

# EXTRACTION OF METALS FROM THE DISCARDED PRINTED CIRCUIT BOARD BY LEACHING

Priya Gautam<sup>1</sup>, Prof. Ashok K Sharma<sup>2</sup>, Prof. Sarita Sharma<sup>3</sup>

<sup>1</sup>M-tech Chemical Engineering, Ujjain Engineering College

<sup>2,3</sup>Professor, Department of Chemical Engineering, Ujjain Engineering College, Ujjain (M.P) India.

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**Abstract:** Electronic waste (E- waste) is the fastest growing new stream in Indian Industrial world which containing obsoletes. This E- waste increasing rapidly not only from the domestic generation but also from imported E-waste volume. E-waste is being exported from Western countries to the Asian/Developing countries like India, China for the disposal, due to lack of proper technology and flexible legislatives for recycling of waste electronic Equipment. E- waste has both its pros and cons i.e. advantages and disadvantages because it contain substances that can be classified as hazardous and non hazardous. The e – waste recycling process involves collection, dismantling, pre-processing, and End processing and final metal recovery.

In this paper mechanically pre- treated PCBs are leached with HCl and HNO<sub>3</sub> acidic solution and the distribution of the metals fraction were determined by using Atomic Absorption spectrophotometer analyses. It is found that the availability of copper in the sample is highest as compare to other metals. Experimental results also shows that leach liquor of concentration 3N HNO<sub>3</sub> was most efficient to recover metals.

After leaching of metals dissolved solution is taken for the final recovery of metals.

**Keywords:** E- waste, Leaching, PCB, recycling, recovery, Hydrometallurgy,

## 1. Introduction

Consumer electronics i.e. desktop, laptop and mobile phones have become an integral part of daily life and revolutionized the way we communicate, retrieve information, and view entertainment. Between computers, televisions, mobile devices, electronic games, and even devices which measure metabolic rate, it is estimated that the average person owns 24 electronic products (Consumer Electronics Association (CEA), 2008). We live in a society where newer is better, and for each new electronic gadget that reaches the market, one or more becomes outdated or reaches end-of-life. As a result e waste continuously increasing day by day. About 20-50 million tonnes of e-waste are generated worldwide <sup>(9)</sup>. E waste mainly involve discarded personal computers and mobile phones. It is estimated that about 100 million mobile phones and 17 million PC's are discarded annually in the world because of malfunctioning equipments, short life or obsoleting technologies <sup>(15)</sup>. These discarded PC's and mobiles having PCB (i.e. Printed Circuit Board) as an integral part. Printed circuit board is an important and essential component of all electronic and electrical equipments, containing lots of valuable metals together with the number of hazardous metals or minerals which can have an adverse impact on environment as well as human health. PCB is composed of non metals such as polymer, fiber glass, ceramics and metals like Cu, Al, Ni, Fe, Zn. About 40% are metals, 30% are non-metals and 30% are ceramics presented in PCB <sup>(2)</sup>. Many developing countries like India faces problem of disposal of rapidly growing discarded PCB due to lack of proper technologies and flexible rules and regulation for disposal. It is estimated that India generated 3.8 lakh tonnes per annum e waste out of which 19000 tonnes are recycled <sup>(11)</sup> and estimated 4.2 lakhs tonnes of e waste generates domestically and by imports from developed countries. E waste is the fastest growing new stream and a very important sector in Indian industrial world. The valuable and hazardous metals containing e -waste required special handling and recycling methods to avoid determinantal effects on human health and environment <sup>(6)</sup>. Ill effects of e-waste could be on soil from land filling through leaching of hazardous content, on air due to emission of gases and burning, in water due to contamination of rivers or other water resources. Impact or ill effects on human health of e -waste through inhalation of gases during burning process and through contact of skin with toxic substances or during recycling process if it is not carried out properly. The recycling process for recovery of metals from e waste including mechanical / physical process<sup>(3,8)</sup>, pyrometallurgical<sup>(2,7)</sup> and hydrometallurgical process<sup>(1,4)</sup> along with purification and refining. Mostly hydrometallurgical process (leaching) is used for recovery of metals from discarded PCB rather than pyrometallurgical process because hydrometallurgical process is environment friendly, energy saving and more easily controlled comprising with pyrometallurgical.

## 2. COMPOSITION OF PCB

Printed circuit board is an essential part of the all electrical and electronic equipments. It is composed of polymers, ceramics and metals <sup>(12)</sup> which all are comes under Hazardous and non hazardous categories. About 40% heavy metals present in it which are turned into hazardous residue if the discarded pcbs are not disposing properly. Metal compositions in PCBs are varies according to the manufacturer and the year of its manufacturing and technology <sup>(10)</sup>. Table 1 shows the composition of PCB <sup>(14)</sup>.

