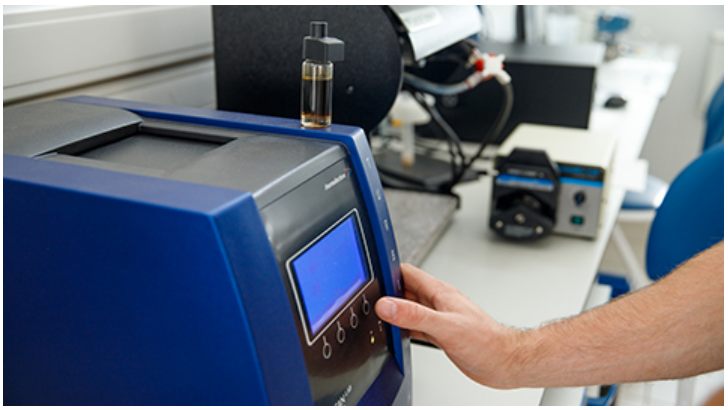
Scientists propose new nanoparticle drilling fluids for the Arctic

Siberian scientists have conducted a comprehensive study on the effect of silicon oxide nanoparticles on the properties of oil-based drilling fluids. Using nanoparticles of various concentrations, the researchers tracked their effect on the various properties of drilling emulsions.



The experiment showed that the addition of nanoparticles to drilling fluids significantly improved their physicochemical properties, and the parameters of the fluids could be changed even at a very low concentration of nanoparticles.

One of the urgent problems in the development of the Russian Arctic today is the development of oil and gas fields that were not previously exploited due to difficult mining and geological, technological, climatic and environmental conditions, which required a revision of the existing technological solutions. Conventional water-based drilling fluids are of little use for drilling in permafrost. Oil-based fluids are capable of providing the required drilling quality as they reduce equipment wear, ensure borehole stability and efficient removal of drill cuttings.

> “We are observing an increasing interest in nanotechnology from the global oil and gas industry. For example, it is promising to create drilling fluids containing small-sized solid particles, the introduction of which, even in small quantities, into the drilling fluid makes it possible to reduce the friction of drill pipes against the borehole walls, reduce filtration losses of drilling fluid, improve cuttings transport conditions and strengthen the borehole walls when drilling weakly cemented rocks. The wettability of rocks also changes, and the likelihood of equipment corrosion decreases,” said **Evgenia Mikhienkova**, senior lecturer at the Oil and Gas Well Drilling Department.

Despite the demand for such studies, the properties of drilling fluids modified with nanoparticles are still poorly understood. The scientists of Siberian Federal University set their mind on studying the effect of nanoparticle additives on the basic physicochemical properties of oil-based drilling fluids.

> *“A base oil-based drilling fluid is an inverse emulsion, in which water is the smallest droplets, and the dispersion medium is a water-in-oil hydrocarbon liquid. At first, we made an aqueous brine with calcium chloride, then we mixed the oil and brine in the required ratio, and then successively added the emulsifier, structurant and bridging agents. The resulting emulsion was injected with hydrophobic (nonwettable) nanoparticles of silicon oxide (SiO2) of various concentrations — from 0.25 to 2 mass per cent,”* continued **Evgenia Mikhienkova**.

The scientist explains that for the best result and for the destruction of large accumulations of nanoparticles, after their addition to the hydrocarbon medium, the solution was subjected to intense ultrasonic treatment. The average nanoparticle size was 80 nm.

The obtained drilling fluids, modified with silicon oxide nanoparticles, were studied according to a number

of parameters: the team investigated the viscosity, density, filtration characteristics and so on.

“This is the first time when such a comprehensive study has been carried out. Having studied the obtained invert emulsions, we came to the conclusion that the addition of nanoparticles to oil-based drilling fluids can significantly change their effective viscosity even at very low concentrations. Also, with an increase in the concentration of nanoparticles, rheological parameters such as plastic viscosity, consistency index, and ultimate shear stress increase. It is important to note that the addition of nanoparticles can significantly reduce filtration losses of drilling fluids — up to 50-70%. In addition, we believe that by reducing the friction coefficient of filter cakes when adding nanoparticles, it is possible to minimize the risk of sticking of drill pipes and increase the efficiency of drilling,” noted **Andrey Minakov**, research supervisor, director of the School of Engineering Physics and Radioelectronics of Siberian Federal University, head of the Laboratory of Physical and Chemical Technologies for the Development of Hard-to-Recover Hydrocarbon Reserves.

The researcher emphasizes that in general, with the help of nanoparticle additives, it is possible to regulate in wide ranges the main technological and physicochemical properties of drilling fluids prepared on a hydrocarbon basis. Moreover, changing the parameters of high concentrations of nanoparticles is not required, therefore, the modification of oil-based drilling fluids will occur without significant changes in their density. This is very important when drilling rocks prone to losses and hydraulic fracturing, and can significantly increase the efficiency of drilling in the difficult mining and geological conditions of the Arctic zone.

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