Petroleum Research

Petroleum Research, 2019(August-September), Vol. 29, No. 106, 8-10

DOI: 10.22078/pr.2019.3509.2603

An Experimental Investigation of Polymer Gels Injection in Carbonate Reservoirs to Study Disproportionate Permeability Reduction (DPR)

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DOI: 10.22078/pr.2019.3509.2603

Received: October/15/2018 Accepted: March/04/2019

INTRODUCTION

Excess water production is one of the most serious problems in oil industry [1, 2]. Moreover, chemical controlling methods such as injection of certain polymers are cheap and easy to handle [3]. In addition, these polymers in the reservoir forms a gelant network which causes disproportionate permeability reduction (DPR). In fact, this method reduces both oil and water permeability; but reduction in water production would be much more than that for oil [4]. Therefore, little water will be produced. However, exact mechanism of DPR is vague, but among different mechanisms which have been presented, the wall-effect model and gel-droplet model are the most probable mechanisms that presented [5].

EXPERIMENTAL PROCEDURE

METHODOLOGY

In this study, the effect of formation water salinity (ions) on the performance of polymer gel injection for DPR operation was investigated. Gelant solution is selected by the way of a Semi-qualitative method as bottle-testing [6]. To this end, four different types of formation water was chosen. Afterwards, distilled water was selected as the reference case for comparison purposes of gel injection on carbonate rock. The choice of distilled water as formation water caused excellent results in DPR of the carbonate rock sample (Figure 1). Addition of NA+ ion to the formation water caused some precipitation of NaCl in the throats and pores openings. However, the relative permeability of water reduced substantially compared to that of oil phase perm ability (Figure 2).

Figure 1: Core No 1 before and after DPR operation (distilled water).

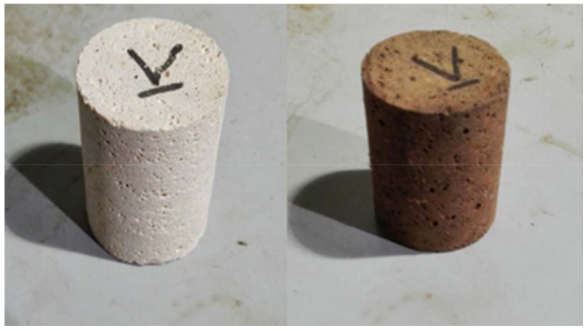

Figure 2: Core No 2 before and after DPR operation (Na^{+}).

In the other experiment, the used formation water contained Mg^{+2} and Na^{+} ions (Figure 3). The DPR process was affected, and the degree of reduction in water relative permeability compared to oil permeability dropped.

RESULTS AND DISCUSSION

According to this study, the adverse effect, which has been explained above, could be contributed not only to precipitation of formed salt in the throats but also to polymer precipitation due to reaction between Mg^{+2} ion with carboxylate which hinders DPR operation and reduce the success degree of water cut in the field operation. Finally, the coexistence of Ca^{+2}, Mg^{+2} and Na^{+} ions in the formation water were tested (Figure 4).

CONCLUSIONS

Results showed that the reduction in oil permeability exceeds the relative permeability of water in the core sample. Therefore, it was concluded that prior to any DPR application in a carbonate reservoir, the analysis of formation water regarding the existence of various salts (ions) is necessary for success of such operation.

Figure 3: Core No 3 before and after DPR operation (Mg^{+2} and Na^{+}).

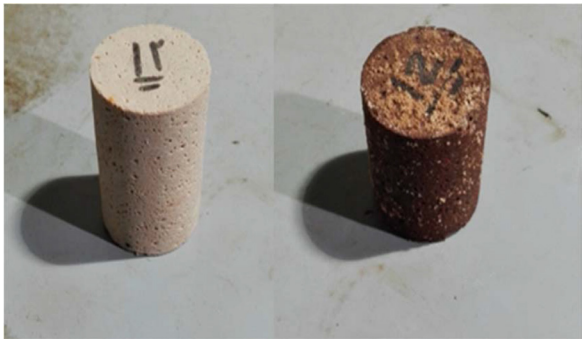

Figure 4: Core No 4 before and after DPR operation (Mg^{+2}, Ca^{+2} and Na^{+}).

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