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Dynamic stabilization of formation fines to enhance oil recovery of a medium permeability sandstone core at reservoir conditions

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ABSTRACT

Fines migration has impacted the efficiency of low salinity water flooding at reservoir condition. However, previous studies on the use of nanoparticles to combat this problem were not done at reservoir condition and the effect of porous media length was neglected. Hence, the objective of this study is to use mesoporous silica (SiO_2) nanoparticles (MSNP) to stabilize formation fines to increase oil recovery during low salinity water flooding at reservoir condition. Likewise, effect of porous media length on dynamic retention of fines at high temperature high pressure (HTHP) reservoir condition was investigated. The breakthrough curves of reservoir fines adsorption by mesoporous SiO_2 nanofluid (MSNF) were described using the Thomas and Yoon-Nelson models. Subsequently, the effect of reservoir fines stabilization on oil recovery was evaluated using a HTHP core flooding equipment. Also, the formation damage remediation propensity of MSNF was investigated. Finally, the oil recovery mechanism was determined using the sessile drop contact angle method. Experimental results of the dynamic adsorption with coefficient of determination (R^2) values in the range of 0.967–0.999 signifies that the reservoir fines adsorption by MSNF were well predicted by Thomas and Yoon-Nelson models. Consequently, MSNF stabilized the reservoir fines by attaching onto their surface rather than on the porous media thereby changing the wettability to water-wet, decreasing the contact angle to 16.1°, 17.1° and 20.7° for kaolinite, illite and montmorillonite, respectively. Subsequently, increasing oil recovery by 22–23% original oil in place. Therefore, the use of MSNF to stabilize formation fines at reservoir condition is proffered.

1. Introduction

The ban on Russia oil and gas by some countries coupled with the lack of activity by most oil and gas companies in searching for sizeable oilfield due to the covid-19 pandemic has increased hydrocarbon scarcity and energy crisis around the world. Oil producing countries have turned to mature oilfields to improve oil production to meet the demand for energy around the world. Enhanced oil recovery (EOR) techniques can recover left over oil after natural drive production. One of the most successful methods of recovering bypassed oil and repressuring hydrocarbon reservoirs in terms of cost, sustainability and simplicity is through low salinity water flooding [1,2,3].

Low salinity water flooding can affect oil recovery because low salinity water with ionic strength lower than the formation brine

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