

Composition of E-Waste and hazards related to E-Waste

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Abstract: E-Waste is a generic term comprising all Waste Electrical and Electronic Equipment (WEEE) that have been disposed of by their original users and includes everything from large household appliances such as refrigerators, microwave ovens, television sets, computers, to hand-held digital apparatuses, cell phones and toys. E-Waste is today the fastest growing sector of the municipal solid waste stream and currently comprises more than 5% of its total flow, which is equivalent to 20-50 million tonnes a year worldwide. These enormous quantities in combination with the fact that E-Waste contains a wide range of hazardous compounds have turned E-Waste into a global environmental issue. When the E-Waste is taken care of, either in general waste processes or in recycling processes, these hazardous compounds may be released and thereby become a threat to humans and the environment. In addition, in some processes used, new hazardous compounds, such as dioxins, may be formed as the original E-Waste components are degraded. Consequently, to avoid serious impacts on human health and the environment it is crucial to ensure that E-Waste is properly taken care of, all the way from collection and handling through recycling and disposal.

This Paper is to summarize the Composition of Electronic Appliances, hazardous constituent present in E-Waste, its health, occupational and environmental hazards. The Persistent Bio accumulative Toxins and its environment and health risks when Electronic Appliances are manufactured, incinerated, land filled or melted during recycling is also discussed briefly.

I. Introduction

E-Waste consist of Mobile phones, Monitors, Television, Computers, Telephones, Fax machines, Printers, DVD and VCD players, CD players, Radio, Hi Fi stereo sets, Refrigerators, Washing machine, Air conditioners, Vaccum cleaners, Coffee makers, Toasters, Iron box etc., The Composition of each E-WASTE is

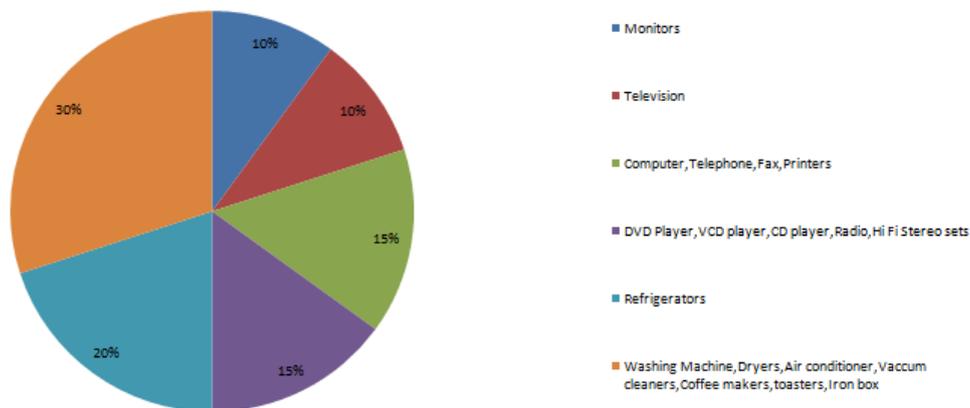


Fig. 1 Composition of E-waste

II. Materials found in E-Waste

Normally the parts or materials found in E-WASTE may be divided broadly into six categories as follows:

- 1) Iron and Steel, used for casing and frames.
- 2) Non ferrous metals, especially copper used in cables, Aluminium used in battery outer cover.
- 3) Glass used for screens and Windows.
- 4) Plastic used as casings, in cables and for circuit boards.
- 5) Electronic components.
- 6) Others (rubber, wood, ceramic.)

III. Composition of Electronic Appliances by Weight percentage

From the survey it is cleared that most of the E-WASTE comes from Computers, Mobile Phones, Television, Refrigerator and washing machine. So it is mandatory to know about the composition of Electronic Appliances. If we know the composition then only it is possible to find the hazardous constituent of E-WASTE and metal recovery from E-WASTE. The composition of each and every appliance in terms of its weight percentage is given as

