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**Diffusion in random networks: Asymptotic properties, and numerical and engineering approximations** JUAN C. PADRINO, DUAN Z. ZHANG, Los Alamos National Laboratory — The ensemble phase averaging technique is applied to model mass transport by diffusion in random networks. The system consists of an ensemble of random networks, where each network is made of a set of pockets connected by tortuous channels. Inside a channel, we assume that fluid transport is governed by the one-dimensional diffusion equation. Mass balance leads to an integro-differential equation for the pores mass density. The so-called dual porosity model is found to be equivalent to the leading order approximation of the integration kernel when the diffusion time scale inside the channels is small compared to the macroscopic time scale. As a test problem, we consider the one-dimensional mass diffusion in a semi-infinite domain, whose solution is sought numerically. Because of the required time to establish the linear concentration profile inside a channel, for early times the similarity variable is $xt^{-1/4}$ rather than $xt^{-1/2}$ as in the traditional theory. This early time sub-diffusive similarity can be explained by random walk theory through the network. In addition, by applying concepts of fractional calculus, we show that, for small time, the governing equation reduces to a fractional diffusion equation with known solution. We recast this solution in terms of special functions easier to compute. Comparison of the numerical and exact solutions shows excellent agreement.

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