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Review

Comprehensive review on the role of salinity on oil recovery mechanisms during chemical flooding

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ABSTRACT

Previous studies have reported contradictory behavior on the influence of salinity on enhanced oil recovery (EOR) chemicals like surfactants, polymers, and nanoparticles among others. This uneven agreement of data and huge variation of experimental results indicates that the effect of salinity on EOR mechanisms is still tenuous in literature. This research presents the recent advances in the influence of salinity on EOR mechanisms and the applications of salinity in EOR. Therefore, the main objective of this research is to draw an informed conclusion on the debate regarding the impact of salinity on oil recovery so that geologists, reservoir, petroleum, and chemical engineers from academia and industry may have a clear standpoint on the impact of salinity on EOR mechanisms. Herein, reservoir salinity was discussed. The effect of salinity on EOR mechanisms was reviewed. Likewise, the application of salinity to oil recovery was elucidated. Finally, the challenges encountered during nanofluid, surfactant, alkaline, foam, and polymer flooding have brought light novel concepts for research which are highlighted herewith proffered technical solutions. Experimental results indicate that the optimal salinity thresholds for augmenting recovery typically fall within the range of 1000 to 6000 ppm. Therefore, it is recommended to maintain salinity below 5000 ppm in laboratory scale experiments and 3000 to 10,000 ppm in field conditions. Most literature has proposed fines migration as an EOR mechanism during low salinity water flooding (LSWF). However, there is no correlation between clay fines migration and EOR, indicating that EOR during LSWF is not caused by fines migration but rather by the injected fluid.

1. Introduction

Energy demand will continue to rise due to industrialization and population growth [1,2]. The global energy scenario is constantly changing, with an increasing emphasis on renewable energy sources and the reduction of greenhouse gas emissions [3–7]. The just concluded conference of the parties (COP 28) has reiterated the need for net zero emissions by 2050 and renewable energy to account for 85 % of global energy production. Although there is a clamor for renewable energy, fossil fuels still account for about 80 % of the world's energy source [8]. However, most oilfields around the world have reached a late stage of production where primary recovery methods can only extract about 30 % of the original oil in place (OOIP) [9–11]. Primary recovery methods have limitations in exploiting oil, as they focus on pay zones with good oil saturation [12–15]. But a sizeable amount of oil is still left unrecovered. The waterflooding process is employed as a secondary method to recover extra oil from the reservoir. It involves the injection of freshwater or seawater to repressurize the reservoir [16–18]. Low salinity water flooding (LSWF) has gained interest over the years due to its inexpensive cost, ease of injection and environmentally friendly [19–22].

According to recent research, LSWF may not often lead to improved oil recovery [23]. Numerous researchers have reported that the salinity of the injected fluid should be lower than the formation salinity to observe an increased oil recovery. Whereas some researchers insisted that the low salinity brine must contain some form of divalent and multivalent cation to be successful. Nevertheless, a high concentration of divalent cations might hinder oil recovery [24]. As a result, the

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