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Densification Behavior and Mechanical Performance of Nepheline Geopolymer Ceramics: Preliminary Study

Abstract

Nepheline geopolymer ceramics have emerged as a promising sustainable alternative to traditional cementitious materials in various applications. As the sintering mechanism plays a crucial role in the densification and mechanical performance of ceramics, therefore, in this paper, a preliminary study was conducted to examine the effects of densification towards mechanical properties of geopolymer-based nepheline ceramics upon sintering. The said innovative geopolymer technology can convert raw materials of aluminosilicate activating with alkaline activator into ceramic-like materials requiring low temperatures. The experimental procedure includes the synthesis of nepheline geopolymer ceramics through the geopolymerization method, then sintered at different temperatures to explore the sintering behavior and its impact on the materials' microstructure and mechanical performance. The densification behavior of nepheline geopolymer ceramics during sintering was analyzed by evaluating the changes in density, shrinkage, and porosity. The microstructural evolution and are determined by using SEM. The relationships between sintering conditions, microstructure, and mechanical performance were investigated to understand the underlying mechanisms affecting the material's strength and durability. The geopolymer exhibited its highest flexural strength of 54.93 MPa when sintered at 1200 ℃, while the lowest strength of 6.07 MPa was observed at a sintering temperature of 200 ℃. The findings demonstrate a positive correlation between the sintering temperature and the flexural strength of the geopolymer ceramics, indicating that higher temperatures lead to increased strength. Ultimately, this knowledge can facilitate the broader utilization of nepheline geopolymer ceramics as sustainable materials in various engineering and construction applications.

Keywords

Ceramics; Geopolymer; Geopolymer-based Ceramics; Sintering Mechanism