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

# DISCONTINUOUS FINITE ELEMENT FORMULATIONS FOR MISCIBLE VISCOUS FINGERING PROBLEMS

**Yoisell R. Núñez, Cristiane O. Faria, Abimael F.D. Loula and Sandra M.C. Malta**

LNCC, Laboratório Nacional de Computação Científica, Av. Getúlio Vargas 333, P.B. 95113, CEP: 25651-075, Petrópolis, RJ, Brazil, {yoisell,cofaria,aloc,smcm}@lncc.br

**Key words:** *Miscible displacements, Stabilized finite element methods, discontinuous hybrid formulations, Viscous fingering.*

We present discontinuous stabilized finite element approaches to investigate the dynamical evolution of two-dimensional miscible flows taking in porous media into account the appearance of viscous fingers and their influence on the breakthrough time of the injected fluid. The problem is modelled by a coupled system of nonlinear partial differential equations. Through a backward finite difference scheme in time, a sequentially implicit time-stepping algorithm that uncouples the system at each time-step is defined [1, 3]. A stabilized dual hybrid mixed method (SDHM) is employed for computing velocity field and pressure approximations, involving the conservation of mass and Darcy's law. Finally, the SUPG (Streamline Upwind Petrov-Galerkin) method is used to approximate the concentration equation. As demonstrated by the authors [2] the SDHM is locally conservative and is free from any compromise between the finite element approximation spaces. Moreover, in contrast with continuous finite element methods [3], the SDHM formulation is flexible for implementing $hp-$adaptivity approaches, making it a efficient strategy in studying flow patterns in oil reservoirs.

Robustness and accuracy will be illustrated by simulations of viscous fingering in quarter five-spot arrangements to homogeneous and heterogeneous porous media. This proposal is a extension of the methodology developed in [2] to miscible displacements with high adverse mobility ratios.

## REFERENCES

[1] A.L.G.A. Coutinho, C.M. Dias, J.L.D. Alves, L. Landau, A.F.D. Loula, S.M.C. Malta, R.G.S. Castro and E.L.M. Garcia. Stabilized methods and post-processing techniques for Darcy flow and related problems. *Comput. Methods Appl. Mech. Eng.*, **193**, 1421–1436, 2004.

[2] Y.R. Núñez, C.O. Faria, A.F.D. Loula and S.M.C. Malta. A mixed-hybrid finite element method applied to tracer injection processes. *International Journal of Modeling and Simulation for the Petroleum Industry*, **6**(1), 2012.

[3] S.M.C. Malta and R.G.S. Castro. Finite element simulations of miscible fingering problems. *International Journal of Computers Mathematics* , **87**, 2053–2063, 2010.