

A PROPOSAL FOR BAUXITE QUALITY CONTROL USING THE COMBINED RIETVELD - LE BAIL - INTERNAL STANDARD XRPD METHOD WITH AN HKL MODEL DEVELOPED FOR KAOLINITE

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In the bauxite industry - exploration, beneficiation and refinery - two main chemical parameters are used for the quality control: available alumina ($AvAl_2O_3$) and reactive silica ($RxSiO_2$). Both are determined using a procedure that simulates the Bayer process at the lab scale [1]. For gibbsitic bauxites, subject of this study, the available alumina is associated with gibbsite, and the reactive silica is associated with kaolinite. For this reason, they are also referred to as gibbsitic alumina and kaolinitic silica. High-grade bauxites contain >41 wt.% $AvAl_2O_3$ and <5 wt.% $RxSiO_2$, while low-grade bauxites contain <41 wt.% $AvAl_2O_3$ and 5-20 wt.% $RxSiO_2$. Gibbsitic bauxites are most valuable in terms of operational cost; the refining process of these bauxites consumes less energy because gibbsite digestion occurs at low temperatures (130-160 °C). However, significant quantities of kaolinite increase the operational costs because under the conventional conditions of the Bayer process, kaolinite reacts with NaOH (leaching agent) to form a sodalite-type desilication product, which results in irreversible NaOH losses [2-4]. In Northern Brazil (Pará State) are located the three largest bauxite mines in the country ($>90\%$ of Brazilian production) and the largest metallurgical alumina refinery in the world (Hydro Alunorte). The loss of caustic soda due to sodalite formation in the Hydro Alunorte refinery has been reported to be much higher than the estimated value based on the amount of reactive silica that has been measured by quality control. It happens mainly in the bauxites from Paragominas (region of Miltônia, Pará State), which typically exhibit high reactive silica contents prior to washing. However, the estimated experimental errors are almost always within the deviations expected by the certified values, which has prevented obtaining a clear answer to this problem. A great innovation for this industry would be to make this control by mineralogical parameters, i.e., the % of gibbsite and % of kaolinite via X-ray Powder Diffraction Analysis (XRPD). Even with the fast increase in the last years of studies related to mineralogical phase quantification using XRPD analysis, there are still some challenges related to bauxite quantification. For instance, the lack of crystal structure information related to kaolinite, which has been underestimated when trying to apply the Rietveld method with available Crystallographic Information File (CFI). In this work, a combination of the Rietveld, Le Bail and Internal standard methods was tested, and the results were very promising for a Brazilian gibbsitic bauxite. This combination not only improved the quality of gibbsite and kaolinite quantification, as decreased computer processing time, making it a more convenient and fast procedure, requirements for an industrial control method.

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