DEVELOPMENT OF NEW RECYCLING APPROACHES AND TECHNOLOGY MANAGEMENT OF E-WASTE

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Abstract *–Electronics, Communication, computers and IT devices(consumer electronics) have changed the human life styles tremendously comfortable with many advantages, but they have brought in some hazardous side effects on environment. Management and disposal of E-waste has become a major problem in the world and is growing at alarming proportions. The accumulation of e-waste causing biggest harm to environment is the dumping of hazardous materials. The aim of this concept research paper is to study, analyze, discuss existing E-waste recycling methodologies and conceptualize and propose some new approaches for recycling 100% of e-waste. In this paper an attempt is made to present and discuss some new recycling approaches and technology management of E-waste through which discarding of e-waste into environment is either nil or minimal. This method also envisages extraction of each and every material from e-waste. Increasing global trends of e-waste and implications of implementation of proposed methodology, commercial and societical are also included here.*

Keywords–*Eco friendly Electronic Devices, E-waste, Recycling, Incineration, Land filling, Million Tonnes(MT)*

I INTRODUCTION

Unwanted, obsolete or unusable consumer electronic products such as computers, computer peripherals, televisions, VCRs, DVD Players, stereo equipment, hand cell phones are commonly referred to as 'electronic waste. Faster obsolescence and subsequent up-gradation, new electronic products are forcing consumers to discard old products, which in turn accumulate huge amounts of e-waste. E-waste contains hazardous materials [8] such as brominated flame-retardants, PVCs and heavy metals like lead, cadmium and mercury, which are known to cause harm to the environment and human lives. Hazardous substances are contained within components such as printed circuit boards, cables, wiring, plastics, casings, displays monitors, cathode ray tubes (CRT), batteries, capacitors, resistors, relays and connectors and so on the land filling of these hazardous materials risks the leaching of heavy metals like lead, cadmium and mercury into ground water or evaporation of mercury into air. The E-waste is growing at an unsustainable rate and is the most toxic component of municipal waste. The e-waste growing trends are as shown in the table.

Sl No	Country	2000 (M T)	2007 (MT)	2015 (M T)	2025 (M T)
1	India	0.48	0.685	4.1	8.0
2	Europe (EU-27)	5.9	8.1	10.53	18.0
3	China	0.82	2.3	10.68	21.0
4	USA	4.6	6.46	9.5	18.0
5	World	34.7	49.0	77.8	130.0

Table1: Growing trends of E-Waste

In 2012 world populations stands at 7.03 billion and by 2050 it is expected to stand at 12 billion. 70% of world population will be owning mobiles, laptops and TVs. With the current rate of production one can imagine the e-waste levels which are going to become unmanageable by 2050 if necessary measures are not initiated. Hence new approaches for recycling are necessary to minimise E-waste dumping in to the environment and prevent human health hazards.

(a) Historical Background and Existing Recycling Methodologies.

In general E-waste treatment and disposable methodologies prevailing are land filling, Incineration, recycling and reuse. In land filling and Incineration methodologies hazardous materials continue to release toxins in to environment causing human health hazards. Details of E-waste management in India and major parts of world are enumerated as follows.

Land filling is one of the most widely used methods [3] for disposal of e-waste. The degradation processes in landfills are very complicated and run over a wide time span. Land filling of e-waste risks are as follows.

(i) Teaching of hazardous materials into soil and water such as broken lead containing glass, cone glass of cathode ray tubes and cadmium. into soil and ground water.

(ii) Cadmium and mercury are emitted in diffuse form or via the landfill gas combustion plant.

(iii) Landfills are prone to uncontrolled fires, which can release toxic fumes.

(iv) Incineration [3] is a controlled and complete combustion process, in which the e-waste is burned in specially designed incinerators at a high temperature at 900-1000 degrees Celsius. The disadvantages of incineration process are as follows.

(v) Emission to air of substances escaping flue gas cleaning and large amount of residues from gas cleaning and combustion.

(vi) E-waste incineration plants contribute significantly to the annual emissions of cadmium and mercury.

(vii) Heavy metals not emitted into the atmosphere are transferred to slag and exhaust gas residues and can re-enter the environment on disposal.

Hence the e-waste incineration will increase these emissions it is very highly disadvantages and not a suitable method in disposal of e-waste. The land filling is not a environmentally sound treatment method for e-waste for substances, which are volatile and not bio-degradable. Therefore, there is a necessity to come up with a viable solution for e-waste recycling to make e-waste either nil or minimal.

(b) E-waste status in India

India is expected to generate about 4.1 million tonnes of E-waste [7] by 2015 and 08 million tonnes by 2025. In India e-waste is growing at the rate of 10% and constitutes 3% of municipal solid waste. At present recovery of useful components for reuse, recovery of precious metals such as gold, silver, copper and other metals, rest is discarded in to environment. Otherwise various methodologies used in India are decontamination, dismantling, hammering (pulverization), shredding and density separation using water. There are about 47 recycling companies accounting for only 27% of E-waste leaving 83% into environment.

