Controlling Bentonite Based Drilling Mud Rheological Properties Using Sepiolite Nanoparticles

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Abstract

Designing drilling fluid for drilling in deep wells and controlling its rheology are of great concern. Drilling in deep oil and gas wells is a challenge due to the high temperature and/or high pressure. Results from this project showed that the addition of sepiolite nanoparticle (size 50 nm) to the bentonite based drilling mud controlled and stabilized the rheology within a wide range of pressure from 500 psi up to 6000 psi and temperature from 50 °C up to 180 °C. This was compared to a base case which rheology was fluctuating and was not stable with increasing pressure and temperature. The effects of this new additive on the fluid loss and permeability reduction was studied using sandstone core flooding at reservoir temperature and pressure. The results showed that there was a reduction in the fluid loss by 15% compared with the base case. Also, the reduction of sandstone permeability caused by bentonite based drilling mud with sepiolite nanoparticle was lower than without sepiolite nanoparticle by 35%. Hence, sepiolite nanoparticle reduced the formation damage caused by bentonite drilling mud.
Scanning Electron Microscope (SEM) was used to measure the sepiolite particle size. It was also used to figure out the mechanism of bentonite and nanoparticle plugging of sandstone pores. SEM images showed nanoparticle bridged sandstone pores and prevented bentonite from invasion into the formation. Hence, bentonite did not invade deep into the formation but it accumulated at the core face, formed a filter cake, and reduced the fluid loss compared with the bentonite based mud without nanoparticles which showed a deep invasion of bentonite particles in the formation.