DRILLING FLUIDS THICKENING THROUGH CHANGES IN THE INTER-PARTICLE INTERACTION

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Abstract: *Various ways of the drilling fluids thickening for their recycling and utilization have been investigated. Only complex treatment including coagulation and flocculation was found suitable for the optimal thickening. The most effective consequence of the admixtures adding and their concentrations have already been determined.*

Introduction

Physicochemical and rheological properties of the drilling fluids (density, viscosity, sedimentation stability etc.) should be ranged within some limits in order to provide effective drilling. Waste drilling fluids consist of much ground rock particles and should be cleaned in hydrocyclones or settlers before discharge. This operation forms dense waste cleaning slurry, which consists of very much solid phase particles along with various chemical modifying agents. Similar slurry can form at the waste drilling fluids decomposition (layering). The slurry consists of numerous toxic agents and can not be stored in the ground settling pits for a long time. Some components of the slurry were added to the initial fluid for its sedimentation and aggregation stabilization but the slurry should be decomposed, which requires its destabilization, layering and thickening.

Phase separation into the solid and liquid parts is the first stage of the slurry cleaning technology. This paper deals with investigation of the most effective phase separation method.

Experimental

Drilling fluid is quite complex and multicomponent system containing truly dissolved compounds, colloid and coarsely dispersed particles. Therefore, stability and behavior of such systems can be described using the DLFO theory [1-3].

Investigation of the phase separation process is important in order to determine efficiency of the whole solution treatment technology.

Drilling fluids slurry from Dolina oilfield (Ivano-Frankivsk region of Ukraine) was used in this investigation. This slurry contains of 30.4 wt % of the disperse phase and its density is 1.241 g/sm^3. The slurry is very viscous and decomposes (layers) at long term storage.

Following treatment operations were engaged to separate the disperse phase.

- treatment with flocculation agent (polyacrylamide);
- treatment with coagulation agent ($Ca(OH)_2$) followed by next flocculation.

Ending water content and relative sample water loss ($\Delta W/W$, where ΔW is weight of the water lost in the sample decomposition and W is weight of the after-treatment remaining water) were determined as criteria of the sample dewatering efficiency.

Results end discussion

Various amounts of different admixtures were added to 40 g samples of the drilling solutions to determine timing data of the water loss. Ending water content was calculated as weight difference between an example after 48 hours of the treatment and the air-dry example.

It was found that the flocculation agent intensifies dewatering of the drilling fluid (see Fig. 1). The flocculation agent concentration of 0.25 kg/m^3 ensured the most efficient dewatering. Further increase in the concentration results in lower dewatering intensity. This result can be caused by changes in the coagulation complexes formation under various concentration of the flocculant. Low concentration of the flocculant causes aggregation of the disperse phase particles and formation of relatively large and unstable particles, which precipitate while the liquid phase releases on the surface.

Higher concentration of the flocculant causes formation of the spatial coagulation structure with stable inner bonds. The most effective dewa tering can be reached at the flocculant concentration of 0.25 kg/m^3 although rate of the process remains very low.

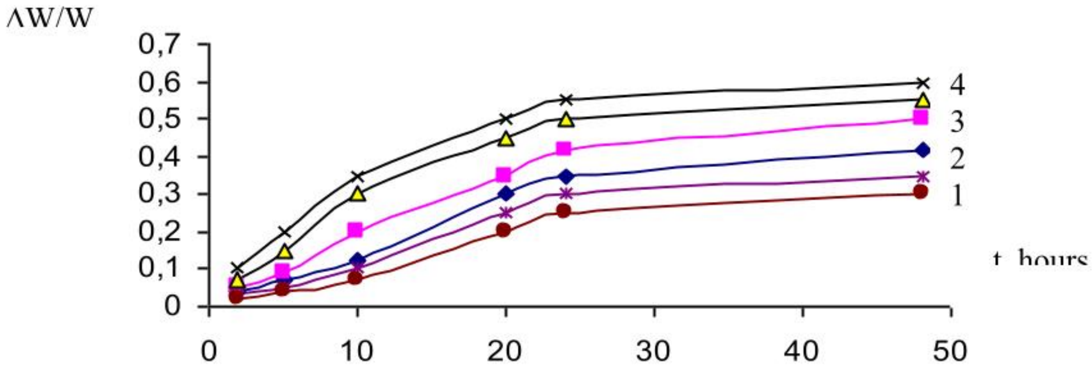

Figure 1. Dependence of relative dewatering of the drilling fluids on the processing time for the following flocculant concentrations (kg/m^3): 1 - 0.1; 2 - 0.15; 3 - 0.2; 4 - 0.25; 5 - 0.3; 6-0.4.

Preliminary samples treatment with a coagulant (calcium hydroxide) has been used to increase the rate of dewatering.

As seen from Fig. 2, this operation intensifies dewatering. The most effective coagulant concentration was found empirically equal to 8 kg/m^3. Further increasing of the concentration causes very fast lowering of the dewatering efficiency.

Analysis of the dependencies in Fig. 2 shows that the accelerating effect of $Ca(OH)_2$ can be caused by reduction of the electrostatic part of disjoining pressure [4, 5]. Low concentration of the coagulant causes decrease of electrokinetic potential of the disperse phase particles.

