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RHEOLOGICAL PROPERTIES AND CRITICAL STRUCTURE-FORMING CONCENTRATION OF KAOLIN SUSPENSIONS WITH COMPLEX ADDITIVES

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The influence of complex additives on the critical structure-forming concentration of kaolin suspensions is studied. A complex consisting of the oxyphenofurfural oligomer SB-FF and sodium tripolyphosphate, which can be used as a fluidizing additive for kaolin suspensions, is most effective at low concentrations.

Slips with minimum moisture content and adequate mobility are obtained by introducing fluidizing additives. Complex additives containing conventional electrolytes are promising: water glass and soda as well as sodium tripolyphosphate (TPP), oxyphenolfurfural oligomers SB-5 and SB-FF, and the superplasticizer S-3 [1, 2].

The present work continues investigations in this direction. The concentrations and optimal ratios of SB-FF (product of the simultaneous condensation of phloroglucine and furfural) and TPP for suspensions of kaolin from the Glukhovetskoe deposit were found. For comparison, the following complexes were used: S-3 + TPP, SB-5 + TPP, and reotan + TPP. The initial suspensions were prepared with water-solid ratio 0.6, i.e., close to the critical concentration of structure formation or optimal moisture content. The effect of the concentration of complex additives on the rheological parameters of a kaolin suspension were investigated with a Rheotest-2 flowmeter. The rheological curves were used to determine the maximum dynamical shearing stress τ_0 and the plastic viscosity η_{pl} of a kaolin suspension. The dependence of the values of τ_0 on the concentration of complex additives is presented in Fig. 1.

When complex additives are introduced, the maximum dynamical shear stress, characterizing the strength of coagulation structures, decreases substantially. The most effective complexes at low concentrations are SB-FF and TPP. Thus, the introduction of 0.2% (SB-FF + TPP) decreases τ_0 from 224 to 47 Pa, and complexes containing the oligomers SB-5, S-3, and reotan decrease τ_0 to 61, 87, and 150 Pa, respectively.

Previous investigations have shown that for a certain ratio of a dispersed phase and a dispersion medium in suspensions a sharp change is observed in the physical and chemical parameters of the system, characterizing a transition of the system from freely dispersed to structured [3, 4]. Attraction forces between particles in the system start to predominate over the repulsion forces, and coagulation spatial structures where particles of the dispersed phase are coupled via thin residual interlayers of fluid are formed. The concentration of the dispersed phase at which such a transition is observed is called the critical structure formation concentration (CSC). An identical concept is used in ceramics technology — the optimal moisture content.

The influence of complex additives on the critical structure formation concentration of kaolin suspensions was investigated in this work. The value of τ_0 was used as an example characterizing the concept of structure formation. Kaolin

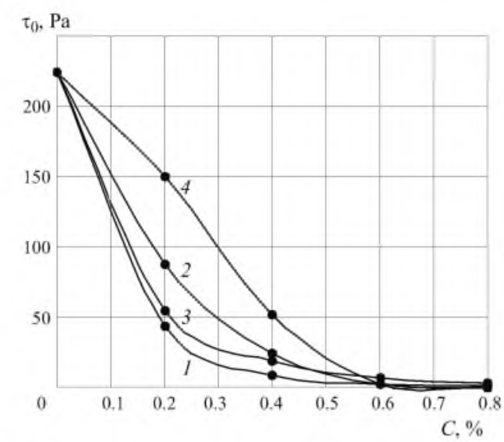

Fig. 1. Maximum dynamical shear stress τ_0 versus the content of complex additives of kaolin suspensions: *1*) SB-FF + TPP, *2*) S-3 + TPP, *3*) SB-5 + TPP, *4*) reotan + TPP.

