Influence of Complex Additives on Electrosuperficial Properties of Kaolin Suspensions

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Abstract: In work influence of the complex additives containing one of oksifenolfurfurolny oligomer-products of joint condensation furfurola with rezortsiny or floroglyutsiny on electro superficial properties of suspension of a kaolin of one of the Ukrainian fields is considered. It is established that at a certain ratio of an oksifenolfurfurolny oligomer and freepoliphsat sodium more significant increase in electrokintichesky potential in comparison with theoretically calculated is observed that allows to draw a conclusion on mutual strengthening of effect of action of separate components at their joint introduction. Processes of adsorption of individual and complex additives on kaolin particles are studied. It is shown that isotherms of adsorption of these additives on a surface of a firm phase have monomolecular character. At joint introduction of an oksifenolfurfurolny oligomer and threopoliphsat sodium competitive adsorption is observed. The assumption that at adsorption as a result of mutual influence of components of complex additives are guided in an adsorption layer is made in such a manner that on dispersive carrier the greatest number gidroksogroup, promoting increase in efficiency of complexes is directed at this ratio of components.

Key words: Kaolin suspensions • Complex additives • Electrokinetic potential • Adsorption • Oksifenolfurfurolny oligomer

INTRODUCTION

Nevertheless, needs of a number of productions for modifying additives, their range constantly grow. Need of their application for dispersions of various mineralogical structure and of different function demand more thorough studying of the mechanism of action of modifying additives of different structure and a structure in industrial suspensions.

Carried out before research [6-9] and also available publications [10-11] show that for many difficult mineral suspensions to which it is possible to carry cement mortars, suspensions on the basis of kaolins, clay etc., application of the complex modifying additives containing some components is more effective. Quite often, at a certain ratio of a look and quantity of components, it is possible to observe effect of a sinergizm-strengthening of action of components at their joint introduction. Complex modifiers expand a range of possibilities of purposeful management with properties of mineral suspensions and products on their basis.
Main Part: We have investigated influence on electrosuperficial properties of particles of a kaolin of the Prosyanovsky field (Ukraine, the Dnipropetrovsk Region) two-componental complex additives which structure includes one of the oksifenolfurfurolny oligomer received by us-products of joint condensation дурфурола with rezortsiny (SB-Russian Federation) and furfurolo with florglyutsiny (SB-FF).

Rezortsiny with furfurolo and florglyutsin with furfurolo in the alkaline environment in a general view it is possible to present schemes of reaction of condensation as follows:

\[
\begin{align*}
\text{Fluxoil sodium triphosphosphate Na_3P_1O_{10}} (TPF) & \text{ has been used as the second component which is widely applied in ceramic industry. Initial suspensions prepared with the water firm relation 0,6, as, according to preliminary researches, this relation is close to critical concentration of structurization of this kaolin, that is to concentration at which spontaneously there is a spatial structure from particles co-operating among themselves.}
\end{align*}
\]

The researches which have been carried out earlier, have shown that introduction of these complex additives in suspension of a kaolin allows to increase mobility and aggregate stability of disperse systems.

Aggregate stability of liofobny systems in relation to coagulation is directly connected with interaction of particles of a disperse phase and depends on properties of blankets of people around of a particle. There is a consensus concerning the nature of forces of a molecular attraction are Van der Waals's strengths (or dispersive forces). Forces of pushing away can have the various nature corresponding to different factors of stability.

One of factors of aggregate stability of liofobny disperse systems is the electrostatic factor consisting in reduction of an interphase tension, owing to emergence of a double electric layer on a surface of particles. Comparative size of forces of electrostatic pushing away at researches usually judge on size of electrokinetic potential of a surface of disperse particles.

Calculation of electrokinetic potential carried out on a formula:

\[
\xi = \frac{A \cdot \kappa \cdot E}{P},
\]

where E-potential of the cell consisting of a membrane and the dispersive medium, MB; P-pressure, atm; [kappa]-a specific elektroprovodnost of the dispersive environment, mS/cm; A-a constant defined by properties of the environment.

\[
A = \frac{\eta}{(\epsilon \cdot \epsilon_0)},
\]

where [eta]-viscosity of the dispersive environment, [epsilon]-dielectric permeability of the environment, [epsilon]_-a dielectric constant.

\[
\kappa = \kappa_{KCl} \cdot \frac{W}{W_{KCl}},
\]

where [kappa]_KCl-a specific elektroprovodnost of solution KCL, W-a membrane elektroprovodnost when in a cell there is a dispersive environment, mS; and W_KCl-a membrane elektroprovodnost when in a cell there is a standard solution KCL, mS.

On figure 1-2 dependence of influence of structure of the complex additives containing the SB-Russian Federation and TPF (complex I) is presented; SB-FF and TPF (complex II) on size of electrokinetic potential.

The maximum quantity of each additive made 0,1 % from weight of a firm phase. At such contents reologichesky parametres of suspensions most intensively change. In drawings influence of a mass fraction [omega] of individual additives from this number (curves 1 and 2) and a mass ratio of components in a complex additive is shown at its constant maintenance of 0,1 % (a curve 3) on electrosuperficial properties of particles of a kaolin. The dotted line has given a settlement curve at independent additive influence of additives on electrokinetic potential (a curve 4).