Further increase of the concentration results in recharge of the particles surface, which leads to new rising of the electrostatic part of disjoining pressure.

Flocculant concentration of > 1kg/m^3 does not bring additional stabilization for the drilling fluid slurry. As seen in Fig. 3, the drilling fluid slurry remains unstable at rather wide range of the flocculant concentration (0.25 – 1.5 kg/m^3). This effect can be caused by the primary aggregations of the disperse phase particles remaining in the system. These aggregations do not form a stable coagulation structure in the system.

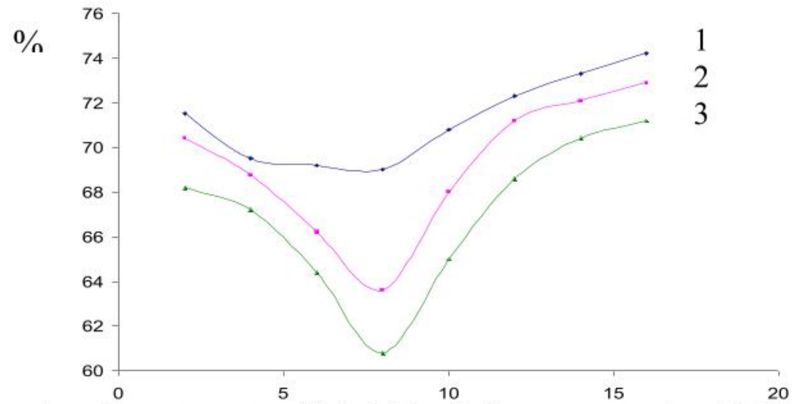

Figure 2. Dependence the water content (%) in drilling fluids on concentration of $Ca(OH)_2$. Flocculant concentration is stable (0.25 kg/m^3):
1 – 15 minutes after beginning of the experiment;
2 – 2 hours after beginning of the experiment;
3 – 7 hours after beginning of the experiment.

This conclusion is very important because such highly concentrated systems are very viscous and uniform distribution of the reagent over the entire systems can hardly be reached.

Conclusion

Simultaneous treatment with flocculants and coagulants is more effective method of dewatering of the drilling fluids slurry. The most effective reagents concentrations have been determined in this work. This simultaneous treatment method can be recommended for preliminary phase separation of the drilling fluids slurry.

This technology provides an opportunity to reduce volume of the highly dangerous drilling slurry, separate and utilize significant amounts of the dissolved compounds. On other hand, this technology would require no new equipment and can be applied at very low cost, practically at the cost of the flocculation and coagulation reagents.

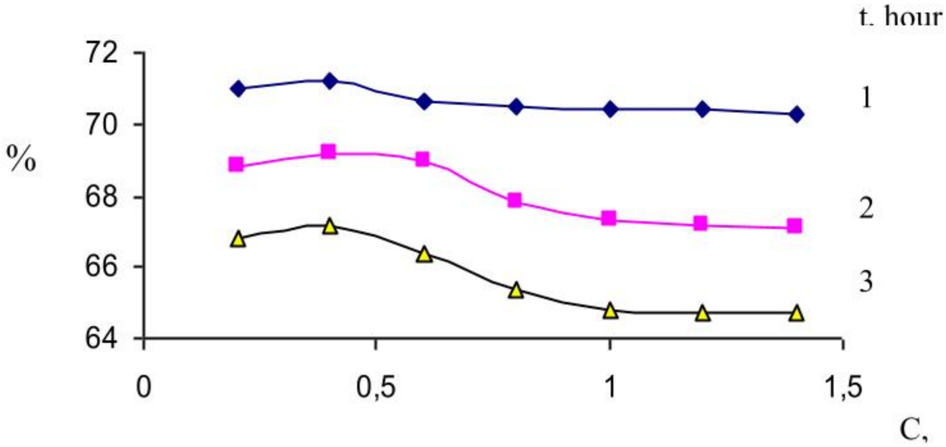

Figure 3. Dependence of the water content in the drilling fluid examples on concentration of flocculant. $Ca(OH)_2$ concentration is equal to 8 kg/m^3 for all the examples:
1 – in 15 minutes after beginning of the experiment;
2 – in 2 hours after beginning of the experiment;
3 – in 7 hours after beginning of the experiment.

References

1. A. K. Zapolsky and A. A. Baran. Coagulants and Flocculants in the Water Treatment Processes. Leningrad: Khimiya, 1987. – 208 p.
2. Kh. M. Aleksandrovych *et al*. Physicochemical Properties of the Potassium Salts Selective Floatation. Minsk: Nauka i Tekhnika, 1983. – 272 p.
3. B. V. Deryagin, N. V. Churaev and V. M. Müller. Surface Forces. Moscow: Nauka, 1987. – 398 p.
4. G. Sonntag and K. Schtrenge. Coagulation and Stability of Disperse Systems. Leningrad: Khimiya, 1973. – 87 p.
5. Yu. G. Frolov and A. S. Grodsky. Particles Aggregation in the Sedimentation-Unstable Systems. *J. Mendeleev Soc*., 1989. – vol. 34, N 2. – 38-47.