Properties and Application of Ugandan minerals in refractories and paper

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Abstract

Development of products which can be produced from a country's natural resources is very important as far as the industrialization of a nation and saving foreign exchange is concerned. Presently, industries in Uganda and the other states in the Lake Victoria region import all refractory-related-consumables, as the demand cannot be met locally. Based on the abundance of ceramic raw materials for high temperature applications in the region and the demand for refractories by industries it is pertinent to develop and manufacture firebricks by exploiting the locally available raw materials.

This work thus, concerns the characterisation of ceramic raw mineral powders from the Lake Victoria region, more particularly, Uganda, with the aim of developing firebrick refractories and also consider other applications from the Ugandan minerals. Two main deposits of kaolin and a ball clay deposit were investigated to assess their potential in the manufacture of refractory bricks. Raw- and processed sample powders were investigated by means of X-ray diffraction (XRD), thermal analysis (DTA-TG) and Scanning Electron Microscopy (SEM). In addition, the chemical composition, particle size distribution, density, and surface area of the powders were determined.

A general production process scheme for manufacturing fireclay bricks starting with raw powder minerals (Mutaka kaolin and Mukono ball clay) was used to make six groups of sample fireclay brick. Experimental results from the characterization of formulated sample bricks indeed revealed the viability of manufacturing fireclay bricks from the raw minerals. Based on these results, industrial samples were formulated and manufactured at Höganäs Bjuf AB, Sweden. Kaolin from the Mutaka deposit was used as the main source of alumina while ball clay from Mukono was the main plasticizer and binder material. The formulated green body was consolidated by wet pressing and fired at 1350°C in a tunnel kiln. Characterization of the sintered articles was done by X-ray diffraction, scanning electron microscopy, and chemical composition (ICP-AES). In addition, technological properties related to thermal conductivity, thermal shock, alkali resistance, water absorption, porosity, shrinkage, permanent linear change (PLC), linear thermal expansion, refractoriness under load (RUL), and cold crushing strength were determined. The properties of the articles manufactured from the selected naturally occurring raw minerals reveal that the produced articles compare favourably with those of parallel types. Thus, the raw materials can be exploited for industrial production.
A comprehensive study on beneficiation of Mutaka kaolin was also carried out using mechanical segregation of particles. The aim of the study was to

explore other potential applications like in paper filling and coating. The beneficiation process improves the chemical composition of kaolin to almost pure, the major impurity being iron oxide.

In this particular study, a kaolin sample was collected from a deposit located at Mutaka, south-western Uganda, –the biggest kaolin deposit in the country. With the aim of upgrading this sample, it was processed by a laboratory hydro cyclone to produce a kaolinite concentrate and this has been characterized to ascertain its use as an industrial raw material. Characterization of the beneficiated sample was carried out by XRD, SEM, particle-size distribution, density and volume measurements, chemical analysis, whiteness index test, thermal analysis (DTA/TG) and surface area measurements. Results show that the laboratory beneficiation exercise improves the kaolin sample to a very high grade with a chemical composition close to that of ideal kaolinite. The major impurity after beneficiation, iron oxide, was further reduced by acid leaching.

Subsequently, Mutaka kaolin was experimented on in paper filling and coating with a commercial clay from Brazil used as a control. This study has shown a first indication that the kaolin from Mutaka have potential as a filler clay in SC paper applications. It is also interesting to note that the cleaning process of the Mutaka clay was simplified compared to the commercial clay and significant improvements were achieved in paper brightness. Another aim of this study was also to investigate paper machine runnability. The paper machine runnability was good for both the commercial as well as for the Mutaka clay. Though, the retention levels with the same polymer dosages were slightly lower for the Mutaka clay. An explanation could probably be the simplified cleaning process of the Mutaka clay. The dryness after the press section of the paper was similar when using both types of kaolin.

The project is moving towards commercialization and exploitation of the Mutaka mine.

Keywords: kaolin; clay; Ugandan minerals; fireclay; refractory; powders characterization; beneficiation; ceramics; mullite, paper.