Geopolymers based on different types of slags. Comparison in terms of reactivity and mechanical properties developed.

M.A. Gómez-Casero[1], L. Pérez-Villarejo[2,3], P. J. Sánchez-Soto[4], D. Eliche-Quesada[1,3]
[1]Department of Chemical, Environmental, and Materials Engineering, Higher Polytechnic School of Jaén, University of Jaén, Campus Las Lagunillas s/n, 23071 Jaén, Spain
[2]Department of Chemical, Environmental, and Materials Engineering, Higher Polytechnic School of Linares, University of Jaen, Campus Científico-Tecnológico, Cinturón Sur s/n, 23700 Linares (Jaén), Spain
[3]Center for Advanced Studies in Earth Sciences, Energy and Environment (CEACTEMA), University of Jaén, Campus Las Lagunillas, s/n, 23071 Jaén, Spain.
[4]Institute of Materials Science of Sevilla (ICMS), Joint Center of the Spanish National Research Council (CSIC)-University of Sevilla, 41092 Sevilla, Spain
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Presenting author email: magomez@ujaen.es

Cement is one of the most used materials in civil engineering, where the most used is Portland cement. This cement has high strength properties and durability (Puertas et al., 2018). However, its manufacture has a high environmental cost, because it need high temperatures to produce it and extraction in quarries of the raw material (Szabó et al., 2006). This implied a high emission of CO_2 into the atmosphere, the main greenhouse gas.

In recent years, many studies have emerged to reduce CO_2 emissions and replace Portland cement with more environmentally friendly binders (Hajimohammadi et al., 2017; Amari et al., 2019). An alternative are geopolymers (Provis, 2018) or alkaline activated cements. These cements have given good results in relation to their strength and durability (Pacheco-Torgal et al., 2012), but their behaviour is different depending on the material used and its provenance.

An investigation on the use of two slags of different origins (black steel slag (BSS); and copper slag (CS) has been carried out. The reactivity of each slag, thus a comparison of the different mechanical properties developed by each material has been studied. Slags have different chemical composition (Table 1). Combination of 35% wt potassium hydroxide (KOH) solution with different concentration (5, 8, and 12) and 65% wt potassium silicate (K_2SiO_3) solution was used as activating solution to manufacture geopolymers. A planetary mixer was used to mix the raw materials with the activator solution. 10x10x60 mm steel molds were used to synthesize geopolymers. The pastes were cured 24 hours in a climatic chamber at 20 °C at 90% of relative humidity, subsequently demoulded and cured at same condition during 1, 7 and 28 days.

Table 1. Chemical composition of slags.

Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	MnO	Na_2O	K_2O	TiO_2	P_2O5	SO_3	LOI
BSS	17.29	10.71	24.16	30.89	2.63	5.68	0.16	0.03	0.79	0.41	0.28	5.39
CS	27.65	2.04	62.18	1.25	0.38	0.03	0.63	0.56	0.21	0.04	0.9	0.00

The reaction grade to determine the amount of geopolymeric gel formed was determined by following method of Bonet-Martínez et al. (2020). Geopolymers have been characterized using Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD) and scanning electron microscopy (SEM). The mechanical properties, flexural strength and compressive strength, and thermal properties, thermal conductivity have been determined.

The results indicate that two types of slags studied are a suitable source of aluminosilicates that can be activated for the manufacture of geopolymers. These precursors are capable of developing high values of flexural and compression strength when optimal concentration of KOH was used. The optimal composition was developed when CS was utilized. Binders with CS and 12M molar ratio achieved compressive strength values up to 70MPa.

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