Accepted Manuscript

Analytical solutions for solute transport from varying pulse source along porous media flow with spatial dispersivity in fractal & Euclidean framework

Vinod Kumar Bharati, Vijay P. Singh, Abhishek Sanskrityayn, Naveen Kumar

PII: S0997-7546(17)30689-1
DOI: https://doi.org/10.1016/j.euromechflu.2018.07.008
Reference: EJMFLU 3328

To appear in: *European Journal of Mechanics / B Fluids*

Received date : 18 December 2017
Revised date : 2 July 2018
Accepted date : 16 July 2018

Please cite this article as: V.K. Bharati, V.P. Singh, A. Sanskrityayn, N. Kumar, Analytical solutions for solute transport from varying pulse source along porous media flow with spatial dispersivity in fractal & Euclidean framework, *European Journal of Mechanics / B Fluids* (2018), https://doi.org/10.1016/j.euromechflu.2018.07.008

Analytical Solutions for Solute Transport from Varying Pulse Source along Porous Media Flow with Spatial Dispersivity in Fractal & Euclidean Framework

Vinod Kumar Bharati [a, *], Vijay P. Singh [b], Abhishek Sanskrityayn [c], Naveen Kumar [d]

[a, c, d] *Department of Mathematics, Institute of Science, Banaras Hindu University, Varanasi-221005, India*

[b] *Department of Biological Engineering and Agricultural Engineering and Zachry Department of Civil Engineering, Texas A & M University, USA*

Abstract

In the present study analytical solutions of the advection dispersion equation (ADE) are obtained to describe the solute transport originating from a varying pulse source along a porous medium with spatial dispersivity in fractal and Euclidean frameworks. Darcy velocity is considered to be a linear non-homogeneous spatial function. The dispersion coefficient is assumed to be proportional to n^{th} power of velocity, where n may take on a value from 1 to 2. Analytical solutions are obtained for three values of the index, n = 1.0, 1.5 and 2.0. The heterogeneity of the porous medium is enunciated in the fractal for n = 1.5 (a real value), for other two integer values it is described in the Euclidean framework. Extended Fourier series method (EFSM) is employed to obtain the analytical solutions in the form of extended Fourier series (EFS) in terms of first five non-trivial solutions of a Sturm-Liouville Problem (SLP). The time dependent coefficients of the series are obtained analytically using Laplace integral transform technique. The ordinary differential equation of the auxiliary system is considered to be different from that used in all the previous studies in which a similar method has been employed. It paved the way for the proposed analytical solutions. The solution in the fractal framework and that in the Euclidean framework for n = 1.0 are novel. A varying pulse source at the origin is considered which is useful in estimating the rehabilitation pattern of a polluted domain. The proposed solutions exhibit all the important features of solute transport and are found in agreement the respective numerical solution in very close approximation.

Key words:
Heterogeneity; Dispersivity; Fractal and Euclidean framework; Sturm-Liouville problem (SLP); Extended Fourier series method (EFSM).

* Corresponding author.
E-mail address : vinodkmr418@gmail.com (Vinod Kumar Bharati).