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## Recovery of noble metal from E-waste using leaching, electro deposition and electro generative process

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### ABSTRACT

*E- Waste describes electrical and electronic products nearing their end of life. In this technical world Usage of electrical and electronic product has been increased and its safe disposal and recycling are also very important for the society to avoid environmental pollution and to increase the economic growth of country. E-waste contains both hazardous and valuable metals such as lead, Polychlorinated biphenyls, copper, nickel and gold, silver, palladium etc. Recovery of noble metal from E-waste (PCB) board can be done in different ways.*

**Keywords:** E-waste, Shredding, Magnetic Separation, Eddy current Separation, Electrostatic Separation, Leaching, Electro deposition, Electro Regeneration.

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### INTRODUCTION

E-Waste Collected at different areas is sent to pretreatment plant, for disassembly and Segregation process. In this process, Plastics, Cables, Wires & Glass will be removed. After removing the cables and capacitors from the PCBs, they are sent to the Heavy Duty Shredder for shredding. The Shredded PCBs are sent to the Ball Mill to reduce the size of the PCB and they are fed to the Magnetic Separator [1-5] to separate the Ferrous and Non-Ferrous Metals. Non Ferrous metals are fed to the Eddy current Separator [6-8] to separate Aluminum. After the removal of Aluminum, the remaining Non-Ferrous Metals are fed to the Electrostatic Separator which separates the conductors (copper), semiconductors (extrinsic silicon), and nonconductors (woven glass reinforced resin). Crushed E-Waste material are fed to the Leaching tank to extract the noble metals such as copper, Silver and gold. Complete recovery of Noble metals is achieved by means of Electro Deposition and Electro generative process.

### MATERIALS AND METHODS

Electronic Waste Treatment process: The electronic waste treatment process Shown in the Figure 1

#### Recycling Process

- Manual dismantling
- Shredding process
- Ball milling
- Electromagnetic separation
- Eddy current separation
- Electrostatic separation.

Manual dismantling: Wires, capacitors, resistors, nuts and screws are removed manually.

