

Kinetic and mechanistic aspects of the dehydration of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$

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Abstract

Gypsum is the mineralogical term used to describe materials that are mainly constituted of calcium sulfate dihydrate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). These materials can be obtained either from natural or synthetic sources and are of paramount importance for modern construction material industry because they represent the main raw materials to produce plaster. This product is widely employed to manufacture gypsum wallboards and serves as an additive for other construction materials (*e.g.* cements). The production process of plaster consists in partially dehydrate gypsum in calcination furnaces, large-scale heterogeneous industrial reactors, to obtain calcium sulfate hemihydrate ($\text{CaSO}_4 \cdot 0.5\text{H}_2\text{O}$), which is the main constituent of plaster. (Kuntze, 2015) In order to better understand the functioning of these industrial reactors and to be able to propose improvements in this matter, it is mandatory to better understand the thermodynamics of the CaSO_4 - H_2O system and the reaction mechanism for each chemical transformation taking place during the calcination process.

In this context, one of the objectives of the present work is to increase the current understanding about the reactivity of calcium sulfate dihydrate, clarify remaining questions on reaction kinetics, and propose a kinetic-geometric model of the transformation of this material. In order to perform this, the dehydration of a highly pure calcium sulfate dihydrate powder was monitored using thermogravimetric analysis under isotherm and isobaric conditions. This was performed in order to obtain kinetic and reaction rate curves. Temperature ranging from 86°C to 110°C and water vapor partial pressure ranging from 10 hPa to 60 hPa were investigated. Morphological and textural characterizations of the solids were also employed to understand the way of transformation. Based on this knowledge, a kinetic nucleation-growth model was then proposed and applied to the experimental data in order to obtain kinetic parameters for nucleation and growth. A growth mechanism was written and the change of kinetic parameters with temperature and water vapor partial pressure was explained. (Mampel, 1940; Helbert *et al.*, 2004; Pijolat *et al.*, 2011)

References

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