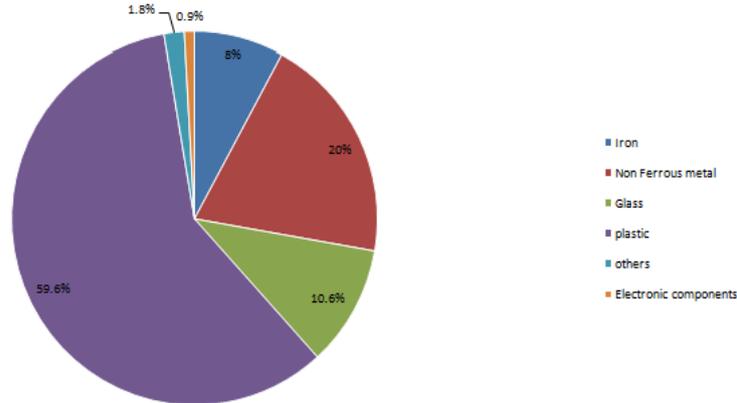


Fig. 2 Composition of Mobile phones

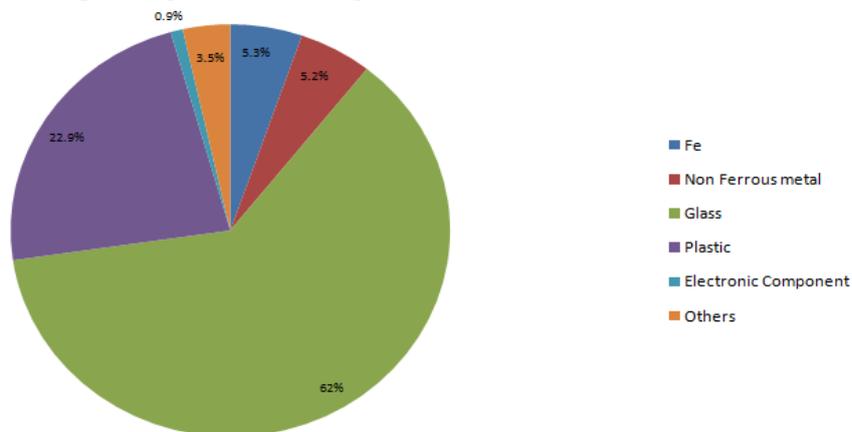


Fig. 3 Composition of Television

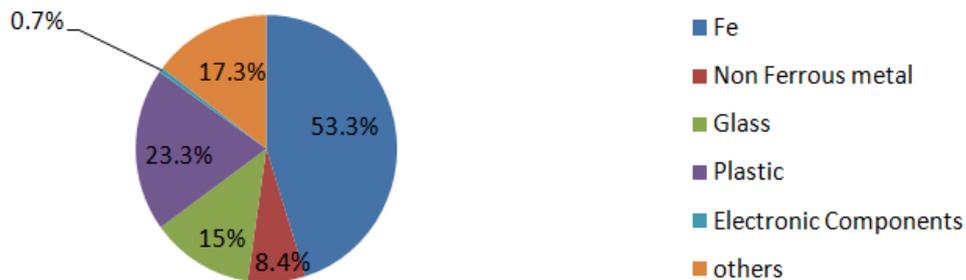


Fig. 4 Composition of personal Computer

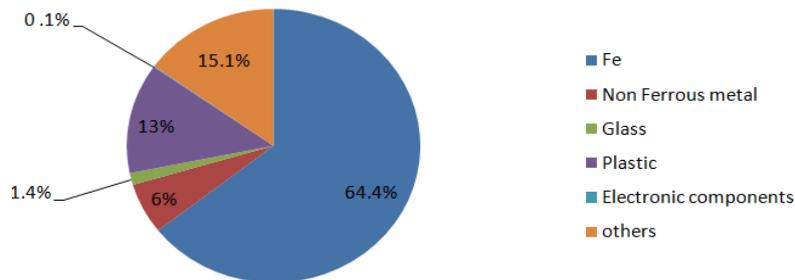


Fig. 5 Composition of Refrigerator

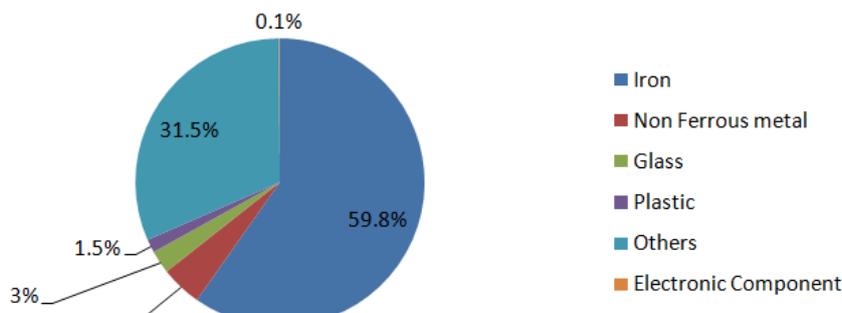


Fig. 6 Composition of washing machine

IV. Hazardous Constituent of E-Waste

Electrical and Electronic Appliances are made up of various types of metals, Plastic, Polymers etc., When these appliances are discarded as waste then only the E-WASTE problem arises and E-WASTE is not hazardous waste per-se. However, the hazardous constituents present in the E-WASTE render it hazardous when such wastes are dismantled and processed. Since it is only at this stage that they pose hazard to health and environment. Table 1.1, 1.2, 1.3 summarises the hazardous constituent present in E-WASTE, health effects due to that hazards, Occupational and environmental hazards due to the components.