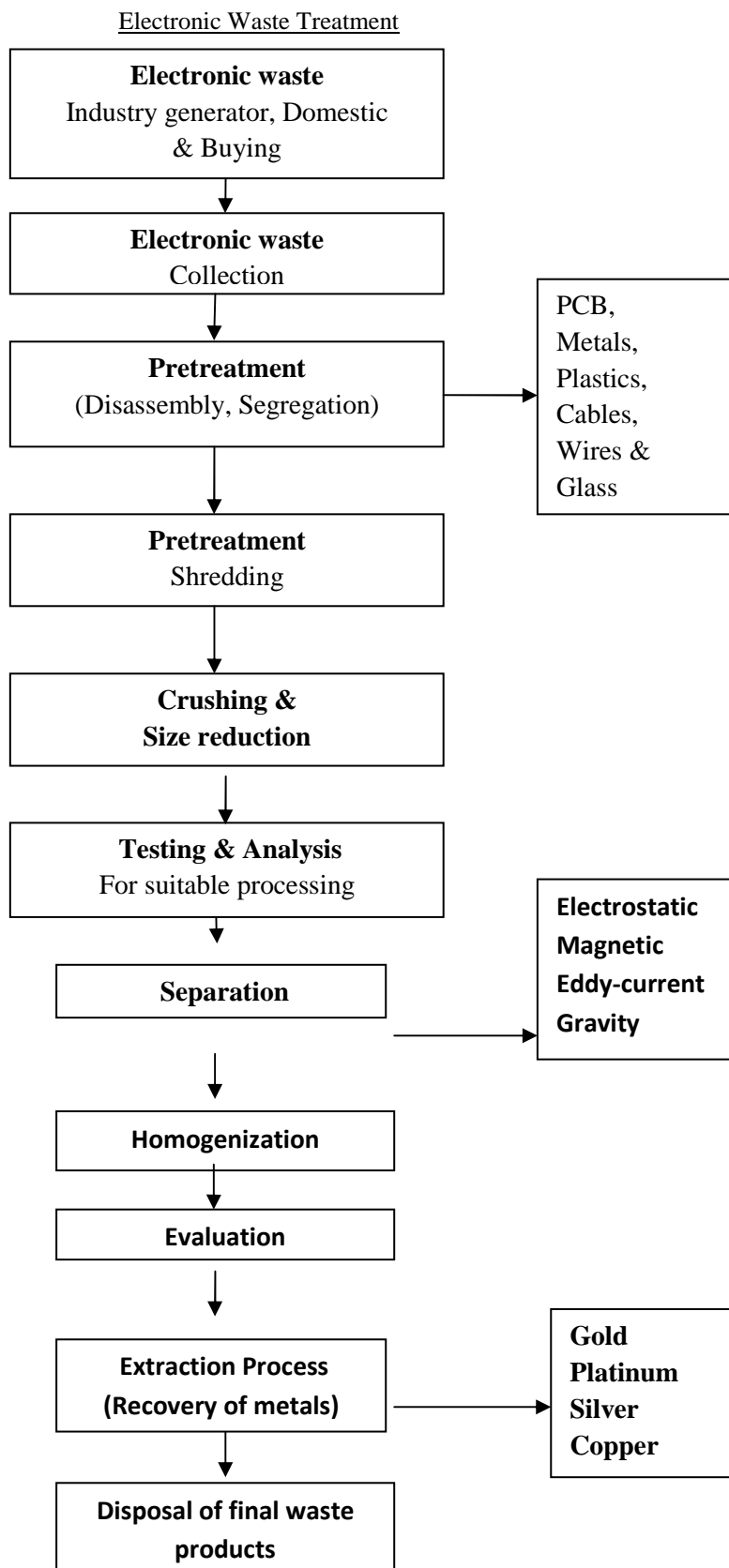


Figure 1: E-waste treatment process

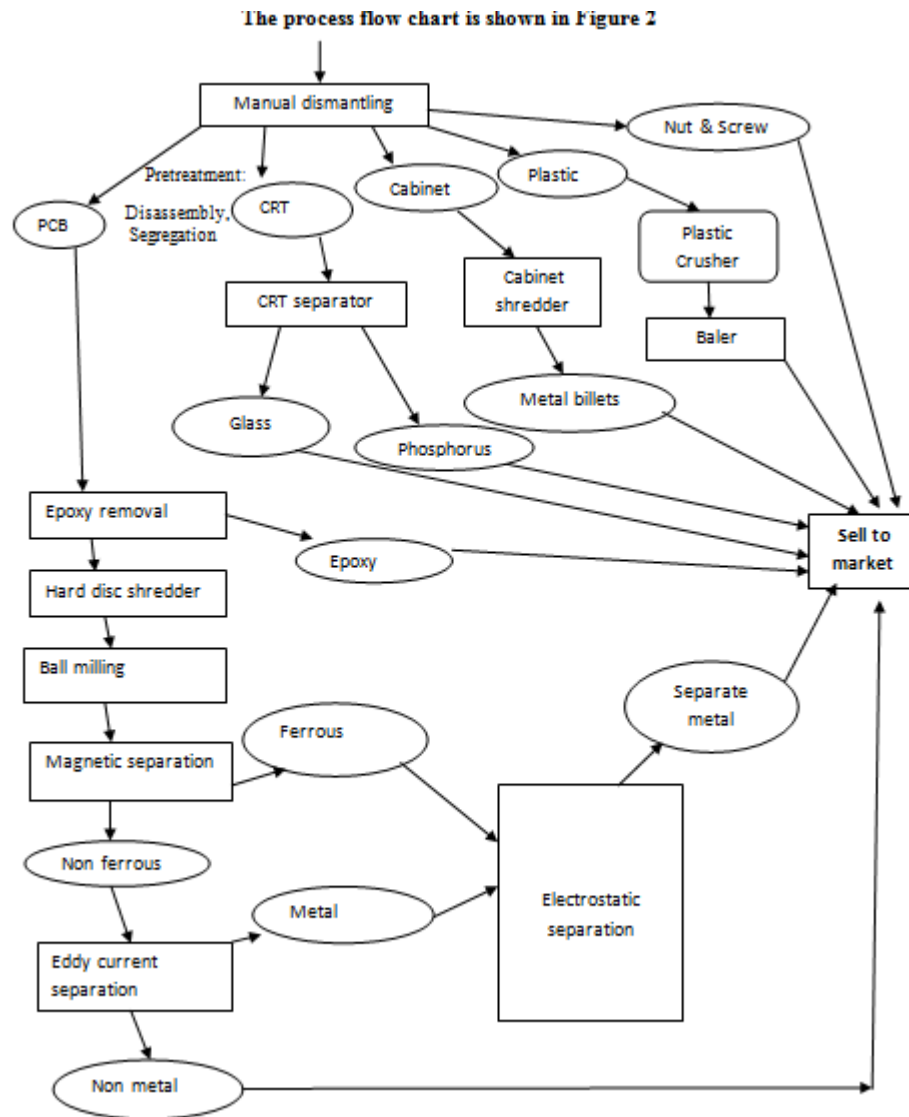


Figure 2: E-waste process chart

**Shredding process**

Shredding is the process where the E-Waste scrap is shredded into pieces.

**Hard disk shredder**

A shredder is a mechanical device used to cut E-Waste into Chad, typically either into strips or fine particles. The hard disc shredder is used to shred PCBs and hard disc into smaller pieces.

**Ball milling**

The shredded PCB pieces from the hard disc shredder are fed to the ball mill machine for reducing the size of the shredded PCB to the micron level.

**Magnetic separation process**

The powder collected from the ball mill is sent to magnetic Separator for the separation of ferrous and non Ferrous Materials.

**Eddy current separator**

The non ferrous material collected from the magnetic separator is fed to the eddy current separator for the Separation of Aluminum.

**Electrostatic separator**

The electrostatic separator separates the metals using electrostatic charges.

Leaching is a Chemical process technique which converts metals into soluble salts in aqueous media. It is easier to perform and less harmful, because no gaseous pollution occurs.

### Electro leaching [9, 12]

Shredded and crushed E-wastes are fed to the leach reactor for the extraction of metals. In the leach reactor, metals (copper, tin, lead, gold, silver, and platinum etc.) are dissolved using chlorine in acidic aqueous chloride solution. After the Leaching Process, Leached liquor samples are collected, filtered and it is sent for Volumetric analysis to determine metal concentration in aqueous solution. 98% of metal dissolution (copper, tin, lead) is achieved in about three hours. Only 82-95% of precious metal concentrations are dissolved after eight hours. Complete recovery of metals from the leachate solution is possible by electro deposition method.

