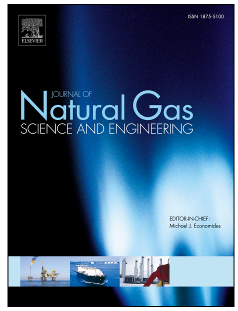
Accepted Manuscript



A semi-analytical approach for analysis of transient linear flow regime in tight reservoirs under three-phase flow conditions

Hamidreza Hamdi, Hamid Behmanesh, Christopher R. Clarkson

PII: S1875-5100(18)30152-5

DOI: 10.1016/j.jngse.2018.04.004

Reference: JNGSE 2526

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

Received Date: 16 January 2018

Revised Date: 16 February 2018

Accepted Date: 2 April 2018

Please cite this article as: Hamdi, H., Behmanesh, H., Clarkson, C.R., A semi-analytical approach for analysis of transient linear flow regime in tight reservoirs under three-phase flow conditions, *Journal of Natural Gas Science & Engineering* (2018), doi: 10.1016/j.jngse.2018.04.004.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

A Semi-analytical Approach for Analysis of Transient Linear Flow Regime in Tight Reservoirs Under Three-phase Flow Conditions

Hamidreza Hamdi*[1], Hamid Behmanesh[2] and Christopher R. Clarkson[1]

1. *Department of Geoscience, University of Calgary*
2. *Anderson Thompson-Reservoir Strategies*

**corresponding author*
Email: hhamdi@ucalgary.ca
Address: Department of Geoscience, University of Calgary, 2500 University Dr NW, Calgary, AB T2N 1N4

Abstract

Current techniques for production data analysis of hydraulically-fractured horizontal wells only consider single- or two-phase flow conditions. Three-phase flow is expected to occur in many practical scenarios of low-permeability reservoir production when water (frac fluid and/or formation) production is occurring along with hydrocarbon phases. In this paper, a new semi-analytical method is developed to allow production data analysis of wells producing from low-permeability (tight) reservoirs exhibiting three-phase during the transient linear flow period.

The proposed technique is based on the modified black oil formulation and is developed by employing the Boltzmann transformation. The modified black oil formulation comprises three highly nonlinear Partial Differential Equations (PDE's) that describe the flow of water, oil and gas in the reservoir. The use of the Boltzmann transformation allows conversion of this set of governing fluid flow PDE's to a set of Ordinary Differential Equations (ODE's) that can be easily solved using numerical techniques such as the Runge-Kutta method. In this paper, oil relative permeability under three-phase flow conditions is modelled using the well-known first Stone's model.

A theoretical basis for the occurrence of straight lines on a plot of $1/q$ vs $\sqrt{t}$ for any producing phase is provided herein. The slope of the line is a function of the flowing fluid properties, and the reservoir and fracture characteristics. One important advantage of using the Boltzmann transformation is that the linear flow parameter, $x_f\sqrt{k}$, can be directly estimated as a part of the solution process without the need for defining any complex pseudo-variable transformations. The results demonstrate that the relative error in $x_f\sqrt{k}$ estimation is generally less than 10% for different fluid models and relative permeability curves. Moreover, the simultaneous solutions of the ODE's provide the pressure and phase saturations as unique functions of the Boltzmann variable; these can be used to find relationships between pressure and phase saturations that in turn can be utilized for other rate transient analysis applications. The derived pressure-saturation relationships are in excellent agreement with numerical simulation for different three-phase relative permeability models.

The significance of this paper is that a new theoretical and practical framework is introduced for the first time to analyze three-phase production data for transient linear flow under constant flowing bottomhole pressure conditions. These conditions are of practical importance for many tight production scenarios where water, in addition to hydrocarbon phases, are mobile in the reservoir. The results are validated using numerical simulation.

Download English Version:

https://daneshyari.com/en/article/8128117

Download Persian Version:

https://daneshyari.com/article/8128117

Daneshyari.com