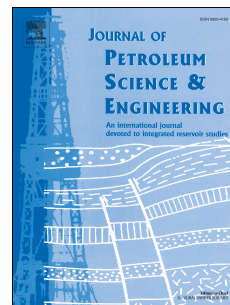


# Accepted Manuscript

A coupled, non-isothermal gas shale flow model: Application to evaluation of gas-in-place in shale with core samples

Meng Lu, Zhejun Pan, Luke D. Connell, Ye Lu



PII: S0920-4105(17)30651-4

DOI: [10.1016/j.petrol.2017.08.051](https://doi.org/10.1016/j.petrol.2017.08.051)

Reference: PETROL 4214

To appear in: *Journal of Petroleum Science and Engineering*

Received Date: 6 April 2017

Revised Date: 26 July 2017

Accepted Date: 15 August 2017

Please cite this article as: Lu, M., Pan, Z., Connell, L.D., Lu, Y., A coupled, non-isothermal gas shale flow model: Application to evaluation of gas-in-place in shale with core samples, *Journal of Petroleum Science and Engineering* (2017), doi: 10.1016/j.petrol.2017.08.051.

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1 A coupled, non-isothermal gas shale flow model: application to evaluation of  
2 gas-in-place in shale with core samples

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4 Meng Lu<sup>a1\*</sup>, Zhejun Pan<sup>a</sup>, Luke D. Connell<sup>a</sup>, and Ye Lu<sup>b</sup>

5 <sup>a</sup>CSIRO Energy, Australia

6 <sup>b</sup>Department of Civil Engineering, Monash University, Australia

7 **Abstract**

8 Shale gas is emerging as an important unconventional resource. To determine the gas-in-place in  
9 shales the so-called direct method is often used. However, the traditional direct method may have  
10 significant errors in evaluation of the lost gas amount during the retrieval process of a core sample,  
11 because it did not take into account the impact of the pertinent pressure and thermal history to the gas  
12 emission profile. The relevant thermal effect, in addition to the effect of pressure change, may play a  
13 critical role in the process because it can greatly affect the gas sorption/desorption behaviour in the  
14 core; it may also significantly change the relevant Knudsen number and alters the gas transport  
15 mechanisms in those nanopores in the core. Thus a flow model incorporating the thermal effect  
16 becomes crucially important in this context.

17 We propose a non-isothermal flow model for gas shales in this study. The model is fundamentally  
18 based on the concept of the dusty-gas model, but with several important extensions. The major  
19 extensions include: (1) Two separate sets of gas transport equations are formulated in the model, one  
20 for free gas and the other for adsorbed gas. The two sets of equations are coupled through a term  
21 which characterises the conversion between the free and the adsorbed gas. (2) The transport equations  
22 are fully coupled with a thermal convection/conduction equation. (3) The formulated permeability and  
23 diffusion model accommodates the stochastic characteristics of pore-size distribution in shales, and  
24 produces a fully self-consistent description for the gas flow behaviour when the flow regimes are  
25 altered with variations of pressure and temperature.

26 Two application examples are presented here, one for a Canadian shale play and the other for a  
27 Chinese one. Both cases are concerned with the evaluation of the lost gas amount and the gas-in-place  
28 in the shales, where thermal effects are significant and cannot be ignored. The results obtained show  
29 that the model developed in this study can well characterise the sophisticated transport mechanisms  
30 involved and can accurately describe the relevant emission profiles. The predicted lost gas content and  
31 the gas-in-place can be used with more confidence than the results reported in the two original studies.

32 **Key words:** shale; gas flow and transport; dusty-gas model; thermal effect; numerical  
33 simulation, core analysis

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<sup>1</sup> \* Corresponding author: E-mail: [meng.lu@csiro.au](mailto:meng.lu@csiro.au); Tel: +61-3-9545 8351; Fax: +61-3-9545 8380

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