro metallurgical processes in which the metals are dissolved are used and often in combination. A Pyro metallurgical process in copper smelters followed by electrolytic refining has thus become the dominant method to recover non-ferrous metals. Including precious metals as well as other valuable metals from e-waste in the last two decades .In the process the crushed scraps are burned in a furnace or in a molten bath to remove plastics .At the same time metals such as iron lead and zinc are converted into oxides that will become fixed within a silica based slag .The melt that mainly contains copper (but also silver, gold, palladium, nickel, selenium and zinc)is further refined in a converter and an anode furnace where it is cast into anodes with a copper[2]

H Deveci studied the effects of concentration of hydrogen peroxides, sulphuric acid and temperature on the extent of recovery of copper from scrap TV boards were demonstrated using 2^3 FULL FACTORIAL DESIGN. The concentration of H2O and temperature were found to be statistically significant parameters while concentration of H2SO4 was insignificant in the range tested[3]T.R. Mankhand and et al studied pyrolysis of

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printed circuit boards in this work a kinetic study on the low temperature pyrolysis of waste printed circuit board using a thermogravimetric analyser has been attempted. The T Ganalysis was conducted in nitrogen and air atmospheres range of 200-600 C at a heating rate of 40 C /min[4].

Felix W. studied the leaching of dolomitic-copper ore using sulphuric acid under controlled conditions with a view to evaluating the economic value and the effect of ore pulverization particlesize, temperature and PH on the recovery of copper from chalcopyrite .The sulphuric acid was found to be effective in recovering copper from chalcopyrite with efficiencies of 72 to 92% for 75 micron particle size and to 65 to 84% for 212 micron sieve size at different pulverizing times. [5]

Experimental procedure

Experimental apparatus used for the experimental work is shown in Figure (1).The computer printed circuit boards where indicating the zone selected in Figure (2). The methodology of this research work comprised a series of experiments performed in the following sequence meticulous:

A- Collection of computer printed circuit boards. B-Cutting of the selected of the parts containing copper and cute to the average pieces of 3-4 mm the copper contend in pieces PCB was 9.5 % massatomic adsorption spectro photometer (AA-6300) (shimadzu).[6] C-The leaching solution were prepared at the required strength of sulphuric acid 1.6 M H_2SO_4 and hydrogen peroxide H_2O_2 (0.2-0.863) the flask was placed on electrical heater with controlled magnetic stirrer where the flask provide with temperature control (32-100 C) and weight of sample (25- 84 gm), the top of the flasks were connected to reflux condenser .Samples were taken at certain intervals i.e. 0.25, 0.5,1,2, 4, 6 hrs. The samples were analyzed of copper using an atomic adsorption spectrophotometer (AA-6300) (shimadzu).

$$Cu + H_2O_2 + H_2SO_4 \longrightarrow Cu^{+2} + + 2\,H_2O$$

Table 1 full experimental work

	Recovery	T	C	W
1	10	32	0.2	25.4
2	12	47	0.308	41.5
3	15	55	0.38	47
4	40	62	0.433	54.2
5	50	66	0.45	58
6	46	70	0.48	60
7	82	76	0.52	65.2
8	80	82	0.60	72
9	70	86	0.612	75
10	66	88	0.65	76
11	78	92	0.68	78.5
12	83	100	0.80	83.1

RESULTS AND DISCUSSION

Statistica 8.0 (data analysis software program) has been used to conduct the analysis of data collected from Twelve experiments was conducted to extract copper from parts of scrap motherboard of the waste Computers.

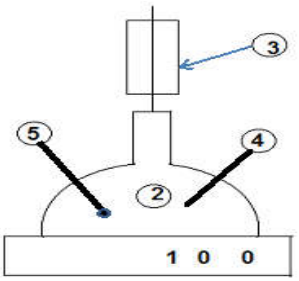


Figure 1 Experimental Apparatus, 1- Electric heater with control and magnetic stirrer.2- 0.5 L container reaction 3- Reflux condenser 4- Outlet (access) for sample.5- Temperature Indicator

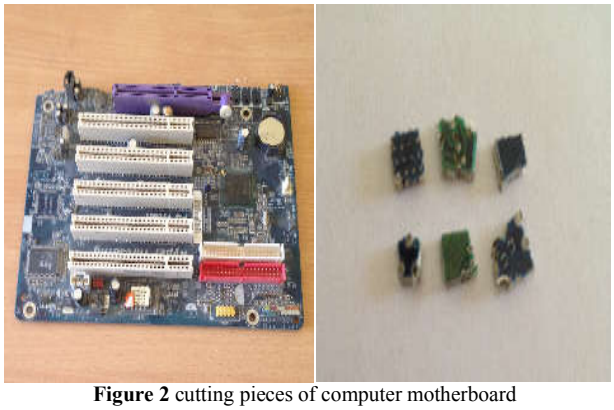


Figure 2 cutting pieces of computer motherboard

To determine the effect of different factors used in the extraction of copper experiments a specific special tests was done where 12 pieces with Various weight of motherboard Pieces Random chosen ranging 25 gm to 84 gm and was conducted twelves experiments , each experiment on weight at certain temperature and a certain concentration of H_2O_2 . The temperature of the experiments and the concentration of H_2O_2 were increased with increasing the weight of the piece. The data was shown in previous table 1. Based on data in table 1, statistica 8.0 program used to perform regression analysis to see the P- values and to figure out the impact of each factor in the reaction are being between sulfuric acid and copper the existence of H_2O_2 at certain temperature, next table (2) shown P- values and estimated effect:

