# Integrated Framework for Solving the Convection Diffusion Equation on 2D Quad Mesh Relying on Internal Boundaries

Saúl Buitrago Boret, Oswaldo Jiménez
Simón Bolívar University
sssbuitrago@yahoo.es, oswjimenez@usb.ve

## Abstract

The aim of this paper is the design and implementation of an integrated framework composed of a preprocessor of the internal boundaries of a 2D oil reservoir structure, a 2D structural quadrilateral grid generator, a solver of the 2D convection diffusion equation (CDE) on the grid and a visualization tool to display the reservoir properties, wells and the simulation results on the grid. The complexity of a 2D reservoir structure (preferential flow channels, faults, areas of high permeability contrast, changes in sediment type, etc.) is represented through a set of polygonal lines, in order to store the corresponding information to be used by the grid generator. To accomplish this matter, a windows based interactive module has been developed under java platform. Given a 2D domain with internal boundaries, it is required to generate a grid consisting only by quadrilaterals with the following features: (1) be conformed, (2) be structured, and (3) the mesh generated must rely on the internal boundaries. The technique for generating such grids, is the deformation of an initial cartesian grid and the subsequent alignment with the internal boundaries, through the numerical solution of an elliptic partial differential equation based on finite differences. The resulting system of nonlinear equations is solved through spectral gradient techniques. The finite volume method was used to solve the 2D CDE, which is conservative and facilitates the treatment of the boundary conditions. In this method the CDE is integrated on each quadrilateral (control volume) of the mesh, thus obtaining the integral form of the equation. After approximating the integrals involved and taking into account the boundary conditions, a discrete equation in each control volume showed up. Finally, a large sparse linear system is obtained, generally non-symmetric and ill-conditioned, which is solved using GMRES with incomplete LU preconditioning. A multiplatform visualization module was developed in java to post-processing the data coming from the numerical simulation study. Examples of typical structures corresponding to an areal view of a hydrocarbon reservoir are presented. Different scenarios were considered varying boundary conditions, source term, and diffusion constant fluid velocity. All the results are consistent with the physical interpretation of each configuration.

## References

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