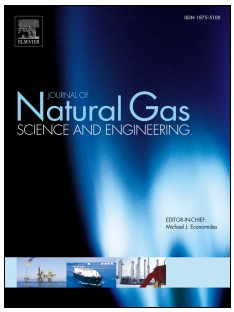
Accepted Manuscript



A comparative study of predictive models for imbibition relative permeability and trapped non-wetting phase saturation

Sh Aghabozorgi, M. Sohrabi

PII: S1875-5100(18)30030-1

DOI: 10.1016/j.jngse.2018.01.017

Reference: JNGSE 2424

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

Received Date: 11 October 2017

Revised Date: 9 January 2018

Accepted Date: 16 January 2018

Please cite this article as: Aghabozorgi, S., Sohrabi, M., A comparative study of predictive models for imbibition relative permeability and trapped non-wetting phase saturation, *Journal of Natural Gas Science & Engineering* (2018), doi: 10.1016/j.jngse.2018.01.017.

A Comparative Study of Predictive Models for Imbibition Relative Permeability and Trapped Non-wetting Phase Saturation

Aghabozorgi Sh.[1], Sohrabi M.[1]

[1]Centre for Enhanced Oil Recovery and CO2 Solutions, Heriot-Watt University

Abstract

The hysteresis in two phase relative permeability occurs when the saturation history of the flow changes from drainage to imbibition or vice versa. The imbibition relative permeability is a strong function of initial non-wetting phase saturation from which the imbibition process starts. Hence, it is very time-consuming to conduct many experiments for measuring all possible imbibition relative permeability (kr) data. An alternative approach is to predict the imbibition relative permeability using the measured Land trapping coefficient and primary drainage relative permeability. Some predictive models, found in the literature, such as that of Land, Carlson and Killough are available in commercial simulators. For prediction of imbibition data, these models require the primary drainage kr data and one set of imbibition kr data to calculate the corrected Land trapping coefficient. However, the imbibition relative permeability is not always available and the inappropriate use of these models can introduce significant errors in the calculations. In this study, the limitations of the available models are discussed and a modified method is suggested, which only requires the primary drainage kr data and the measured Land trapping coefficient.

The available models for prediction of imbibition kr data are based on the calculations of trapped non-wetting saturation (S_{nwt}). Therefore, in this study, a modified method was introduced which improved the estimations of trapped non-wetting phase saturation. The predicted values of imbibition relative permeability using this improved method were in good agreement with the experimental data. It was shown that this method can be used for both gas and oil as non-wetting phases in a water-wet medium. However, the trapped non-wetting phase is a function of capillary number and the Land trapping coefficient changes as the capillary number changes. Hence, the measured Land trapping coefficient cannot be assumed as constant in cases where severe changes in pressure result in changing interfacial tension (IFT) and fluid viscosity.

Keywords

Relative permeability; hysteresis; trapped non-wetting saturation; imbibition; drainage; saturation history.

Introduction

The relative permeability of fluid in a porous medium is a function of its saturation history, as well as the fluid saturation. This fact was first mentioned by Geffen et al. and Osaba et al. [1, 2] for two-phase flow in porous media. The history dependence of relative permeability is called hysteresis and it has been reported for fluid relative permeabilities in three-phase systems [3, 4]. The observed hysteresis in relative permeability is a result of two phenomena: the contact angle hysteresis and the trapping of the non-wetting phase [5, 6].

Relative permeability hysteresis is important in simulations of the water flooding process. In this process, the water phase is imbibed into different blocks in the reservoir which may