

COMPARISON STUDY OF Sc EXTRACTION FROM BAUXITE RESIDUE USING PHOSPHORIC AND SULPHURIC ACID

Lamprini-Areti TSAKANIK¹, Theopisti LYMPEROPOULOU², Giorgos PANAGIOTATOS¹, Elias CHATZITHEODORIDIS³, Maria OCHSENKUEHN-PETROPOULOU¹

¹ Laboratory of Inorganic and Analytical Chemistry, School of Chemical Engineering, National Technical University of Athens, Iroon Polytechniou 9, , Zografou Campus, 15773, Greece

² Products and Operations Quality Control Laboratory, School of Chemical Engineering, National Technical University of Athens, Iroon Polytechniou 9, , Zografou Campus, 15773, Greece

³ Laboratory of Mineralogy, Petrology & Economic Geology, School of Mining and Metallurgical Engineering, National Technical University of Athens, Iroon Polytechniou 9, Zografou Campus, 15773, Greece

Emails: btsakanika@gmail.com, veralyb@chemeng.ntua.gr, oxenki@central.ntua.gr

ABSTRACT

Bauxite residue (BR) is the alkaline by-product of bauxite digestion for alumina production causing serious disposal problems since it is mainly stored on land in Bauxite Residue Disposal Areas (BRDAs). The residue is enriched in numerous metals including technoeconomically critical elements such as rare earth elements-REEs (Sc, Y and lanthanides). Its composition depends on bauxite ore and Bayer process operating conditions. It has been found that Greek BR contains a significant and consistent amount of REEs close to 1kg/ton and a high Sc concentration of about 120g/ton. REEs and especially Sc high demand in high tech materials combined with low availability, renders Greek bauxite residue to a potential resource of valuable elements reducing additionally BR environmental impact. Hydrometallurgical treatment is the most common, simple and of low cost technique applied for Sc and other REEs quantitative recovery¹.

Several acids have been employed so far in hydrometallurgical processes. Organic acids, HNO₃, HCl, H₂SO₄, H₃PO₄ or acid mixtures (e.g. aqua regia) are some examples. In most cases optimization of Sc and lanthanides recovery is achieved at the expense of selectivity obstructing any consecutive purification process. H₃PO₄ has been used as extraction reagent for Sc recovery and/or removal of main elements for other raw materials, depending on its concentration and process conditions^{2,3}. H₂SO₄ has been proposed for selective leaching of Sc in respect to iron recovery¹.

The aim of this study is to investigate the use of phosphoric acid for the leaching of scandium from BR and the comparison of the leaching efficiency with those of sulfuric acid. Furthermore, the study of the consecutive use of phosphoric and sulfuric acids is in progress

investigating the possibility to remove with phosphoric acid silicon or other main elements in respect to Sc enrichment and afterwards selective extraction of BR with sulfuric acid. Based on previous studies⁴ several variables were studied individually or combined. Acid molarity (1-7M), leaching time (1-4h), solid/liquid ratio (2-20%) final pH value and reaction temperature up to 85°C were selected as control parameters for the selective Sc recovery. H₃PO₄ was also used for the pretreatment of BR for main elements removal and REEs enrichment in the solid residue prior to H₂SO₄ leaching. All results were compared to those obtained by direct leaching of BR with sulfuric acid as described in details elsewhere¹. Efficiency of leaching process is assessed by Sc concentration and recovery while selectivity by reference to main elements. Main elements and Sc determination was accomplished by ICP-OES. Temperature was proven to be the most influential parameter for Sc recovery although negatively affects selectivity similarly to sulfuric acid as mentioned in previous studies^{1,5}. Solid to liquid ratio has significant impact on Sc concentration (Fig. 1) despite the decrement of percent recovery. Increased molarities (>5M) do not enhance Sc extraction possibly due to the high viscosity of acid solution. The increment of acid molarity enhances Sc recovery due to lower pH values obtained (Fig. 2). In any case leaching efficiency of phosphoric acid is less than sulfuric at ambient temperature and identical acid molarity. Sc leachability under ambient conditions ranged from 6% (1M H₃PO₄ S/L 20%) to 48% (5M H₃PO₄ S/L 2%). Regarding main elements, Fe recovery remains low (~3%) similarly to sulfuric acid while for Al, Si, Ti the recoveries ranged between 6-50% depending on the element and acid molarity.

