

Non-Isothermal Stationary Laminar Oil Flow Numerical Simulation

Authors : Daniyar Bossinov

Abstract : This paper considers a non-isothermal stationary waxy crude oil flow in a two-dimensional axisymmetric pipe with the transition of a Newtonian fluid to a non-Newtonian fluid. The viscosity and yield stress of waxy crude oil are highly dependent on temperature changes. During the hot pumping of waxy crude oil through a buried pipeline, a non-isothermal flow occurs due to heat transfer to the surrounding soil. This leads to a decrease in flow temperature, an increase in viscosity, the appearance of yield stress, the crystallization of wax, and the deposition of solid particles on the pipeline's inner wall. The deposition of oil solid particles reduces a pipeline flow area and leads to the appearance of a stagnant zone with thermal insulation in the near-wall area. Waxy crude oil properties change. A Newtonian fluid at low temperatures transits to a non-Newtonian fluid. The one-dimensional modeling of a non-isothermal waxy crude oil flow in a two-dimensional axisymmetric pipeline by traditional averaging of temperature and velocity over the pipeline cross-section does not allow for explaining a physics phenomenon. Therefore, in this work, a two-dimensional flow model and the heat transfer of waxy oil are constructed. The calculated data show the transition of a Newtonian fluid to a non-Newtonian fluid due to the heat exchange of waxy oil with the environment.

Keywords : non-isothermal laminar flow, waxy crude oil, stagnant zone, yield stress

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