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The gas mass transport model considering the dynamic change of micro-fracture width in shale

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Shale gas reservoirs generally develop micro fractures. During pressure-relief production, the change of micro-fracture width caused by stress-sensitivity is an important factor affecting shale gas transport. Based on the cubic grid model, the slippage flow model, the Knudsen diffusion model and the surface diffusion model, a gas mass transporting model considering the dynamic change of shale micro-fracture width is established by using elasto-plastic mechanics and desorption theory of adsorption gas, meanwhile, the molecular simulation results verify the reliability of the model. On this basis, considering the dynamic change of micro-fracture width , the law of shale gas mass transport is studied, and the contribution of different transporting mechanisms to the total gas transport is discussed.The results show that: (1) Considering the change of micro-fracture width caused by stress-sensitivity,the model established in this paper can well reflect these coexisting flows including continuous flow, slippage flow, Knudsen flow and surface diffusion flow. (2) Compared with original transporting capacity of unconsidering the change of micro-fracture width, When the formation pressure is higher than 3.4MPa, the change of micro-fracture width decreases the gas transporting capacity, and the minimum transporting capacity is only 0.45 times of the original transporting capacity, while the formation pressure is less than 3.4MPa, the change of micro-fracture width increases the gas transporting capacity, the maximum transporting capacity is 4.5 times of the original transporting capacity. The gas mass transport is negatively correlated with the compressibility of micro fracture and positive correlation with the Young's modulus and Poisson's ratio of the rock. When the formation pressure is less than 4MPa, the gas mass transport is positively correlated with the gas desorption. When the formation pressure is greater than 4MPa, The effect of different gas adsorption on gas mass transport is almost the same. (3) Considering the change of the micro-fracture width, only when the micro-fracture width is smaller than nano-scale and the formation pressure is relatively low , the surface diffusion can exert a great influence on the gas transport. When the contribution of surface diffusion to total gas transport is small, the contributions of slippage and Knudsen flow respectively to total gas transport show a tendency of "shifting from one another".When the proportion of surface diffusion is larger, with the decrease of contribution of surface diffusion, The contributions of slippage and Knudsen flow respectively to total gas transport will increase together in the first stage and then "shifting from one another" in the second stage.
Key words: shale gas; micro-fracture; dynamic micro-fracture width; gas mass transport; effect laws

References

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