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Thermal transformation of red mud and its surface properties

De Noni Jr., A.(1); Scaratti, G.(1); Deoti, J.(1); Dutra, M.(1); Rodrigues, A.(2);
(1) UFSC; (2) UFSc;

Red mud (RM) is the main residue from the Bayer process, which consist in the refinement of the bauxite to obtain alumina. In the World, the annual volume of RM generated is approximately 120 million tons. RM can be stored either as a slurry in dams/basins/ponds or as sludge in dry stacking storage sites. The safe storage and disposal of RM is one of the major environmental challenges for the aluminum industry. Due to its high alkalinity and the presence of heavy metals, RM is classified as a hazardous waste. The RM deposition in dams, basins or ponds represents a constant contamination risk. Besides of leaking's risk, dams' collapses are causing great environmental and social impact in Brazil. In 2016 and 2010, dams containing red mud collapsed in China and Hungary, respectively. Therefore, the development of technologies to destinate RM for other applications than simple storage is urgent. For that, the evaluation of RM behavior during thermal treatment is necessary to propose environmental applications for it, for example, adsorbent and catalyst for water and wastewater treatment. For this reason, the aiming of this study is characterizing the phases detected by X-ray diffraction (XRD) when RM is treated thermally at temperatures varying from 100 °C to 1000 °C and link these phases to the thermograms obtained by the thermogravimetric analysis (TGA) and differential thermal analysis (DTA). The RM was obtained from Hydro/Alunorte (Pará, Brazil). First of all, the RM was dried at 80 °C overnight, grounded and sieved through a 200 mesh sieve. RM was characterized by chemical composition using an X-ray fluorescence equipment (XRF), TGA and DTA. Then, the RM was treated thermally at 100 °C, 200 °C, 400 °C, 600 °C, 800 °C and 1000 °C for two hours under air atmosphere. The samples were denominated by the temperature applied: RM100, RM200, RM400, RM600, RM800 and RM1000. Each sample treated thermally was characterized by XRD and specific superficial area by BET method. The chemical composition of the RM consists in Fe2O3 (34.69%), Al2O3 (21.11%), Na2O (10.02%), SiO2 (17.10%), TiO2 (5.72%), others (3.0%) and loss on ignition (8.40%). The specific surface area obtained for RM100, RM200, RM400, RM600, RM800 and RM1000 were 32.0 m2 g-1, 22.5 m2 g-1, 33.1 m2 g- 1, 21.9 m2 g-1, 25.7 m2 g-1, 16.2 m2 g-1. The main mineralogical phases detected in the XRD diffraction for RM100 and RM200 were Fe2O3, gibbsite (Al(OH)3) and sodalite (Na4Al3Si3O12Cl). For RM400, RM600 and RM800 were Fe2O3 and Na4Al3Si3O12Cl. Gibbsite was decomposed at 263.42 °C, as we can see in the DTA curve. DTA curve shows one exothermic peak at 892.42 °C, corresponding to the transformation of the sodalite in nepheline. For this reason, sample RM1000 presents the phases Fe2O3 and (Na,K)AlSiO4. The thermal transformation presented by RM makes this waste material suitable and versatile for many materials development, mainly in the field or adsorbents and catalyst applications.