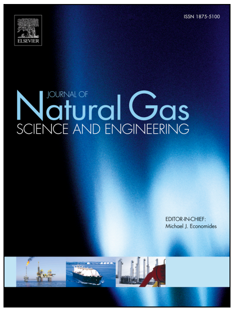
Accepted Manuscript



A new method for production data analysis in shale gas reservoirs

Qingyu Li, Peichao Li, Wei Pang, Daolun Li, Haibo Liang, Detang Lu

PII: S1875-5100(18)30229-4

DOI: 10.1016/j.jngse.2018.05.029

Reference: JNGSE 2587

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

Received Date: 5 February 2018

Revised Date: 21 April 2018

Accepted Date: 22 May 2018

A New Method for Production Data Analysis in Shale Gas Reservoirs

Qingyu Li, University of Science and Technology of China; **Peichao Li**, Shanghai University of Engineering Science; **Wei Pang**, Sinopec Research Institute of Petroleum Engineering; **Daolun Li**, Hefei University of Technology; **Haibo Liang**, Xinjiang Petroleum Engineering Construction Supervision Co, Ltd.; **Detang Lu**[*], University of Science and Technology of China

Abstract. For most shale gas wells, frequent shut-ins and nozzle size changing often occur, leading to significant discontinuities in production data. This study proposes a new production data analysis (PDA) method to address the abrupt change issue based on the virtual equivalent time. With the virtual equivalent time, the qualities of type curve matching and production data analysis can be improved when there are abrupt changes in production data. The mathematical model with a variable flow rate provides new definitions of normalized pseudopressure and pseudotime with consideration of the pressure dependent permeability for multi-fractured horizontal wells in shale gas reservoirs. Subsequently, the virtual equivalent time is calculated based on the average formation pressure to consider the abrupt changes of the production data, which also can reduce the time of superposition principle calculations. Duhamel's principle, Laplace transform and inversion, and Newman's method are employed to solve the PDA model, which is validated by analytical and numerical solutions. Then sensitivity analysis are performed on the dimensionless constrained axial modulus, which shows that the larger the dimensionless constrained axial modulus, the lower and later the curves. Finally, a field case study is carried out using the proposed method. The results show that by using the virtual equivalent time, the matching qualities are good, and the issue caused by abrupt changes is satisfactorily addressed. Therefore, it has great potential for estimating the formation parameters and predicting the well production performance more effectively and practically.

Keywords: Production data analysis; shale gas reservoir; multi-fractured horizontal well; normalized pseudopressure; virtual equivalent time

1. Introduction

Currently, shale gas reservoirs are aggressively explored and developed in North America and China (EIA 2016). Horizontal wells with multiple hydraulic fractures are the most popular stimulation technique for shale gas reservoirs (Ali et al. 2013). The application of multi-fractured horizontal wells is expected to create a complex sequence of flow regimes (Nobakht et al. 2012). In addition, the existence of pressure-sensitive effects, gas adsorption/desorption, and diffusion cannot usually be ignored in shale gas reservoirs. Consequently, fractured shale gas wells exhibit a complex production behavior. In this situation, conventional well performance analysis is not applicable (Behmanesh et al. 2013). To ensure that shale gas wells

[*] Corresponding authors
E-mail address: dtlu@ustc.edu.cn (D. Lu).