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MODERN METHOD OF HIGH VALUE E-WASTE RECOVERY & REUSE PROCESS: REVIEW

Avtar Krishna
Department Of Mechanical Engineering, XIPT, Ranchi

ABSTRACT

Electronic waste or e-waste describes discarded electrical or electronic devices like T.V, radio, mobile or cell phone etc. Informal processing of electronic waste in developing countries may cause serious health and pollution problems, as these countries have limited regulatory oversight of e-waste processing. Electronic scrap components contain contaminants such as gold, silver, lead, cadmium, beryllium, or brominated flame retardants. These materials are very costly and precious materials so these materials are classified as high value e – waste materials. During the disposal and recycling of these e – waste a number of environmental problems like air (dioxin), water (increase in heavy metals levels like lead, cadmium, copper nickel etc) and soil occurs. So, for recycling process several very sophisticated methods are present these days. In this paper I discuss some of these techniques.

Keywords—*E–waste, High value waste, recycling, reuse, recovery & eco-friendly process.*

I. INTRODUCTION

An end-of-life equipment, whose working depends on electric current or electromagnetic field is referred to as electrical and electronic waste (e-waste) . It includes discarded electronic and electrical equipment. In recent years, the amount of consumers and business of electronic equipment has increased enormously. According to the recent studies by researchers, the production of Electrical and Electronic Equipment (EEE) is growing very fast, i.e. about 3-5% per year. Also the advances in information and communication technologies, resulting into increasing versatility of most electronic devices together with the ever decreasing electronics prices have led to a drastically reduced lifespan for most electronic equipment. The growing use of such equipment, together with their early obsolescence has contributed to the generation of e-waste, to a large extent. E-waste contains precious and special metals, including gold, silver, palladium and platinum, as well as potentially toxic substances such as lead, mercury, cadmium and beryllium. Therefore, responsible end-of-life management of e-waste is imperative in order to recover valuable components and properly manage hazardous and toxic components.

E-waste contains many recyclable materials such as ferrous metals and aluminum, copper and precious metals gold as well as different engineering plastics. Most importantly disposal of e-waste causes loss of these valuable, non-renewable resources as electronics products contain wide range of valuable materials, many of them becoming scarce in the nature. Electronics waste recycling processes may also pose a risk to environment if electronic products are not treated in a proper manner at their end of life stage.

II. HIGH VALUE E - WASTE

In terms of world demand – electronic products consume 30% of world gold production, 30% of copper output and 14% of the total world silver production. The printed circuit boards (PCBs – are the most valuable e-waste in terms of presence of precious metal. Gold, Silver, Palladium and other precious metals are used in the leads and solder in PCBs. Copper is also present in abundance – nearly 20% of the weight of a PCB is due to Copper. Typically PCBs contain about 5%weight of Iron, 27% of Copper, 2% of Aluminum and 0.5% of Nickel, 2000ppm of Silver 80 ppm of Gold.

Table 1. Metal recovered from 1000 Kg of PCBs

Recovered metal	Weight
Gold	279.93 g
Precious metals (Pt, Pd, In)	93.31 g
Copper	190.512 Kg

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Aluminium	145.152 Kg
Lead and Tin	30.844 Kg
Silver	450 g

When not recycled the e-waste is incinerated and land filled. These methods involve not only wasting High value metals, but also creating a potential risk for the environment.

India generates about 4.1 million tonnes of e-waste currently and it is expected to reach 8 million tonnes by 2025. In India e-waste is growing at the rate of 10% per annum and it constitutes 3- 8% of municipal solid waste. At present recovery is restricted to only useful components and for precious metals such as gold, silver, copper and other metals but the rest is discarded in to environment. Electronic appliances are composed of hundreds of different materials that can be both toxic and equally of high value. While majority materials such as iron, aluminum, plastics and glass account for over 80 weight % of e-waste,

Where as valuable and toxic materials are found in smaller quantities but are still of high importance

III. E-WASTE RECYCLING PRACTICES IN INDIA- IN FORMAL SECTOR

The fast growing rate of electrical and electronic waste (e-waste) generation has become a major global concern and e-waste recycling is now an important economic activity. Recycling activities have invariably been associated with small backyard operators involving a large work force and located mostly in the developing nations. The major activity in e-waste recycling is dismantling which is labor intensive and requires manual operations which are available in abundance in poor nations. The informal recycling system includes small to me-dium scale units and are involved in dismantling, sorting and also harmful processes such as burning and leaching in order to extract metals from the e-waste particularly the PCBs. The methods of salvaging material from circuit boards drawn from monitors, CPU disc, floppy drives, printers, etc. are highly destructive as they involve heating and open burning for extraction of metals. Toxic chemicals are used to recover valuable metals such as gold, silver and copper from the PCBs. After Working in poorly ventilated areas without proper personal protec-tive equipment leads to exposure to dangerous and slow- poisoning chemicals. Even after such harmful methods are used, only a very few of the metals are recovered and the recovery percentage is very low. Improper recycling can cause irreversible dam-age to the human body and environment. Women and children are often directly exposed to lead and other ha-zardous materials in this process. The acid treatment and burning cause occupational hazards to the workers and contaminate the environment through effluents and toxin laden smoke.

