NATURAL CEMENTS FOR CONSTRUCTION APPLICATIONS

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INTRODUCTION

Alternative cements, such as hydraulic lime or natural cement, can be capable of replacing Portland cement in many construction applications where they have advantages. Hydraulic lime and natural cement have properties intermediate between ordinary lime and Portland cement but are produced in a similar way to ordinary lime. Both hardens partly by reaction with water and so differ from other types of lime, which harden by chemical reaction with CO_2 in the air. The raw material for hydraulic lime and natural cement is a limestone with some clay, or amorphous silica. After heating between 950–1250 °C silicates and aluminates can be formed. In natural cements, C_2S (Larnite) is the major hydraulic phase. In natural hydraulic lime, a certain amount of free CaO remains that will convert to free $Ca(OH)_2$ after slaking.

MATERIALS AND EXPERIMENTAL

Samples of two diatomitic marls (Po1, Po2) and a calcarenite (Po4) from Porcuna (Jaén) were studied to evaluate their properties as natural cement raw materials. The raw samples were investigated by X-ray diffraction (XRD), X-ray fluorescence spectrometry (XRF), Scanning electron microscopy (SEM) and calcimetry analyses. Samples were crushed to produce pebbles of 2 - 3 cm in size. The crushed materials were burned between 750 and 900°C for 15 hours. After air slaking for a few days in the laboratory, the calcination products were examined again chemically and mineralogically. A quantitative mineral phases analysis by XRD was performed using the Siroquant V2.5 Quantitative XRD software.

RESULTS

The raw materials are mainly composed of calcite, with some quartz and halite, and traces of gypsum. The amount of silica is about 30%, corresponding to a rock that contains much more silica than limestones used for lime or cement manufacture. SEM observation showed the presence of amorphous silica in form of diatomites. The XRD analysis of the calcined products showed the decomposition of calcite to form lime (e.g. portlandite) and larnite (C_2S) in all samples, together with wollastonite, gehlenite and kilchoanite. Also quartz is present in minor amounts in the calcined products. The quantitative analysis by XRD showed a larnite increase with the temperature (from 30 to 50%) in the three products. It can be also observed that the amount of free lime after the air slaking is rather low in Po1 and Po2. Most the lime is combined with the amorphous silica present in the raw samples forming C_2S and the rest is slaked to portlandite, indicating the high reactivity of the products.

On the other hand the air slaking process converted the burned limestone pebbles to a fine dry powder, producing a more appropiate product for construction.

In summary, materials such as Po1 and Po2 can be used for the production of natural cements, but the calcarenite is more suitable for hydraulic lime binders.