**Effect Activated Coal Gangue via Vibratory Ball Mill as Sustainable Product for Geopolymer**

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Abstract

This paper discusses tests conducted with a vibratory ball mill that show that a type of high-energy grinding can be used to process coal gangue. Coal gangue is a secondary resource from the coal mining industry that can be considered for geopolymer applications. Pretreatment with mechanical activation promotes its development into a valuable product [1][2]. Mechanical activation by high-energy ball milling leads not only to a reduction in particle size and an increase specific surface area and free surface energy, but also to defects and dislocations on the surface of the coal gangue (without changing the chemical composition) [3][4]. In general, mechanical activation by intensive grinding for the application of geopolymers is attracting a lot of attention due to the environmentally friendly technologies that require less or no solvents [5][6]. In addition, vibration mills and stirred media mills are frequently used in industrial practice. In a study by Tan et al [7], they found that the grinding time and grinding media size (10-25 mm) of the dry mixing process (ball mill) affected the activated construction waste on the geopolymer properties. Meanwhile, Chu et al [8] found that fly ash induces a mechanochemical reaction by forming new chemical bonds in the vibrating mill for the application of geopolymers.

Experiments

Within the framework of this study, the coal gangue was mechanically activated in a vibratory ball mill under different grinding times (1-120 min) with grinding media size 10 mm. As outputs, particle size distribution, specific surface area SBET, specific grinding energy *E*m, morphology and bond energy of Si–O and Al–O (ATR-FTIR) of activated coal gangue were analysed. The corresponding geopolymer was also synthesized and characterized by compressive strength and scanning electron microscopy to assess the mechanical properties and polymerization reaction.

Findngs

It was found that the initial median particle size x50 value could be reduced from 235.01 μm to 6.65 μm and the SBET value could be increased from 6.65 m2/g to 11.432 m2/g with a grinding time of 30 minutes. The increase in SBET and the decrease in x50 values lead to a significant improvement in coal gangue for the application of geopolymers, with a clear relationship between agglomeration and the compressive strength of the geopolymer. The compressive strength showed that due to the agglomeration of the activated coal gangue after 30 minutes, the compressive strength decreased from 5.25 MPa to 4.02 MPa at a grinding time of 120 minutes

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