11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

DENSITY-DRIVEN FLOW IN POROUS MEDIA MODELING USING A NUMERICAL SCHEME WITH LOW DISSIPATION

***Ivan V. Kapyrin[1,2], Sergey P.Pozdnyakov[3,1] and Alexandr V. Rastorguev[4,1]**

[1] Nuclear Safety Institute Russian Academy of Sciences, 52 Bolshaya Tulskaya, Moscow 115191, Russia, ivan.kapyrin@gmail.com

[2] Institute of Numerical Mathematics Russian Academy of Sciences, 8 Gubkina str., Moscow 119333, Russia, www.inm.ras.ru

[3] Moscow State University, 1 Leninskie Gory, Moscow 119991, Russia, sppozd@mail.ru,

[4] Moscow State University, 1 Leninskie Gory, Moscow 119991, Russia, alvr9@mail.ru,

Key Words: *Density-driven flow, finite volume methods, unstructured polyhedral grids, numerical dissipation, iterative coupling.*

The effects of density-driven flow are often met in real life environmental applications: injection of highly mineralized liquid wastes into subsurface aquifers, leakage of surface reservoirs containing heavy contaminated solutions, salt water intrusion problems etc. Modeling of this effect features several challenges. Flow and transport problems are coupled, and in two and three dimensions usually no exact analytical solutions are present. The numerical solutions appear to be highly dependent on the grid and the precision of numerical schemes used, as well as on the precision of linear and nonlinear problem solutions on each time step. One may observe completely different structure of the calculated fluxes and concentration fields obtained by use of different codes and grids.

We introduce a numerical scheme which is applied for the solution of density-driven flow problems with the commonly used neglect of the density gradient within the diffusion term. The scheme is designed for the application on arbitrary 3D polyhedral grids. For the groundwater flow problem and the diffusion operator discretization a multi-point or a two-point flux approximation scheme is used. The transport problem is solved using an operator-splitting scheme in time, advection is solved explicitly while diffusion is treated implicitly. Advective term is discretized using a scheme with local linear reconstruction of concentration on mesh elements, which provides second order accuracy and low artificial diffusion. Transport and groundwater flow solvers are coupled using either iterative or noniterative approaches.

On a couple of well-known tests, such as the Elder and Henry problems, the salt dome case and others, the solutions obtained by the proposed scheme are compared to those generated by other codes and by a scheme which uses standard upwinded finite volume method for the advection term. Effects of the grid size, precision of the linear and nonlinear systems solution and quality of the advection operator discretization are studied as well.