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Complex Diluting Additives for Kaoline Suspensions

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Abstract: In work influence of complex diluting additives on properties of suspensions of a kaolin of one of the Ukrainian fields is considered. The optimum structure of the complex additives, containing an oksifenolfurfurolny oligomer and threepolifosfat sodium is picked up. Influence of complexes on mobility of kaolinovy suspensions is studied. It is established that the optimum structure of additives does not depend on a type of an oligomer. Introduction of these complexes in kaolinovy suspensions allows to observe effect of a sinergizm-mutual strengthening of action of components at joint introduction in suspension in comparison with total action of individual components. Dependences of limiting dynamic tension of shift and plastic viscosity of suspensions on concentration of additives are presented. It is established that at certain concentration of additives transition from the structured character of a current of suspensions to the Newtonian is observed. Possibility of regulation of aggregate stability of systems is shown. Curve distributions of particles of suspensions in the sizes are presented. It is established that studied modifying additives make the maximum impact on reologichesky parametres at such ratio of components when electrostatic pushing away between particles and action of structural forces is most fully shown.

Key words: Kaolin suspensions · Complex additives · Reologichesky properties · Aggregate stability · oksifenolfurfurolny oligomer

INTRODUCTION

Regulation of aggregate stability, reologichesky properties, processes of structurization of water mineral suspensions in production of construction materials, fire-resistant and pottery is very actual task. One of ways of the solution of this task is application of various modifying additives [1-4]. As show our researches [5-8] and also available publications [9-10], for many difficult mineral suspensions to which it is possible to carry kaolinovy, clay suspensions, cement mortars etc., application of the complex modifying additives containing some components is more effective. However the range of such additives and volume of their production is insignificant and the mechanism of action is studied not enough.

Growing needs of a number of productions for modifying additives, their range, need of application for polydisperse systems of various mineralogical structure and of different function demand more thorough colloidal and chemical ideas of the action mechanism as individual and complex modifying additives.

Main Part: It is known that the most difficult reologichesky properties the high-concentrated disperse systems with spatial structures possess. Education and the change of structures caused by physical and chemical, colloidal and chemical or purely physical processes, always lead to change of their reologichesky properties.

We have investigated influence of various complex plastifitsiruyushchy additives on mobility of a kaolin of the Prosyanovsky field (Ukraine, the Dnepropetrovsk Region) as it is a component of the vast majority of shlikerny masses.

The oksifenolfurfurolny oligomer-a product of joint condensation furfurola with rezortsiny (SB-RF) and with floroglyutsiny (SB-FF) was one of components of modifying complex additives.

Резорцина with furfuroly in the alkaline environment in a general view it is possible to present the scheme of reaction of condensation as follows:

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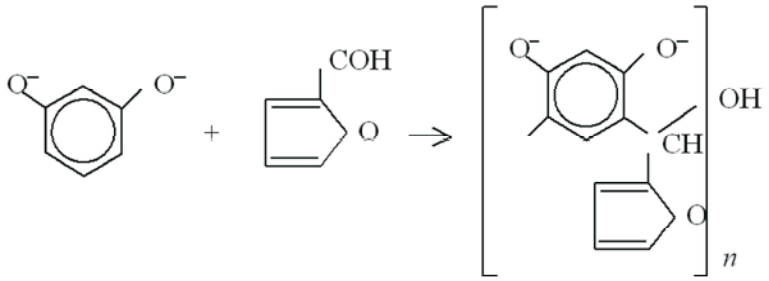
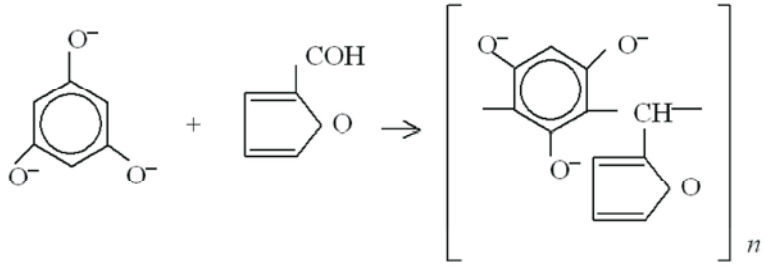


where $n \approx 4$

Floroglutsiny with furfuroly in the alkaline environment it is possible to present the general scheme of reaction of polycondensation as follows:



where $n \approx 4\text{-}5$

As the second component for modifiers the razzhizhitel rather widely applied in ceramic industry-threepolifosfat sodium (TPF) [9] has been used. It is known that polyphosphates are formed as a result of thermal processing (300-7000 C) sour phosphates of sodium and represent sodium salts of polyphosphoric acids. At dissolution in water they dissociate on a cation of sodium and polyphosphatic àíèîíû, capable to formation of the low-dissociated complexes with ions of calcium, magnesium, iron and other polyvalent cations. Polyphosphates of sodium are capable to dissolve slowly a precipitation of such low-soluble connections in water as barium sulphate, a carbonate of calcium, etc., connecting cations-Ca^{2+}, Mg^{2+}, Fe^{2+} in stronger complexes.

