BREAKING LIQUID BRIDGES

D. Peric, W. Dettmer and C. Kuttler

School of Engineering
University of Wales Swansea
Swansea SA2 8PP, U. K.
d.peric@swansea.ac.uk

This work is concerned with numerical modelling of free surface flows in which surface tension becomes a dominant physical phenomenon. The focus is on dynamic behaviour of liquid bridges and jets experiencing instabilities that ultimately lead to break-up.

Two numerical approaches that have recently been developed for modelling of such problems will be described. The first approach is based on the generic Lagrangian finite element methodology developed for simulation of fluid flows with free surfaces and interfaces. Unlike the Eulerian based methods, the Lagrangian methods provide explicit tracking of the free surfaces and interfaces, which has proved beneficial for a variety of problems arising both in nature and industrial practice [1,2]. Some basic aspects of the underlying finite element methodology in the Lagrangian description are discussed. Aspects of computational modelling of interface behaviour are also described, including a finite element formulation of a surface tension model. The Lagrangian approach suffers from excessive mesh distortion due to often very large particle displacement, and requires frequent remeshings during the simulation. Apart from the expense, remeshings may also degrade the accuracy of the computation due to frequent transfer of relevant variables between different meshes. This work briefly describes an adaptive strategy, previously developed in the context of finite element deformations of inelastic solids at finite strains [2], which is re-formulated in the context of Lagrangian description of fluid flows.

The second approach developed for modelling deformation and break-up of liquid bridges is based on the one dimensional approximation of fluid flows resulting from the perturbation analysis [3]. Essential aspects of the theoretical formulation are briefly reviewed, while the finite element formulation and implementation, which relies on a version of the ALE method, are discussed in some detail.

The described computational strategies are employed in simulation of a range of physical problems incorporating break-up of liquid bridges. A comparative analysis is performed of the two computational approaches and conclusions are drawn.

References

[1] D. Peric and P. H. Saksono, "On Finite Element Modelling of Surface Tension: Variational Formulation and Applications", *Trends in Computational Structural Mechanics*, p. 731-740, Barcelona, Spain, 2001.
[2] D. Peric, M. Vaz Jr. and D. R. J. Owen, "On adaptive strategies for large deformations of elasto-plastic solids at finite strains: computational issues and industrial applications", *Computer Methods in Applied Mechanics and Engineering*, v. 176, p. 279-312, 1999.
[3] X. Zhang, R. S. Padgett and O. A. Basaran, "Lagrangian finite element analysis of Newtonian fluid flows", *International Journal for Fluid Mechanics*, v. 329, p. 207-245, 1996.