MECHANICAL PRETREATMENT OF WASTED PRINTED CIRCUIT BOARDS (WPCBS) IN AN INDUSTRIAL MECHANICAL TREATMENT LINE

Anđelka Popović[1], Branislava Nikolovski[1], Borivoje Adnađević[2], Vaso Manojlović[3], Jelena Bajac[1]

[1]University of Novi Sad, Faculty of Technology Novi Sad, Bulevar Cara Lazara 1, 21000 Novi Sad, Serbia;
[2]University of Belgrade, Faculty of Physical Chemistry, Studentski trg 12-16, Beograd, Serbia
[3]University of Belgrade, The Faculty of Technology and Metallurgy, Karnegijeva 4, 11120 Belgrade, Serbia

barjakb@uns.ac.rs

ABSTRACT

Nowadays, more than 3 Mt of waste printed circuit boards (WPCBs) is produced annually. This large amount is potentially a big environmental problem, but also a great economic potential through recycling and "urban mining". Copper, gold, silver and palladium can account for up to 80% total material value of waste PCBs. The current PCB recycling treatments, relying on pyrometallurgy, hydrometallurgy, or electrochemical processes, retrieve approximately 99% of metals, precious as well as bulk, from the metal fraction. An assessment is that barely 10 to 15% of e-waste is recycled in Serbia, and this mainly refers to mechanical recycling, because officially there is no adequate recycling of e-waste in Serbia. This work is aimed to show results of mechanical pretreatment of WPCBs in an industrial mechanical treatment line in Serbia.

A mix of WPCBs from mobile phones (10%), old laptop (10%) and desktop personal computers (80%) were used for the experiments. The input WPCBs were processed through a mechanical treatment line of a WEEE treatment plant operating in Serbia that mainly enables the separation of recyclable metals from plastic fractions. A sample of 100 kg of WPCBs was shredded by a ball mill to get homogenized samples. Additional grinding by a knife mill was done after this first mechanical pretreatment in order to reduce particle sizes to less than 8 mm. Thereafter, the material was separated of ferrous metals (iron, steel, nickel, etc.) by using a magnetic separator. The dust formed in the process was collected by cyclones, and bag air filters. Separation of non-magnetic fraction obtained in the first stage of mechanical pretreatment was performed with a two stage electrostatic metal/plastic separator. In the first stage three fractions were obtained: conductive (A1), non-conductive (C1) and a mix (B1). Since the mixed fraction (B1) was abundant of 33% (w/w), another separation step of that fraction was performed. Consequently, three new fractions labeled A2, B2 and C2 were obtained. Obtained fractions were further characterized in terms of size distribution. Chemical composition was determined from XRF analysis done by a JEOL JSX-1000S Fluorescence Spectrometer X-ray analyser.

Metals such as Cu (65.40%), Sn (67.55%), Pb (57.11%) and Ba (79.30%) were predominantly distributed in B1 fraction. Aluminum (67.65) was mainly concentrated in A1 fraction and Br (74.50%), Ca (83.59%) and Fe (70.67%) were concentrated in C1 fraction. Silicon was almost equally distributed between B1 and C1 fractions, while Zn is almost equally distributed between A1 and B1 fractions. After the second separation stage, in A2 conductive fraction was found Cu (47.2% of the quantity found in B1), Sn (74%) and Pb (42.2%). In contrast, Zn (59.57%) and Fe (65.71%) were concentrated in C2 fraction while Ba (54.71%) is distributed in B2 fraction. Bromine is predominantly distributed in the B2 fraction. Silicon is predominantly distributed in the C2 fraction.