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Production prediction of fractured horizontal wells in shale gas reservoirs based on multi-scale flow

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There are abundant shale gas resources in China. The technological recoverable resources amount to 21.8 trillion cubic meters, with a proven rate of only 4.8%, and the resource potential is huge. Shale reservoir permeability is very low. It must be fractured to obtain effective productivity. Moreover, the research on the special seepage law of shale gas reservoir is far behind the production practice: the complex multi-scale reservoir and flow space and various modes of existing of shale gas reservoir lead to strong non-linear and multi-transport mechanism characteristics of gas in the flow process, and lack of comprehensive flow model to characterize the multi-scale flow law of shale gas reservoir; At the same time, complex fracture network is formed around horizontal wells. How to accurately simulate and predict the production performance after fracturing become the technical bottleneck of restricting the efficient development of shale gas reservoirs. Considering the non-linear seepage mechanism of adsorption-desorption, slippage, Knudsen diffusion, surface diffusion, stress-sensitive effect, the mathematical models of shale gas seepage at different scales were established. The multi-scale seepage mechanism was coupled with the continuous medium-discrete fracture model, and the gas-water two-phase synthesis of multi-stage fractured horizontal wells in shale gas reservoirs were constructed. In order to avoid the large increase of mesh number and computation caused by local refinement around fractures by traditional orthogonal grids, based on unstructured triangular mesh and tetrahedral mesh, combined with the control volume-finite element (CVFE) method, a fully implicit numerical model of gas-water two-phase seepage was constructed. Finally, the effects of shale reservoir properties, multi-scale seepage, fracture network geometry and production system on the production performance of multi-stage fractured horizontal well and the optimization of parameters were studied.

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