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Nonlinear Fluid-Structure Coupling in Flow through a Deformable Porous Medium TYLER LUTZ, LARRY WILEN, JOHN WETTLAUFER, Yale University — Fluid flow through a deformable, porous matrix of solid particles is generally seen to exhibit non-Darcy behavior; viscous drag forces exerted on the solid constituents by the fluid may be communicated throughout the solid matrix, leading to a spatially inhomogeneous permeability and ultimately a nonlinear relationship between bulk pressure drop and volume flux. We present results of an experiment in three dimensions designed to provide a closure condition on the mathematical theory of large-deformation flow through a deformable porous medium. Our specific realization of uniaxial flow through a cylindrical foam is robust enough to capture the nonlinear coupling between the solid and fluid components, while the geometry is sufficiently simple to enable detailed comparisons to theoretical expectations. We focus in particular on precision measurements of the pore pressure gradient as a function of the driving pressure head; we use these measurements in combination with direct measurements of the foam deformation to determine the relationship between porosity and permeability, a crucial theoretical input parameter. This closure condition allows us to make explicit, quantitative comparisons to theoretical predictions.

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