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Probing the permeability of porous media by NMR measurement of stochastic dispersion dynamics TYLER BROSTEN, ROBERT MAIER, Engineer Research and Development Center, U.S. Department of Defense, SARAH CODD, Department of Mechanical and Industrial Engineering, Montana State University, SARAH VOGT, JOSEPH SEYMOUR, Department of Chemical and Biological Engineering, Montana State University — A generalized short-time expansion of hydrodynamic dispersion is derived using non-linear response theory. The result is in accordance with the well-known reduced cases of shear flow in ducts and pipes. In terms of viscous dominated (low Reynolds number) flow in porous media the generalized expansion facilitates the measurement of permeability by PGSE-NMR measurement of time dependent molecular displacement dynamics. To be more precise, for porous media characterized by a homogeneous permeability coefficient along the direction of flow K, and fluid volume fraction ε, the effective dispersion coefficient $D(t) = \langle|\mathbf{R}\text{-}\langle\mathbf{R}\rangle|^2\rangle/6t$ of molecular displacements $\mathbf{R}$ due to flow and diffusion for a saturating fluid of molecular diffusivity κ in viscous dominated flow is shown to be partially governed by the coefficient of permeability at short times. The short-time expansion is shown to be in agreement with pulsed field gradient spin echo NMR measurement of $D(t)$ in a random sphere pack media and analogous pore-scale random-walk particle tracking transport simulation.

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