



Generation & Recycling of Waste Electrical and Electronic Equipment (WEEE): In South Korea

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Worldwide, the production of various electrical and electronic equipments (EEE) is one of the fastest emerging areas. The production of these electrical and electronic equipments resulted in an increase of waste electrical and electronic equipment (WEEE). Every year several million tons of WEEE are being generated in the U.S., EU and Japan. Even in U.S.A. during its last decade, most of the waste electronic equipments have been destined for landfills and incineration or exported to developing countries despite of international accords to limit international shipments. It is expected in USA up to the year 2010 about three billion units of computers, televisions, and other electronics containing hazardous as well as valuable materials will generate. Generation of this huge amount of WEEE will make essential need to examine the product design, systems for component reuse, and process design to improve materials recovery from waste goods. In the European country, when the WEEE directives are successfully implemented, now the protection of environment and the conservation of resources are expected. In China, some projects on WEEE management and recycling are being carried out but there are still some problems that restrict the commercial operation of qualified WEEE recycling enterprises. Some scientists reviewed the research to improve demanufacturing processes through disassembly, automation, bulk recycling of ferrous and nonferrous metals, and plastics identification and separation from electronics waste. He also concluded that there are additional challenges in this area to improve product design, acquisition and management of information, and co-ordination with planning and scheduling.

Particularly in Korea due to the rapid economical growth and continuous changes in equipment's features and capabilities causes tremendous increase in sale of new electrical EEE. This development has resulted in an increase of waste electrical and electronic equipment WEEE. This leads the rapid increase in the sales of new facilitated models of EEE in the world. The rapid replacement of old model by latest advanced model causes the mass generation of WEEE. The generation of

tremendous amount of bulky WEEE containing variety of hazardous substances is a major social problem and threat to the environment. In 1992, based on the waste control act, the waste deposit-refund system was introduced in Korea. In this system, a deposit is imposed at a constant rate on products and packages that are readily recyclable, and is returned after the recycling of material. In the year 2003 the Extended Producer Responsibility (EPR) system was enforced in Korea to promote recycling practices.

These days the electrical home appliances (EHA) are the basic need of each modern family. However there are lots of different types of EHA are available in market and similarly the peoples are using this selectively depends on their choice and needs. But as TVs, refrigerators, washing machines and air conditioners are the most common EHA and, simultaneously a huge amount of the waste of these appliances is generated after the completion of their end-of-life. This is due to the rapid economical enhancement followed by improvement of living standards of the people. The population growth, new household appliances and decrease in product life span occurs due to the preference for new advance models. But in the period 2000-2004 the sales of EHA decreased up to 25%. The reason of this decrease in sale is attributed to the saturation of households with EHA. Another major reason observed during this period is the mass demand of small sophisticated refrigerator to keep Traditional Korean pickle "Kimchi", caused the rapid decline in the sell of normal big refrigerator in Korea.

Due to the competitive market and the rapid changes in equipments features resulted in increase in the sale of EHA and simultaneously due to the replacement of old model by new one the quantity of WEHA is increased. In case of TVs the 0.237 million units of WEHA were generated in the year 1996. The launching of new models of TVs with plasma display panel (PDP) and liquid crystal display (LCD) with large screen has also attracted the customer to purchase the new model of digital TV by replacing the old model. The increase in the generation of waste for all four items viz. refrigerator, washing machine, air-



conditions and television has been analyzed. The major WEHA is TVs and refrigerator. If we analyze this rate wise the generation of waste of TVs and air-condition is maximum. As reported in Korea many different agencies are active for the collection and proper recycling of the WEHA. The total unit collection per year is increased during the year 1999 to 2003 from 1.116 million units to 2.031 units. Due to the public awareness and Government policy, the collection quantity was increased from 1.2 million to 2 million units. As Korea is resource deficient country, the target is 100% recycling. The recycling will conserve the resources and protect the environment. This rapid increase in rate of recycling of WEHA is expected due to the implementation of EPR system in the year 2003.

