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Unsaturated Flow Theory Including Interfacial Phenomena

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The macroscopic porous medium equations for mass, momentum, and energy transport for air, water, and solid phases and the interfaces between these phases are examined in light of the second law of thermodynamics. Attention is focused on the momentum balance for the water phase. Appropriate forms of the momentum balance are obtained, in general, for the slow flow situation and for the case when the water phase completely wets the solid. This last case suggests that the relative wettability of the water and air phases is an important dependent thermodynamic variable which contributes to the hysteretic nature of the capillary pressure versus saturation curve.