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Electronic Waste: Emerging Health Threats

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Abstract:- The mammoth growth of waste in general and electronic waste in particular is a growing threat to the health and environmental issues the world is facing today. The electronic waste (e waste) constitutes around 2.7 to 3 % of the total waste and in majority contains hazardous and toxic elements which have many elements and constituents which when handled carelessly i.e. without proper care and protection will lead to numerous health and environmental problems which can be deadly and endangering the life of living beings. The proper advocacy and information passage to the consumers is day by day becoming utmost urgent requirement. The hazardous effects of the constituents ranges from irritation to development of deadly cancer and is endangering the existence itself. Proper regulation development means and facilities of recycling and disposal are need of hour and time. The threats are numerous and are indicator of concerns is growing requirement. The regulations so far enacted are inadequate and lack from total commitment to deal with the situation. The latest regulations are steps towards betterment but are still far from satisfactory. The global situation of passing the buck is also threat for the developing and underdeveloped countries as the disposal in informal sector is predominant in these areas. The means are minimal and the value of life is valueless and the appropriateness of health facilities is also far from satisfactory. The dependence on developed nations further adds to the problems.

Keywords:- E waste, Hazardous, Leaching, Toxic, Health, Immune System, Environment, EEE

I. INTRODUCTION

The modernization and latest mindset in general, consumer behavior in particular and tendency of making life automated and mechanized requires the development of Electrical & Electronic Equipments (EEE). These EEE and electronic gadgets are the basic modes and ideas getting generated. The rapidly changing and technological development are pushing the existing EEE to the new profile consumers making place for the affluent consumers opting for the newer products. The transfer of EEE to sectorial and classical classes of consumerisation gives rise to secondary markets and new dimension of market growth. The shifting of EEE sometimes leads to defects in the products which may not find replacement or be repaired and lead to end of life of the product requiring disposal. The excessive use and obsolesce also leads to end of life of products. The end of life and situation where the products are left with option of non utilization and non application or have become hazardous leads to growth of waste popularly known as Electronic Waste (e waste) or WEEE. The dimension of industrial pollutants released into environment mixed with the new e waste adds to the problem. The e waste mainly consists of high use and consumer driven day to day usable and being used like mobile, smart electronic gadgets, television, computers, laptops, printers, photocopy machines, toys, house hold electric appliances etc. These are mostly made-up of plastics, metals, and other materials which are sometimes hazardous also. The toxic contents of the e waste makes it more vurnable and hazardous. The constituent are roughly in proportion of 60 % which comprises iron, copper, aluminum, gold and other metals The presence of plastics account roughly to t 30% and the being talked hazardous pollutants responsible for health hazards are around 2.70% to 3 %. Electronic equipments results in a mix of materials and components containing several hundreds of substances which can be toxic and may be responsible for serious pollution when these are disposed off after becoming e waste. The materials responsible for such pollution ranges from heavy metals like mercury, lead, cadmium, chromium to flame retardants such as polybrominated biphenyls (PBB) and polybrominated diphenyethers (PBDEs).

The workers involved in industries manufacturing electronics chips, drives and circuit boards are reporting serious health problems. Employees and labors engaged in recycling, extracting valuables from e wastes and handling e-waste as scrap are observed to have health problems caused by toxic hazardous pollutions caused by various types of pollutants. The careless disposal of e wastes is posing threats by showing signs of deterioration of local drinking water. The ill effects and possible hazards of e-waste have to be recognized.

1. Different Categories and constituents of E-waste

E-waste means electrical waste and electronic equipment, whole or in part included in, but not confined to equipment, scraps or rejects from their manufacturing process. E-waste is divided into different categories according to Environment Protection Act, 1986 (figure 1). Figure 2 shows composition of e wastes in terms of percentage.