**Composition of PCB**

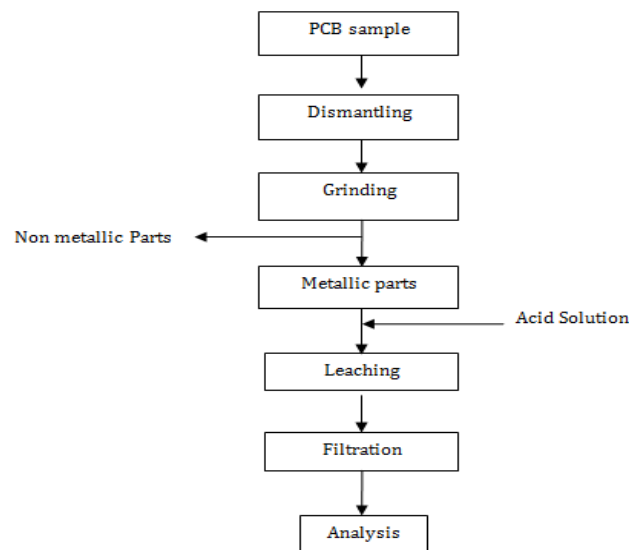
| Metals   | Availability (wt%) |
|----------|--------------------|
| Copper   | 30.57              |
| Aluminum | 11.69              |
| Zinc     | 1.86               |
| Tin      | 7.3                |
| Nickel   | 1.58               |
| Iron     | 15.21              |
| Lead     | 6.70               |

## 3. RECYCLING/RECOVERY PROCESS

Pyrometallurgical and Hydrometallurgical processes are used as end Processing for the recovery of discarded PCB. Mechanical process is usually used as pre treatment process before pyrometallurgical and/or hydrometallurgical process. In this paper hydrometallurgical process (leaching) is used for recovery of base metals from discarded PCB rather than pyrometallurgical process because it is a high temperature process easily causes serious environmental problems especially air pollution. Hydrometallurgy process is divided into three stages;

- Leaching
- Solution concentration and purification
- Metal recovery

Leaching is an important and first stage of Hydrometallurgical process. It is the extraction process in which a soluble substances are extracted from a solid by means of a solvent. After that the extract obtain from leaching is often subjected to concentration and purification before the metal recovery. The final step may involve precipitation or cementation process .



**Fig 1. Block Diagram of the Process**

#### 4. METHODOLOGY

The waste PCB of a discarded computer used in study. It is commonly used PCB that can be easily available at the e- waste disposal area or an electronic shops. Various components like RAM, ICs etc are attached on PCB were first removed manually from it. Then Chemical coating of epoxy resin present on pcb was removed by using NaoH <sup>(12)</sup> because the covering of this coating does not allow the leaching agent to penetrate through it. For the recovery of metals, waste PCB were cut into small pieces in different sizes instead of powder form. About 10gms of PCB sample was allowed to react with the 100ml of leach solution of 3N HCL/HNO<sub>3</sub>. The experiment was carried out at 60°C for 1hr. The leach liquor sample was collected, filtered and sent for chemical analysis by AAS to determine the metals concentration in aqueous solution.

