Implementation strategies and applications of Finite Element Methods based on the Arbitrary Lagrangian-Eulerian formulation to Environmental Flows

Norberto Mangiavacchi*, Jose Pontes[1], Gustavo Rabello dos Anjos[2]

*,2Group of Environmental Studies for Water Reservoirs - GESAR
State University of Rio de Janeiro
R. Fonseca Teles 524, 20550-013
Rio de Janeiro, RJ, Brazil
norberto.mangiavacchi@gmail.com, gustavo.rabello@gmail.com
www.gesar.uerj.br

[1] Metallurgy and Materials Engineering Dept. PEMM/COPPE/UFRJ,
P.O. Box 68505, 21941-972, Rio de Janeiro, RJ,
jose.pontes@uerj.br

ABSTRACT

Finite elements in environmental flows frequently require the solution of problems with moving boundaries or interfaces, such as in two-phase flows. The Arbitrary Lagrangian-Eulerian (ALE) [1] formulation can, in many cases, be an effective approach to these problems. The development of ALE Finite Element Method for some relevant environmental flows applications is presented, discussing some advantages and disadvantages of the approach. Some specific issues of the implementation of this approach are addressed. A successful adaptive mesh update procedure [2] is described for effective management of the mesh at interfaces to remove, add and repair surface elements, since the computational mesh nodes move according to the an arbitrary, conveniently chosen, velocity. The Lagrangian description explicitly describes the two-phase interface position by a set of interconnected nodes which ensures a sharp representation of the boundary, including the role of the surface tension and phase change [3]. The methodology proposed for computing the curvature leads to accurate results with moderate programming effort and computational cost and it can also be applied to different configurations with an explicit description of the interface. Results of environmental flows applications, including two-phase bubbly flows and flow in porous media, will be discussed.

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