Mechanics and thermodynamics of multiphase flow in porous media including interphase boundaries

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The main purpose of this work is to develop a macroscale thermodynamic theory to describe two-phase flow in porous media. Full thermodynamic properties are assigned to the boundary surfaces separating the phases at the microscale. Macroscopic equations of balance for mass, momentum, and energy for each phase and interface along with the averaged entropy inequality are employed as the starting point. A constitutive theory is developed resulting in balance equations and thermodynamics appropriate for modelling multiphase flow in porous media. Volume fractions of phases and areal fractions of interfaces are explicitly included in the theory. Incorporation of the interface equations into the theory allows for a complete description of the problem. The manipulations provide explicit functional dependence of the capillary pressure. An extended form of Darcy's law for multiphase flow is obtained from the macroscopic equations of momentum balance. An additional term which accounts for non-uniform fluid saturation at equilibrium appears in the result.