Quantitative Chemical Analysis of Red Mud and Products of its Processing to Scandium, Zirconium and REE Oxides by ICP AES

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Abstract

Establishment of scandium production from the red mud of the Ural alumina refineries by RUSAL required implementation of effective process control and quality assessment of the pure scandium oxide produced. To this end, techniques for scandium, zirconium and REE determination in bauxites, muds, semi-products and commercial products using the existing equipment and methods of the facility’s central laboratory (i.e. without the purchase of new equipment and/or adoption of additional methods of analysis) were developed by RUSAL’s Engineering and Technology Center. Investigations were performed to develop the quantitative chemical analysis of red mud and products of its processing for determination of Sc, Zr and REE oxides by inductively coupled plasma-atomic emission (ICP-AES) on the PerkinElmer OPTIMA 8000 CROSS FLOW-L15 model. The possibility to analyse a wide range of concentrations from 1 ppm to 10% is shown. Comparative determinations of basic element oxides, trace contamination and REE by various analytical methods were performed.

Keywords: scandium, REE, zirconium, ICP-AES, analytical methods.

1. Introduction

The unique chemical and physical properties of scandium and REE are widely used in various fields of science and industry: electronics (superconductors), optics and nuclear (filters for quasi-monochromatic neutron beam production, neutron tube and generator targets, β-particles source). Scandium is used for the production of halogen lamps. Scandium is also used as alloying material in production of high-strength cast iron, low-alloyed steel and special alloys, most promising of which are alloys with aluminium. Adding Sc to aluminium alloys can increase their strength by 2 times, increases its plasticity and corrosion resistance, and most importantly, makes alloys weldable with seam properties the same as base alloy material. This opens new areas of aluminium use in civil aviation (shifting to welded construction significantly reduces the weight of aircraft), shipbuilding, etc.

At present scandium is produced in small quantities (world production is about 14 tpy) and mainly extracted from liquors of the uranium and titanium dioxide industries, where it is contained in trace quantities. One of the factors limiting production is the absence of a large raw material base. One potentially huge source are bauxites, which accounts for more than half of the world’s Sc. When bauxites are processed in alumina production, soluble scandium forms are concentrated in bauxite residue – red mud, so scandium production from bauxite residue has very good prospects. Due to the amounts of red mud produced and accumulated annually and the possibility to implement Bayer process friendly scandium extraction technology as an addition to alumina production process, it almost has no capacity constraints.