A linear iterative investigation for MFS with EEM to solve the 3D Nonhomogeneous Diffusion Equation

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Abstract

The eigenfunctions expansion method (EEM) will first introduce in the present study to combine the method of fundamental solutions (MFS) and the method of particular solutions (MPS) to get the numerical solutions of 3-D diffusion equation with nonhomogeneous type. Proposed meshless numerical model named the model of MFS-MPS-EEM are adopted further to analyze the nonhomogeneous diffusion equation in complex domain corresponding the boundary conditions. For complex domain, the nonhomogeneous diffusion equation can divide individually into a Poisson equation and a homogeneous diffusion equation through the presented numerical model. In which the Poisson equation was calculated by the MFS-MPS model where the compactly-supported radial basis functions has direct adopted for the MPS and the fundamental solution of Laplace operator has used for the MFS. Furthermore, in terms of homogeneous diffusion equation was translated into a Helmholtz equation by EEM, which can be solved using the MFS combined with the singular value decomposition (SVD). Good agreement with the analytical and finite element solutions was obtained; hence, the present numerical scheme has shown a promising mesh-free numerical tool to solve the 3-D nonhomogeneous diffusion equations with time-independent source terms and boundary conditions.

Keywords: method of fundamental solutions; method of particular solutions; eigenfunctions expansion method; 3-D nonhomogeneous diffusion equation; singular value decomposition