

THE WORKING MECHANISM OF STARCH AND DIUTAN GUM IN CEMENTITIOUS AND LIMESTONE DISPERSIONS IN PRESENCE OF POLYCARBOXYLATE ETHER SUPERPLASTICIZERS

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ABSTRACT:

Polysaccharides provide high potential to be used as rheology modifying admixtures in mineral binder systems for the construction industry such as concrete or mortar. Since superplasticizers have become state of technology, today, concrete is more and more adjusted to flowable consistencies. This often goes along with the risk of segregation, which can be effectively avoided by adding stabilising agents supplementary to superplasticizers. Stabilising agents are typically based on polysaccharides such as cellulose, sphingon gum, or starch. Starch clearly distinguishes in its effect on rheology from other polysaccharides, mainly due to the strong influence of amylopectin on the dispersion and stabilisation of particles. Based on rheometric investigations on cementitious and limestone based dispersions with different volumetric water to solid ratios, the mode of operation of modified potato starch is explained in comparison to a sphingon gum. It is shown that the stabilising effect of starch in a coarsely dispersed system is mainly depending upon the water to solid ratio and that above a certain particle volume threshold starch mainly affects the dynamic yield stress of dispersions, while plastic viscosity is affected only to a minor degree. Sphingons operate more independent of the particle volume in a coarsely dispersed system and show significantly higher effect on the plastic viscosity than on the yield stress. In systems incorporating superplasticizers, influences of both stabilising agents on yield stress retreat into the background, while both observed polysaccharides maintain their effect on the plastic viscosity.

ZUSAMMENFASSUNG:

Polysaccharide weisen als Rheologiemodifizierer für in der Baustoffindustrie verwendete mineralische Bindemittelsysteme wie Beton oder Mörtel ein hohes Anwendungspotential auf. Seit Fließmittel gängige Zusatzmittel in der Baupraxis geworden sind, kann Beton heutzutage verstärkt hinsichtlich seiner Fließfähigkeit spezifiziert werden. Erhöhte Fließfähigkeit geht allerdings häufig mit einer erhöhten Entmischungsneigung einher, der durch zusätzliche Zugabe von stabilisierenden Zusatzmitteln effektiv entgegengewirkt werden kann. Stabilisierer haben üblicherweise Polysaccharide als Grundstoff, z. B. Zellulose, Sphingon oder Stärke. Hierbei unterscheidet sich Stärke in ihrem Einfluss auf die Rheologie deutlich von anderen Polysacchariden, was durch den starken Einfluss ihres Amylopektinmoleküls auf die Dispersion und Stabilisierung von Partikeln begründet werden kann. Anhand rheometrischer Untersuchungen an Zement- und Kalksteinmehlsuspensionen mit unterschiedlichen volumetrischen Wasser-Feststoffverhältnissen werden die unterschiedlichen Wirkungsweisen von modifizierter Stärke im Vergleich zu Sphingon erklärt. Es kann gezeigt werden, dass der stabilisierende Effekt der Stärke in grobdispersen Systemen im Wesentlichen vom Wasser-Feststoffverhältnis abhängt und dass oberhalb eines Partikelvolumengrenzwertes vor allem die dynamische Fließgrenze und weniger stark die plastische Viskosität beeinflusst. Der Wirkungsmechanismus von Sphingonen in grobdispersen Systemen ist deutlich weniger abhängig vom Partikelvolumen. Hier kann ein deutlich größerer Einfluss auf die plastische Viskosität ausgemacht werden. In Systemen, die Fließmittel enthalten, treten Einflüsse der Stabilisierer auf die Fließgrenze in den Hintergrund, während ein deutlicher Effekt hinsichtlich einer höheren plastischen Viskosität ausgemacht werden kann.

RÉSUMÉ:

Les polysaccharides présentent un grand potentiel dans des applications de mixtures modifiant les propriétés rhéologiques de liants minéraux pour la construction civile comme le béton ou le mortier. Puisque les superplastifiants sont devenus une technologie à la mode, de nos jours la consistance du béton est de plus en plus ajustée afin de présenter des caractéristiques de fluidité. Celles-ci s'accompagnent souvent d'un risque de ségrégation qui peut être évitée de manière effective en additionnant des agents stabilisant en plus des superplastifiants.

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similar. Compared to diutan gum, starch is more complex for the use in cementitious systems, since its performance depends on factors such as the particle size distribution and the water to solid ratio. However, since its influence seems to be more independent of the adsorption of particles, it might less interfere with PCE adsorption.

The obtained results are based on the assumption that a Bingham approach can sufficiently describe the stabilising agents' rheological properties. However, particularly at low shear rates, it can be assumed that the observed stabilising agents show clear non-linear behavior. Furthermore, it was observed that particularly the stabilising effect of starch can be reduced over the course of time (e.g. when, due to cold temperatures, the stability is not supported by hydration). Therefore, for future research, it is important to put focus on the behavior particularly at low shear forces.

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