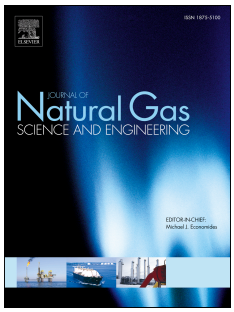
Accepted Manuscript



Review of multi-scale and multi-physical simulation technologies for shale and tight gas reservoirs

Lei Wang, Shihao Wang, Ronglei Zhang, Cong Wang, Yi Xiong, Xishen Zheng, Shangru Li, Kai Jin, Zhenhua Rui

PII: S1875-5100(16)30887-3

DOI: 10.1016/j.jngse.2016.11.051

Reference: JNGSE 1961

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

Received Date: 9 August 2016

Revised Date: 15 November 2016

Accepted Date: 24 November 2016

Please cite this article as: Wang, L., Wang, S., Zhang, R., Wang, C., Xiong, Y., Zheng, X., Li, S., Jin, K., Rui, Z., Review of multi-scale and multi-physical simulation technologies for shale and tight gas reservoirs, *Journal of Natural Gas Science & Engineering* (2016), doi: 10.1016/j.jngse.2016.11.051.

Review of Multi-scale and Multi-physical Simulation Technologies for Shale and Tight Gas Reservoirs

Lei Wang[a], Shihao Wang[a], Ronglei Zhang[a*], Cong Wang[a], Yi Xiong[a], Xishen Zheng[b], Shangru Li[b], Kai Jin[b], Zhenhua Rui[c]

[a] Energy Modeling Group, Petroleum Engineering Department, Colorado School of Mines, USA

[b]Jiangxi Unconventional Gas Institute, China

[c] Independent Project Analysis, Inc., USA

*Corresponding author: Ronglei Zhang, Email: zhangronglei@gmail.com

Abstract

This paper provides a comprehensive literature review on the simulation techniques being developed in recent years for describing unique flow behaviors in shale and tight gas reservoirs. The advances in modeling gas flow and transport mechanisms during the primary and enhanced gas recovery processes are reviewed in detail. The capabilities of reservoir simulation tools are discussed in terms of mathematical treatment (finite difference, finite element, explicit/implicit scheme, sequentially and fully coupled schemes), fluid flow characteristics (Darcy and non-Darcy flow, desorption, Klinkenberg effect and gas slip flow, transitional flow, Knudsen diffusion), reservoir rock properties (pore size distribution, fractures, geomechanics), multidisciplinary coupling scheme (THM, THC, THMC), modeling scale, and computational efficiency. For pore-scale modeling of gas flow and transport in unconventional reservoir rocks, the numerical methods for generating pore network models and the procedure for constructing real 3D digital rocks are first explained. Then, the network modeling methods used for simulating slip and transitional flows in pore networks are introduced and compared. After that, existing lattice-Boltzmann models developed for slip flow simulation are illustrated. Along with the explanation, pros and cons of the models for pore-scale modeling have been identified. Overall, dwelling on the concerns and challenges in shale and tight gas reservoir simulation, current status, progress and bottlenecks of numerical simulation technologies are discussed and perspectives on future development of unconventional gas reservoir simulators are proposed.

Keyword:

Shale and tight gas reservoir, reservoir simulation, pore-scale simulation, adsorption and desorption, Klinkenberg effect and slip flow, transitional flow, Knudsen diffusion, non-linear and non-Darcy flow, geomechanics, THMC

Highlights

1. Fluid flow and transport mechanisms along with geomechanics in shale and tight gas reservoirs are recapitulated.

2. Advances in macroscopic THMC simulation techniques for shale and tight gas reservoirs are reviewed.

3. Pore-scale modeling methods for fluid flow and transport in unconventional reservoir rocks are illustrated and compared.

4. Challenges from unconventional reservoirs and perspectives on developing new simulation techniques are discussed.