Initial suspensions prepared with a water firm ratio equal 0,6. Preliminary researches have shown that such ratio is close to critical concentration of structurization of this kaolin, that is to concentration of a disperse phase at which system transition from svobodnodispersny to structured when in system forces of an attraction between particles over forces of pushing away start to prevail is observed, koagulyatsionny spatial structures where particles of a disperse phase are connected through thin residual layers of liquid are formed. Comparison of parametres near area of critical concentration of education yields the most correct result.

Influence of concentration of modifying complex additives on reologichesky parametres of suspension of a kaolin investigated on реометре "Reotest-2 M" with coaxial cylinders. As the parametre characterising the beginning of structurization, value of limiting dynamic tension of shift ($[tau]_0$) was used.

The total maintenance of components of modifying additives was constant (0,1 % from weight of a disperse phase), varied mass fractions ([omega]) of components in complex additives.

Dependence of limiting dynamic tension of shift ($[tau]_0$) of suspensions of a kaolin on structure of the complex additives containing the SB-Russian Federation and TPF (complex I); SB-FF and TPF (complex II) it is shown on fig. 1.

As have shown researches, for both complexes TPF ratio is optimum: oksifenolfurfurolny oligomer equal 4:1 respectively. It should be noted that at such ratio value [tau] 0 essentially deviates from calculated by a rule additivities (dashed line), that is the effect of a sinergizm-mutual strengthening of action of separate components at their joint introduction is observed. In further researches we adhered to this ratio.

On fig. 2 reologichesky curve suspensions of a kaolin with various concentration of a complex I are presented. Apparently from drawing, initial suspension represents a vyazkoplastichny body. For the description of character of a curve Ostvald's equation is applicable:

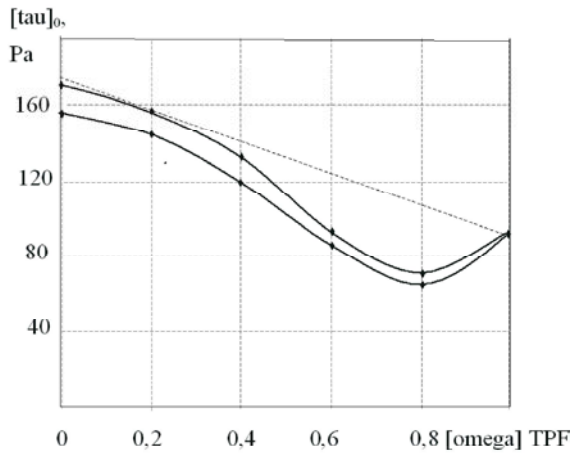


Fig. 1: Dependence of $[tau]_0$ on structure of complex additives for kaolin suspensions: 1-complex I; 2-complex II

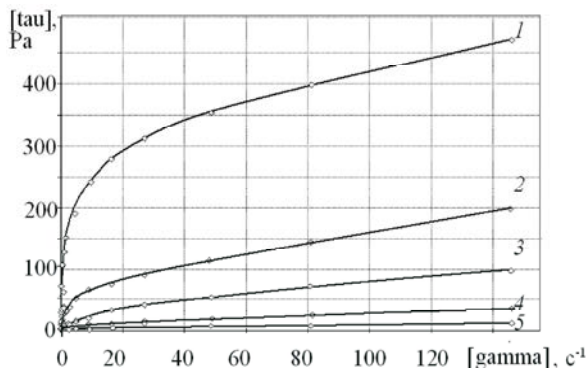


Fig. 2: Reologichesky curves of suspensions of a kaolin with various concentration of a complex I: 1-without additives; 2-0,1 %; 3-0,2 %; 4-0,4 %; 5-0,6 %

$$\tau = k \bullet \gamma^{n},$$

where [gamma]-speed of deformation, c^{-1}; [tau]-shifting tension, Pa; *k* and *n*-the constants characterising this system.