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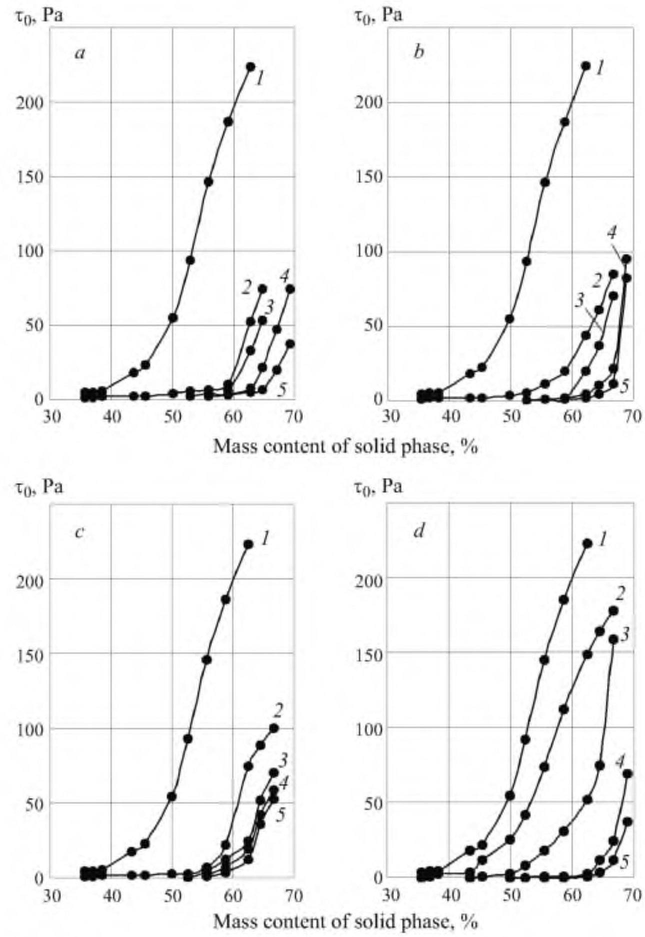

Fig. 2. Maximum dynamical shear stress τ_0 of kaolin suspensions versus the content of the solid phase and complex additives SB-FF + TPP (*a*), S-3 + TPP (*b*), SB-5 + TPP (*c*), reotan + TPP (*d*): *1*) no additives; *2*, *3*, *4*, and *5*) 0.2, 0.4, 0.6, and 0.8% additives.

suspensions with a different content of the solid phase were prepared. The influence of the solid-phase content on the maximum dynamical shear stress of kaolin suspensions is shown in Fig. 2.

Evidently, the CSC of kaolin suspensions with no additives is close to 44%, which agrees quite well with published data [3].

When the proposed complex additives are introduced, the CSC increases or the moisture content decreases substantially. For example, introducing 0.8% (SB-FF + TPP) increases the CSC from 44 to 65%, the complex with SB-5 up to 62%, and complexes containing S-3 and reotan to 66%. It was determined that the proposed additives based on oxyphenolfurfural oligomers are more effective at content in suspension from 0.2 to 0.4%, which is cost-effective, since the effect can be obtained at low cost of the additives.

For elevated additive content, the complexes based on S-3 and reotan are somewhat more effective, but the curves after the points corresponding to the CSC rise more sharply, showing that there is a more intense loss of suspension mobility as the solid phase concentration increases. A sharp drop of the suspension mobility is undesirable, since this can degrade the formability of the clay paste.

The increase of the CSC occurring when additives are introduced into the suspension is explained by the fact that a developed adsorption layer consisting of additives and water molecules is formed on the surface of the particles and the electrokinetic potential of the surface increases at the same time. This promotes aggregative stability of the system at a much higher concentration of the dispersed phase.

A further increase of the concentration of complex additives does not increase CSC. This is because at high dispersed phase concentrations the system is under "crowded" conditions, particles are so close to one another that molecular attraction forces start to predominate. The amount of the liquid phase is too small for developed adsorbed hydrate layers, promoting aggregative instability and flowability of suspensions, to form on the additive-modified surface of the particles.

In summary, new complex additives which make it possible to increase the CSC of kaolin from 44 to 65 – 66% have been obtained.

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