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Characterisation of Spent Ni-MH Batteries

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Abstract. Spent Ni-MH batteries are not considered too dangerous for the environment, but they have a considerable economical value due to the chemical composition of electrodes which are highly concentrated in metals. The present work aimed at the physical and chemical characterisation of spent cylindrical and thin prismatic Ni-MH batteries, contributing for a better definition of the recycling process of these spent products. The electrode materials correspond to more than 50% of the batteries weight and contain essentially nickel and rare earths (RE), and other secondary elements (Co, Mn, Al). The remaining components are the steel parts from the external case and supporting grids (near 30%) containing Fe and Ni, and the plastic components (<10%).

Elemental quantitative analysis showed that the electrodes are highly concentrated in metals. Phase identification by X-ray powder diffraction combined with chemical analysis and leaching experiments allowed advancing the electrode materials composition. The cathode is essentially constituted by 6% metallic Ni, 66% $Ni(OH)_2$, 4.3% $Co(OH)_2$ and the anode consists mainly in 62% $RENi_5$ and 17% of substitutes and/or additives such as Co, Mn and Al.

Introduction

Recycling of nickel-metal hydride batteries is very interesting from the point of view of metals recovery. This type of electrochemical system is not considered too harmfull to the environment (in opposition to Ni-Cd and Pb-acid batteries) but it has high metal contents as they comprise a complex polymetallic deposit [1,2].

The electrode materials, major components to be considered in recycling, are constituted by several metals with economic value. The cathode is made of nickel coated with nickel hydroxide while the anode is a hydrogen storage alloy based on a mischmetal (rare earths mixture, mainly lanthanum and cerium, and possibly traces of praseodymium and neodymium) and nickel with substitutes such as cobalt, manganese and aluminium [3-6]. Ni-MH batteries are designed in cylindrical, button and thin prismatic configurations [3]. The electrodes are plaques with a highly porous structure and a large surface area to provide a low internal resistance and a capability for high-rate performance.

When batteries are exhausted, nickel hydroxide and the metal alloys are the species expected to be found in the spent electrodes. The metal alloys, commonly utilised, are based on AB_5 and AB_2 types compositions, where A represents rare earths for AB_5 alloy, and a transition metal with low atomic number for the AB_2 system. In both cases, B may include several transition metals with high atomic number. The AB_5 alloys are usually based on the composition $LaNi_5$ (or more generally $RENi_5$, RE being rare-earths) in which small amounts of other metallic elements can substitute atomic crystallographic positions of La or Ni, in order to increase the alloy charge storage capacity and, therefore, to increase the batteries life cycle.

In this paper, the characterisation of cylindrical and thin prismatic spent Ni-MH batteries is presented and discussed. Several methods were utilised for characterising qualitative and quantitatively the electrode materials, concerning their physical and chemical composition. The characterisation of Ni-MH components is essential to assess their economic value, to develop the