The hazard may be solid, liquid or gas based on the treatment techniques used. In Cathode Ray Tube treatment no liquid is used to recover picture tube, Phosphor coating and copper yoke, so it is dry process. But recovery of glass need acid and the end products that is neck glass, funnel glass and panel glass are solids. So in Cathode Ray Tube air emission in the form of dust coming from recovery of components is hazardous. Recovery of metals from Printed Circuit Board, Battery, Cold Cathode Lamp are liquids. Metal extraction from these generate effluents and burning of Printed Circuit Board produces air emission. Recovery of plastic from electronic appliances is liquids and the hazard arises here is mixed E-WASTE fraction.

Table 1 Hazardous constituent of E-WASTE

Sources of E-WASTE	Electronic Equipment or Component	Hazardous constituent
Printed Circuit boards	Mobile phones, Computer, TV, Printers etc.,	Lead, Beryllium, Antimony, Brominated Flame Retardants, Silicon Oxide, Cadmium Oxide, Aluminium Oxide, Chlorinated and Inorganic Compounds.
Cold Cathode Lamp (Gas discharge lamp)	Used for backlighting LCD's	Mercury
LED	Printed Circuit boards	Gallium Arsenide
Resistor, Capacitor, micro chip	Printed Circuit boards	Poly Chlorinated Biphenyls
Electrolytic Capacitor(L/D 25mm)	Printed Circuit boards	Glycol
Freons (CFC, HCFC, HFC, HC)	Refrigerator	Ozone Depleting substances
Batteries	Portable Electronic Devices(laptops, Mobile phones),Portable power tools	Mercury, Cadmium, Lithium, lead, nickel, Lead acid, Lithium ion, Nickel metal hydride, Nickel Cadmium, Sulphur
Thermostats, sensors, Relays, Switches	Printed Circuit boards, Space heaters, Ovens, Medical Equipment, Thermal Equipment, Air handling unit, pumps, Levelling Devices, Electric ranges	Mercury , Cadmium (switches)
Insulation	Electrical Devices	Asbestos, Refractory Ceramic Fiber, Ozone Depleting Substances in Insulation foam
Rubber	Electrical and Electronic Devices	Brominated Flame Retardants, Phthalate Plasticizers
External Electric Cables	Connector in all devices	Brominated Flame Retardants, Phthalate Plasticizers

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Condenser, Transformer	Power supply units and Stabilisers, Converting devices	Poly Chlorinated Biphenyls
Power supply boxes which contain Silicon Controlled rectifiers and X-ray lenses	Electrical and Electronic Devices	Beryllium
Toner Cartridges	Laser printer, Photo copying machine, Fax machine	Carbon particle and polymer, 7% carbon black, fine toner powder, tin
Ink toners in printers, Printer drum in photo copying machine	Ink jet printers, Photo copying machine	Cadmium
Photo drums	Older photo copying machine	Selenium
Floppy disc, Data tapes	Computer, DVD player, Tape Recorder	Chromium
Solder metal glue	Printed Circuit boards	Lead
Chip resistor, Semiconductor Devices	Printed Circuit boards	Cadmium
Glass panels, Gaskets	Computer monitor	Lead
Front panel	Cathode Ray Tube	Cadmium
Mother Board	Computer	Beryllium
Cabling	Computer housing	Plastics including PVC
Corrosion protection of untreated and galvanized steel plates, decorator or hardner for steel housings	Housing of Household Appliances	Hexavalent chromium
Interior of CRT plate	Cathode Ray Tube	Phosphor
Wires and Cables	Connector to all Household Appliances	Poly Vinyl Chloride
Plastics	Outer cover of all Household Appliances	Phthalates as Plasticizer, Metals like organo tin, Lead, Cadmium as stabilizer, Teflon for thermal Degradation process and Brominated Compounds as Flame Retardants
Liquid Crystal Displays	Electronic Equipment contain flat display(Mobile phones, Note book Computer)	Liquid Display embedded between display glass and Electrical control Equipment), Phosphor, Flame Retardants, Antimony.
Cathode Ray Tube	Older desktop computers, Television set	Lead, Phosphor, Hexavalent chromium, Lead Oxide (Cone glass, Neck glass, Funnel glass), Antimony and Barium Sulphide in Screen glass or panel glass.
Fluorescent phosphor layer	Cathode Ray Tube screen	Rare earth metal

Electron gun	Cathode Ray Tube screen	Nickel
Getter plate in Electron gun	Cathode Ray Tube screen	Barium and its compounds.