In the field of rather small dosages of additives (to 0,3 %) it is observed significant increase in a linear part of curves, the current of such suspensions can be described by Bingam's equation:

$$\tau = \tau 0 + \eta * \gamma,$$

where [eta] *-plastic viscosity, Pa•c, $[tau]_0$-limiting dynamic tension of shift, Pa.

The curves received for suspensions with the maintenance of complex additives more than 0,3 %, show that reologichesky properties of suspensions

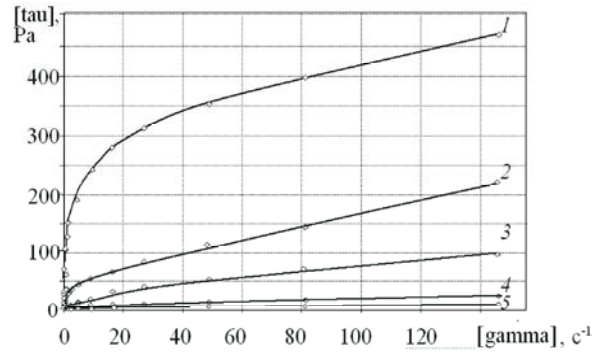


Fig. 3: Reologichesky curves of suspensions of a kaolin with various concentration of a complex II: 1-without additives; 2-0,1 %; 3-0,2 %; 4-0,4 %; 5-0,6 %

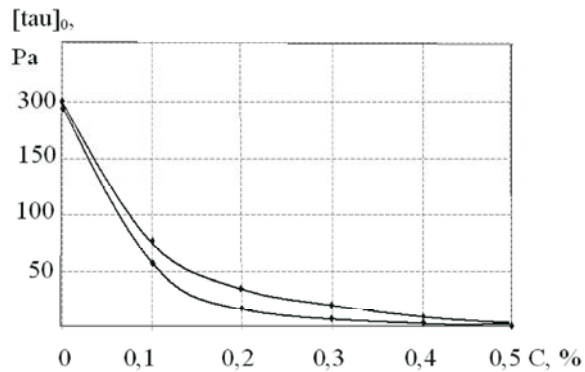


Fig. 4: Dependence of $[tau]_0$ on concentration of complex additives for kaolin suspensions: 1-complex I; 2-complex II

come nearer to reologichesky properties of zhidkoobrazny systems for which description Newton's equation is applicable:

$$\tau = \eta \bullet \gamma^{\cdot},$$

where [eta]-dynamic factor of viscosity, Pa•c.

Similar dependences have been received and for a complex II (Fig. 3).

Apparently from drawing, in process of increase in concentration of a complex II, character of a current of suspensions also changes from vyazkoplastichny to the zhidkoobrazny.

On fig. 4-5 dependences of limiting dynamic tension of shift and plastic viscosity on concentration of complex additives are presented.

Researches have shown that at introduction of complexes in number of 0,4-0,5 % limiting dynamic tension of shift and plastic viscosity come nearer to zero values.

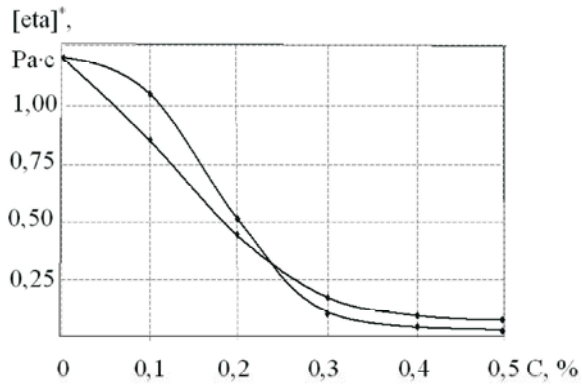


Fig. 5: Dependence [eta]* from concentration of complex additives for kaolin suspensions: 1-complex I; 2-complex II

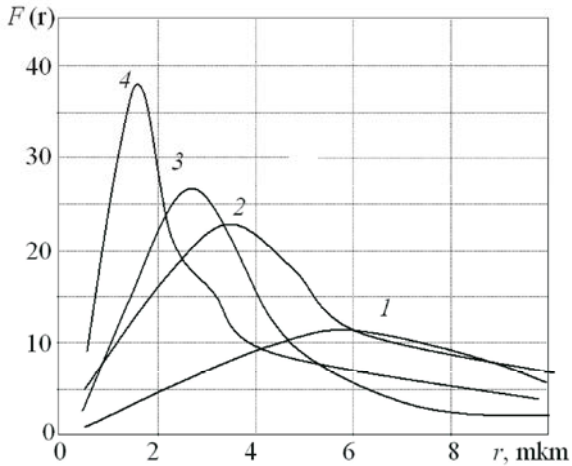


Fig. 6: Differential curve distributions of particles on radiuses for kaolin suspensions with a complex I: 1-without agents; 2-SB-RF; 3-TPF; 4-complex

