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Two-Phase Flow in Porous Media with Slip Boundary Condition
S. BERG, A.W. CENSE, J.P. HOFMAN, R.M.M. SMITS, Shell International Exploration & Production B.V. — 2-phase flow in porous media is typically described by Darcy's law extended with the concept of relative permeability, k_r, for the water and the oil phase. Using a single phase permeability of a wetting fluid (water) as reference, krnaturally assumes a maximum value of $0 \leq kr \leq 1$. Several reports in literature and our own experimental data show in some cases endpoint relative permeabilities of the non-wetting phase with $2 < kr < 4$. That means that in 2-phase flow in the porous medium, the flux of the non-wetting phase is higher when a small amount of the wetting phase is present. We explain this behavior by drawing an analogy between $kr¿1$ and a *slip-boundary condition* for the pore scale flow using a model description assuming flow in capillary tubes with a slip boundary condition. This model predicts that the flux increase due to slip depends on the equivalent capillary radius of the flow channels. Our kr data specifically follows this dependence indicating that slip is a plausible explanation for the observation of $kr > 1$.

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