An Investigation of Interaction Between Water/Oil Surface in Present of Metal Oxide Nanoparticle for Petroleum Production

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ABSTRACT: Nanoparticles (NPs) are recognized as essential nanotechnology for a variety of commercial and scientific applications owing to their physical features and properties. By altering the rock wettability, increasing the mobility of the oil drop, and lowering the interfacial tension (IFT) between oil and water. The fundamental goal of enhanced oil recovery (EOR) operations is to increase overall oil displacement efficiency, which is a function of molecular and atomic displacement efficiency. This research is to study the effect of nanoparticles on interaction tension and interfacial between water/oil surface using metal oxide nanoparticles namely aluminium oxide (Al_2O_3) through low porosity sand pack was investigated. The nano powders were dispersed in de-ionized water and the horizontal column was packed with low porosity sand (30% - 40% porosity) of the size 500µm. This experiment was carried out with four different pore volumes (PV) of nanoparticles suspensions ranging from 0.25, 0.5, 0.75, and 1.0 PV. It can be concluded that the effect of metal oxide nanoparticles and oil displacement efficiency on interaction tension can maximize hydrocarbon production of enhanced oil recovery (EOR).

Keywords: *Nanoparticles; resistivity; porosity; core sample test; Interfacial tension*

1. INTRODUCTION

Nanotechnology has become more widespread in the oil and gas industry, as shown by the studies conducted in recent years [1, 2]. Nanotechnology creates nanoparticles with a variety of useful properties that can support with enhance oil recovery (EOR), oil well drilling, and production, such as improving mud cake strength, reducing friction, maintain reservoir pressure issue, control mobility ratio, and protecting the reservoir especially heavy crude oil reservoir [2, 3]. Nanoparticles used in EOR are typically between 1 and 100 nm (nanometres) in size, but this varies significantly between international organizations. Because of the recent global increase in energy demand, which is required to be provided by the oil and gas industry, enhance oil recovery (EOR) is becoming extremely valuable [4].

With EOR experiments with nanoparticles such as magnesium oxide, aluminium oxide, zinc oxide, zirconium oxide, tin oxide, iron oxide, nickel oxide, hydrophobic silicon oxide, and silicon oxide treated with saline showed improved recovery and increased hydrocarbon extraction. According to Cheraghian et al [3], nanoparticles possess unique properties due to their small sizes and greater surface area per unit volume. These nanoparticles are corrosion resistant in oil and gas reservoirs with high water temperature and salinity. Surfactant solutions containing nanoparticles were also studied as nanofluids in several experiments to improve oil recovery in water/oil surface reservoir conditions. This study aims to investigate the effect of nanoparticles on interaction interfacial tension between water/oil surfaces using metal oxide nanoparticles for petroleum production.

2. METHODOLOGY

Metal oxide nanoparticles, water, paraffin oil, and brine solution are the raw materials used in this experiment. The nanoparticles used in this analysis, Metal Nano powder with a purity of 99.5%, were purchased from a well-known supplier.

The transport of nanoparticles in the presence of synthetic brines containing salinity levels at 40ºC to 90oC and 1atm determined in this analysis using a brine solution. Table 1 lists the compounds contained in brine water solutions.

Table 1: Salinity formation water compounds synthetic brine solutions [5].

Compound	Normal salinity formation	High salinity formation
Sodium Chloride	132,000	132,000
Magnesium Chloride	35,625	35,625
Calcium Chloride	25,677	110,045
Sodium Chloride	482	482
Strontium Chloride	1,521	3,347

Paraffin oil, also known as liquid paraffin oil, is made from crude oil distillation. Paraffin oil is used for sand pack flooding. The sand pack used the sand sieved using sieves with a 500-micrometer mesh scale. The columns are made of transparent polyvinyl chloride pipe (PVC) so that the sample processing and measuring process can be seen directly. The columns are 35cm long and have a 6.6cm inner diameter. Furthermore, sand may be compressed into columns and agitated to facilitate sand compaction. Meanwhile, the porosity caused by grain stacking can be reduced by agitating the samples. The columns are estimated to have a porosity of 30-40%.

