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Core Tests and Field Case Studies of Successful and Unsuccessful Low-Salinity Waterfloods from Four Oil Fields

V. Khisamov (TatNIPIneft), V. Akhmetgareev* (TatNIPIneft), T. Shilova (TatNIPIneft),

Summary

The aim of the work is to define successful and unsuccessful cases of low-salinity waterfloods (LSW) and to determine the incremental recovery if compared with high-salinity water injection. Four oil fields have been studied. Double-coreflood tests showed: a) fines: three-fold decrease of water relative permeability (k_{rw}) for the Pervomaiskoye field and five-fold decrease for the Bastrykskoye field; b) wettability alteration in carbonates: three-fold reduction of residual oil saturation (S_{or}) for the Romashkinskoye field; however, no changes were noted for the Arkhangelskoye field. 3D models of the fields were built and history matched. To simulate salinity-dependent effect of fines migration and wettability alteration, options of k_{rw} and S_{or} decrease were used. Field performance analysis showed that LSW resulted in increase of incremental oil recovery by 3.5% in the Pervomaiskoye field, but in the Bastrykskoye field, the LSW effect was negligible. Analysis of two LSW pilots in the Romashkinskoye field showed improvement of the incremental oil recovery by 2.7% due to LSW, while LSW pilot in the Arkhangelskoye field was unsuccessful. For sandstones, LSW into aquifer yields no positive effect, nor does it at the initial and final stages of reservoir development. For carbonates, the effect depends on viscosity of oil.

Abstract

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Authors: Rais Khisamov, Vadim Akhmetgareev, Tatyana Shilova

Main objectives

The aim of the work is to define successful and unsuccessful cases of low-salinity waterfloods (LSW) and to determine the incremental recovery if compared with high-salinity water injection. Four oil fields have been studied. Double-coreflood tests showed: a) fines: three-fold decrease of water relative permeability (k_{rw}) for the Pervomaiskoye field and five-fold decrease for the Bastrykskoye field; b) wettability alteration in carbonates: three-fold reduction of residual oil saturation (S_{or}) for the Romashkinskoye field; however, no changes were noted for the Arkhangelskoye field. 3D models of the fields were built and history matched. To simulate salinity-dependent effect of fines migration and wettability alteration, options of k_{rw} and S_{or} decrease were used. Field performance analysis showed that LSW resulted in increase of incremental oil recovery by 3.5% in the Pervomaiskoye field, but in the Bastrykskoye field, the LSW effect was negligible. Analysis of two LSW pilots in the Romashkinskoye field showed improvement of the incremental oil recovery by 2.7% due to LSW, while LSW pilot in the Arkhangelskoye field was unsuccessful.

New aspects covered

For sandstones, injection of low-salinity water into aquifer yields no positive effect, nor does it at the initial and final stages of reservoir development. For carbonates, the effect depends on viscosity of oil. Viscous oils have heavy components, which can be removed from pore surfaces if temperature is increased.