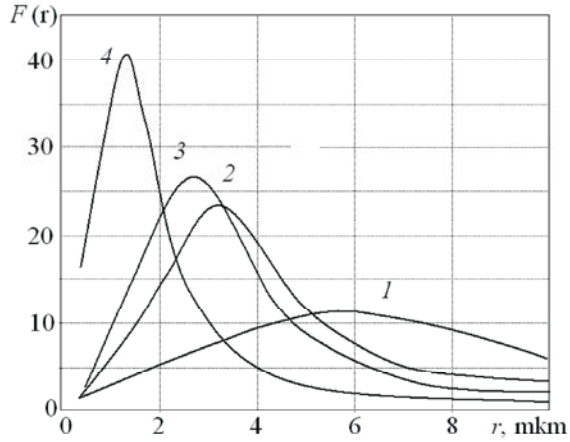


Fig. 7: Differential curve distributions of particles on radiuses for kaolin suspensions with a complex II: 1-without additives; 2-SB-FF; 3-TPF; 4-complex

From bingamovsky to the Newtonian it is possible to explain change of reologichesky character of a current of suspensions to that introduction of complex diluting additives leads to decrease in total energy of communication between particles in koagulyatsionny structures and to destruction of koagulyatsionny structures. In the diluted suspensions to the same phases at introduction of additives there is a dezagregatsiya -disintegration of rather large units to primary particles.

Aggregate stability of particles of suspensions with complex additives determined by a method of the sedimentatsionny analysis. Differential curve distributions of particles of a disperse phase in the sizes have been received at various concentration of additives. To the maximum on differential curves found naiveroyatny radius of particles.

On fig. 6-7 differential curve distributions of particles for kaolin suspensions are given at the maintenance of additives of 0,5 %. Apparently from drawing, introduction of complex additives in suspension of a kaolin leads not only to reduction of naiveroyatny radius of particles, but also to narrower distribution of particles on radiuses that testifies to increase of aggregate stability of system.

Therefore, complex additives are more effective dispergators in comparison with individual.

CONCLUSION

Thus, introduction of the complex additives, containing oksifenolfurfurolny oligomer, allows to increase mobility of kaolinovy suspensions considerably. Experimental data have shown that the optimum ratio of components in an additive depends on a type of an oligomer a little. The greatest diluting effect when $[tau]_0$ decreases to the minimum values, is observed at introduction in suspension of an oligomer and TPF in the ratio, close to 1:4. Possibly, it speaks certain nature of adsorption of components of complex additives a surface of particles of a kaolin. At such ratio of components it is observed bigger decrease in limiting dynamic tension of shift of suspension, than assumed according to an additivity rule is considerable. That is the effect of a sinergizm-mutual strengthening of action of components at joint introduction in kaolin suspension in comparison with total action of individual components is observed.

These complex additives are also effective dispergators as as a result of their adsorption on particles of a kaolin there is a peptizatsiya of units, reduction of radius of particles on the average to 1-2 microns, that is till the sizes of primary particles, the maximum decrease in polydispersion of system and increase in sedimentatsionny and aggregate stability is observed.

Conclusions: Comparison of reologichesky and sedimentatsionny characteristics of disperse systems allows to draw a conclusion that at introduction in systems of the received complex additives forces of pushing away between particles of a disperse phase therefore aggregate stability of dispersions raises increase and the considerable razzhizheniye of suspensions is observed.

Nature of influence of modifiers similar in general on aggregate stability and reologichesky properties of different suspensions gives the grounds to assume the similar mechanism of operation of modifiers in these suspensions.

Studied modifying additives make the maximum impact on reologichesky parametres at such ratio of components when electrostatic pushing away between particles and action of structural forces is most fully shown. The first is caused more TPF, the second arises mainly at the expense of additives on the basis of the oksifenolfurfurolny oligomer having volume aromatic rings with well solvatiruyemy functional groups. The role of structural forces can be very essential in the concentrated suspensions being in special "constrained" conditions when particles of a disperse phase in places of contacts considerably approach.

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