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Model formulation of fluid flow in phase domain for fracturing-shut in-flowback-production process in tight oil reservoirs

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Multistage hydraulic fracture stimulation is commonly used with horizontal well technology as one of key technologies for the economical and effective development of unconventional reservoirs such as tight oil. The applicable method of numerical simulation will provide effective modeling tools for quantitative studies of tight oil reservoir dynamics and performance, fractures and their effects on oil production, well and stimulation design, and optimal production schedules in the field. The field shows that the flowback rate of fracturing fluid in tight oil reservoir is related to increasing and stabilizing production, and the technology of fracturing, shut in and production has achieved a positive effect on increasing production. However, there are few standardized and effective numerical modeling approaches available for guidance. Based on the summary and analysis of recent research results on the imbibition and flowback of fracturing fluid in tight reservoirs, a novel numerical model of fluid flow for fracturing, shut in, flowback, and production process in tight oil reservoirs is proposed considering the mechanism of spontaneous imbibition, hysteresis effects of capillary pressure and relative permeability, osmotic pressure, stress sensitivity, fluid compression effect in fractures and water-rock interaction. In this model, the multi-scaled fracture system of tight oil reservoirs is described as a set of subdomains and handled by a multi-continuum conceptual model. To model the effect of fluid compression, the pores and fractures of tight reservoir are classified and described according to the different compressibility of tight oil and fracturing fluid. When considering the stress sensitivity of different types of pores and fractures, the effects of fluid distribution difference and fluid compressibility are considered. The model in this paper can describe the fluids flow in pores and fractures in a more detailed and accurate manner, and has certain reference value for understanding the mechanisms of fracturing fluid imbibition and retention, and enhancing tight oil recovery.

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