Prediction of soluble alumina in the kaolin calcination reaction from diffuse reflectance infrared spectra

Guatame Garcia, Adriana; Buxton, Mike; Tang, Pik Leung

Publication date
2017

Document Version
Final published version

Published in
Scientific Research Abstracts

Citation (APA)
Guatame Garcia, A., Buxton, M., & Tang, P. L. (2017). Prediction of soluble alumina in the kaolin calcination reaction from diffuse reflectance infrared spectra. *Scientific Research Abstracts*, *6*, 37.

Scientific Research Abstracts
Vol. 6, p. 37, 2017
ISSN 2464-9147 (Online)
Applied Mineralogy & Advanced Materials | AMAM-ICAM 2017

PREDICTION OF SOLUBLE ALUMINA IN THE KAOLIN CALCINATION REACTION FROM DIFFUSE REFLECTANCE INFRARED SPECTRA

Adriana Guatame-Garcia (1)*, Mike Buxton (1), Pik Leung Tang (2)

(1) Delft University of Technology, Resource Engineering, Delft, CN, the Netherlands, (2) Agilent Technologies, Edinburgh, United Kingdom
*l.a.guatame-garcia@tudelft.nl

For industrial applications, highly refined kaolin is calcined at temperatures above 1000ºC, triggering chemical, morphological and mineralogical changes. The aim of the calcination process is to create a white, non-abrasive and chemically inert product. In order to control these properties, the Standard Operating Procedure (SOP) in the industry is the extraction of soluble aluminium. This parameter measures the reactivity of the calcined kaolin and estimates on its abrasiveness. However, this procedure has a long turn-around time that prohibits operational feedback. As a consequence, there is a strong industrial interest on the development of an on-line and automated measurement of soluble aluminium.

This study proposes a methodology based on diffuse reflectance infrared (IR) spectroscopy that serves as a proxy for the measurement of soluble aluminium. The technique was chosen based on its capabilities for implementation as an on-line and automated tool, and because it can detect the mineralogical changes associated to the crystallinity of the calcined kaolin, which are linked to the soluble aluminium content. For this, feed and products collected from a calcined kaolin processing plant were characterised using diffuse reflectance IR spectroscopy in the mid- and long-wave ranges (MWIR and LWIR, respectively) using a portable instrument. The spectral features that explain the transformation in the calcined kaolin reaction were identified, and the IR spectra were used as input for a Partial Least Squares (PLS)-based regression model for the prediction of soluble aluminium.

In the IR spectra, the amorphous and highly reactive phase was characterised by broad Al-OH, Si-O and Al-O absorption features. The transition towards a crystalline phase was evidenced in the spectra by changes in the shape and wavelength position of the absorption features. These variations describe the stability of the mineral structure, which is related to the reactivity of the material, and the formation of crystals that influence the abrasiveness. The input for the PLS model was restricted to the wavelength ranges where the relevant absorption features occur, thus avoiding the influence of environmental factors. The resulting model has a good performance for the prediction of the soluble aluminium values, showing that the IR spectra can be used as a proxy for the measurement of the SOP.

In a mineral processing environment, portable IR instruments can record spectra from the calcined kaolin production on-site and periodically. The short time required for the data collection and processing enables the generation of results in near real-time. These data can be integrated to the plant's monitoring system giving timely feedback to operators for adjusting the parameters for calcination. As a consequence, reduction of energy and costs can be expected, thus increasing the efficiency of the operations.

Acknowledgments: this work was facilitated by the STOICISM and MONICALC research projects. It has been supported by the European Commission under the 7th Framework Programme through the grant number 310645 and the EIT Raw Materials KAVA funding through the grant number 15045.