Thermodynamically consistent model of non-isothermal two-phase filtration with capillary and thermal nonequilibrium effects

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Several hydrocarbon production processes involve the injection of hot fluids into a cold reservoir. The opposite scenario is possible as well and it is well known when fluids enter the formation through a system of natural or man-made fractures. There are various approaches to describe the non-equilibrium two-phase fluid motions in porous media with a skeleton consisting of a complex structure. Among these approaches direct numerical calculation of fluid flow in the pore space, multicontinuous models with the laws of mass exchange between continua and single-continuum models of nonequilibrium filtration exist [1], [2], [3].

In this work, we generalize the relaxation model of capillary nonequilibrium [3] to the non-isothermal case. The model is based on the analysis of the dissipation inequality, thermodynamically consistent kinetic equations for the evolution of these parameters are proposed. A key feature of the model is the interdependence of the processes of capillary and thermal relaxation. A linear approximation is formulated in the work. The key peculiarities of the model we clarified with special examples and modeling.

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