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ORIGINAL PAPER

Influence of superplasticizers on the course of Portland cement hydration

Pavel Šiler*, Iva Kolářová, Josef Krátký, Jaromír Havlica, Jiří Brandštetr

Centrum for Materials Research, Faculty of Chemistry, Brno University of Technology, Purkyňova 118, 621 00 Brno, Czech Republic

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A multicell isoperibolic – semiadiabatic calorimeter was used for the measurement of temperature and the determination of the hydration heat evolution at earlier period of cement pastes setting and hardening. The measurements were aimed at the determination of the effect of superplasticizers (SPs) on the course of the Portland cement hydration. Commercial polycarboxylate SP was added to the mixtures and the heat effect was measured. With the increasing content of SP, the hydration temperature increased up to a certain value and then decreased. In case of a sufficient amount of water in the mixture to achieve complete hydration of cement, samples with the highest values of the maximum hydration temperature reached the highest values of the released total heat. If there is not a sufficient amount of water to achieve complete hydration, the samples with the highest values of the maximum hydration temperature reach the lowest values of the released total heat.

Keywords: calorimetry, cement, superplasticizer, hydration, temperature development, total heat development

Introduction

Increasing requirements for new classes of building materials (self compacting concretes, high and ultra-high performance concretes) have led to the development of new types of chemical additives and considerable progress has been made over the last two decades in the application of superplasticizers (SPs) improving the workability and performance of concretes with reduced water-to-cement ratio (w/c). It is a matter of fact in building construction engineering that the performance (mainly strengths and durability) of mortars or concretes increases when the w/c value decreases (Živica, 2009). The w/c of 0.4 is reported (Aitcin, 2005; Siler et al., 2012) as the theoretical amount of water needed for complete hydration of cement; however, this value can vary with the composition of the cement used. Although, an excess of water in concrete accelerates the hydration reaction leading to the formation of more hydrated products, the material becomes porous and consequently its performances decreases. On the other hand, decreasing the w/c worsens the workability (mixing, fluidity, or pumpability) of fresh building materials and the subsequent decrease of the resulting properties. To avoid using an excess of water and to assure good workability of the material, plasticizers or SPs are used (Sakai et al., 2006). Mainly by application of SPs, the rheological properties of various samples can be adequately adjusted to the method and conditions of concrete processing (Aydın et al., 2009) considering the mixture composition and particle size distribution.

Superplasticizers are soluble, natural, or artificial polymers. Two kinds of SPs are generally used: polycarboxylate (polymers and co-polymers of carboxylic acrylic acid) and sulfonate (salts of naphthalene sulfonate formaldehyde polymers) ones (Collepardi, 1998; Yoshioka et al., 2002).

High concentrations of polycarboxylate SP in the solution cause the formation of micellar structures of

*Corresponding author, e-mail: siler@fch.vutbr.cz