6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

Numerical Approximation of Highly Convective Thermally Coupled Flows of non-Newtonian Fluids Using a VMS Finite Element Formulation

Ernesto Castillo[1], Ramon Codina[2] and Joan Baiges[3]

[1] Universidad de Santiago de Chile, Av. Libertador Bernardo O'Higgins 3363, ernesto.castillode@usach.cl and http://www.dimec.usach.cl/

[2] Universitat Politècnica de Catalunya, Carrer de Jordi Girona 31, ramon.codina@upc.edu and https://www.upc.edu/ca

[3] Universitat Politècnica de Catalunya, Carrer de Jordi Girona 31, jbaiges@cimne.upc.edu and https://www.upc.edu/ca

Key Words: *non-Newtonian Fluids, Stabilized Finite Element Formulation, Convection Dominated, Thermally Coupled*

Fluids, depending on their behavior under the action of shear-stresses, can be classified as Newtonian and non-Newtonian. The non-Newtonian behavior is caused by the complex microstructure present in these fluids, in some cases originated by a mixture of different fluids, many times composed by long chain molecules. Shear-thinning fluids have very advantageous properties of heat transfer and transport, because they have an increased mixing capacity and, therefore, heat transfer coefficients are increased. In addition, pressure losses are reduced in the transport of these type of fluids, decreasing the cost associated with the pumping or reducing the drag forces [1].

The numerical study of non-Newtonian fluids and the possibility of making accurate simulations is of interest in many industrial areas where these type of fluids are used. In this work, a stabilized finite element formulation of the VMS type is used to approximate numerically highly convective flows of inelastic non-Newtonian fluids [2], including heat transfer. The work includes a description of the proposed methods and some of their implementation issues. Numerical results takes account three-dimensional benchmark solutions and simplified industrial examples where the influence of the non-Newtonian effects are discussed, and the robustness and accuracy of the formulations are justify.

Acknowledgments: This work has been partially founded by the Chilean Council for Scientific and Technological Research through the proyect CONICYT-FONDECYT 11160160. We also acknowledge the support received by DICYT-VRIDEI at Universidad de Santiago de Chile.

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