Mathematical modeling of fluid migration through impermeable layers along fractures of auto-fracturing

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The work is devoted to the mathematical modeling of the process of vertical fluid migration through a fluid-impermeable layer along fractures of auto-fracturing under the action of gravity.

A closed system of integral-differential equations is presented, which allows to simulate the fluid flow along the fracture in planar 3D formulation, including the equations of hydrodynamics for an incompressible fluid in the approximation of the lubricating layer and the equilibrium equations of a linearly elastic deformed medium in a gravity field..

The quasi-stationary mode of fracture growth with the domination of the buoyancy force is analytically investigated, under the assumptions that the fluid pressure in the fracture isn't much greater than the minimum confining stress and the pressure gradients in the horizontal direction are small. Analytical solutions connecting the fracture width and half-length with the fluid flow rate and net pressure in the fracture are obtained. It is shown that in the quasi-stationary approximation the analytically calculated geometrical parameters of the fracture and the effective pressure are consistent with the numerical calculations with four percent accuracy.

The considered mechanism of vertical hydrocarbons migration based on the assumption of loss of continuity of fluid-impermeable layer due to the formation of auto-fracturing cracks and further movement of reservoir fluid through them, according to the authors, may be one of the main ones in the formation of oil and gas deposits.