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Prediction model of permeability in porous media with different arrangements

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Abstract:
Permeability is a measure of flow resistance in porous media. As an important characterization parameter of porous media flow capacity, it is widely used in oil/gas development, filtration analysis, groundwater transport, hydrocarbon recovery and so on. However, on the one hand, the permeability was considered a monodrome function of porosity by many researchers in their studies [1~3]. On the other hand, its determination for different types of porous media is challenging due to its complex dependence on the pore-scale structure of porous media [4], which always includes fractures caused by hydraulic fracturing and geological factors.
We first established an absolute permeability computational method to determine the actual relation between permeability and other pore-throat parameters. The method is based on the Darcy equation and Lattice Boltzmann method (LBM). Then we calculated the permeability for porous media with different pore-throat parameters. A modification to the Kozeny-Carman equation was made by considering the effects of pore-throat ratio and coordination number. Finally, we studied the impact of fracture and arrangement. The compound porous media (CPM) with different initial porous media (IPM) structures and arrangements, such as series connection and parallel connection, were constructed and the compound permeabilities were calculated. According to the electric resistance network analogy [5], the relationship between the compound permeability and the permeabilities of IPM was established mathematically.
Using the LBM, our revised permeability calculation method matched well with the theoretical prediction compared to the classical Kozeny-Carman equation. In low-permeability tight reservoirs or shale reservoirs, fracture contributes more to fluid transport rather than matrix, which was confirmed by its higher permeability. Besides, our calculation results revealed that the arrangement, while directly affecting the compound permeability, will further affect the compound permeability by changing the tortuosity. This effect through tortuosity is more pronounced in CPM with series connection.

Key words: *Permeability, Lattice Boltzmann method, Kozeny-Carman equation, Porous media arrangement*

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