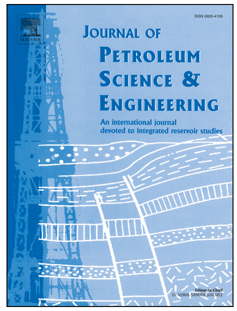

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Employing a Quad-Porosity Numerical Model to Analyze the Productivity of Shale Gas Reservoir

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Abstract: During the production of a gas well in shale play, the shale gas would go through multi-scale flow with various physical mechanisms, therefore multi-porosity models need to be developed. This paper establishes a quad-porosity model basing on the production scenario of multi-stage fracturing horizontal well, and four systems are included: Organic Matrix, Inorganic Matrix, Natural Fracture Network and Hydraulic Fracture Network. Langmuir adsorption equation is utilized to describe the effect of gas desorption in organic matrix, and a new apparent permeability model is applied to consider Knudsen diffusion in both organic matrix and inorganic matrix. The pressure of each system is solved numerically using implicit scheme. This model is applied to a synthetic reservoir to predict the gas rate and cumulative production, and a field case is employed to validate our model. Through various sensitivity analyses we can conclude that the gas rate will rise with the increase of meshing size, Langmuir volume, IM-NF transmissibility and NF-HF transmissibility. Knudsen diffusion can increase the gas rate by increasing the apparent permeability in matrix systems, and its influence in organic matrix is stronger than in inorganic matrix. In addition, increasing the transmissibility between hydraulic fractures and natural fractures is more effective than only increasing the conductivity of main fractures.

Keywords: numerical simulation; shale gas reservoir; quad-porosity model; Langmuir equation; Knudsen diffusion

Nomenclature

C_g	Compressibility, MPa
D	Pore diameter or fracture width, m
h	Reservoir thickness, m
OM	Organic Matrix
IM	Inorganic Matrix
HF	Hydraulic fracture
NF	Natural fracture
Kn	Knudsen number, dimensionless
k_{IMi}	The intrinsic permeability of inorganic matrix, mD
k_{IMa}	The apparent permeability of inorganic matrix, mD
k_f	The permeability of natural fracture, mD