Chapter 27

A Novel Flowsheet for the Recycling of Valuable Constituents from Waste Printed Circuit Boards

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ABSTRACT

Waste printed circuit boards (PCBs) contain a number of valuable constituents. It is of great significance to separate precious metals and non-metallic constituents from waste PCBs with appropriate methods for resource recycling and environment protection. A novel flowsheet for the recycling of waste PCBs using physical beneficiation methods was constructed. Waste PCBs were disassembled into substrates and slots firstly. The substrates were crushed to the size below 1mm through wet impact crushing and separated with a tapered column separation bed. The results indicated that products with integrated separation efficiency of 93.9% and metal recovery ratio of 93.7% were obtained by the primary separation with the water discharge of 5.5 m³/h, feed-rate of 250g/min and inclination angle of 35°. Waste PCBs slots components were crushed to the size of 0.5-5mm through impact crushing and separated.

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with an active pulsing air classifier. The separation results showed that products with integration separation efficiency of 92.4% and metal recovery ratio of 96.2% were obtained with the airflow velocity of 2.90m/s and pulsing frequency of 2.33Hz. Precious metals could be obtained by further separation and purification of the metal components and the non-metal components could be used as refuse derived fuel. The flowsheet has great potential to be applied in the field of waste PCBs treatment and recycling.

INTRODUCTION

As more and more electronic waste is generated around the world with the continuous development of electronics industry, recycling and reuse of electronic waste has been recognized as a great challenge. Obsolete electronic equipments contain a large amount of metal, glass, plastics and other materials. Waste printed circuit boards (PCB) are common e-waste. How to achieve the reuse of waste PCBs is an important topic in the field of environment protection and resource recycling. Waste PCBs contain metallic elements such as Cu, Pb, Sn, Ni, Fe, Al, Cd, Be, Pd, etc., including the precious metals Ag, Au, etc. On the one hand, a number of toxic and hazardous metal components, such as Pb, Cd, Pd, etc., exist in the waste PCBs in multiple existing states. These heavy metals may cause serious environment pollution. On the other hand, wastes PCBs are rich in numerous valuable constituents and have high value for recycling. Therefore, separating the hazardous components from e-waste and recycling valuable constituents would be of significant importance.

Substantial studies have been done and reported in literature. A number of processing methods were applied to recycle waste PCBs. Zhang et al. (1998) recovered aluminum from waste PCBs with an eddy current high-pressure separator and also recycled metal-rich components of PCBs by electric separation. Araujo & Chaves (2008) recovered valuable materials from discarded cables with a dense medium separator and electric separators. Au, Ag and other kinds of precious metals were extracted from waste PCBs by chemical methods (Young & Derek, 2009). William & Paul (2007) recovered valuable constituents from the PCBs of discarded computers, televisions, mobile phones, etc., by high temperature pyrolytic cracking. Cui & Eric (2007) invented a dry separation method for recovering valuable metals from PCBs. It was based on new equipment named pneumatic table.

In conclusion, the common recycling technologies of waste PCBs are hydrometallurgy, pyrometallurgy, mechanical recycling process or in conjunction with above methods (He et al., 2006). For the recycling of PCBs, hydrometallurgy processes are used for recycling precious metals with higher grade and recovery, such as gold, silver and non-ferrous metals such as copper and zinc, but the residual leaching in waste water may cause more serious secondary pollution. Pyrometallurgy is another feasible method for e-waste recycling. However, this method suffers from the loss of valuable resources and the emission of fugitive odor and dust as it generates volatile metallic components. (He et al., 2006). Mechanical recycling processes include dismantling, shredding, classification and separation (Zhao et al., 2006). Compared with hydrometallurgy and pyrometallurgy, mechanical processes are geared towards better environmental protection, lower cost, higher material recovery and easier industrialization. In addition, the metals after separation could be concentrated again by purification. The mechanical recycling processes of PCBs can achieve full constituent recovery including ferrous metals, non-ferrous metals, precious metals, and organic substances in PCBs (Duan, 2007). Therefore, the mechanical recycling processes gradually dominate the reutilization of waste PCBs (Vetri et al., 2007; Eswaraiah et al., 2008).

As mentioned above, several latest research achievements have been listed and summarized. Despite these achievements, however, the existing methods have several disadvantages, such as...