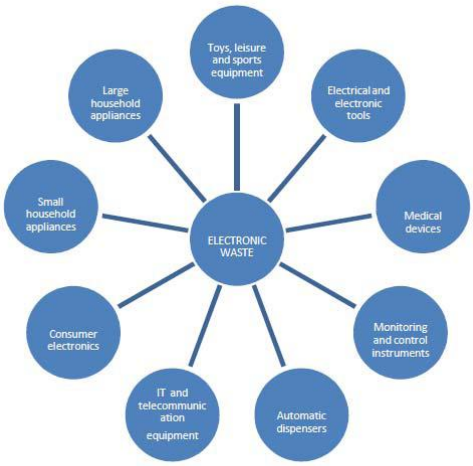

Figure 1 Composition /categories of e waste

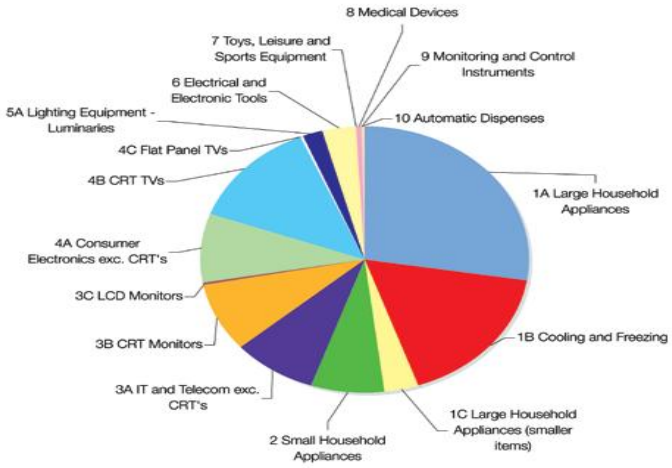

Figure 2 Composition of e waste

Hazardous Components of E-Waste: The main composition or constituents responsible for health and environment concern are Americium , Arsinic , Barium , Beryllium , Lithium, Nickel, Mercury, Sulphpur , Lead , Cadmium, Chromium, Beryllium Oxide, Brominated flame retardants (BFR), Rare earth elements etc. The brief descriptions of presence and basic threats are as follows:-

Americium is basically radioactive sources present in the e waste. It is also known as carcinogenic.

Arsenic : These are present in form of GaAs in form of LEDs. After disposal when mixes in the soil can lead to very harmful affect to health.

Barium: These are present in form of getters in the CRT. These when come in contact of moisture can lead to explosive gases which can cause burns and other toxic affects.

Beryllium : Present in the power supply which contains SCR and beam line components. These are harmful if inhaled.

Lithium : Often these are in the lithium batteries. Can cause burns when comes in contact with moisture or becomes wet.

Nickel : Often present in the NiCd batteries used in electronic equipments for power sources. These are extremely poisonous and harmful in long run.

Mercury: The perfect liquid conductor often finds place in the fluorescent tubes, tilt switches, conducting electronic tubes, control solid state devices and flat screen monitors. The harmful effect on contacting include

dermatitis, sensory impairment, memory loss, weakness in muscle reduced fertility causing slowing of growth and development etc. The severe effect can be resulting in death of living beings when affected.

Sulphur: The main source can be witnessed in lead-acid batteries. Hazardous effects on contact and inhalation include heart damage, liver damage, kidney damage, and eye and throat infections causing irritation. In environment it can be source of formation of Sulphuric Acid in humid and wet conditions which can lead to loss of fertility of land etc.

Lead: Lead-acid batteries are the main source. It is present in the CRT monitor glass etc. The amount of lead in the CRT tube can vary from 1.5 pounds to 8 pounds.

Cadmium: In electronic products main sources are cadmium batteries, light-sensitive resistors, florescent layer of the CRT and printer inks and toners. If these are allowed in day to day use and particularly in corrosion alloys for marine and aviation environments they can cause severe health problems. The presence of cadmium if allowed in the soils then it can leach into the soil and harm the microorganism and disrupt the ecosystem of soil. If person comes in contact by inhalation in the sites of recycling without proper care it can cause severe damage to lungs and kidney.

Beryllium oxide: These are Fillers mostly for the thermal interface materials and are mostly used as heat transfer fins in vacuum tubes lasers, CPUs and power transistors, magnetrons, X ceramic windows etc .

Brominated flame retardants (BFR): The BFR are mostly used as flame retardants in plastics for the electronics product and these includes the banned product PBBs, PCB , Octa BDE, Penta BDE. The hazardous hygienic and health effects ranges from thyroid problem , impaired development of the nervous system etc.

Rare earth elements are often present in the florescent layers of CRT and these can cause irritation to eyes skins.

II. E WASTE SCENARIO IN INDIA

The Manufactures Association of Information Technologies (MAIT) in its report of 2007 has generated 380000 tonnes of e waste mostly comprising of disposed Computers , TV and Mobile Phones. The projection as been predicted to touch 800000 tonnes by 2012. The average increase in e waste growth is around 15 % The global growth rate is 50 million tonnes per annum. The china and US waste growth annually are 2.3 million tonnes and 3 million tones while of India it is 400000 tones per annum .