The laboratory setup used in this analysis is depicted schematically as Figure 1 below. The nanoparticle suspensions will be weighted and moved to a 250 mL measurement cylinder, which is injected into the column using a peristaltic pump with a volumetric flow rate of 45 mL/min. After that, the column effluent was collected in a beaker installed at the column outlet. This experiment was carried out with four different pore volumes (PV) of nanoparticles suspensions ranging from 0.25, 0.5, 0.75, and 1.0 PV. The experiment was conducted 3 times to get a precise number of run times.

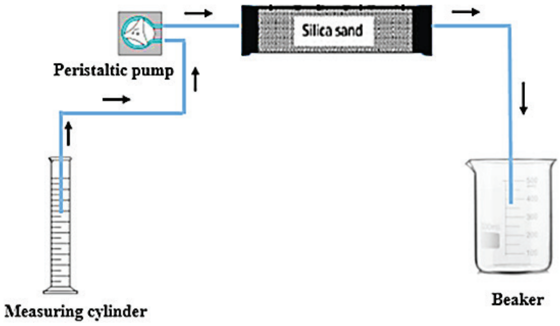

Figure 1 Sand Pack test set up for observed the flow effect between nanoparticles, brine, and oil such as real reservoir for enhanced oil recovery.

3. RESULTS AND DISCUSSION

In this section, the result obtained from the experiment being discussed is as follows. Figure 2 showed the stability gained by 1.0 wt% of Al_2O_3 nanoparticles obtained the least stable nanoparticles with very short stability of only about 10 min. The nanoparticle concentration can be ranked in terms of their stability in absence of paraffin oil as follows: 0.5 wt% > 0.3 wt% > 0.1 wt% > 0.0 wt% > 1.0 wt%.

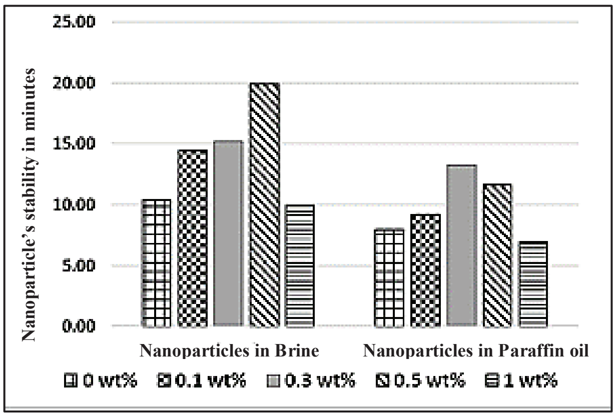

Figure 2 Effect of different weight percentages of Al_2O_3 Nps concentration in terms of stability in brine and paraffin oil.

Figure 3 shows the result of percentage recovery of paraffin oil after the injection of nanofluid nanoparticles Al_2O_3. It shows that the recovery of paraffin oil is at optimum with the injection of nanoparticles just at 0.5PV. it shows that nanoparticles can be a good interaction for oil recovery in petroleum.

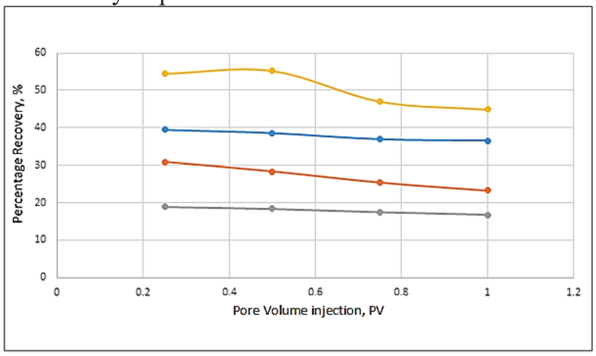

Figure 3 Effect of different pore volume injection of nanofluid Al_2O_3 concentration with the paraffin oil recovery.

4. CONCLUSION

The investigation done shows the potential of using nanoparticles as push recovery for petroleum production. The experimental done showed that with 0.5 PV of nanofluid injection already can be made optimum recovery for the oil production in EOR. The study shows the potential of using the nanoparticle as an interfacial tension reducer for oil and water. It achieves with only 0.3wt% stability usage of Al_2O_3 nanoparticles. It can be summarized that the use of nanoparticles is the potential to increase petroleum production.

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