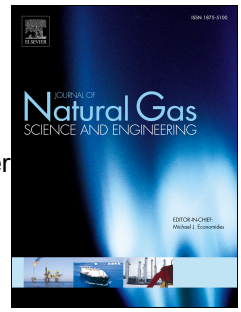
Accepted Manuscript



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PII: S1875-5100(17)30028-8

DOI: 10.1016/j.jngse.2017.01.019

Reference: JNGSE 2036

To appear in: *Journal of Natural Gas Science and Engineering*

Received Date: 3 September 2016

Revised Date: 24 January 2017

Accepted Date: 26 January 2017

Please cite this article as: Hajirezaie, S., Wu, X., Peters, C.A., Scale formation in porous media and its impact on reservoir performance during water flooding, *Journal of Natural Gas Science & Engineering* (2017), doi: 10.1016/j.jngse.2017.01.019.

Scale Formation in Porous Media and its Impact on Reservoir Performance during Water Flooding

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Abstract

Water flooding is the most widely used improved oil recovery technique, and many other methods, such as chemical methods, are based on water flooding performance. If the injected water is not compatible with the formation water, scaling and other solid deposition would occur, which reduces the formation permeability and transmissibility of the reservoir. The objective of this research is to model the in-depth reservoir formation damage as a result of scaling and to simulate its impact on reservoir performance. Literature survey shows that the development of a theoretical model for estimation of permeability and porosity reduction is of practical importance.

In this paper, two models based on barium concentration were proposed to estimate permeability reduction in porous media as a result of scale deposition. Model development was conducted by using 216 experimental data points from literature covering various thermodynamic properties and reservoir conditions, and statistical and graphical error analyses were employed to evaluate the accuracy of the proposed model.

The results showed that the proposed models are capable of predicting permeability alteration caused by scale deposition with absolute average relative errors less than 1% compared with the experimental data. In addition, the values of root mean square error and coefficient of determination were found to be nearly 0.1 and 0.95 for the high barium concentration model and 0.07 and 0.94 for the normal barium concentration model. Moreover, error distribution curves of the developed models showed that the models do not have any significant error trend under different reservoir and thermodynamic conditions.

A synthetic field was used to simulate the injection and production performance of an incompatible water flooding operation to better study the impact of scaling issue on reservoir performance. In particular, the impacts of scale deposition on reservoir properties and injection pressure were investigated. The results of numerical simulation indicated that scale formation could reduce the reservoir porosity from 0.2 to nearly 0.07. Moreover, the injection bottom hole pressure needed for the operation increases significantly up to nearly 19000 psi when the reservoir is affected by scale formation.

Keywords: *Mineral Scale Formation; Porous Media; Multivariate Regression Analysis; Statistical and Graphical Analysis.*