Blended Cements with Kaolinitic Calcined Clays: Study of the Immobilization of Cr(VI)

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Abstract Numerous investigations on the immobilization of chromium in cement-based systems were carried out in the recent years. The aim of this study is to analyze the influence of the crystallinity of kaolinite used to make calcined kaolinitic clay when are used in pastes for immobilization of Cr(VI). In previous study, it was found that the reactivity of kaolinitic calcined clays used as partial replacement of Portland cement largely depends on the crystallinity of kaolinite in the raw clay. Calcined clays obtained from raw materials containing kaolinite with disordered structure presents a very high pozzolanic activity allowing high-percentage replacement (30 %) in blended cements. In this study, pastes of blended cement with 15 % and 30 % by mass of two kaolinitic calcined clays (order and disorder structure of kaolinite) were elaborated using a solution of 5000 ppm of $K_2Cr_2O_7$ and a solution-to-cementing material ratio of 0.50. The immobilization efficiency was measurement by lixiviation test and the modifications in the hydrated phases was studied by X-ray diffraction and SEM/EDS analysis. The results shown that kaolinitic calcined clay from ordered kaolinite was more efficient than disordered kaolinite to retention of Cr(VI), reaching values higher than that of PC-paste.

1 Introduction

Numerous investigations on the immobilization of chromium in cement based systems were carried out in the recent years [1–6]. Results indicate the incorporation of this metal at different hydrated phases of cement like Cr- Etringitte [7–9] and others in the gel as Cr-C-S-H [9], and others like new chromium compounds such

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$Ca_5(CrO_4)_3OH$ [4] or $CaCrO_4.2H_2O$ [10]. In the Cr-incorporation mechanisms, the cement composition plays an important role and the type of mineral addition, too.

Metakaolin (MK) is a pozzolanic material obtained by calcination of kaolinitic clays. Highly reactive pozzolanic materials, including calcined clays, can lead to help the sustainable cement production.

In previous studies, two kaolinitic clays with different cristalinity were characterized, calcined and analyzed as partial replacement of Portland cement at 15 % and 30 % by mass. Calcined clays obtained from kaolinite containing disordered structure present very high pozzolanic activity allowing high replacement levels (30 %) in blended cements [12].

The aim of this study is to analysis the influence of the crystallinity of kaolinite, in pastes elaborated with calcined kaolinitic clay, when are used for immobilization of Cr(VI). The immobilization efficiency was measurement by lixiviation test, and the modification in the hydrated phases was studied by X-ray diffraction (XRD) and SEM/EDS.

2 Materials and Methods

2.1 Blended Cements

In this study, blended cements (BC) were prepared with two kaolinitic calcined clay (MK1 and MK2) added as a partial replacement of Portland cement at levels of 15 % and 30 % by mass.

The cement used is a normal Portland cement (PC) with a Blaine fineness of 383 m^2/kg. The clinker composition reported by the cement factory was 53 % C_3S, 24 % C_2S, 9 % C_3A and 10 % C_4AF. For this cement, limestone is added as minor component (< 5 %).

Two Argentine kaolinitic clays were used: K1 with very high kaolinite content (94 %) and ordered structure, and K2 with high kaolinite content (76 %) and disordered structure. Complete details for these clays can be obtained elsewhere [12]. The clays were calcined to obtain metakaolinite (reactive amorphous phase), and then they ground until 80 % of mass passed through the 45 μm sieve (# 325), a typical goal for grinding process of blended cements. Both samples (denominated MK1 and MK2) have good pozzolanic activity, but MK2 from kaolinite with disordered structure (K2) is more reactive [12].

2.2 Pastes

Blended cement pastes were elaborated using a solution of 5000 ppm of $K_2Cr_2O_7$ and the water solution to blended cement ratio (ws/bc) was 0.50. Pastes were sealed