The key e waste generators sector wise are basically categorized as Individual households, Govt., Public and private sector (over 70%), Retailers, manufacturers, Secondary market and Imports.

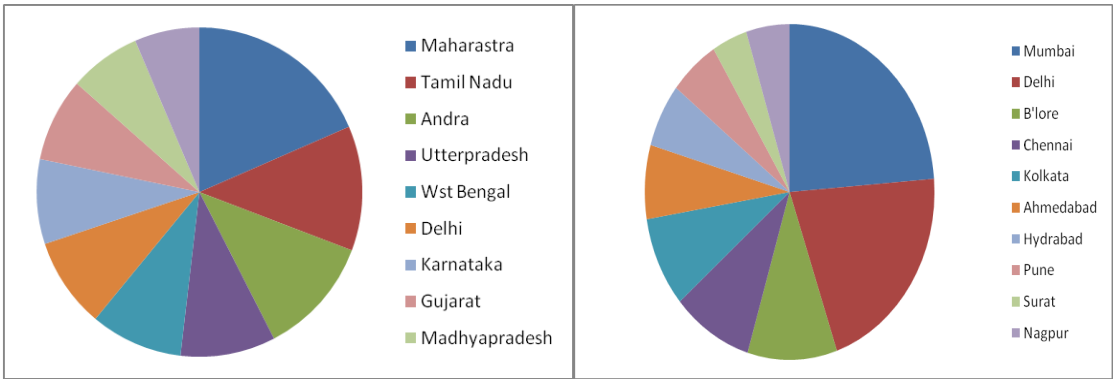

Fig 3 top 10 states of India and top 10 cities producing e waste in percentage

The growth pattern of most likely constituents of e wastes of the EEE industry in India can be viewed as per the following figures in millions

EEE	2005-06	2006-07	2007-08
PC	4.62	5.5	5.6
Laptop	0.45	0.86	1.83
Mobile	41.9	66.5	93.2
TV	10.3	11.78	14.9
Washing machine	1.68	1.73	2.97
Refrigerator	4.37	4.84	5.29

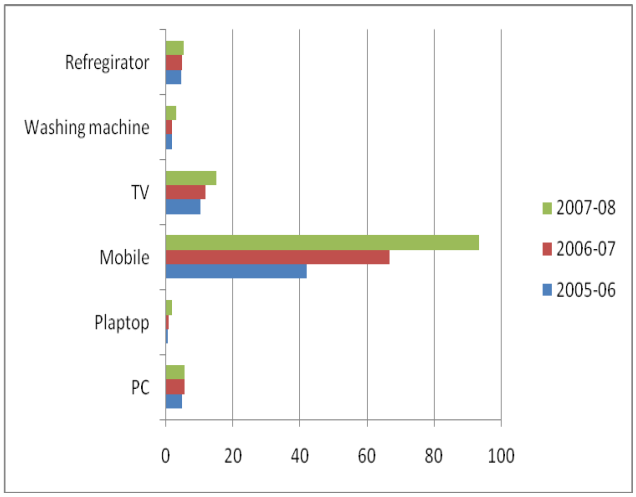

Figure 4 showing the growth pattern of major constituents of EEE

III. FORMAL RECYCLERS AND DISPOSAL UNITS IN INDIA

The present condition of formal and informal recycling and disposal activities in India is alarming. Only 5 % e wastes recycling and disposal is done in the formal sector leaving remaining 95 % to be handled by the informal sector. The present scenario is that the recycling and disposal activities in the formal sector being undertaken at the following centres:-

E-Parisaraa Pvt Ltd. (first government-authorized eco-friendly recycling unit)

Earth Sense Recycle Private Limited (Joint venture of E-Parisaraa Private Limited and M/S. GJ Multiclave India Private Limited)

Trishyiraya Recycling India Pvt. Ltd (TPL) (The GOI & Pollution Control Board certified company for disposal of e waste)

Plug-in to e Cycling (Environmental Protection Agency and consumer electronics manufacturers, retailers, and service providers joint venture)

The Manufacturers' Association for Information Technology (MAIT) initiated Electronics Recyclers' Association (ERA)

Besides these there are other not noticeable agencies to be listed out here.

