Synthesis of sodium waterglass from rice husk ash as an activator to produce slag-based alkali-activated cements

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Alkali activated cements are considered as a green environmentally friendly material and becomes interesting alternative to replace ordinary Portland cement in the worldwide. It exhibits many excellent properties such as high early strength, low creep, low shrinkage, and good chemical resistance as well as a variety of other potentially valuable characteristics (Sathonsaowaphak, et al. 2009; Sata, et al. 2012). Alkali activated process relies on the reaction of silica, alumina and calcum with high alkaline solution. Commercial sodium silicate solutions which are added to sodium hydroxide solution and then mixed with the aluminosilicate source to activate the dissolution and polymerization process are very expensive compared to sodium hydroxide pellets. The manufacture of commercial sodium silicate solution is energy intensive because the syntheses involve silica sand and sodium carbonate treated at approximately 1400 °C (Turner & Collins, 2013). The total CO_2 emission during the synthesis of sodium silicate estimated at 1.514 kg CO_2 emitted per Kg of sodium silicate (Duxon, et, al. 2007). This process is considered very expensive due to the energy consumption with the fuel burning to reach high temperature. Besides producing considerable air pollution by emissions such as carbon dioxide, dust, nitrogen and sulphur oxides. The synthesis of sodium waterglass from pure silica obtained by only rice husk ash with sodium hydroxide pellet and distilled water as starting materials and then using its to produce alkali activated cements could be great interested.

The purpose of this work was to investigate the possibility to synthesize sodium waterglass from rice husk ash (RHA) and used as an activator to produce electric arc furnaces (EAF) based alkali activated cements. This process consumes low energy compared to current melting method used to produce commercial sodium waterglass. The starting materials, RHA and EAF were characterized by their chemical and mineralogical compositions. Commercial sodium silicate/NAOH solution was used as alkaline activator as control specimens. The effects of the ratio RHA/NaOH solution used for the synthesis of sodium waterglass on the formation of alkali activated cements have been studied using infrared spectroscopy, , X-ray diffraction (XRD), scanning electron microscope (SEM) coupled with energy dispersive X-ray spectroscopy (EDS) , physical, mechanical and thermal properties. Alkali activated cements were prepared by adding each activating solution gradually to EAF in a in a Proeti planetary mixer. Precursor and activator were mixed for 90 s. Subsequently, the walls of the container were stirred and the mixture was mixed again for another 30 s. The liquid/solid ratio was kept constant at 0.35 obtaining a suitable workability. The fresh alkali-activated material were molded into 60x10x10 mm stainless steel moulds and subjected to 60 hits on a Proeti shaking table to eliminate bubbles and achieve better compaction. During hardening of the alkali activated pastes, the samples were covered with a thin film of polyethylene for 24 h at the ambient atmosphere before demolding. After demoulding, the samples were left for 7 and 28 days at ambient temperature prior to measure the engineering properties. The results showed that materials activated with RHA reached higher compressive strengths than those activated with commercial sodium silicate. The study confirms the possibility of using rice husk ash as an alternative source of silica in alkaline activation process. This study demonstrates that an economically and environmentally sustainable technology can be used to produce waterglass, reducing the environmental impact of alkaline activation materials.

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