Chapter 11

E-Waste Recycling by Electrostatic Separation

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ABSTRACT

This chapter discusses the problem of Waste Electric and Electronic Equipment (WEEE) as one of the largest growing waste streams globally, the influence of the product complexity and liberation in separation, and the basics of electrostatic separation. A very short review of mechanical separation processes is given and research conducted on one fraction of CRT TV set is presented. A CRT TV set fraction with higher copper content consists of yokes of a cathode tube, cables, connectors, and wires, which were tested by electrostatic separation method. The aim of this research is to evaluate the effectiveness of electrostatic separation, to determine and rank the influence of separator operating parameters, and to set models for assessment of the concentration quality and recovery of metals. The results show that it is possible to achieve a high quality of concentrates (metal content from 77 to 100%), while recovery varies greatly (from 10 to 99%).

INTRODUCTION

Waste management problem has existed since ancient times but it was not recognized for a long time, until it started to leave its “footprints” in environmental components such as water, air and soil. More rapid population growth, economic development, concentration of population in cities, increase of living standard, continuous development of technology, market spreading and availability and cheaper products are the main reasons that have led to the increase of consumption. Consumption is an indicator of the society development. Unfortunately, it is followed by the adequate amounts of waste. Hence, sustainable waste management has become one of the greatest challenges of modern society (Seo et al., 2004). Waste could be defined as unwanted material at the point generation which does not have immediate use, and the term solid waste is used for waste which is solid (Ramesha & Diganta, 2012). The quantities, composition and properties of solid waste depend on its source (urban or rural) and on the income of the countries of its origin. Waste generated in urban areas is usually called “Municipal Solid Waste”. Unlike developed countries, waste...
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management in the cities of developing countries has been long neglected (Ahmeda & Alib, 2004; Zhen-shan et al., 2009; Batool & Ch, 2009; Imam et al., 2008; Sharholy et al., 2008; Lohri, Camenzind & Zurbrugg, 2014). There are many reasons for solid waste management, among the most relevant are minimizing the environmental impact associated with solid waste, improving public health, safety and resource recovery. Municipal solid waste management has become one of the major decision making issues in all local communities of the EU and all societies (Fiorucci et al., 2003; Pires, Martinho & Chang, 2011).

Integrated municipal solid waste management could be defined as the selection and application of suitable techniques, technologies and management programs to achieve waste management objectives and goals (Tchobanoglous, Theisen & Vigil, 1993). Recycling, as an integral part of modern waste management in accordance with 3R principle (Reduce, Reuse, Recycle) or according to some authors 4R principle (Reduce, Reuse, Recycle and Recover) provides secondary raw materials for producing new products. Recycling results in several positive effects like decreasing waste quantity, as well as decreasing the space required for its dumping, saving primary raw material resources, lower energy consumption and also lower emissions during the production of new products. The rapid development of new technologies and therefore rapid obsolescence of devices is nowadays obvious in electrical and electronic equipment industry. Due to that, Waste electrical and electronic equipment (WEEE) is one of the largest growing waste streams globally (Tanskanen, 2013). The recycling of electric and electronic waste is a complex process which requires use of a number of different procedures.

This chapter presents the research of applying electrostatic separation in recycling a material fraction obtained after television set dismantling by hand. The research was carried out on the sample of eight CRT TV devices of different manufacturers and production dates. After dismantling TV devices, obtained materials were divided in four fractions on the basis of different material properties. Cathode ray tubes, condensers, larger metal parts and wooden and plastic housings were segregated as one fraction. Loudspeakers were segregated as the other fraction since they contain mostly iron and a smaller quantity of copper in yokes, as well as plastic, cardboard and textile. Printed circuit boards were segregated as an individual fraction since they contain a high share of copper and also a lot of rare metals on a non-conductor basis of vitroplast or pertinax. Yokes of cathode tubes, Cables, Connectors and Wires compose a separate fraction, briefly called “YCCW” fraction, which is the subject of the research presented in this chapter. The following objectives of the research carried out on the “YCCW” fraction were established:

- To determine the efficiency of electrostatic separation of metals as a valuable component of “YCCW” fraction,
- To determine and rank the influence of the separator operating parameters on a separation process,
- To establish a model for the assessment of concentrate quality and recovery during the electrostatic separation of “YCCW” fraction on the basis of statistical analysis.

E-WASTE

E-waste comprises of discarded electronic goods, such as televisions, computers and cell phones, while WEEE also includes traditionally non-electronic goods such as refrigerators and ovens (Robinson, 2009). However, some authors do not make a difference between these two terms and there are several definitions of WEEE or e-waste defined by EU WEEE Directive, Basel Action Network, OECD, SINHA and StEP (Widmer et al., 2005). According to the EU directive 2002/96/EC WEEE means electrical or electronic equipment