INVESTIGATION OF THE RELATIONSHIP BETWEEN THE CONDENSED STRUCTURE AND THE CHEMICALLY BONDED WATER CONTENT IN THE NETWORK OF GEOPOLYMER CEMENTS

Hervé K. Tchakouté, University of Yaounde I, Faculty of Science, Department of Inorganic Chemistry, Cameroon; Institut für Mineralogie, Leibniz Universität Hannover, Germany
htchak@yahoo.fr
Sorelle J. K. Melele, University of Yaounde I, Faculty of Science, Cameroon
Claus H. Rüscher, Institut für Mineralogie, Leibniz Universität Hannover, Germany
Elie Kamseu, Local Materials Promotion Authority, Cameroon; Department of Engineering "Enzo Ferrari", University of Modena and Reggio Emilia Via Vivarelli 10, Italy
Cristina Leonelli, Department of Engineering "Enzo Ferrari", University of Modena and Reggio Emilia Via Vivarelli 10, Italy

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The main objective of this work was to investigate the relationship between the condensed structure and the chemically bonded water content in the metakaolin-based geopolymer network. The kaolinite clay used in this work as an aluminosilicate source was transformed to metakaolin by calcination at 700 °C. The powder of the waste glass and the silica fume were used as silica sources for the synthesis of the hardeners. The obtained hardeners were characterized by infrared spectroscopy and MAS-NMR ^{29}Si. The metakaolin and the hardeners were used for producing geopolymers cements. The synthesized products were characterized by X-ray diffractometry, infrared spectroscopy, mercury intrusion porosimetry, scanning electron microscopy, MAS-NMR ^{29}Si and ^{27}Al, thermal analyses (TG and DSC) and compressive strength. The results show that the compressive strength of geopolymer cements using hardener from silica fume and the one from waste glass are 62 and 26 MPa, respectively. The microstructure (SEM observations) geopolymer cements obtained using hardener from silica fume are homogeneous, compact and dense with an average pore diameter around 10 nm. Whereas, the one obtained using hardener from waste glass are heterogeneous and contains larger pores (170 nm). MAS-NMR ^{29}Si and ^{27}Al results show that the specimen obtained using hardener from the silica fume contains more aluminum in four-fold coordination in its network than waste glass geopolymer, GWG. This indicates a higher degree of crosslinking of poly(sialate-siloxo) chains which could lead to a smaller pore sizes and a higher water uptake in the structure of the sample. The amount of chemically bonded water contained in the network of geopolymer cements using hardeners from waste glass and silica fume were 6.82 and 11.23%, respectively, as determined from weigth loss in the range 100-300 °C. All these results indicate that the higher content of chemically bonded water in the network of geopolymer obtained using hardener from silica fume is related to the much smaller average pore size diameter and the hydrophilic character of aluminum, which reveals obviously better mechanical and microstructural properties of the specimen. This could indicate here a higher degree of condensation using silica fume based hardeners for geopolymerisation.

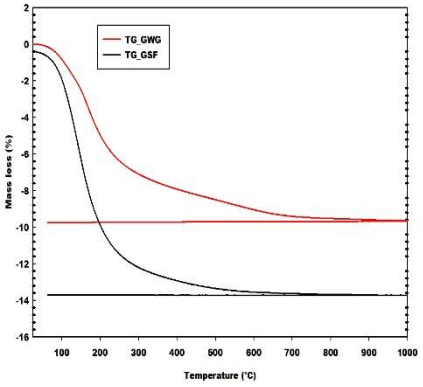

Figure 1 – TG curves of geopolymer cements GSF and GWG

Samples	Cumulative pore volume (mL/g)	Average pore diameter (µm)	Bulk density at 0.52 psia (g/mL)	Apparent density (g/mL)	Total porosity (%)
GWG	0.25	170	1.43	2.27	37
GSF	0.23	10	1.70	2.88	41

Table 1: Mercury intrusion porosimetry of geopolymer cements GSF and GWG.