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Construction and Building Materials 19 (2005) 359–365
Construction and Building MATERIALS
www.elsevier.com/locate/conbuildmat

Thermal decomposition study of crystalline limestone using P-wave velocity

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Received 7 February 2003; received in revised form 30 July 2004; accepted 2 August 2004
Available online 25 September 2004

Abstract

A high-calcium limestone was calcined in order to study its thermal decomposition using P-wave velocity. The onset of calcination is at approximately 750 °C, while its completion according to the size of the cubic specimens is noted between 1000 and 1150 °C. We found that P-wave velocities are a very good index for the study and estimation of calcination. P-wave velocity decreases due to a temperature rise from 650 to 1150 °C for the cubic specimens of 4, 6 and 8 cm mean edge, while for 1 and 2 cm cubic specimens mixed behavior is observed, with a considerable increase in velocities at calcination temperature higher than 1050 °C.

Keywords: Limestone; P-wave velocity; Thermal decomposition

1. Introduction

The main chemical property of limestone is its thermal decomposition, known as ''calcination'', during which quicklime (CaO) and carbon dioxide are produced. It is a reaction that is strongly affected by the partial pressure of the gas phase (PCO_2). An increase in PCO_2 partial pressure leads to a rise in the initial calcination temperature [1,2]. According to Boynton [1] $CaCO_3$ decomposition temperature determined by several researchers at the beginning of the 20th century are generally still accepted as 898 °C at 1 atm in a 100% CO_2 environment. However, according to some studies, this temperature is set at 902.5 °C [3–5].

The thermal decomposition of $MgCO_3$ (magnesite) is performed at much lower temperatures between 402 and 550 °C depending on the CO_2 partial pressure [1,6,7]. Since the $MgCO_3/CaCO_3$ ratio varies with the type of limestone, the decomposition temperature does not remain constant and therefore must be determined for every type of limestone. Moreover, differences in the crystallinity of the limestone seem to consolidate the discordance of data. The decomposition of $MgCO_3$ of dolomite is performed at higher temperatures than magnesite. A complete decomposition average value of a high-crystallinity dolomite at 1 atm pressure and 100% CO_2 environment is set at 800 °C [1]. The $CaCO_3$ of dolomite resists at higher temperatures, resulting in two decomposition stages.

The aim of this study is to examine the calcination process using P-wave velocity of cubic specimens of several sizes from specific crystalline limestone subjected to calcination experiments under various temperature conditions and retention times.

2. Materials and methods

Cubic specimens of 1, 2, 4, 6 and 8 cm mean edge were prepared from crystalline limestones collected in

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doi:10.1016/j.conbuildmat.2004.08.002