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Fractal characterization of time-dependent shape factor for counter-current imbibition in fractured reservoirs

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The fluid exchange behavior for counter-current imbibition in fractured reservoirs can be quantitatively characterized by the transfer function in the numerical simulation. The time-dependent shape factor (TDSF) in the transfer function is one of the main factors controlling fluid transport, and it directly affects the result of ultimate oil recovery prediction. However, the current TDSFs proposed for counter-current imbibition assume that the microscopic pore structure has no impact on the fluid inter-porosity flow behavior, which is inconsistent with the actual situation. In this work, the fractal theory is employed to establish the TDSF of counter-current imbibition which is related to microscopic pore structure. The analytical solutions of average water saturation and imbibition rate under different conditions related to maximum pore diameter and tortuosity fractal dimension of the matrix are first obtained. The validity of the new analytical solution is ascertained by single-porosity model and experimental data. Then, the new analytical solution is applied to the two-phase transfer function to introduce the new TDSF for counter-current imbibition. The results demonstrate that the unsteady state duration of the TDSF is proportional to characteristic length and tortuosity fractal dimension of the matrix, and negatively proportional to maximum pore diameter of the matrix on the contrary. The influence of characteristic length, tortuosity fractal dimension and maximum pore diameter of the matrix on the value of constant shape factor under quasi steady state is exactly the opposite. This work fosters a better understanding of fluid exchange behavior during counter-current imbibition in fractured reservoirs.

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Participation

Online

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