
Abstract: Solute transport through heterogeneous porous media considered in environmental and industrial problems is often characterized by high Peclet numbers. In this paper we develop a new numerical approach to advection-dominated transport consisting of coupling an accurate mass-conservative mixed finite element method (MFEM), used to solve Darcy flows, with a particle method, stable and free of numerical diffusion, for non-reactive transport simulations. The latter is the efficient global random walk (GRW) algorithm, which performs the simultaneous tracking of arbitrarily large collections of particles on regular lattices at computational costs comparable to those of single-trajectory simulations using traditional particle tracking (PT). MFEM saturated flow solutions are computed for spatially heterogeneous hydraulic conductivities parameterized as samples of random fields. The coupling is achieved by projecting the velocity field from the MFEM basis onto the regular GRW lattice. Preliminary results show that MFEM-GRW is tens of times faster than the full MFEM flow and transport simulation. JOURNAL OF COMPUTATIONAL AND APPLIED MATHEMATICS, 246, 27-37, JUL 2013

Radu, Florin A.; Muntean, Adrian; Pop, Iuliu S.; Suciu, Nicolae and Kolditz, Olaf: A mixed finite element discretization scheme for a concrete carbonation model with concentration-dependent porosity

Abstract: We investigate a prototypical reaction-diffusion-flow problem in saturated/unsaturated porous media. The special features of our problem are twofold: the reaction produces water and therefore the flow and transport are coupled in both directions and moreover, the reaction may alter the microstructure. This means we have a variable porosity in our model. For the spatial discretization we propose a mass conservative scheme based on the mixed finite element method (MFEM). The scheme is semi-implicit in time. Error estimates are obtained for some particular cases. We apply our finite element methodology for the case of concrete carbonation—one of the most important physico-chemical processes affecting the durability of concrete. JOURNAL OF COMPUTATIONAL AND APPLIED MATHEMATICS, 246, 74-85, JUL 2013

Christoph Kirfel: A generalisation of Archimedes' method

Abstract: Archimedes developed a method for calculating the area of a segment of a parabola. This result was outstanding in mathematical antiquity. The idea and the method were not developed further until nearly 1800 years later. In our article his method is presented in modern notation using modern concepts. We show that the method generalises to curves of higher order. Many of Archimedes’ arguments can be used without any adjustments and thus show the strength of his original approach. The Mathematical Gazette 97 (538) March 2013.