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Comparison of two-phase Darcy's law with a thermodynamically consistent approach STEFFEN BERG, Shell International Exploration & Production B.V., JENNIFER NIESSNER, University of Stuttgart, S. MAJID HASSANIZADEH, Utrecht University — The extended Darcy's law is a commonly used description of immiscible two-phase flow in porous media. Fractional flow theory and reservoir engineering in the oil & gas industry is to a large extent based on this approach. In this description, the hydraulic conductivities of the porous medium for the two phases are parameterized with relative permeability-saturation functions which were introduced as empirical relationships. Within the last two decades, more advanced and physically based descriptions for multiphase flow in porous media have been developed. In this work, the extended Darcy's law is compared to a thermodynamically consistent approach by Hassanizadeh and Gray (1990) which explicitly takes the important role of phase-interfaces into account, both as entities and as parameters. It turns out that the extended Darcy's law and the thermodynamically based approach are compatible if either (i) relative permeabilites are a function of saturation only, but capillary pressure is a function of saturation and specific interfacial area or (ii) relative permeabilities are a function of saturation and saturation gradients. The latter would imply a more complex material behavior than commonly assumed in particular for the general case of irreversible displacement.

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