IV. IMPACTS OF E WASTES

The changing structure of procurement of EEE and its transfers to the various layers and sections often lead to the non use and disposal in an unattended way by the section who is not affordable and does not have knowledge of ill effects of these discarded e wastes. The society of various economic sections exists throughout world and it has lead to a global phenomenon. The hazardous and toxic contents in the e wastes affect the environment and human health. Unknowingly the e-waste takes up space in the communities and sections it penetrates through in name of modernization and advancement and can result to be very harmful to humans and other living beings. The toxicity and carcinogenicity of some of the substances present in the e waste if disposed improperly processed can lead to severe harmful effects. E-waste contains mostly electronic gadgets which contain thousands of components having deadly chemicals and metals like lead, cadmium, chromium, mercury, polyvinyl chlorides (PVC), brominated flame retardants, beryllium, antimony and phthalates are the main source of concern than the other waste materials. The exposure to the substances which can be carcinogenic and neuro-toxic in nature present in the e waste can cause damages to the nervous systems, kidney and bones, and the reproductive and endocrine systems besides affecting the environment. Primitive and unscientific recycling or crude disposal of e-waste to landfills like other wastes may lead to irreversible environmental damage by polluting water and soil, and contaminating air which we inhale for breathing.

Various studies by formal and informal sectors in major cities including the national capital Delhi by formal and informal sectors reveals that in 2005 in case of electronic recycling yards in Delhi confirmed the presence of high levels of hazardous deadly Dixons and furans chemicals in the areas where present**.** Workers are poorly protected against the risk of hazardous ingredients in e-waste disposal sites. Normally the workers (workforce of 25000) perform the dismantling of e wastes of the tune of 10000 to 20000 tons by hand without any protection .The e wastes being handled are about 25 % reaching in this region. Mumbai, Chennai, Bangalore, Kolkata, Meerut, Firozabad, Poona and many other localities the e waste scrap yards exist. The presence of hazardous substances like lead, cadmium, chromium and flame-retardant plastics are present in subsequent quantity. High lead content CRT and components content are considered most dangerous to health.

Handling by naked hands i.e. without protection and inhaling such hazardous toxic and dangerous substances can damage the nervous system, lungs, kidneys and the reproductive system and even brain. Often such dismantling works are carried out in confined areas without proper ventilation without masks and required technical expertise results in attacks of dangerous and slow-poisoning chemicals by exposer. Lack of awareness is further reason of risk to the health and environment. The environmentalist and scientists who have examined the areas having e waste recycling and disposal activities have found that the dioxins causing cancer exist in those areas. The women workers who are pregnant are at additive risk to the extent that they are six times more susuptable than their counterparts. The women workers are at greater risk of even miscarriage. The kids who work because of extreme poverty to meet the two ends of meals in the family it is observed that seven out of ten kids have high lead content in their blood. At present there is no reliable data available for these studies particularly in case of child labors and fairer sex.

In order to extract the metals from e wastes chemical leaching is done. The chemical leaching can be done by either by using acid or ligand supported complication or by involving complexometry. In later case the ligands get complexed with metals. In chemical leaching the H2SO4 or HCl or H2SO4 with HNO3 acids are used for extraction of metals from the E-waste. The extraction can be done using Sodium hypochlorite with acid or alkali for the recovery of gold and other precious metals The use of organic solvents are done for extraction of heavy metals like Fe, Cu, Al, Ni, Au and Ag. Use of sulfuric acid and hydrogen-peroxide is normally done for extraction of copper from discarded Printed Circuit Boards (PCB).

The use of acidophilic group of bacteria plays an important role in extraction of heavy metals from the wastes in biological leaching. Particularly in case of Acidithiobacillus ferrooxidans, Acidithiobacillus thiooxidans, Lep-tospirillum ferrooxidans, and Sulfolobus the bioleaching is economical. It s observed that in the earth's crest for inorganic and organic matters the microorganisms are active in the formation and decomposition. Here the natural ability of microbes namely Autotrophic , heterotrophic bacteria and heterotrophic fungi are used to transform solid metallic compounds to its solubility and extractable form are employed in the bioleaching This is effective in case of metals Chemolithotrophs of iron-and sulfur-oxidizing nature. The chemical and biological leaching has their own risks as handling of acids are highly dangerous where as microorgans have their own risks to persons involved in extraction from the e waste.