(c) E-waste status in China

China is expected to generate 10.68 million tonnes of E-waste by 2015 and 21 millon tonnes by 2025. There are about 500 villages in Guiyu, E-waste town in china recovering gold and silver and discarding 80% into environment, polluting ground water and creating human health hazards.

(d) E-waste status in USA/Europe world

Europe and USA are likely to generate 18 million tonnes of E-waste each by 2025. There are 500 recycling companies in USA alone but only 20% of E-waste is recycled and rest is discarded into environment. World is expected to generate 77.8 million tonnes of E-waste by 2015 and 130 million tonnes by 2025. World average stands at 20% of recycling of e-waste as of now.

Present recycling process involves dismantling and removal of different parts of E-waste containing dangerous substances, plastics, ferrous and non ferrous metals, their separation and segregation. Recyclers use strong acids to remove precious metals such as gold, silver and copper. The value of recycling from the element could be much higher if appropriate technologies are used. The recyclers working in open areas. Poorly ventilated enclosed areas without mask and technical expertise and machinery results in exposure to dangerous and slow poisoning chemicals. There is an urgent need to find suitable newer recycling and technology management methodologies for reducing of pumping of hazardous materials into environment to protect environment, ground water contamination and human lives.

II PROPOSED METHODOLOGY

Performance and profit making should not be the main criteria for any Electronics and Communication products. Also along with this the ill effects they bring after discarding into environment must be addressed to reduce hazardous materials causing harm to human lives. Disposing of E-waste such as computer peripherals, storage media, printers, monitors, consumer electronics, networking equipment and communication equipment should be such that it is efficient and effective at the same time with minimum or no impact on environment. This paper conceptualizes and proposes newer approaches for recycling and technology management of E-waste to address the future safety of environment and human lives. Also proposes further research for identification of machineries and industrialization sites for setting up of chain of small scale industries. Any major manufacturing facility is generally has a chain of ancillary or small scale industries producing spares and accessories for the major facility. The E-waste contains hazardous and non hazardous materials. For example personal computer generally composes of 26% silica gel glass, 23% plastic, 20% ferrous metals, 14% Aluminium and 17% others like gold, silver, copper, lead, zinc, mercury and cadmium. The block diagram of the proposed E-waste recycling methodologies is as shown in fig. 1. The salient features of proposed recycling and technology management methodologies envisaged in this paper are as follows.

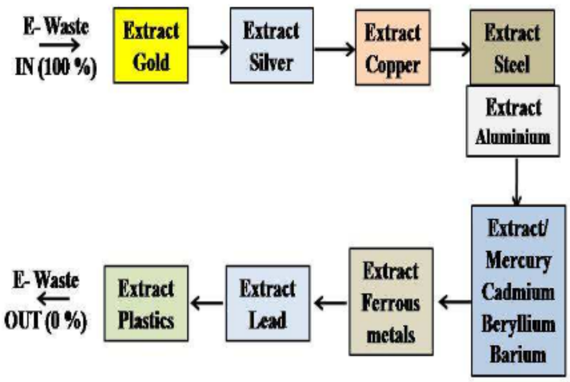

Figure1: Block Diagram of Chain of Ancillary (Small Scale) Industrial setup

(i) Identify and Select the key cities which are generating large quantities of E-waste

(ii) Identify suitable area near IT parks(consumer electronics industries) in those cities.

(iii) Set up chain of ancillary or small scale industrial belts for extracting all the materials used and found in the E-waste.

(iv) Extract the materials one by one with respective ancillary or small scale industrial set up. After extraction of gold the e-waste content moves to next stage where silver is extracted, then to copper, aluminium, lead, Barium, Mercury, Beryllium, Steel, zinc, cadmium, nickel, ferrous metals, plastics and so on.

(v) There is a need to consider design of this chain of ancillary or small scale industrial set up for processing and extraction of materials suitably depending on the content and on their hazardous or non-hazardous nature.

(vi) Most of the materials used are procured from existing bigger industries, hence they must set up mini models for extraction of respective materials for reuse.

(vii) E-waste needs to be centrally transported to these centres and inputted to the chain of ancillary or small scale industrial set up for processing and extraction of respective materials found in the E-waste.

(viii) The final out come from the ancillary or small scale industrial set up of this kind should be minimal from the E-waste or nil amount of materials so that no harm/minimal harm is envisaged to environment or for human lines.

III IMPLICATIONS OF PROPOSED METHODOLOGY

The proposed setting up of ancillary and small scale industrial for processing and extraction of E-waste at selected cities will give rise to the following factors which will have to be accepted.

(i) Cost considerations for setting up of chain of ancillary/small scale industrial set up will certainly go high.

(ii) There will be resistance from the respective bigger industries for this set up.

