A New Method for Determining The Equivalent Permeability of A Cleat Dominated Coal Sample

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Introduction

Permeability of coal is one of the key parameters in coal seam gas (CSG) reservoir development. However, to obtain an accurate permeability is a big challenge because of the special characteristics of the coals and their geological environments. This paper will firstly investigate the applicability of the existing conventional permeability upscaling methods in coal through comparisons with numerical simulation results, and then propose a quick and simple approach to determine the equivalent permeability of naturally fractured coal samples.

Methodology-Numerical simulation

Optimization of numerical models

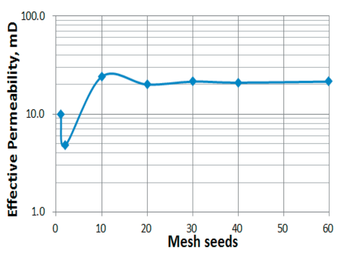

Fig.1. The variance of effective permeability vs. various mesh seeds.

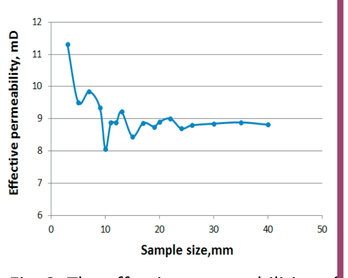

Fig. 2. The effective permeabilities of the samples change with different sample sizes.

Application

Fig.4. A coal sample from GG-2 ED009.
(Different permeabilities are marked by different colours)

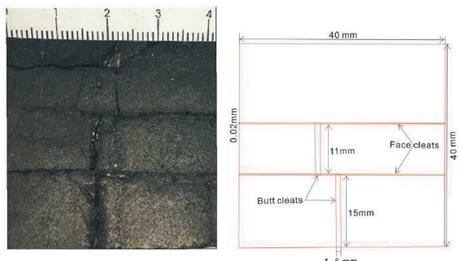

Fig.5 (a)A subsection of the coal sample GG-2 ED009(Subsection A); (b)a schematic diagram of subsection A.

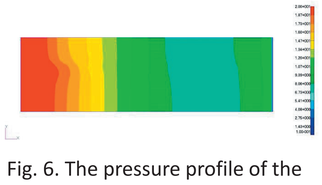

Fig. 6. The pressure profile of the coal sample from GG-2 ED009.

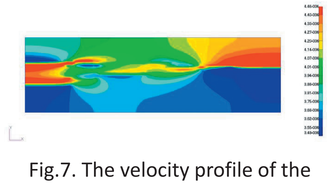

Fig.7. The velocity profile of the coal sample from GG-2 ED009.

Results

(1) The new formula based on Darcy's law, statistics and arithmetic mean

$$k_{E(x)} = \frac{k(x)F_c L^2}{N_c} \sum_{i=1}^{N_c} \frac{1}{(L_{fi} + \frac{1}{2} L_{bi})^2}$$

(2) Verification of the new formula

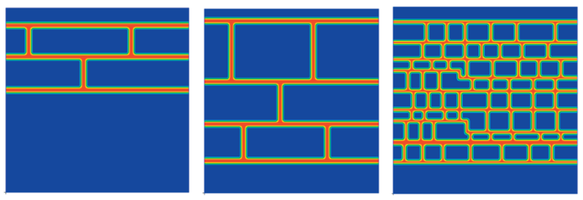

Fig. 3. Three numerical models of coal samples.

Table 1. Equivalent permeability calculated by two methods

	Model A (mD)	Model B (mD)	Model C (mD)
Simulation results	0.901	1.20	1.96
Empirical formula	0.907	1.23	1.91

Conclusions

Our numerical models are optimized by using refined grid networks and models in their representative elementary volume. The new empirical formulas presented in this paper were validated and applied in a coal sample from the Surat Basin.

References

Begg, S., Carter, R., and Dranfield, P. (1989). Assigning effective values to simulator gridblock parameters for heterogeneous reservoirs. SPE Reservoir Engineering, 4(04), 455-463.
Chilingar, G. V., and Liu, M. (2015). Evaluation of Representative Elementary Volume for a Vuggy Carbonate Rock-Part: Porosity, Permeability and Dispersivity, by B. Vik, E. Bastesen and A. Skauge. Journal of Petroleum Science and Engineering.

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