The major constituent of the e waste which is day by day becoming need of growth and development is the PC. On an average each PC contains the following constituents 7.24 kg plastics, 1.98 kg of lead, 9.92g of barium, 4.94g of beryllium, 2.961g of cadmium, 1.98g of chromium, 0.693g of mercury, 0.4095g of arsenic etc.

V. E WASTE HAZARDOUS TOXIC AFFECTS

The e waste contains numerous hazardous and toxic constituents responsible for many health and environment degradation specially while recycling or disposing in unsafe and crude manner. The major components of e wastes, its constituents and health effects of part of body effecting can be summarized as follows:-

Components of e waste	Constituents	Seriousness and affects
Capacitors and Transformers	Brominated Flame-retardent casing cable, PCB (polychlorinated biphenyls)	Cancer, effects immune system, reproductive system, nervous system, endocrine system
Plastic	Polyvinyl chloride	Results in release of chlorine which converts to dioxins and furans and are harmful.
Cable insulating coating Plastic housing	Bromine	Immune system
Chlorofluorocarbon (CFC)	Cooling unit, insulation foam	Toxic emission
PCB Printed circuit Board	Lead, Cadmium Beryllium	Nervous system , kidney and lungs
CRT (Cathode Ray Tube) Fluorescent lamps that provide backlighting in LCDs, in some alkaline batteries and mercury wetted switches	Mercury	Heart Liver and Muscles central nervous and endocrine systems and risk to neurological development of unborn fetuses
Getters in CRT	Barium	Develops explosive gases
Computer Mother Board	Lead oxide , Barium and Cadmium	Lung and Skin
Switches and Flat Screen	Cadmium	Brain and Skin

Monitors		
Power supply boxes which contain silicon controlled rectifiers, beamline components	Beryllium	Breathing Problem if inhaled carcinogenic for the lungs acute Beryllium Disease
Computer Batteries	Polychlorinated biphenyls (PCBs)	Kidney and Liver
Rechargeable NiCd-batteries, fluorescent layer (CRT screens), printer inks and toners	Cadmium	Potentially carcinogenic affects lungs, kidneys and liver
Data tapes and floppy disks	Chromium	Injurious and causes allergic reactions
CRT screens, batteries, printed wiring boards	Lead	Central & peripheral nervous systems damage May cause seizures, retardation, high blood pressure, Affects kidneys & liver affects child development
Li Batteries	Lithium	Causes burns when comes in contact with moisture or becomes wet and is extremely poisonous and harmful
Gallium Arsenide within light emitting diodes	Arsenic	Inflammation in muscle and kidney
Rechargeable NiCd-batteries , electron gun in CRT	Nickel	Extremely poisonous and harmful and causes allergic reactions
Rare earth elements	Florescent layer	Irritation in skin and eye
Interior of a CRT screen, mixed with rare earth metals	Zinc sulphide	Toxic on inhalation
Condensors and Liquid Crystal Display	Toxic Organis Substances	Irritation in eyes
Toner cartage for Laser Printer and photocopier	Toner Dust	Breathing problem

Besides these there are many more hazardous substances which are extremely harmful to health and environment to living being.

VI. CONCLUSION

The current situation of waste in general and e waste in particular and the addressing of the composition and constituents of the hazardous and toxic population of the e waste is of main concern. The Recycling and disposal requirements are specialized ones but the facilities available when compared to production and use through various means have a large gap . The poverty and illiteracy are the major factors which do not get persons get the proper knowhow for protection from the hazardous ingredients which one comes across while working in recycling and disposal institutions and industries. The pushing of old and obsolete appliances and equipments in name of technology transfer is becoming affair of the developed nations. This is means of saving themselves from the means of disposal and thereby pushing away the threats of radioactive radiations and environmental exposer to have-not regions. Due to this tendency the human kind is at stake. The various constituents and compositions of e waste cause the damage which ranges from irritation to deadly effects to the extent of development of cancer. Proper regulation development and means and facilities of recycling and disposal is need of hour and time. The treats are numerous and concerns are also required. The regulations so far are inadequate and lack from total commitment to deal with the situation. The latest regulations are steps towards betterment but are still far from satisfactory. The global situation of passing the buck is also threat for the developing and underdeveloped countries as the disposal in informal sector is

predominant in these areas. The means are minimal and the value of life is valueless and the appropriateness of health facilities is also far from satisfactory. The dependence on developed nations further adds to the problems.

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