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Derivation of fractional differential equations for modeling diffusion in porous media of fractal geometry

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Abstract

Utilizing the double-porosity approach it is assumed that porous medium is constituted by two groups of pores in such way that major mass transport takes place mostly along the network of larger pores (group 1) and these larger (stem) pores are surrounded by the medium formed by the dead-end porous of fractal geometry (group 2). Solving analytically equation for the stem pore from the group 1 and accounting for the mass exchange with pores from the group 2, it is proved that diffusion in a stem pore should be described by the fractional differential equation. Based on this result, equation of mass flux that models non-Fickian diffusion in complex fractal medium is proposed. Applying this generalized form of mass transfer equation for modeling the contaminant transport in fractured porous aquifer leads to a fractional order differential equation, where mass exchange between blocks and fractures is modeled by the temporal fractional derivatives. This equation is solved analytically.

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