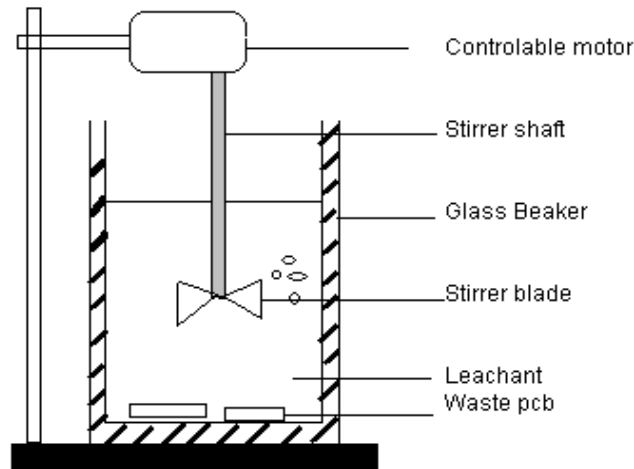


Fig2. Schematic of leaching test

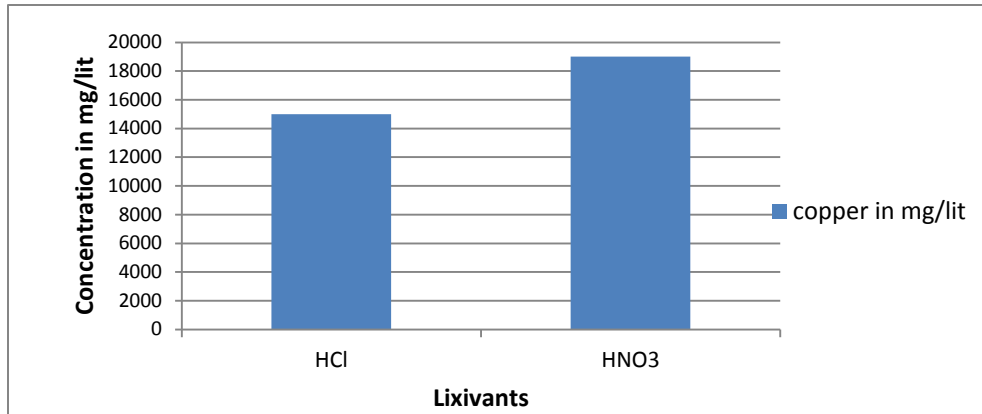
#### 5. RESULT AND DISCUSSION

Result obtained from analysis are shown in table1. The objective of this experiment is to determine the leaching ability of different acids at same concentration and compare the availability of different metals extracted from pcb with leaching of HCl and HNO<sub>3</sub>. It was found that at the same concentration (i.e. 3N) of HNO<sub>3</sub> leach liquor was more efficient than HCl to recover the metals. Graph 1 shows the availability of copper in different acidic solution and graph 2 shows the other metals obtained from leaching solution.

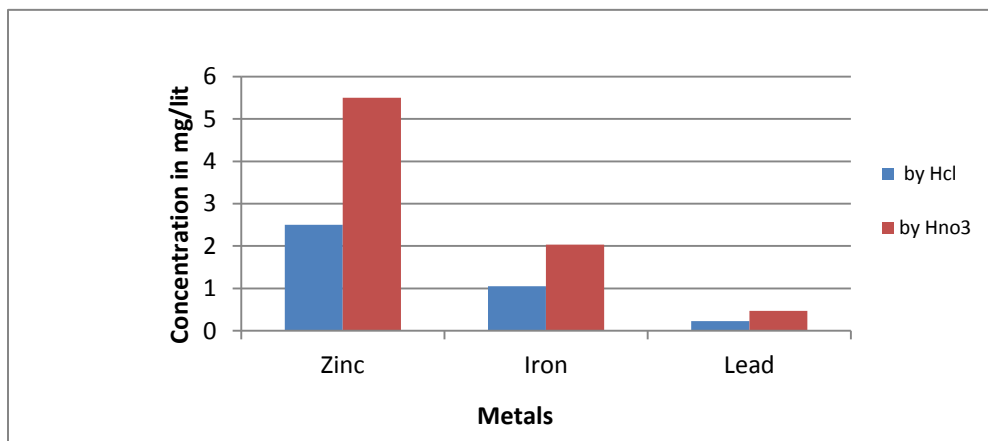
Table 1

Metals obtained from acidic leaching solution after 60 mins

| s.no | Metals | Availability by hcl (mg/lit) | Availability by hno3 (mg/lit) |
|------|--------|------------------------------|-------------------------------|
| 1    | Copper | 15000                        | 19000                         |
| 2    | Zinc   | 2.5                          | 5.5                           |
| 3    | Iron   | 1.05                         | 2.036                         |
| 4    | Lead   | 0.23                         | 0.467                         |



Graph 1



Graph 2

## 6. Conclusion

E- waste is one of the most hazardous waste which growing rapidly. If it is not regulated properly may be proved to be dangerous not only for humans but also for the environment. The main purpose of recycling PCB waste is to reduce the harmful effects cause due to hazardous material present in it and ensure maximum recycling<sup>(16)</sup>. Selection of efficient recycling method is required to achieve these goal<sup>(5)</sup>. Leaching was applied to determine suitable solvent to extract metallic parts. The result shows that the recovery of large pieces of PCB sample is efficiently recovered. The use of large pieces of pcb will facilitate the recycling of remaining board. Basic and most effective way to reduce the problem of generating e-waste is 3 R's. They are REDUCE, REUSE & RECYCLE. With the help of this 3R's minimize the impact of hazardous component present in the environment. Strict rules & regulations and public awareness should be implemented regarding e -waste. Adopted Economic, efficient and sustainable concept of e waste management system.

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