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Inorganic polymers synthesized using biomass ashes-red mud as precursors based on clay-kaolinite system

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ABSTRACT

Geopolymers are a new class of non-Portland cements produced using an aluminosilicate material (natural minerals, waste and/or industrial by-products) and an alkaline activator to be subsequently cured at relatively low temperatures. The aim of this work is to produce a new type of geopolymer using metakaolin (MK), rice husk ash (RHA) and red mud (RM) by alkaline activation containing sodium silicate and sodium hydroxide (NaOH). Four different geopolymer compositions were prepared at various Si/Al molar ratios (3.85, 4.30, 4.45 and 5.30). A metakaolin based geopolymers were synthesized as a reference. Specimens were characterized by XRD, ATR-FTIR and SEM/EDS. The study revealed that geopolymerization products exhibit an amorphous homogeneous structure with acceptable mechanical properties. RMRHA1 geopolymers shows the best mechanical characteristics (30 MPa) after 60 curing days. MK-RHA-RM based geopolymers obtained seem to offer a feasible alternative to conventional Portland cement contributing to the valorization of the wastes.

Keywords: Geopolymer; Red mud; Rice husk ash; Microstructure, sustainability

1. Introduction

Inorganic polymers or geopolymers constitute a new class of materials synthesized from materials of aluminosilicate nature (clays and kaolin) and an alkaline activator to be used in multiple applications: cementitious material [1], catalytic support [2] and even as a reinforcing matrix for composite materials with fibers [3]. Geopolymers synthesis by chemical reaction between amorphous silica and alumina in combination with a highly alkaline environment at slightly elevated temperature produce a three-dimensional polymer gel of Si-O-Al-O-Si [4]. Wastes and by-products from various industrial fields, such as rice husk ash (rich in amorphous SiO₂) and red mud (rich in aluminum oxides and hydroxides) were used as precursors materials, as well as the dehydroxylated clay and metakaolin (calcined kaolin).

Rice husk is an agricultural waste obtained from the outer covering of rice grains. Rice husk constitutes about 20 wt. % of rice. Rice husk ash (RHA) is an industrial by-product generated by burning rice husks. Rice husk ash is essentially amorphous silica, with gives it a great pozzolanic activity [5]. Red mud is the insoluble by-product generated during the production of alumina in the Bayer process. The large amount of wastes

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