

The Effect of Shredding and Particle Size in Physical and Chemical Processing of Printed Circuit Boards Waste

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Abstract. Circuit boards present in most electric and electronic devices are very important components, which should be removed during sorting and dismantling operations in order to allow further adequate treatment for recovering valuable metals such as copper, nickel, zinc, lead, tin and rare elements. This recovery can be made by physical and chemical processes being size reduction by shredding the first step.

In this paper, the effect of particle size in physical and chemical processing of printed circuit boards is presented and discussed. Shredding using cutting-based equipment allowed the comminution of boards and the liberation of particles composed by different materials (mainly metals and resin). Particle sizes less than 1 mm seems to be appropriate to attain high liberation of materials, which is crucial for the physical separation using gravity or electrostatic processes. Concerning chemical treatment, hydrometallurgical processing involves a leaching operation which can be also influenced by particle size of shredded boards. Samples with different granulometries were leached with 1 M HNO₃ solutions, being leaching yields evaluated. It was concluded that particle size can be an important factor for the solubilization of some metals, but the effect is not similar for all elements. When average diameters change from 2.0 to 0.20 mm, nickel, aluminium and tin reactivity were not significantly affected, being this effect important for copper. Zinc behavior was very dependent from extreme particle sizes but was less affected in intermediate granulometries. Lead leaching showed also a peculiar behavior, exhibiting high and almost constant yields (80-90%) for particle size of solids up to 1.2 mm, and decreasing suddenly for higher granulometries. The effect of time on chemical reactivity for samples with different granulometries demonstrated that particle size affects reaction rates but eventually similar efficiencies can be obtained for long time periods. Therefore the relationship between results from shredding operation and chemical leaching step needs to be optimized, considering the balance between factors like consumption of energy during grinding operation and residence time in leaching.

1. Introduction

Waste of electric and electronic equipment (WEEE) is one of the most important waste streams which correct management through material valorization is fundamental. In Europe (EU27), about 7 - 9 million tonnes of electric and electronic scrap are generated every year, corresponding to about 20 kg per year and per habitant.

Printed circuit boards (PCB) are important components in all electronic devices and in most electric equipments, being part of the list of components which need to be removed from any collected WEEE, and sent to selective treatment, according with the European legislation. The importance of PCB is related with environmental and economic issues. Some substances in PCB can be potentially hazardous (e.g. heavy metals, halogenated organics), but metal contents are interesting in the economic point of view. PCB can be considered high grade copper concentrates (typically with 20-