Numerical Methods In Subsurface Hydrology, With An Introduction To The Finite Element Method

Subsurface transport modeling using adaptive finite elements

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Abstract

A multi-dimensional finite element method (GWADAPT) which utilizes local mesh adaptation is used to calculate groundwater flow and subsurface transport of contaminant in saturated and unsaturated conditions. The model uses simple modifications to increase computational speed and reduce storage, allowing the model to run on PCs and workstations. GWADAPT can be accessed from the web and downloaded to a file. A parallel version of the model runs on an SGI Origin 2000 computer.

1 Introduction

Increasing emphasis is now being placed on the use of predictive computer models for regulatory and cleanup activities associated with groundwater flow and subsurface contaminant transport. Modeling such problems involves complicated physics, chemistry, and multi-phase flow phenomena, and typically requires the use of numerical techniques. A particularly attractive numerical scheme now being used to model subsurface transport is the finite element method (FEM).

Finite element codes have been used for many years to simulate transport of subsurface contaminant[1,2]. Early successes with the FEM in groundwater transport subsequently lead to increased application of the method.[3-5] Huyakorn and Wadsworth[6] developed a 3-D finite element model for fluid flow and solute transport in saturated or unsaturated porous media. Camp Dresser and McKee[7] used a 3-D finite element model and a random walk technique with Lagrangian particles to simulate tritium dispersion. Application of the FEM is rather commonplace today, and widely used for groundwater transport.[8] Two promising finite element codes now being used for assessing radioactive contaminant dispersion from former underground nuclear tests are FEFLOW[9], a multi-dimensional code commercially available from Waterloo Geohydrologic and FEHM, a multi-dimensional code developed by Zobylovski et al[10] at Los Alamos National Laboratory.

The employment of adapting, unstructured meshes permits one to calculate difficult problems with a minimum of nodal points. Approaches in using FEM and mesh adaptation have been shown to be very successful for advection-dispersion problems.[11,12] The adaptive mesh algorithm lifts much of the burden of mesh generation from the user while increasing accuracy of the

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