Modelling and Numerical Calculation of Piston-like Oil Displacement for Doubly-periodic Systems of Oil Fields Development

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ABSTRACT

Prediction of the motion of the oil-water contact boundary has great importance in the problems of design of oilfield development by waterflooding: knowledge of the nature of coupled motion of oil and water, displacing oil in the reservoir allows us to optimize the system of oil field development. The simplest model of coupled filtering of oil and water is the model of "multicolored" liquids, which assumes that oil and water have the same or similar physical properties (density and viscosity).

In this paper we consider a more complex "piston-like" model of oil-water displacement, which takes into account differences in viscosity and density of the two fluids. Oil reservoir assumed to be homogeneous and infinite, fixed thickness, with constant values of porosity and permeability coefficients. It is assumed that the reservoir is developed by a group of a finite number of production and injection wells recurrent in two directions (doubly-periodic cluster). Filtration of liquids is described by Darcy's law. It is assumed, that both fluids are weakly compressible and the pressure in the reservoir satisfies the quasi-stationary diffusion equation.

Piston-like displacement model leads to the discontinuity of the tangential component of the velocity vector at the boundary of oil-water contact. Use of the theory of elliptic functions in conjunction with the generalized Cauchy integrals reduces the problem of finding the current boundaries of oil-water contact to the system of singular integral equations for the tangential and normal components of the velocity vector and the Cauchy problem for the integration of the differential equations of motion of the boundary of oil-water contact.

An algorithm for the numerical solution of this problem is developed. The monitoring of oil-water boundary motion for different schemes of waterflooding (linear row, four-point, five-point, seven-point, nine-point, etc.) is carried out.

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