Modelling flow through petroleum reservoirs: different from saturated groundwater flow?

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The present article highlights a few fundamental aspects that need to be considered while characterizing fluid flow through a petroleum reservoir. Darcy's law, as applied in describing fluid flow through pipes or saturated groundwater aquifers, cannot be directly applied under all circumstances. Darcy's original version of Darcy's law carries a simple algebraic equation relating linear Darcy flux with the hydraulic gradient. Steady-state Darcy's law is being applied with lots of assumptions, even when describing saturated groundwater fluid flow. However, fluid flow through a petroleum reservoir involves multi-dimensional, multi-phase and multi-component, compressible fluid flow with inertial effects under non-isothermal conditions. This article highlights first why already established Navier–Stokes Equation cannot be applied to characterize fluid flow through a petroleum reservoir; and then shows why the fundamental principle associated, even with fluid flow through a saturated groundwater aquifer, cannot be applied directly to characterize the flow through a petroleum reservoir. Finally, the article presents critical limitations associated with mass conservation equation, momentum conservation equation and fluid flow equation used to characterize flow through petroleum reservoirs.

Keywords: Darcy's law, groundwater flow, Navier–Stokes equation, petroleum reservoir, representative elementary volume.