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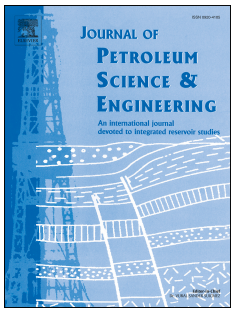

The effect of nanoparticles additives in the drilling fluid on pressure loss and cutting transport efficiency in the vertical boreholes

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The effect of nanoparticles additives in the drilling fluid on pressure loss and cutting transport efficiency in the vertical boreholes

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The effect of nanoparticles of various chemical components and sizes on the rheological behaviour of drilling fluids, pressure loss and cuttings transport in the vertical borehole for a laminar flow regime is considered in the paper. The results of numerical and experimental studies are presented. Silicon, aluminium and titanium oxides nanoparticles are considered. A drilling fluid is Bentonite-water solution with a mass fraction of 5%. The particles concentration in the solution was varied from 0.25 to 2 weight percentages and the particles sizes ranged from 5 to 50 nm. The dependences of the effective viscosity and rheological parameters of the solutions on the nanoparticles concentrations, sizes and materials were obtained. It was shown that nanoparticles in drilling fluid increase cuttings transport by 17% and decrease the average slip velocity of the sludge particles in 1.7 to 2.0 times, but the pressure losses when pumping the drilling fluid increase in 2.5 times.

Key words: non-Newtonian fluids, drilling fluid, nanoparticles, rheology, annular channel, pressure loss, Herschel-Bulkley model, cutting transport, vertical borehole, laminar flow.

Introduction

Active interest in the suspensions with nanoparticles (nanofluids) has been appeared a quarter of a century ago and still continues to grow up. The number of publications devoted to the study of nanofluids properties and applications is increasing exponentially. Nanoparticles have a number of unusual properties that are absent in the macroscopic dispersed particles due to their small size. Unusual properties of nanoparticles make the properties of nanofluids (in which they are an integral part) unconventional too, that lead to the widest range of nanofluids applications [1-7]. The influence of nanoparticles additives on heat transfer has been studied in a large number of works. As it was shown in the experimental investigations of laminar and turbulent forced convection of water-based nanofluids, the CNT-nanofluids can increase the heat transfer coefficient within the range from a few percents up to 350%. Also, it was found, that the nanoparticles adding to a fluid increase the boiling critical heat flux by several times. Many investigations of nanoparticles applications in the medical technologies were carried out. Nanoparticles are used for localized drug delivery and cancer therapy. Nanoparticles are also