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Nano Oxide Particles Modified Drilling Fluid for Deep, Complicated Drilling Conditions

Liu, B.C.[1,2,3], Liu S.Q. [1,2], Chen, Z.R. [1,2], Meng, Q.N. [1,2] and Sun Y.H. [1,2,3]

[1]College of Construction Engineering, Jilin University, Changchun, 130061,China
[2]Key Lab of Drilling and Exploitation Technology in Complex Conditions, Ministry of Land and Resources, Changchun, 130061,China
[3]State Key Laboratory of Superhard Materials, Jilin University, Changchun, 130021, China

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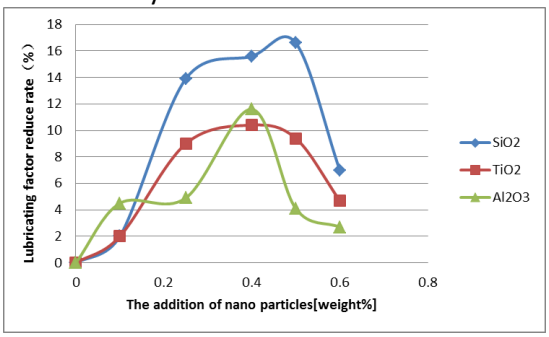
In well drilling, during the process of drilling down and tripping out of drill string, the inevitable contact and friction between drill pipe and casing will cause the wear of the drill pipe and casing tube, especially in the case of drilling deep, ultra-deep and horizontal well [1]. Compared with steel drill pipe, the wear of aluminum alloy drill pipe will be more serious [2]. Nanoparticles as additives in drilling fluids could potentially reduce mechanical friction, thus greatly enhance lubricating properties of drilling fluids and reduce the drill pipe and casing materials surface loss [3].

This study had tried to improve lubricating properties of drilling fluid for deep, complicated drilling conditions by adding oxide nanoparticles to it. Spherical alumina (Al_2O_3), titania (TiO_2) and silica (SiO_2) nanoparticles were selected as modified drilling fluid additives. The effects of different kinds and concentrations of oxide nanoparticles addition on lubricating properties and friction reduction of drilling fluid had been studied by using extreme pressure lubrication device and pin-on-disk tester. In pin-on-disk tests, the pin material was AISI316 steel (casing material) and the disk material was 7075 aluminum alloy (drill pipe material). The pin-on-disk friction and wear tests were carried out with the condition that the pin and disk were immerged in drilling fluid. The results indicated that the lubricating properties of water-based drilling fluid were significantly improved by adding appropriate amount of SiO_2 nanoparticles, meanwhile TiO_2 and Al_2O_3 nanoparticles had limited effect on the lubricating properties of drilling fluid. The LR (lubricating factor reduce rate) of drilling fluid increased to the maximum value of 16.6% by the 0.5wt% SiO_2 nanoparticles addition (Fig.1). And the WV (wear volume) of aluminum alloy disc decreased to the minimum value of 0.31mm^3 by the 0.4wt% SiO_2 nanoparticles addition (Fig.2).

Based on the above experiment results, 0.4wt% SiO_2 nanoparticles were added to the oil based drilling fluids used in SK-II well drilling, a scientific continental drilling project in the Cretaceous Songliao Basin, northeast China. The results showed that the lubricating coefficient of the drilling fluid was reduced by 20.3%, the friction factor reduce rate was increased by 29.7% and the aluminum disc wear volume decreased by 26.3%.



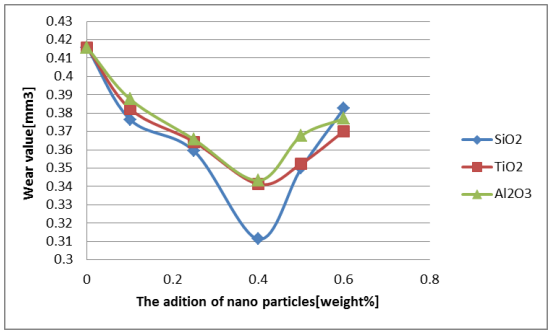


Figure 1: LR depending on the added nanoparticle *Figure 2: WV depending on the added nanoparticle*

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