Apparently from drawings, settlement and experimental curves in some interval of ratios practically coincide that speaks about additive influence on electrokinetic potential of components of this complex additive at their joint introduction.
In case of system solution - a firm body adsorption represents, increase in concentration on limit of the section of phases. On size of adsorption it is possible to judge structurization in suspensions, a dispergatsiya of particles etc. Adsorption of additives on particles of a disperse phase studied by means of UF-spektrometra SPECORD UV in ultra-violet area at $\lambda = 50 \cdot 10^3 \, \text{cm}^{-1}$ on a decrease of concentration of studied oligomer in the dispersive environment after establishment of adsorbtionny balance. Preliminary researches have shown that adsorbtionny balance is established within several minutes.

In the simplified look adsorption on limit of the section solution-the firm body can be calculated by the equation:

$$ A = (C_1 - C_0) \cdot \frac{V}{m}, $$

where $C_0$-concentration of the dissolved substance before adsorption, kg/m$^3$; $C_r$-concentration of the dissolved substance after adsorption, kg/m$^3$; $V$-volume of solution, ml; $m$-mass of adsorbent.

On figure 3-4 isotherms of adsorption of additives are given in kaolin particles from the solutions containing as individual additives (a curve 1) and complexes (a curve 2). Apparently from drawings, character of isotherms of adsorption of components from solutions of these components, in the studied interval of concentration, is close to character of isotherms of monomolecular adsorption. At small equilibrium concentration linear dependence of adsorption on concentration is observed, at further increase in concentration curves leave on saturation and adsorption reaches the maximum value.
Fig. 4: Isotherms of adsorption SB-FF for kaolin suspension from solutions: 1-SB-FF; 2-complex II

Researches have shown that at adsorption of oksifenolfurfurolny oligomer and SB-FF the capacity of a monolayer makes $2 \times 10^7$ and $2.7 \times 10^7$ kg/m² of solutions of the SB-Russian Federation respectively while adsorption of the same oligomer makes $0.5 \times 10^7$ and $0.75 \times 10^7$ kg/m² of solutions of the corresponding complexes. That is at joint introduction of TPF and oksifenolfurfurolny oligomer competitive adsorption is observed. The share of the SB-Russian Federation or SB-FF in an adsorbtsionny layer of studied suspensions of a kaolin in the presence of TPF makes 20-25% that well coincides with researches of electrokinetic potential.

At adsorption of molecules with various by the nature gidrofilny groups it is necessary to consider interaction "adsorbate adsorbate" or so-called attraktsionny interaction.

This interaction can be estimated on Frumkin's equation:

$$K \cdot C = \frac{\Gamma}{\Gamma_{\text{Max}}} \cdot e^{-2 \frac{A \cdot \Gamma}{\Gamma_{\text{Max}}}}$$

where \([\gamma]\)-equilibrium adsorption, kg/m²; \([\gamma]_{\text{Max}}\)-the maximum adsorption, kg/m²; \(A\)-a constant of adsorbtsionny balance; \(C\)-equilibrium concentration, kg/m²; \(A\)-an attraktsionny constant.

According to adsorption by means of Frumkin's equation counted a constant of adsorbtsionny balance \(K\) and the constant of attraktsionny interaction of \(A\). Results of calculation are presented in table 1.

<table>
<thead>
<tr>
<th>Being adsorbed additive</th>
<th>[\gamma]_{\text{Max}} \times 10^7 \text{ kg/m}^2</th>
<th>To</th>
<th>And</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB-RF</td>
<td>2.00</td>
<td>2.3</td>
<td>1.34</td>
</tr>
<tr>
<td>SB-FF</td>
<td>2.70</td>
<td>8.0</td>
<td>1.65</td>
</tr>
<tr>
<td>Complex I</td>
<td>0.50</td>
<td>1.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Complex II</td>
<td>0.75</td>
<td>5.5</td>
<td>2.0</td>
</tr>
</tbody>
</table>

adsorption considerably decreases, value of a constant of adsorption falls \(A\). It is possible to assume that at introduction of a complex additive of a molecule of TPF the most adsorbtsionnoaktivny centres and joint adsorption of molecules of TPF and an oligomer borrow can lead to some change of orientation to surfaces of a disperse phase. The increase in a constant \(A\) on absolute size characterises increase in interaction "adsorbate adsorbate".

CONCLUSION

Nature of adsorption of components of a complex additive on surfaces of a kaolin decides by the adsorbtsionny centres related, generally on the maintenance of alyuminatny components. Considering that the received oligomer are anionaktivny substances, it is possible to assume possibility of their adsorption on positively charged adsorbtsionny centres of a surface. Possibly, at an optimum combination of components of complex additives, as a result of mutual influence at each other, additive SB-FF, the SB-Russian Federation and TPF are guided thus in an adsorbtsionny layer that on dispersive Wednesday the greatest number ñäpoêcoöpyïï, promoting increase in efficiency of complexes is directed at this ratio of components and to more considerable increase of electrokinetic potential on absolute size in comparison with theoretically calculated.

Thus, during researches it is established that adsorption of complex additives on a surface of particles of a kaolin leads to increase in a charge of a surface on absolute size. It is possible to assume that thus forces of pushing away between the same charged particles and consequently, action of an electrostatic factor of aggregate stability increases considerably increase that, in turn, can lead to a peptizatsiya of units to primary particles, to change of reologichesky character of a current of suspension and increase in sedimentatsionny stability of system.

At a certain ratio of components of an additive the effect of a sinergizm, that is the greatest increase in absolute value of electrokinetic potential in comparison with individual additives is observed that apparently, is connected with orientation change a complex additive as a result of competitive adsorption.
REFERENCES


