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One-Dimensional Transient Inter-Porosity Flow Model in Tight Porous Media with Consideration of Fracture Pressure Depletion

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Tight porous media have the characteristics of extremely low permeability and the permeability of it is sensitive to the effective stress. Stimulated reservoir volume (SRV) is usually performed to improve the production of well in tight porous media. The SRV zone is usually considered as a dual-porosity medium in well test or numerical simulation due to the computationally efficient. The shape factor is the key of the dual-porosity model, which determines the ability of mass transfer between the matrix block and fracture. However, the conventional shape factor model which is usually obtained based on the assumptions of pseudo-steady state and constant fracture pressure, which lead to a poor application in the characterization of mass transfer between matrix and fracture in tight porous media.
In this paper, a new model was established by considering the effect of stress sensitivity and time-dependent fracture pressure boundary condition. Pedrosa substitution and perturbation method were applied to eliminate the nonlinearity of the model. By using the Laplace transformation method, the analytical solution in the Laplace domain was obtained. According to the Duhamel principle, the solution for time-dependent fracture pressure boundary condition was obtained. Then validation was performed to show that the model is valid. Finally, influence of stress-sensitivity and fracture pressure depletion on shape factor and inter-porosity rate were discussed. Study shows that: Stress sensitivity of the matrix has an obvious influence on the inter-porosity flow. As the value of stress sensitivity coefficient increases, the value of the shape factor and inter-porosity rate decrease. After considering the impact of fracture pressure depletion, the effect of stress sensitivity on the shape factor is more significant. The faster the decreasing rate of fracture pressure, the larger the value of the shape factor at the initial time. However, the value of the shape factor is smaller at the later time due to the earlier and faster decreasing of fracture pressure. The inter-porosity rate will rise first to reach equilibrium and then decrease when the decreasing rate of fracture pressure is small. The new model can be used in the study of well test interpretation and numerical simulation, which provides a theoretical guidance for the reasonable development of tight porous media.

References

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