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HIGH-ORDER HDG METHOD FOR ONE PHASE FLOW SIMULATION

Albert Costa-Solé[1*], Eloi Ruiz-Gironés [2] and Josep Sarrate[1]

[1] Laboratori de Càlcul Numèric (LaCàN), Universitat Politècnica de Catalunya, Building C2, Campus Nord UPC, Jordi Girona, 1-3, 08034 Barcelona, Spain, {albert.costa,jose.sarrate}@upc.edu, https://www.lacan.upc.edu

[2] Barcelona Supercomputing Center - BSC, Building Nexus II, Jordi Girona, 29, 08034 Barcelona, Spain, eloi.ruizgirones@bsc.es, https://www.bsc.es

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During the primary oil recovery stage, the pressure difference between the surface and the reservoir is high enough to move the hydrocarbon upward [1]. A simplified model for this scenario is the one-phase flow through porous media. The equation that governs this model is a non-linear transient PDE, which is obtained from the combination of the mass conservation with Darcy's law and equations of state for fluid and porous media [2].

Nowadays, faster and more accurate numerical methods that can handle the geometry complexity and heterogeneous properties of the reservoir are required [1]. High-order continuous Galerkin methods meet these requirements. Nevertheless, high-order hybridizable discontinuous Galerkin (HDG) method also achieves mass conservation at the elemental level.

In this work, we present a high-order hybridizable discontinuous Galerkin formulation (HDG), combined with a high-order temporal integration scheme to simulate non-linear one phase flow through porous media without mass transport. This method allows to obtain a convergence rate for the scalar unknowns and their fluxes of order $p+1$ in L^2-norm, respectively, when a time integration scheme of order $p+1$ and element-wise polynomial of degree $p \geq 0$ are used [3]. Moreover, we apply a local post-processing to obtain a $p+2$ convergence rate for the scalar unknowns [3]. Finally, we detail several 2D and 3D examples with homogeneous and heterogeneous material properties to assess the main advantages of the proposed formulation for the one phase flow problem.

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