CHARACTERIZATION ON E-WASTE PROCESSING METHODS

Che Muhammad Faris Bin Che Mohd Nuran , Muhammad Azizi Bin Hakimi, Noor Hanani Hanis Binti Jaidi, Nurul Najihah Binti Rosli, En. Muhammad Firdaus Bin Husin

Abstract

Electronic waste or known as "E-waste" is a popular, informal name for electronic products nearing the end of their useful life or defines rejected electrical or electronic devices. Electronic waste can be identified as discarded computers, electronic office equipment, electronic for entertainment devices, cell phones, television sets and refrigerators. E-wastes are considered dangerous, as certain components of some electronic products contain materials that are hazardous, depending on their condition and density. Because of its toxic components, unsafe handling of e-waste can cause harm to the environment and human health. Waste Electrical and Electronic Equipment (WEEE) contains many toxic hazardous compounds in addition to precious metals. Although the current focus is on the end-of-life management of e-waste operations, such as reuse, maintenance, remanufacturing, recycling and disposal, more attention is paid to the upstream reduction of e-waste generation by green design and clearer development. It is appropriate to study the peculiarities and compositions of different materials in e-waste and how to handle their recycling by green eco-friendly methods in order to avoid the toxicity of these pollutants to the living things. The objective of the review is to reduce the e-waste by looking for the method that suitable for the categories of e-waste and to look for the process that green technology without harms the environment. The framework was developed based on literature review from journals, articles other sources. For this study, there are 16 method processing that were found based on the category e-waste and four process have been chosen and identified which are pyrometallurgy, hydrometallurgy, centrifugal separation and vacuum pyrolysis also surface passivation. Based on the analysis four processes, the results show that category 3 and 7 which are IT and telecommunication and consumer devices are the most common category e-waste among the four processes. Next, in the chemical recycling process equipment analysis, centrifugal separation and vacuum pyrolysis process has the highest amount of equipment used which is 50 but in the physical recycling process equipment analysis, surface passivation process has the highest amount of equipment used which are 67 between the four processes. Furthermore, in the chemical recovered analysis, copper (Cu) is the most items that recovered among the four processes. In the chemical used (Total Rating NFPA) by process and chemical analysis, the highest maximum value is surface passivation process which are 36 and 10. Besides that, in the temperature used analysis, centrifugal separation and vacuum pyrolysis process has the highest maximum value which is 1750^{o}C and the lowest minimum value, -40^{o}C than the other two processes. In the pressure used analysis, surface passivation process has the highest maximum value which is 55 MPa but the lowest minimum value is 0.02 kPa which is used in the centrifugal separation and vacuum pyrolysis process. Hence,

it can be conclude that the green process among these four processes is hydrometallurgy. This is shown that the objective of this review was achieved.

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1. Introduction

Electronic waste or known as "E-waste" is a popular, informal name for electronic products nearing the end of their useful life or defines rejected electrical or electronic devices. A number of countries have created their own definition of E-waste, but the most generally agreed definition is the European Union (EU) Directive, which describes E-waste as "E-waste electrical or electronic equipment that includes all components, subassemblies and consumables that are part of the product at the time of disposal" (D. Mohan and P. M. K. Bhamawat, 2008). The Basel Convention states that e-waste concerns a vast and increasing variety of electronic products that have been discarded, including major household appliances such as refrigerators and air conditioners, mobile phones, personal stereos, consumer electronics and computers. In the other hand, the Organisation for Economic Cooperation and Development (OECD) defines e-waste as any electrical appliance that has reached its end-of-life. In 2012, the total e-waste generated in Malaysia was approximately 10–15 per cent of the total scheduled waste generated and is projected to rise when household e-waste collection is fully implemented. The high rate of obsolescence in the electronics industry is a big explanation for the fast generation of e-waste. In Malaysia, hazardous waste management systems were initiated in 1989 as a result of the rapid expansion of manufacturing operations involving different waste products and materials. E-Waste is classified as scheduled waste under the Environmental Quality (Scheduled Waste) Regulations 2005. Malaysia, through its Department of Environment (DOE), has given licenses to 18 full recovery facilities and 128 partial recovery facilities to turn different forms of e-waste into source materials.

Malaysia is expected to be a developing world by the end of this decade by the introduction of the Vision 2020 program. Malaysia is expected to be a developing world by the end of this decade by the introduction of the Vision 2020 program. Rapid economic growth in the region, combined with massive urbanization, has greatly increased electric and electronic (E&E) equipment use. In 2010, the E&E industry was the leading sub-sector in Malaysia's manufacturing sector, adding substantially to the country's manufacturing production (31 per cent; 29.3 per cent in2008), exports (48.7 per cent; 55.9 per cent in 2008) and jobs (33.7 per cent; 28.8 per cent in2008) (Brandt and Sue Wei 2012). As a result, the waste electrical and electronic equipment (WEEE) generation is posing a major challenge to the climate and likely to sustainable economic development in the region. In developed countries such as Japan, Europe and the USA, stringent regulations and measures for the proper management of WEEE have been adopted, but Malaysia is still at an early stage in the management of WEEE. At present, WEEE management is mostly business oriented, although some charitable efforts are seen on a small scale. As such, the time seems apt to design new methods and processes for e-waste generation, recycling and re-use in Malaysia. Hence, for this study, there are 16 processing methods that were found based on the category e-waste as they were shown in Table 1. Hence, four processes have been chosen and identified which are pyrometallurgy, hydrometallurgy, centrifugal separation and vacuum pyrolysis also surface passivation.