Investigation of Water Compatibility and Injectivity Decline in an Omani Oil Field

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Abstract

Water flooding is one of the most extensively used technologies in oil fields for pressure maintenance and enhanced oil recovery. Treated produced water can be used for the injection process. However, the injection water quality can cause formation damage by reducing reservoir permeability and result in injectivity decline. Several factors are assumed to be contributing to reservoir permeability reduction and injectivity decline such as scale formation, clay swelling and fines migration. The main scope of this work is to identify the causes of injectivity decline and formation damage during water injection into an Omani oil field. Various approaches have been adopted in this study including; scale modeling, formation damage simulation, water quality analysis, swelling tests and core flooding experiments. The results of scale modeling revealed that the scale is limited for barium sulfate (BaSO$_4$) and the scale is unlikely for calcium carbonate (CaCO$_3$). In some cases, the total suspended solids and oil content in the injection water exceeded the limit which might contribute in the injectivity decline. Results of one of the core flooding experiments demonstrated that suspended solid particles in injection brine can cause plugging of pore throats and injectivity issues. In addition, clay swelling was observed in another three core flooding experiments. Swelling analysis showed that the injection water has swelling tendency for bentonite and it was observed that this tendency increases with time. Moreover, formation damage simulation showed that fines migration and clay swelling are possibly the main damage mechanisms. Clay swelling reduces formation permeability and causes pressure drop increase and hence injectivity decline.