Leaching & Electro deposition Process is shown in Figure: 3

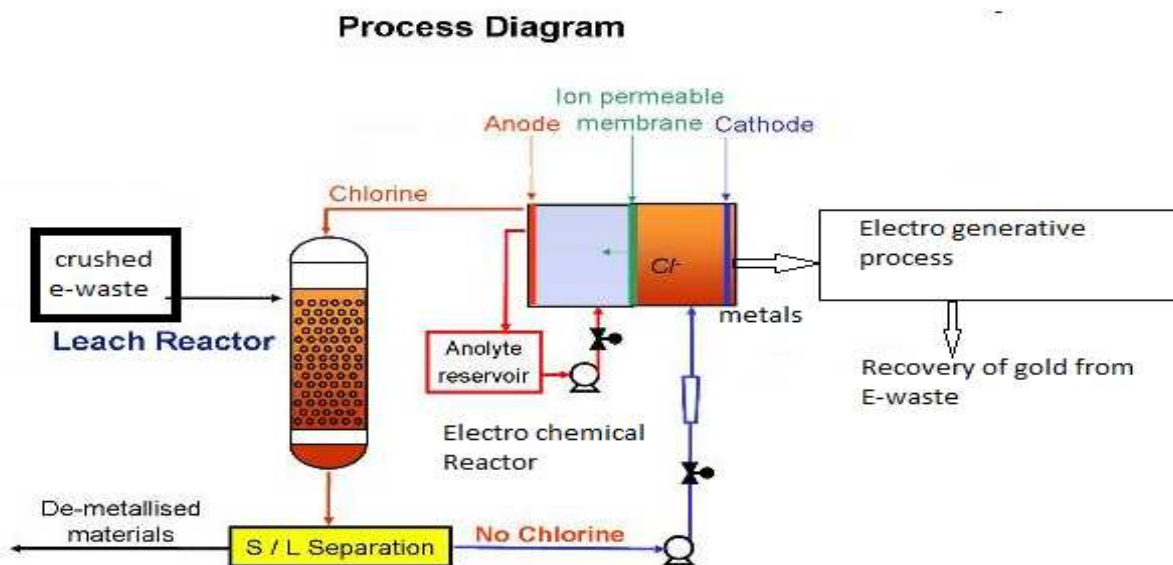


Figure 3 – Leaching & Electro deposition Process chart

### Electro deposition method [10, 11]

Electro Deposition is a deposition of a substance on an electrode by the action of electricity in an Electro Chemical Reactor. Electro chemical reactor consists of anode, cathode separated by iron permeable membrane. Complete recovery of metal will be at the cathode. Re-generation of chlorine will be at the anode. Completed recovery of copper, gold, silver, lead and palladium from the leachate solution is possible by electro deposition method about eight hours, with high current efficiency.

Different methods are available to recover gold; they are electro generative processes [33, 34], cementation [18], use of ion exchange resins [35] and biosorption process. “Electrogenerative Process” involves coupling suitable electrochemical reactions at opposing electrodes, separated by an electrolyte barrier, to yield a desired chemical product with the generation of low voltage electrical energy as a byproduct. Recovery of gold using cyanide solution in electrochemical reactor is highly toxic. In order to avoid the toxic effect, alternative -lixiviates such as thiourea [13], thiosulphate [14-16], sulfite, thiocyanate [17-18], ascorbic acid, mixed baths [19] and chloride media [20-27] [17, 23, 25, and 28] [29-32] are used. Compared to other processes [33, 34, 18, 35], electro generative processes has a lot of advantages they are

1. It does not require any external power supply,
2. very easy operation
3. Operating cost is very less.
4. It has more benefits in terms of reducing effluents and side reactions when compare to other methods.

Recovery of gold from chloride media using elect generative process is less toxic when compared to cyanide media. In the electro chemical reactor, specially designed three dimensional cathodes namely RVC (Reticulated vitreous carbon) and PG (porous graphite) and two dimensional cathode materials, such as copper and stainless steel plates were coupled with a zinc anode. RVC has low density and low thermal expansion, highly corrosion resistance and higher electrical conductivity. RVC structure is an open pore foam material of honey comb composed of vitreous

carbon. Pure gold can be recovered using chloroauric acid as lixivants. In three hours 90% of gold is recovered. Using superior cathode material, the Activated RVC recovers 99 percent of gold in one hour of operation.

### RESULTS AND DISCUSSION

By Leaching process, metals are recovered without any gaseous pollution. Through Electro deposition methods metals are recovered to 98% extent. For recovering the gold at optimum cost Electro generative method is used.

### CONCLUSION

Feasible methods for removing high percentage of the hazardous and valuable metals from electronic scrap, at low cost have been discussed. The proposed methods do not pose an environmental threat.

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