Based on the existing evidences informal recycling is the most pressing environmental issue
associated with the E-waste. Nearly 95 % of the E-waste in India is being recycled in non-formal sector and 5% of the E-waste volume are handled in formal unit. The authorized E-waste recycling facilities in India capture only 3% of total E-waste generated; the rest makes its way to informal recycling yards in major cities like Delhi, Mumbai and Bangalore. This is because businesses sell their discarded IT and other equipment to informal recyclers for quick money without realizing the hazardous implications it causes to health and environment. There are well-established networks of waste collectors/dealers, dismantlers, and recyclers in India, most of which belong to the informal sector. Owing to the high demand for second hand EEEs and low initial investment required for starting a collection, dismantling, sorting, or a recovery facility , the E-waste recycling business has become very attractive for small entrepreneurs. For E-waste recycling facility owners in India, rather than creating environmental or social awareness, the financial profit is the main incentive in India .This is the reason that many urban poors are involved in the E-waste re cycling business. These people have least knowledge on the harmful effects of improper E-waste recycling on their health and environment.

The informal sector deploys “three methods for profit making: Collection of recyclable materials, manual dismantling and Metal Recovery”.

IV. E-WASTE RECYCLING - FORMAL SECTOR

There are very few E-waste dismantling facilities in formal sector in India for example M/s. Trishiraya Recycling facilities, Chennai and M/s E-Parisara, Bangalore. Currently the authorized e-waste recycling facilities in India capture only 3% of the total e-waste generated and rest make way in informal recycling. Also due to lack of awareness of hazards of the e-waste, consumers sell their electronic waste to informal recyclers for quick money as it is easier and faster.

E-Parisaraa Pvt. Ltd, India’s first Government authorized electronic waste recycler started operations from September 2005,is engaged in handling, recycling and reusing of Waste Electrical and Electronic Equipment

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(WEEE) in eco friendly way. The objective an opportunity to transfer waste into socially and industrially beneficial raw materials like valuable metals, plastics and glass using simple, cost efficient, home grown, environmental friendly technologies suitable to Indian Conditions.
With now rising e-waste quantities and with new regulatory requirement entering into force soon on the other hand, formal recyclers increasingly enter the e-waste recycling sector. There is a widespread expectation that these formal sector recyclers would be able to manage e-waste in an environmentally sound manner by using Best Available Technologies (BAT) leading to better environmental management and enhanced resource recovery.

V. CHALLENGES IN FORMAL SECTOR RECYCLING

As India has been moving towards digital age, the rising e-waste management is necessary for ensuring sustainable growth. "Digital India" campaign for digital connectivity involves handling a lot of electronics for transmission and dissemination of information. Thus India must focus on this waste because conventional waste management was belated and improper. India must not delay on this e-waste management. India has almost 2.4% of global e-waste almost more than its contibution to global GDP. The rise in waste upto 1.7 million tonnes is testimony of the fact that this waste was improperly managed. Moroever, according to a study 70% of the landfills are composed of e-waste. This is concern because e-waste like Mercury in CFL can leach and create land pollution, skin diseases, cancer, etc. The Kodaikanal mercury poisoning case is one such example, though it doesn't deal explicitly with e-waste. Also, the laborers who work on disposed electronic waste like circuit boards resort to corrusion with acids, burning, manual pricking for extracting metals like Copper, tungsten, etc. They are vulnerable to diseases. Often the disposed waste is thrown in canals and waterbodies leading to water pollution and skin diseases.

The informal recyclers with primitive and environment unfriendly e-waste disposal methods lead to pollutants explosion in the atmosphere. After recovery of target material, it is being left either in open or put in the municipal waste resulting contamination of air, water and soil. The heavy metals leak out from the components if not handled properly and harm our natural resources.
Due to the absence of any proper disposal system followed in our country, enormous amount of e-waste has been generated in last 60 years. This has leads to the requirement of a proper disposal and recycling system so that the environmental pollution and health hazard is get reduced.E awste recycling has three main challenges that need to be improved in the way to the full recycling society.These are consumer awareness and collection, best practices in processing such as cost efficiency and value generation, and getting the material to proper recycling.

Recycling Process:
The e-waste recycling process is highly labor intensive and goes through several steps.
1. Picking Shed
When the e-waste items arrive at the recycling plants, the first step involves sorting all the items manually.

2. Disassembly
After sorting by hand, the second step involves a serious labor intensive process of manual dismantling. The e-waste items are taken apart to retrieve all the parts and then categorized into core materials and components. The dismantled items are then separated into various categories into parts that can be re-used or still continue the recycling processes.

3. First size reduction process
Here, items that cannot be dismantled efficiently are shredded together with the other dismantled parts to pieces less than 2 inches in diameter. It is done in preparation for further categorization of the finer e-waste pieces.

4.Second size reduction process
The finer e-waste particles are then evenly spread out through an automated shaking process on a conveyor belt. The well spread out e-waste pieces are then broken down further. At this stage, any dust is extracted and discarded in a way that does not degrade the environmentally.