(iii) Imposition of strong legislation attracts protests from designers/manufacturers because they need profits.

(iv) The major advantage will be that E-waste discarded into environment would be either minimal or nil.
(v) Another major advantage would be that it would generate employment.

(vi) Even though large profits are not expected marginal profits are expected. But the service done to protect environment and greener earth and human lives goes a long way for human kind.

IV DISCUSSION

The inference from this research paper is that the issue of hazardous material discarded in to the world through E-waste is assuming alarming proportions. It is estimated that on global scale approximately 20 kg of this material is put into market every year per inhabitant and an estimated 50 million tonnes of E-waste is produced every year.

It is estimated that 80% of e-waste is put in to landfills where as 20% is re-cycled for reuse.

The best example to be quoted here is the Guiyu, the world's largest e-waste site in China's Guangdong province. Here e-waste processing business, often with primitive and hazardous methods has led to severe health problems to the township. It is expected that one tonne of computer e-waste contains more gold than 17 tonnes of gold ore. Due to this Guiyu township[4] has the unique way of gold and silver harvesting from e-waste where basic safety protocols are compromised and then the remaining e-waste is discarded in to landfills or so. Some of the land fills can be reclaimed decades later[5], but there are multiple issues involved. If the locations are concentrated with toxic materials, like this Guiyu as an example, we might have to wait for centuries before the land could be safe for human living. There is a strong lesson from this example for countries like India and the whole world to apply the concepts proposed in this paper as early as possible.The first such ancillary or small scale E-waste recycling industrial set up is required to be set up on war footing at the earliest at Guiyu, in China where toxic E-waste has assumed alarming proportions which can only be ensured by UNO. In India Ministry of Environment and Forests, Government of India is the nodal agency for policy, planning, promoting and coordinating environmental programme including e-waste [15]. An exclusive notification on e-waste (Management and Handling) Rules, 2010 have been made effective from 01 May 2012 to address the safe and environment friendly handling, transportation, storing, recycling and also to reduce the use of hazardous substances during manufacturing of electronics and electrical equipments. Central and state pollution control boards have also stepped in to effective management of e-waste. It is expected that these measures will be far away from effective addressing of the e-waste compared to recycling approaches presented in this paper.

The concept presented in this paper for recycling is certainly expected to solve and address the e-waste problem to the maximum extent possible not only for India but for entire world on implementation.

V CONCLUSION

The major contributed solution proposed in this paper is the idea of setting up of chain of ancillary and small scale industrial belt to ensure prevention of discarding of e-waste into the environment and society. At the same time entire e-waste is recycled for reuse which will be a profit making venture through employment generation.

The present methodology of usage of e-waste processing business, often with primitive and hazardous methods which has led to severe pollution and health hazards to the township of Guiyu in China's Guangdong province has to be treated as a lesson by other countries. They have to invest heavily in modern recycling facilities to process the e-waste the cleanest way possible as suggested in this paper.

It may not be very easy to invest in the beginning but the existing material industries have to be convinced for the cause of environment and society to safeguard the future.

This paper recommends that India has to start the ancillary or small scale industrial set up at most e-waste producing cities in the first phase considering the E-waste accumulation. They are Mumbai, Delhi, Bengaluru, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat and Nagpur. Since number of IT parks has come up in these cities, it is a novel idea for setting up of E-waste recycling industrial set up next to these parks. In the second phase by 2030 India has to plan setting up of these ancillary/small scale industrial E-waste recycling set up in Indore, Bhopal, Coimbatore, Trivandrum, Mangalore, Mysore, Lucknow, Patna, Gauhati and visakapatnam, Jaipur, Jodhpur.

In addition to draw backs of present recycling processes, the existing dumping grounds in India and other countries are full and overflowing beyond capacity and it is difficult to get new dumping sites due to scarcity of land by 2025 and by 2050. Therefore, the methodology proposed in this paper for setting up of chain of small scale industries across the major cities for E-waste recycling is the best possible option, including for future needs.

The following points needed to be driven for protection of eco friendliness of E-waste recycling proposal suggested in this research paper.

(i) Consumer Electronics Manufacturers have to accept the hazards to environment leaving the desire for large profits alone and set up ancillary or small scale industrial set up.

(ii) Consumers also have to compromise on performance factor.

(iii) Extended producer responsibility must be encouraged whereby those who produce e-devices are responsible and to give helping hand for the setting up of ancillary industrial set up.

(iv) A strong standard legislation is required to be imposed on all concerned agencies.

(v) Discipline and ethics of all concerned and cooperation in recycling industrial set up goes a long way in ensuring environment pollution control.

VI FUTURE SCOPE

Future scope exists for further research for identification of comprehensive machinery and methodology for small scale industrial set up for effective e-waste recycling for environment pollution control. Scope also exists for development of suitable machinery and new extraction techniques for E-waste recycling.

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