Pyrolysis of Waste Printed Circuit Board Particles

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ABSTRACT

Electrical and electronic apparatus and instruments which are obsolete value in use or completion of the life can be defined as e-waste. E-waste is one of the fastest growing types of hazardous waste. Printed circuit boards a major component of this waste. In this study, printed circuit board particles of mobile phone (MPCB) were used as electronic waste. MPCB waste was obtained from a local electronic waste factory. The elemental analysis and ICP-MS analysis were performed on these electronic wastes and thereafter pyrolysis runs were carried out between 500 and 900°C in a horizontal furnace. The liquid yields were determined and compared at different temperatures.

Keywords: Printed Circuit Board, Pyrolysis, Recycling, Waste

1. INTRODUCTION

Today because of technological development, the types of electric and electronic equipments and producing of them are increasing and as a result of this, rapid consumption is also gaining speed. The decreasing costs and increasing availability of electronic products of all kinds, including mobile phones, audio and video equipment, and personal computers and their accessories, coupled with advances in technology that rapidly make these products obsolete, produce a large amount of electronic wastes in the trash (Molto et al., 2009). In the direction of small waste electronic equipments, the amount of waste which increase gradually and complex structure of this wastes have an important problem. The United Nations Environment Program prediction that the world production is between 20 to 50 m tonnes each year, comprising more than 5% of all municipal solid waste (Cobbing, 2008). In Europe the rise of e-waste is faster than that of municipal wastes and by year 2015 this growth can reach 12 million tons (J. Churchman-Davies, 2002).

According to REC’s researches (Regional Environmental Center), in Turkey approximately 539,000 tons e-waste -turns out every year, but only 4% of this recycled in accordance with the required conditions. According to data

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from the Ministry of Environment and Urbanization, the significant amounts of the e-wastes are televisions and computer monitors. The average amount of e-waste per person is 7 kg in Turkey. Another important part of e-wastes is mobile phones. Registered number of mobile phones has exceeded the population of country. 90 million mobile phones currently on the market each year, around 10 million are added to the new mobile phone. If it is considered, that an average renewal period of telephone 18 months is, the amount of e-waste from mobile telephone will increase further. However, only 3% of these phones comes to recycling (Cevko, 2013).

The electronic waste is chemically and physically distinct from other forms of municipal or industrial waste; it contains both valuable and hazardous materials that require special handling and recycling methods to avoid environmental contamination and detrimental effects on human health (Robinson, 2009).

The waste contain certain heavy metals such as mercury, lead, cadmium, chromium etc., chloroflorocarbon (CFC), polychlorinated biphenyl (PCB), polyvinyl chloride (PVC), halogenated compounds, asbestos and arsenic they require substantial precautions in disposal stage. Lead, mercury, cadmium, chromium reaches groundwater seeping into the soil. It also carries the risk of contamination of drinking water. On average 40% of the lead in the areas of solid waste disposal is estimated that due to electronic waste (Font et al. 2011). If not taken adequate precautions in storage areas, chromium is easily possible to reach water sources. In the case of incineration of wastes containing chromium, chromium fly ashes are at risk of reaching the air environment.

Brominated flame retardants are a group of other pollutants and they are widely used in electronic products as protection against fire or burn. Thermal decomposition of these wastes can produce high amounts of brominated compounds. Some of these pollutants have structures similar to the high toxicity of dioxins and furans (Molto et al., 2009).

Collecting the e-waste, separating e-waste from its many hazardous substances which are extremely dangerous to human health and the environment and their disposal is evaluating with special logistic requirements and special treatment to prevent the leakage and dissipation of toxics into the environment. Besides these weakness, being a rich source by recovery create lucrative business in both developed as well as developing countries. While some countries have organized systems for the collection, recycling, disposal and monitoring, other countries are still to find a solution that ensures jobs while minimizing the negative environmental impacts of e-waste recycling.

About 65-80 per cent of the material content of a mobile phone can be reutilization and reclamation (Molto et al., 2011). The pyrolytic process is an opportunity to recycle electronic waste instead of landfill, incineration and disposal by other methods. Pyrolysis in an alternative approach to recycling electronic waste since the organic part is decomposed into liquids and gases, which can be used as fuels and chemicals (Blazso et al., 2002; Sun et al., 2002; Chiang et al., 2007; Hall et al., 2007; Vasile et al., 2008; Font et al., 2011; Ortuno et al., 2013).

The liquids obtained in the pyrolysis process are a complex mixture of organic compounds. However they contain significant amounts of nitrogen and other heteroatoms-containing compounds, so that in order to use such liquids as fuels, blending with petroleum refinery streams and/or upgrading should be needed. Alternatively MPCB pyrolysis liquids may be used as source of chemicals, such as phenol or styrene. (Marco et al., 2008)

In the present study, the pyrolysis of printed circuit board particles of mobile phone (MPCB) has been investigated. Primarily, elemental analysis and ICP-MS analysis of MPCB sample were carried out. Thereafter, MPCB sample was pyrolysed between 500 and 900°C in a horizontal furnace. The product yields were determined and compared at different temperatures.
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