Table 2 P- values and estimated effect of H_2O_2 , Temperature, weight

Term	Estimate	P-value
H_2O_2	3.42706	0.000000
weight	31.16535	
Temperature	0.84601	0.000001
H_2O_2 * weight	1.247039	0.000001
H_2O_2* Temperature	9.090335	
weight*Temperature	0.088943	0.000025

The linear least square regression analysis used to see and check the importance and the impact of the factors used in the Model : H_2O_2 ,weight of cutting piece , Temperature , then to know the importance and effect of Coupling these factors together in a Model : H_2O_2 * weight , H_2O_2* Temperature , weight*Temperature .The estimated model is: C = -a1+a2*W-a3*T The resulting equation from linear regression analysis is: C = 3.427092 + 31.16586 W + 0.846006T

The R value was R =.99914999, this R value means that data

was valid. The P- value represent indicator of the level of importance of the factors involved in Model and are associated the value of Alpha value =0.050. P-value definition: "the probability, if the test statistic really were distributed as it would be under the null hypothesis, of observing a test statistic [as extreme as, or more extreme than] the one actually observed."[7], when the p-value smaller than alpha value the factor effect in the tested model was important else not. Now if we look to data table: for H_2O_2 P-value=0.000000 lower than alpha=0.05 that mean H_2O_2 has a Signiant effect in the process, now let take (H_2O_2 * weight)the P-value equal 0.000001 which is also less than alpha value but here the temperature doesn't have large effect because this P-value is = 0.000001 , As for the factor (weight*Temperature)the P-value is 0.000025 which is less than 0.05 and this give us indication that there is an important association between weight of cutting pieces and the temperature at which the experiment conducted**.**

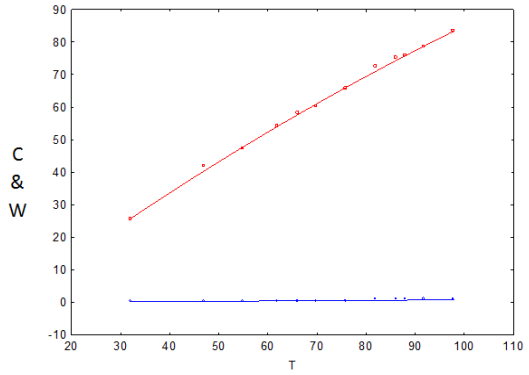
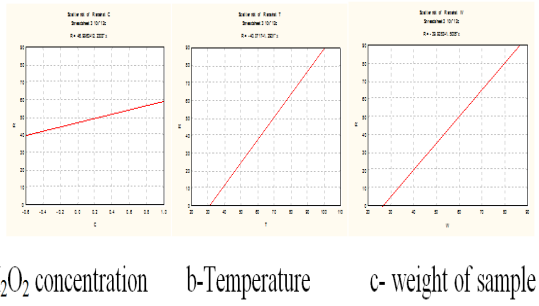


Figure 3 curve relation between H_2O_2 concentrations, Temperature C, weight of sample

The above figure3 gives the relation between H_2O_2 concentration , , Temperature C, weight of sample , the curve in previous figure a smooth curve that is mean the data and the resulting equation in the right direction .The following figures (4) a, b, c show us the relation between each of H_2O_2 concentration Temperature, weight of Piece sample with Mean Copper Recovery and it describes how the impact of each of these factors to extract copper from broken pieces of scrap motherboard for each one separately.



a- H_2O_2 concentration b-Temperature c- weight of sample

Figure 4 impact of a-H_2O_2 concentration, b- Temperature C, c- weight of sample on copper recovery

we note that copper recovery increasing with H_2O_2 concentration increase. The temperature of experiment effects positively on copper recovery where recovery increase with temperature, also copper recovery increased with more weight of sample.

CONCLUSION

The rapid increase of e-waste in recent years have a significant impact on the environment and lead to the existence of serious environmental problems on people and it prefer to be treated before the problem get worse. So it is to e waste recycle very important for the purposes of managing waste treatment and considered as sources of economic. This study shows the possibility to process computer motherboard scrap after cutting and it show ease of handling and extract copper by using sulfuric acid, also the presence of H2O2 increase the effectiveness of copper extraction.

A result shows the importance of effect of the weight sample, then the effect of the presence of hydrogen peroxide and finally shows temperature effect. Test results also shows that the presence of hydrogen peroxide and temperature together are the most important factors affecting the rate and extent of extract copper. Then in second degree comes the effect of H_2O_2 and weight factors together on copper leaching. Finally the result shows that High recovers for copper (>%80(under suitable condition of size of elements concentration of H_2O_2 (0.86)and temperature 100 ^{O}C in 0.5 hr.

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