Experimental Investigation of Low and High Salinity Water Injection Simulation and Their Comparison with Pure Water Injection to Determine Optimum Salinity

Afshin Davarpanah

Abstract

Analyzing the sensitivity of high and low salinity, according to the moderately low recovery factor of high and low salinity among injection scenarios, illustrates the low sensitivity of this parameter in a fractured carbonated reservoir. By reviewing different scenarios, it could be demonstrated that if water injection was being applied to the reservoir from the preliminary times of production, the recovery factor rate will increase. Pure water injection has a high recovery factor than salty water injection. By the way, these two methods have a little difference in their recovery calculating methods. Moreover, in water injection methods, if the injection rate of water increases, the recovery factor will increase and give rise to a higher efficiency. Besides, this parameter is significantly dependent on well-head equipment properties, safety factors and economic issues (water production). Analyzing the figures and the volumes of low salinity water injection after the injection of pure water in different injection scenarios showed that all these scenarios have the highest rate of recovery and the maximum production efficiency.

Keywords

Salinity water • Enhanced oil recovery
Recovery factor • LSWI

1 Introduction

Due to the growing population and increasing demand for energy in different areas of life, especially in major industries and in manufacturing, it seems that this God-given and non-renewable resource should be used optimally, and any improper use and application of this energy source is not only causing problems at the present time but also jeopardizing the survival of future generations [1–5]. Fossil energy, such as oil, gas and coal, which at first glance looks great and endless, is generally not fully recoverable and huge amounts of wealth remain in situ. In general, it depends on the operation at harvest time, such as the speed and method of operation [6]. With the continuous drop in reservoir pressure, the production rate is gradually reduced until the normal production of the reservoir is no longer cost-effective. This point occurs when the oil recovery from the reservoir is relatively low. This recovery for Iranian reservoirs is about 15–20%; in other words, 80–85% of their oil remains in the Formation.

2 Methods

The economic output of the reservoir depends on water cut and wellhead pressure. If the wellhead pressure exceeds a specified level, injection scenarios have to be planned accordingly. Six different scenarios were defined based on the analysis of different degrees of salinity. Scenarios 1, 2, and 3 focus on the impact of salinity on the recovery factor, and scenarios 4, 5 and 6 compare previous scenarios. This study assumes a low salinity of 5 g/kg (density, 1005 kg/m^3 and 1.15 cP at 15 °C) and a high salinity of 40 g/kg (density 1030 kg/m^3 and viscosity 1.23 at 15 °C).

3 Results and Discussion

1. Among the different scenarios of water injection, scenario no. 5 with an injection rate of 2000 barrels per day is the best known injection plan (Fig. 1).
2. In case of a low salinity scenario, better support and performance efficiency results in marginal recovery.

A. Davarpanah (✉)
Department of Petroleum Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran
e-mail: Afshin.Davarpanah@srbiau.ac.ir

S. Banerjee et al. (eds.), *Advances in Petroleum Engineering and Petroleum Geochemistry*, Advances in Science, Technology & Innovation, https://doi.org/10.1007/978-3-030-01578-7_10

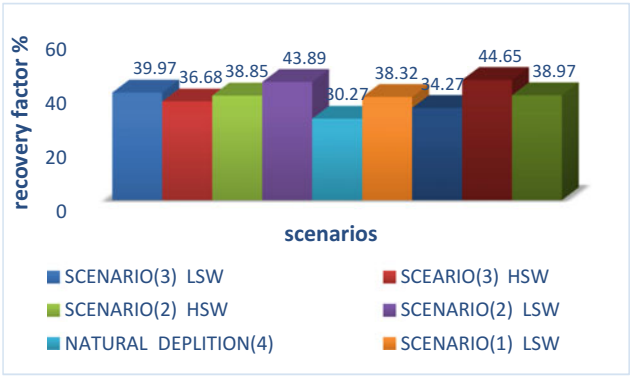

Fig. 1 Various scenarios of water injection and natural depletion mode

3. Water injection from the beginning of production supports better and higher efficiency performance.
4. Higher injection rate results in higher recovery.
5. Low salinity levels in all injection scenarios and maximum production efficiency result in the highest rate of recovery.

4 Conclusions

As time passes and production decreases significantly, the difference in salinity between the top and the bottom of a reservoir (before and after production) increases, which reflects the effects of high salinity water injection with time. Injection of pure water results in a higher recovery factor than low salinity water injection, although the difference in the recovery factors is less. This injection rate applies in both 1000 and 2000 barrels per day.

References

1. Zeinijahromi, A., Ahmetgareev, V., Ibatullin, R., Bedrikovetsky, P.: Sensitivity study of low salinity water injection in Zichebashskoe oilfield. J. Petrol. Gas Eng. **6**(1), 10–21 (2015)
2. Al-Shalabi, E.W., Sepehrnoori, K.: A comprehensive review of low salinity/engineered water injections and their applications in sandstone and carbonate rocks. J. Petrol. Sci. Eng. **139**, 137–161 (2016)
3. Teklu, T.W., Alameri, W., Graves, R.M., Kazemi, H., AlSumaiti, A. M.: Low-salinity water-alternating-CO_2 EOR. J. Petrol. Sci. Eng. **142**, 101–118 (2016)
4. Davarpanah, A., Zarei, M.: Analysis of enhanced oil recovery methods like gas injection in the fractured reservoirs and optimize its efficiency. J. Mater. Sci. Eng. **6** (2017)
5. Dang, C., Nghiem, L., Nguyen, N., Chen, Z., Nguyen, Q.: Mechanistic modeling of low salinity water flooding. J. Petrol. Sci. Eng. **146**, 191–209 (2016)
6. Davarpanah, A.: Evaluation of gas injection in the horizontal wells and optimizing oil recovery factor by Eclipse software. J. Chromatogr. Sep. Tech. **7** (2016)