ALE-FEM for two-phase flows with heat and mass transfer

G. Anjos1, G. Peixoto2, N. Mangiavacchi3 and and J. Pontes4

1 GESAR- Department of Mechanical Engineering, State University of Rio de Janeiro, Brazil. gustavo.anjos@uerj.br  
2 [gustavo.oliveira@uerj.br](mailto:gustavo.oliveira@uerj.br), 3 [norberto@uerj.br](mailto:norberto@uerj.br), 4 jose.pontes@uerj.br

property.pdfinterface.pdfA numerical method is described to study two-phase flows for single and multiple bubbles with phase change for efficient cooling systems. The fluid flow equations are based on the Arbitrary Lagrangian-Eulerian formulation (ALE) and the Finite Element Method (FEM), creating a new two-phase method with an improved model for the liquid- gas interface in microchannels. A successful adaptive mesh up- date procedure is also described for effective management of the mesh at the two-phase interface to remove, add and repair surface elements, since the computational mesh nodes move according to the flow. The Lagrangian description explicitly defines 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. The governing equations are shown in dimensionless vector form, where **u**,pand*T* represent the velocity, pressure and temperature fields respectively; *ρ*, *μ, k*and**cp** is stand for density, viscosity, thermal diffusity and the specific heat of the phase Φ, ***Re, Fr*** and ***We*** are dimensionless parameters to characterize the flow regime; t is the time and g is the gravity. On the heat transport equation, **q** stands for the heat flux and H is the Heaviside function.

Fig 1: Interface/properties representation in ALE-FEM.

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. The obtained numerical results will be discussed, therefore proving the capability of the proposed new methodology.

**References**

ANJOS, G. “A 3d ale finite element method for two phase flows with phase change”. PhDthesis, École Polytechnique Fédérale de Lausanne, July - 2012.

ANJOS, G., BORHANI, N., MANGIAVACCHI, N., and THOME, J. “3d moving mesh finite element method for two- phase flows”. *Journal of Computational Physics, 270*, pp. 366–377 - 2014.

JURIC, D. and TRYGGVASON, G. “Computations of boiling flows”. *Journal of Computational Physics, 24*(3), pp. 387–410 – 1998.