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5.Over-band Magnet
At this step, over-band magnet is used to remove all the magnetic materials including steel and iron from the e-waste debris.

6. Non-metallic and metallic components separation.
The sixth step is the separation of metals and non-metallic components. Copper, aluminum, and brass are separated from the debris to only leave behind non-metallic materials. The metals are either sold as raw materials or re-used for fresh manufacture.

7. Water Separation.
As the last step, plastic content is separated from glass by use of water. One separated, all the materials retrieved can then be resold as raw materials for re-use. The products sold include plastic, glass, copper, iron, steel, shredded circuit boards, and valuable metal mix.

VI. RECYCLING PROCESS FOR HIGH VALUE METALS:

The extraction of high value metals, copper, lead and zinc from e-waste are done using hydrometallurgical routes. These routes are based on traditional hydrometallurgical technology of metals extractions from their primary ores. Similar steps of acid or caustic leaching are employed for selective dissolution of PMs from e-waste. The pregnant solution is separated and purified for the enrichment of metal content thereby impurities are removed as gangue materials. The isolation of metal of interest is conducted through solvent extraction, adsorption and ion exchange enrichment processes. Finally, metals are recovered from solution through electrorefining (electrometallurgy) or chemical reduction processes. It has been reported that hydrometallurgical processes have additional benefits compared to pyrometallurgical processes because they are more exact, predictable, and easily controllable. Solvents especially halides, cyanides, thiourea and thiosulfates are used for the leaching of high value metals from their primary ores.
Electro leaching 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: 1

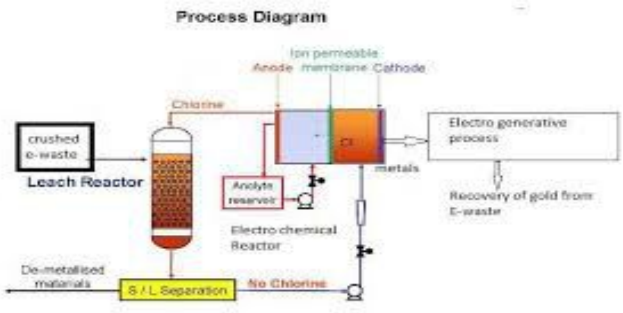

Figure 1
Leaching & Electro deposition Process chart Electro deposition method .Electro Deposition is a deposition of a substance on an electrode by the action of electricity in an Electro Chemical Reactor. Electro chemical reactor consists of anode, cathode separated by iron permeable membrane. Complete 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 , cementation , use of ion exchange resins 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 -

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lixiviates such as thiourea, thiosulphate , sulfite, thiocyanate ascorbic acid, mixed baths and chloride media are used.
By Leaching process, metals are recovered without any gaseous pollution.

VII. RECOVERY AND REUSE

This technique could eliminate waste disposal cost, reduce raw material costs and provide income from a saleable waste.From an environmental viewpoint reuse is always better than recycling because recycling requires energy and not all parts of an electronic device may be recyclable. Electronics manufacturers and e-waste recycling companies differ in their efforts to refurbish devices or take them apart for spare parts. Recent types of cell phones, computers or TVs are usually checked and refurbished or disassembled for parts, but other devices often are not. Re-use is a key part of the e-waste solutions toolkit. Re-use, then, is not a solution to the e-waste problem in its own right but seen as a means of alleviating, or moderating, the existing problems until such a time that products are utilized to a much more optimal level before being recycled in the most efficient means possible.
The practice of electronics re-use also happens to generate another wide range of ancillary benefits. These range from providing employment and training opportunities for people with disabilities or the long-term unemployed to providing access to good equipment for people with low incomes in both the developed and the developing world helping to bridge the digital divide. It is also a major source of IT equipment for businesses and educational establishments in the developing world resulting in the promotion of vital economic development. Reuse also plays a significant role in the provision of spare parts for long life and high-value equipment where the manufacturing of new parts may be rather expensive.

VIII. ECO FRIENDLY PROCESS GREEN COMPUTING

Green computing is the study and practice of using computing resources efficiently. The goals are reduce the use of hazardous materials and promote recyclability or biodegradability of defunct products and factory waste. Two major issues associated with green computing are: reduction in energy consumption and pollution control. green technology, green computing seeks to minimize negative environmental impacts through the responsible use of electronics, through the creation of energy-efficient designs (such as with CPUs), through the implementation of recycling programs that can repurpose existing computers, and through the designing of manufacturing processes that minimize waste.

IX. CONCLUSION

The recycling of e-waste is important for resource and waste management. The presence of high value metals in e-waste makes recycling an attractive and viable option both in terms of environment and economics. Providing proper infrastructure for processing the e waste and starting an effective training program for innovative recycling and recovery methods and for the use of e waste will strengthen the future generation technically to solve the important issue. Although the per-capita waste production in India is still relatively small in terms of developed countries but the total absolute volume of wastes generated is huge because of the size of population. Recycling involves various steps in India which generates the income on each level and generally running in micro units in unhygienic conditions and increases the bad impacts on environment.

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