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EDITA
Enrique Rodríguez Castellón, Universidad de Málaga
Mercedes Moreno Recio, Universidad de Málaga

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Synthesis and behavior of Belite-Alite-Ye'elimite (BAY) cement

D. Londono-Zuluaga[1,2], J.I. Tobon[2], M.A.G. Aranda[1,3], I. Santacruz[1], A.G. De la Torre[1]

[1] *Departamento de Química Inorgánica, Cristalografía y Mineralogía, Universidad de Málaga, 29071 Málaga-Spain, dlondonoz@uma.es*
[2] *Grupo del Cemento y Materiales de Construcción, CEMATCO, Universidad Nacional de Colombia, Facultad de Minas, Medellín-Colombia.*
[3] *ALBA Synchroton, Carretera BP 1413, Km. 3.3, 08290 Cerdanyola, Barcelona-Spain.*

Ye'elimite based cements have been studied since 70's years in China, due to the irrelevant characteristics from a hydraulic and environmental point of view. One of them is the reduced fuel consumption, related to the lower temperature reaction required for this kind of cement production as compared to Ordinary Portland Cement (OPC), another characteristic is the reduced requirement of carbonates as a typical raw material, compared to OPC, with the consequent reduction in CO_2 releases (~22%)from combustion. Thus, Belite-Ye'elimite-Ferrite (BYF) cements have been developed as potential OPC substitutes. BYF cements contain belite as main phase (>50 wt%) and ye´elimite as the second content phase (~30 wt%). However, an important technological problem is associated to them, related to the low mechanical strengths developed at intermediate hydration ages (3, 7 and 28 days). One of the proposed solutions to this problem is the activation of BYF clinkers by preparing clinkers with high percentage of coexisting alite and ye'elimite. These clinkers are known Belite-Alite-Ye'elimite (BAY) cements. Their manufacture would produce ~15% less CO_2 than OPC. Alite is the main component of OPC and is responsible for early mechanical strengths. The reaction of alite and ye´elimite with water will develop cements with high mechanical strengths at early ages, while belite will contribute to later curing times. Moreover, the high alkalinity of BAY cement pastes/mortars/concretes may facilitate the use of supplementary cementitious materials with pozzolanic activity which also contributes to decrease the CO_2 footprint of these ecocements.

The main objective of this work was the design and optimization of all the parameters evolved in the preparation of a BAY eco-cement that develop higher mechanical strengths than BYF cements. These parameters include the selection of the raw materials (lime, gypsum, kaolin and sand), milling, clinkering conditions (temperature, and holding time), and clinker characterization The addition of fly ash has also been studied.

All BAY clinker and pastes (at different hydration ages) were mineralogically characterized through laboratory X-ray powder diffraction (LXRPD) in combination with the Rietveld methodology to obtain the full phase assemblage including Amorphous and Crystalline non-quantified, ACn, contents. The pastes were also characterized through rheological measurements, thermal analyses (TA), scanning electronic microscopy (SEM) and nuclear magnetic resonance (NMR). The compressive strengths were also measured at different hydration times and compared to BYF.

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