THE EFFECT OF SHREDDING AND PARTICLE SIZE IN PHYSICAL AND CHEMICAL PROCESSING OF PRINTED CIRCUIT BOARDS WASTE

P.C. Oliveira[1], F. Charters Taborda[2], C.A. Nogueira[1*], F. Margarido[2]

[1] *LNEG – Laboratório Nacional de Energia e Geologia, UPCS, Estrada do Paço do Lumiar, 1649-038 Lisboa, Portugal, carlos.nogueira@lneg.pt*
[2] *CVRM - Centro de Geo-Sistemas, Instituto Superior Técnico, Technical University of Lisbon (TULisbon), Av. Rovisco Pais, 1049-001 Lisboa, Portugal*
[*] Presenting author

Electronic scrap is one of the most important waste streams which correct management by material valorization is fundamental. 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 work, the effect of particle size in physical and chemical processing of printed circuit boards is studied and discussed. Shredding using cutting-based equipment allowed the comminution of boards and the liberation of particles with different materials (mainly metals and resin). Particle sizes less than 1 mm were appropriate to attain high liberation of materials, which is crucial for the physical separation by gravity or electrostatic processes.

Concerning chemical treatment, the 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 HNO_3 solutions, being leaching yields evaluated. It was concluded that particle size can be important 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 is very dependent from extreme sizes but was less affected in intermediate granulometries. Lead leaching showed also a peculiar behavior, exhibiting high and almost constant yields (80-90%) for solids up to 1.2 mm, and decreasing suddenly for higher particle sizes. 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 data 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.

Acknowledgement: The financial support made by Amb3E (Associação Portuguesa de Gestão de Resíduos de Equipamentos Eléctricos e Electrónicos) is gratefully acknowledged.

Keywords: Printed circuit boards; Recycling; Shredding; Leaching.