Research Article

Journal of Chemistry Letters
journal homepage: www.jchemlett.com
ISSN (online) 2717-1892

Experimental and theoretical investigation of low salinity water injection timing in high water cut sandstone reservoirs for enhanced oil recovery

Ernest Peter MAIKI1*, Renyuan SUN1*, Haipeng CAO, Yingsong HUANG2, Shaoran REN1

1.School of Petroleum Engineering, China University of Petroleum (East China), Qingdao, China
2.Petroleum Exploration and Development Institute, Shengli Oilfield Company, Sinopec, Dongying, Shandong, China

ARTICLE INFO

Article history:
Received
Received in revised form
Accepted
Available online

Keywords:
low salinity flooding. High water cut, sandstone, residual oil saturation, Fines migration

ABSTRACT

In this research, low salinity water flooding was used to investigate its low salinity effect in a high water cut sandstone reservoir to improve oil recovery. The application was done to five different sandstone cores in high water cut levels of 70%, 75%, 80%, 85% and 90% by injecting low salinity brines of 2000mg/L – 20,000mg/L NaCl concentrations. These Cores chosen for research had 27%-28% porosity and 280mD – 300 mD permeability. Different brine injection rates were considered from 0.5cm^3/s to 3cm^3/s in each experiment. The results showed that low salinity flooding can be used to harness more oil from high water cut reservoirs. However, water should be injected earlier to avoid porous particle dislodge by continuous flooding. Brines of 200mg/L-5,000mg/L NaCl yielded the highest Oil recovery compared to higher salinities of 10,000mg/L-20,000mg/L. This was partly due to increased jamin effect created as fluids flow at high water cut levels. Three water cut rising model levels were discussed for better timing to avoid porous particle detachment from the sandstone matrix. Early injection timing was discussed to be critical for low salinity injection to avoid the mentioned Particles phenomena and hence high water cut levels and low oil recovery.

1. Introduction

Due to global energy demand increase resulting from dwindling energy resources, maximizing oil recovery from previously exploited matured oil fields have become exceedingly crucial to meet the ever-increasing energy demand[1], [2]. Processes of oil recovery are majorly classified into three categories namely: primary, secondary and tertiary. However, the application of primary and secondary oil recovery techniques approximately leaves two-third of the original oil in place (OOIP) trapped in reservoirs. This is as a result of oil trapping by capillary forces or being bypassed during initial oil recoveries of primary and secondary production. To enhance the overall oil displacement efficiency, numerous enhanced oil recovery (EOR) methods have been devised and utilized. During oil recovery, the overall oil displacement efficiency is a combination of macroscopic (volumetric sweep) and microscopic (pore scale) displacement efficiency. Macroscopic displacement efficiency which is the measure of the effectiveness of injected fluids to contact with the oil zone with respect to the total reservoir volume well us microscopic displacement efficiency is related to the ability of the displacing fluid(s) to mobilize oil trapped at the pore scale when it contacts the oil[3].

Water flooding has been known for some time as an established essential practice in petroleum industry injected in the secondary mode to maintain reservoir pressure and produce some oil. It has been observed. However, the injection of low brine in tertiary mode increases oil recovery as compared to high salinity water injection [4]–[7]. Extensive laboratory studies have been done and more still in progress to understand this vital area of research which is regarded as a potential EOR method clearly. The low salinity water flooding (LSWF) has been tested in many oil reservoirs and showed promising results in agreement as a promising EOR technique[8]–[10]. Besides the earlier known water flooding which supplemented the in-built reservoir natural energy to expel crude oil to the production well, LSWF also interact with crude oil-brine-rock (COBR)

∗ Corresponding author. e-mail: epmaiki@cns.mak.ac.ug