HIGH-TEMPERATURE PROPERTIES OF GEOPOLYMER MATERIALS

Simona Pawlasová, František Škvára
Department of Glass and Ceramics, ICT Prague

Abstract

High-temperature properties of geopolymers on the basis of

- Czech brown coal fly ash,
- brown coal fly ash with the addition of a CaO-containing component (dolomitic lime stone, lime stone, slag, gypsum),
- geopolymers precursor

were investigated within the framework of the present work.

Geopolymer materials were prepared by alkali activation of brown coal fly ashes by using an activating agent composed of soda water glass and NaOH, followed by a heating at temperatures ranging from 60 to 80°C for 8 to 12 hours. The use of potassium-containing activating agents with Czech brown coal fly ashes had a very poor efficiency (very low strength values were obtained). The materials on the basis of the geopolymer precursor were prepared by alkali activation of fly ashes; in this case, the alkali activating agent consisted of the geopolymer precursor and NaOH. Subsequently, the materials were cured at a temperature of 20°C, respectively heated (for 6 to 12 hours) at a temperature of 60 to 80°C.

The high-temperature properties of geopolymer materials prepared in the above way were subjected to investigation at temperatures ranging from 200 to 1000°C. Material properties of samples were investigated and, in particular, the strength was determined after the periods of time (7 to 360 days) elapsed from the moment of their preparation. Furthermore, mechanical properties determined after the heat exposure to temperatures ranging from 200 to 1000°C were evaluated; the temperature dependence of the sample deformation at three-point bending under given load was also assessed.

The composition of both starting materials and reaction products is characterized by physical/chemical methods: RTG diffraction, thermal analysis, electron scanning microscope, high-pressure mercury porosimetry, FTIR spectroscopy and NMR analysis in solid phase (Si, Al).


Standard Portland cement served as reference material.

In contrast to the cement concrete that starts disintegrating at temperatures above 300°C the geopolymer materials exposed to high temperatures do not disintegrate. Geopolymer materials exhibit rather high values of residual strength. A measurable deformation of geopolymer materials starts at temperatures as high as 600°C. The presence of geopolymer precursor results in an improvement in the mechanical properties of geopolymers materials.

Acknowledgements

This study was part of the of research project CEZ:MSM 6046137302: “Preparation and research of functional materials and material technologies using micro- and nanoscopic methods” and Czech Science Foundation Grant 103/05/2314 „Mechanical and engineering properties of geopolymer materials based on alkali-activated ashes“.

Simona Pawlasová
Department of Glass and Ceramics, ICT Prague
Prague 6, Technická 5, 166 28, Czech Republic
E-mail: Simona.Pawlasova@vscht.cz