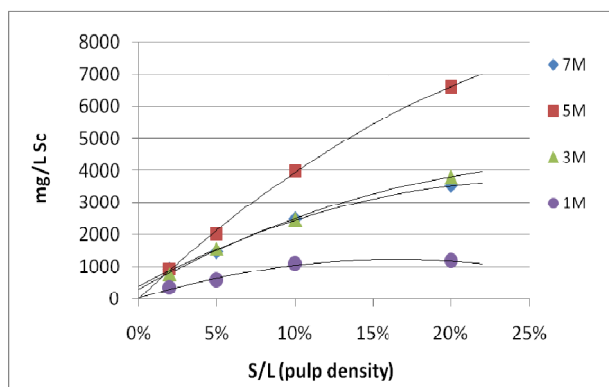


Figure 1: Effect of solid to liquid ratio (S/L, pulp density) on Sc concentration

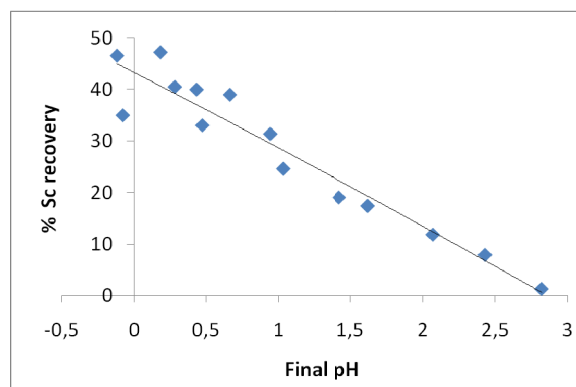


Figure 2: % Sc recovery vs final pH of the leachate

Mineralogical analysis of the residue before and after leaching was performed by XRD technique. Differences observed were attributed to dissolution of calcium, sodium and iron compounds (Fig. 2).

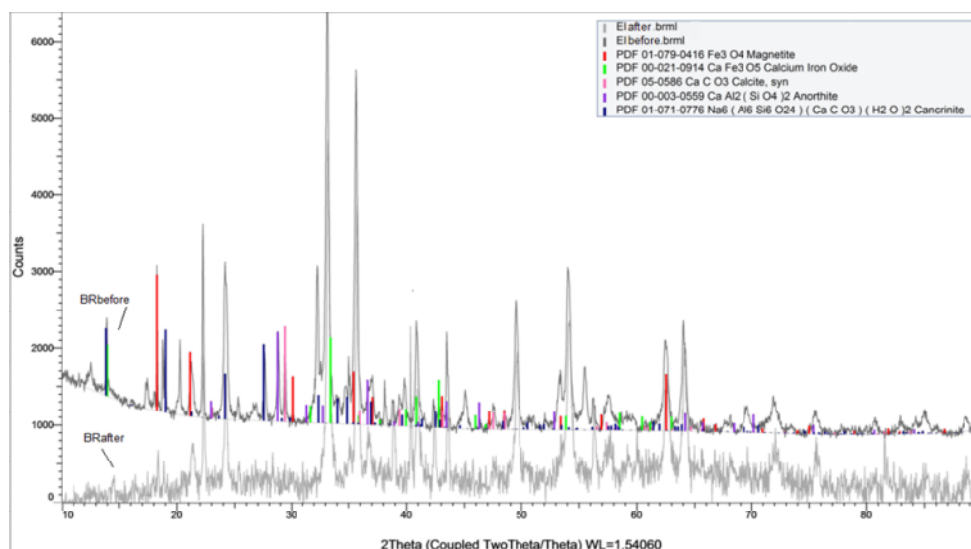


Figure 3: XRD spectrums of BR before (up) and after (down) leaching process (3M H₃PO₄/1:20)

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