Physical Chemistry

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Fig. 1

Figure 1: Fig. 1

Abstract

Full Text

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Kinetics of the Processes of Coagulation Structure Formation in Aqueous Dispersions of Clays

Questions connected with the kinetics of the processes of coagulation structure formation in aqueous dispersions of clays are of substantial importance in the preparation and use of drilling fluids under the complex geological conditions of industrial drilling of oil and gas wells. To perform a number of functions ([1]), flushing fluids must possess definite physicomechanical properties and a corresponding degree of strengthening of the coagulation structures. Especially important is the quantitative assessment of the degree of strengthening of the system with time, which ultimately makes it possible to control the properties of the flushing fluid and to obtain drilling muds of the required quality. Knowledge of these processes is also of substantial importance for preventing sticking of the tool if the circulation flow is stopped during well drilling.

In connection with this, we have studied the kinetics of the processes of coagulation structure formation in aqueous dispersions of Cherkassy palygorskite and Gorb montmorillonite (Ukrainian SSR) by methods of the physicochemical mechanics of disperse systems ([2]).

Fig. 1. Kinetics of structure formation in aqueous dispersions of clays: palygorskite (a)
1 –19%; 2 –16.8%; 3 –12.9%; 4 –10%; 5 –7.3% and montmorillonite (b) 1 – 24.4%; 2 –20.8%; 3 –16.5%; 4 –12.8%; 5 –11.1%

On a Weiler-Rebinder instrument, the limiting static shear stress θ_s was determined as a function of time for suspensions of various concentrations. As the investigations showed, the nature and kinetics of the processes of coagulation structure formation in aqueous dispersions of clays are substantially influenced by the mineralogical composition of the clay minerals and their physicochemical properties.

Palygorskite clay is represented chiefly by the mineral palygorskite, with a characteristic layered-ribbon crystalline structure resembling the structure of amphibole ([3]). In its exchange complex, magnesium and calcium cations predominate; the amount of monomolecularly bound water is 24.3%, and the total exchange capacity is 29.4 mg-equiv. per 100 g of sample.

Aqueous dispersions of the indicated clay display a high tendency toward coagulation structure formation (Fig. 1a). At low concentrations of the disperse phase, the increase in the limiting static shear stress depends little on the time of structure formation and, in practice, its magnitude (from 4 to 24 hr of aging of the system) remains constant. With an increase in the clay concentration (from 12 to 19%), a clearly expressed thixotropic strengthening of the coagulation structure is observed with time.

Thus, a 16.8% suspension, from 10 min to 18 h of rest, is characterized by a sharp increase in the limiting static shear stress from 480 to 870 dyn/cm^2. The same picture is observed in a 19% suspension, only in different quantitative ratios.

A characteristic feature of the kinetics of the process of coagulation structure formation, beginning from 18 h of rest of the system, over the entire range of concentrations studied, is the constancy of the limiting static shear stress with time, which indicates complete strengthening of the structure that has formed. The most optimal concentrations of the dispersed phase, necessary for obtaining drilling fluids with well-pronounced thixotropic properties, fluctuate in the range from 12 to 16%, which agrees with our previous investigations ([4]). It should be noted that a further increase in the concentration of clay leads to strong strengthening of the structure with time, which may adversely affect the process of circulation of the drilling fluid in the borehole.

The bentonite clay of the Gorbskoye deposit consists of the mineral montmorillonite with an admixture of kaolinite of imperfect structure, resembling halloysite, but not having a tubular morphology of the crystals. Calcium ions predominate in the exchange complex; the total exchange capacity is 40.5 mg-eq per 100 g of sample; the amount of monomolecularly bound water is 11.7%.

At a significantly higher concentration of the solid phase than in the case of palygorskite clay, in aqueous dispersions of montmorillonite the process of coagulation structure formation is manifested to a lesser degree with the passage of time (Fig. 1b). The thixotropic strengthening of the structure with time is most pronounced at dispersed-phase concentrations of 13–20%. This concentration region practically satisfies the requirements imposed on a high-quality drilling fluid ([4], [5]). Increasing the solid phase in the clay–water system above 20% leads to strong strengthening of the coagulation structure, which is irrational in the preparation and use of drilling fluids.

Thus, differences in the mineralogical composition and physicochemical properties of the clays studied exert a substantial influence on the character and kinetics of the processes of coagulation structure formation in their aqueous suspensions. In contrast to montmorillonite, the elongated anisodiametric particle shape, high dispersity and hydrophilicity, and low cation-exchange capacity of palygorskite create more favorable conditions for the manifestation of thixotropic coagulation structure formation and for obtaining drilling fluids with high aggregate stability.

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LITERATURE CITED

[1] Walter F. Rogers, *Drilling Fluids for Oil-Well Drilling*, 1960.
[2] N. V. Mikhailov, P. A. Rebinder, *Kolloidnyi zhurnal*, **17**, 2, 107 (1955); P. A. Rebinder, *Physicochemical Mechanics—a New Field of Science*, 1958; P. A. Rebinder, *Journal of the All-Union Chemical Society named after D. I. Mendeleev*, **8**, 2, 163 (1963).
[3] F. D. Ovcharenko, E. G. Kukovskii et al., *Colloid Chemistry of Palygorskite*, 1963.
[4] V. Yu. Tretinnik, F. D. Ovcharenko, *Ukrainian Chemical Journal*, **19**, 5, 487 (1963); V. Yu. Tretinnik, Author' s abstract of Candidate' s dissertation, Kiev, 1963.
[5] F. D. Ovcharenko, N. N. Kruglitskii et al., *Ukrainian Chemical Journal*, **19**, 4, 376 (1963); N. N. Kruglitskii, Author' s abstract of Candidate' s dissertation, Kiev, 1963.

Note: Figure translations are in progress. See original paper for figures.