Table 2 Health effects of the contaminants

Constituent	Health effects
Lead (Pb)	Damage to central and peripheral nervous systems, blood systems and kidney damage. Affects brain development of children.
Cadmium (Cd)	Toxic irreversible effects on human health. Accumulates in kidney and liver. Causes neural damage.
Mercury (Hg)	Chronic damage to the brain. Respiratory and skin disorders due to bioaccumulation in fishes.
Hexavalent chromium	Asthmatic bronchitis. DNA damage.
Plastics including PVC	Burning produces dioxin. It causes Reproductive and developmental problems, Immune system damage, Interfere with regulatory hormones
Brominated Flame Retardants (BFR)	Disrupts endocrine system functions
Barium (Ba)	Short term exposure causes: Muscle weakness, Damage to heart, liver and spleen.
Beryllium (Be)	Carcinogenic (lung cancer) Inhalation of fumes and dust. Causes chronic beryllium disease or beryllicosis. Skin diseases

Table 3 Occupational and environmental hazard of the E-WASTE components

E-WASTE Components	Process	Potential occupational Hazard	Potential Environmental Hazard
Cathode ray tubes (CRTs)	Breaking and removal of copper yoke and dumping.	Silicosis. Inhalation or contact with phosphor containing cadmium or other metals.	Lead, Barium and other heavy metals leaching into groundwater, release of toxic phosphor.
Printed Circuit Boards	Disordering and removing computer chips.	Tin and lead Inhalation. Possible brominated dioxin, beryllium, Cadmium, mercury Inhalation.	Air emission of brominated dioxin, beryllium, cadmium, mercury, Tin and lead
Dismantled Printed Circuit Board processing.	Open burning of waste boards to remove inside metals.	Toxicity to workers and nearby residents from tin, lead, brominated dioxin, beryllium, cadmium and mercury inhalation. Respiratory irritation.	Tin and lead Contamination of immediate Environment including surface and ground waters. Brominated Dioxins, beryllium, cadmium and Mercury emissions.

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Chips and other gold Plated Components.	Chemical stripping using nitric and hydrochloric acid along river banks	Acid contact with eyes and skins may result in permanent injury. Inhalation of mists and fumes of acids, chlorine and sulphur dioxide gases can cause respiratory irritation to severe effects including pulmonary edema, circulatory failure and death.	Hydrocarbons, heavy metals, brominated substances, etc., discharged directly into river and banks. Acidifies the river destroying fish and flora.
Plastics from Computer and peripherals e.g. printers keyboards, etc.	-	-	Emissions of Brominated dioxins and heavy metals and hydrocarbons.
Shredding and low temperature melting to be reutilized in poor grade plastics.	Probable hydrocarbon, Brominated dioxin and heavy metal exposure.	Brominated and chlorinated dioxin, polycyclic aromatic Hydrocarbons (PAH) are carcinogenic to workers living in the burning works area.	Hydrocarbon ashes including PAHs discharged to air, water and soil.
Miscellaneous computer parts encased in rubber or plastic e.g. steel rollers	Open burning to recover steel and other metals.	Hydrocarbon including PAHs and potential dioxin exposure.	Hydrocarbon ashes including PAHs discharged to air, water and soil.
Secondary steel or copper and precious metal smelting	Furnace recovers steel or copper from waste including organics	Exposure to dioxins and heavy metals.	Emission of dioxins and heavy metals.

V. Persistent Bio Accumulative Toxins (PBTs)

- Lead, mercury, cadmium, and polybrominated flame retardants are all persistent, bio-accumulative toxins (PBTs)
- They can create environmental and health risks when computers are manufactured, incinerated, land filled or melted during recycling.
- PBTs, in particular are a dangerous class of chemicals that linger in the environment and accumulate in living tissues and because they increase in concentration as they move up the food chain, PBTs can reach dangerous levels in living organisms, even when released in minute quantities.
- PBTs are harmful to human health and the environment and have been associated with cancer, nerve damage and reproductive disorders.