Simulation of Two Phase Flows in Petroleum Reservoirs with a Non Orthodox Multipoint Flux Approximation Method (MPFA-D) Coupled to a High Order Correction Procedure Via Reconstruction (CPR)

G. G. Ramirez[1], Fernando R. L. Contreras[2], Márcio R. A. Souza[3],

Darlan K. E. de Carvalho[4] and Paulo R. M. Lyra[5]

Mechanical Engineering Department,

Federal University of Pernambuco UFPE, Recife, PE, Brazil.

email: [1]ggalindezr@gmail.com, [2]unica_ferlicapac@yahoo.es, [3]souza2105@gmail.com,

[4]dkarlo@oul.com.br and [5]prmlyra@padmec.org

ABSTRACT

The development of high resolution numerical approximations for the modelling and simulation of multiphase flows in petroleum reservoirs is still a challenge from the computational viewpoint due to the difficult posed by some physical features such as heterogeneity and anisotropy of the medium, non-convex advective flux function, as well as, the non-linearity of the saturation equation and its coupling to the pressure equation, that are of paramount importance in this class of applications. The solution procedure is the classical IMPES. Here, we perform an investigation of the very high order CPR method [1], for the discretization of the saturation equation, which results from the modelling of the 2-D Oil-Water displacement through porous formations. To prevent numerical oscillations, a hierarchical MLP [3] is used in the reconstruction stage. The integration in time is uses a 3rd R-K method. To solve the pressure equation a non-orthodox cell centred MPFA-D finite volume is employed [2]. To properly couple the MPFA-D method with the CPR formulation, it is necessary to obtain an adequate velocity reconstruction throughout the control volumes of the mesh. As the cell-centred FVM naturally delivers fluxes across cell faces that belong to the primal grid, a reconstruction operator based on the Raviart-Thomas MFEM is built, to get the complete knowledge of conservative velocity field throughout the domain. The reconstruction operator receives, as input, fluxes across element faces and returns the point-wise values of velocity anywhere within the cell. To evaluate the performance of the proposed scheme, some benchmark problems are solved.

REFERENCES

[1] Wang, Z; Gao and Kim, C., "A unifying discontinuous formulation for hybrid meshes", *Adaptive High-Order Methods in Computational Fluid Dynamics*, Edited by ZJ Wang, World Scientific Publishing, p. 423-453, (2011).

[2] Contreras, F.R.L.; Lyra, P.R.M.; Souza, M.R.A. and Carvalho, D.K.E., "A cell-centered multipoint flux approximation method with a diamond stencil coupled with a higher order finite volume method for the simulation of oil- water displacements in heterogeneous and anisotropic petroleum reservoirs", *Computers & Fluids*, v.127 p. 8-24, (2016).

[3] Jin S. Park, C. Kim, "Hierarchical multi-dimensional limiting strategy for correction procedure via reconstruction", *Journal of Computational Physics*, V. 308 p. 57–80 (2016).