PCs and mobile phones have much importance in each area due to the need of quick exchange of global information. The increase in percentage of obsolete from 22% to 42% during the year 1999-2003. In coming years, there is a chance to increase the quantity of the obsolete as the PCs have short average life i.e. 5 years only. These waste generally kept in home as obsolete due to its small size and the chances of its upgradation. Simultaneously, the amount of the waste generation is also increased from 273 to 597 thousands units. However, the sale of PCs was found maximum 3,409 thousands unit in the year 2000. The sale of PC was decreased comparatively after the year 2000; this may be due the saturation. According to the Korean Association of Electronics Environment KAE, the number of the waste PC recycled by producers in 2002 is only 6.4% of the estimated waste PCs. After the implementation of EPR system in subsequent year, the quantity of recycling increased about 50% of the estimated waste PCs. In the year 2002 total population of subscribers of the mobile phone was 33,591 thousand units i.e. 3/4 th of the total population of Korea. Korea is one of the leading producers of mobile phone in the world. However the quantity of the obsolete increased from 6,645 to 12,494 thousand units during this period but sales remained almost constant with slight enhancement. The EPR system holds producers accountability for the entire life cycle of their product in order to incite innovation in product design, material use, and business management through economic incentives. Since January 2003, the EPR system has applied on 15 items including TVs, refrigerator, air conditioners, washing machine etc. Furthermore, audio products and cellular

phones are considered under EPR system in 2006.

Existing technologies for recycling

The manufacturers had no mandatory responsibility for the recycling of WEEE before the enforcement of EPR system. After the implementation of EPR system, the mandatory recycling for each product is fixed by Govt. of Korea on the producers and importers under EPR system. The mandatory cost for recycling is included with the production cost by Govt. of Korea. After EPR enforcement extra money related to the environmental pollution & resources on product, increased the price of the product. The increase in price of the EEE relatively decreased the number of customer and resulted in the optimum level to balance in demand and supply gap.

The recycling of WEHA became more effective due to the effect of EPR system. The domestic electronic companies are recycling the major EEE viz. refrigerators, washing machines and air conditioners equipments in their recycling centers. The cathode ray tubes (CRT) of TVs and monitors are recycled on commission basis by private CRT recyclers for the glass. Generally, the recycling processes consist of dismantling-shredding/grinding followed by mechanical separation for beneficiation. There is no feasible economical process available for the recycling of printed circuit boards (PCBs). CRT recycling is gaining more importance, due to its weight as major waste in TVs and PCs. The lead component present is generally serrated by various technologies and recycled for the manufacturing of new CRTs. The several researchers have carried out the studies by using strong acids but switch off due to strict environmental regulations. The attempt has been also made to recover yttrium fluorescent material from panel sludge.

The recycling of waste PCBs of PCs and mobile phones is gaining importance due to the presence of valuable metals in it. After the dismantling of major components of the PCs, the classified materials are used for the recycling. The recycling of waste mobile phones is much attractive due to its small size and, the PCBs containing relatively high contents of precious metals such as gold, silver, palladium and rhodium, etc. The shredding of waste PCBs and shipment to a copper smelter is one route for recycling and, the other route is shredding-incineration-melting into copper alloy containing



precious metals and their refining processes utilizing hydrometallurgical techniques. In addition to these processes, Korea has made sincere effort to develop eco-friendly process using mechanical pretreatment in combination with hydrometallurgical technique. Researchers have reported that the metal liberation could be achieved up to 95-100% from PCBs utilizing a swing hammer type impact mill or stamp mill, but those pretreatment processes are not applied in the commercial plant yet. Korea is facing difficulties to develop the technology for metal liberation from PCBs due to the complex material of construction of PCBs and lack of appropriate grinding technology. A series of hydrometallurgical processes, including leaching, separation and recovery has been employed for the recovery of valuable metals from the metallic concentrate. Some Korean technologies are under investigation for leaching of the valuable metals from waste PCBs viz. electro-generated chlorine leaching, ammoniacal leaching and bacterial leaching. The development of individual process or combined processes, including precipitation, cementation, solvent extraction, ion exchange and supported liquid membrane is underway. Eco- friendly and energy-saving processes are necessary to comply with stringent

environmental regulations.

Remarks: The Korean government is making consistent efforts to improve the recycling rate to the standards indicated in the EU directives for WEEE. The EPR system is playing very important role in this direction. The need of time is to increase more awareness among the people. In Korea, the recycling of WEEE has been taken into consideration not only by government but also by public, manufacturer and recycling associations. The recycling of WEHA is successfully carrying out by recyclers except CRTs for glass recycling. The recycling of PCBs and mobile phones needs more development as these are made-up of variety of complex hazardous heavy metals, materials and components. Due to the lack of feasible technologies, the PCBs are still incinerated and landfilled.

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