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**Application of experimental techniques in metallurgy for the characterization and recovery of lead (Pb) via hydrometallurgical and pyrometallurgical processes**

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The lead-acid battery (pb-ac) is made up of four main components: the plastic case (PP), the lead alloy grids, the electrolyte solution (H2SO4) and the paste (Pb). Of these components, the lead paste was the object of study because it is the most critical material. The main components of spent battery lead paste (pb-ac) are lead sulphates (~60%), lead oxides (~37%) and lead metal (~3%) [1, 2]. The experiment was carried out in a number of stages and classified as: 1. opening of the pb-ac battery; 2. separation and preparation of the lead paste sample; 3. chemical, physical, structural and morphological characterization of the sample (XRD with Rietveld refinement, ICP-OES, granulometry, SEM-EDS); 4. desulphurization of the paste by hydrometallurgical process; 5. preparation of the desulphurized lead paste and other inputs for the pyrometallurgical process. The desulphurized lead paste was used as the raw material, solid carbon (coke) is used as a reducer, cast iron chips are used to capture sulphur and form slag, and sodium carbonate (Na2CO3) is used as a flux. For the bench experiment, each input was weighed on a semi-analytical balance and inserted into a static 200 mL porcelain crucible and then placed in a muffle furnace at a temperature of 950°C, simulating the real conditions of the pyrometallurgical process. After the casting process, the crucibles were broken and the materials obtained were carefully separated [3, 4, 5]. Hydrometallurgical desulphurization is indicated to reduce sulphur dioxide emissions. Early desulphurization of the Pb paste considerably facilitates pyrometallurgical processing and this is expressed in the following ways: a reduction in the temperature of the melting process, a reduction in the quantities of fluxes used and soda, slag and powders, SO2 in the gases and the use of chemical reagents in the refining cycle, an increase in the level of lead extraction, etc [2, 6]. When lead sulphate is desulphurized, it is transformed into lead carbonate by sodium carbonate, according to Equation 1. PbSO4 (s)+Na2CO3 (aq)->PbCO3 (s)+Na2SO4 (aq); and the desulphurization rate of the lead paste is calculated by Equation 2. Desulphurization rate (%)=(m1.w1-m2.w2)/(m1.w1). The pyrometallurgical process is made up of a number of stages: 1. the roasting stage; 2. the reduction stage; 3. the lead/matte separation stage; and 4. the slag formation stage. After the pyrometallurgical process, the solid metallic lead produced (recovered) was analyzed by ICP-OES. The direct Pb recovery rate is calculated by Equation 3. Direct Pb recovery rate (%)=(m4 x w4). The results show that the hydrometallurgical removal of sulphur from the lead paste was effective and the desulphurization rate of the lead paste should remain around 90% to 95%. The lead recovery rate should remain around 95% to 98%.