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

FLOW SIMULATION INSIDE PACKAGING MACHINES: MOVING INTERFACE PROBLEMS

Fabian Key[1,*], Stefanie Elgeti[1]

[1] Chair for Computational Analysis of Technical Systems
CCES, RWTH Aachen University
52062 Aachen, Germany
key@cats.rwth-aachen.de
http://www.cats.rwth-aachen.de

Key Words: *CFD; Space-Time FEM, Moving Interfaces, Mesh Update Method, VR-SSMUM, Multiphase Flow, Level Set Method, Packaging Machines.*

We will focus on the flow simulation inside packaging machines and the associated moving interface problems. Typically, the packages are transported through the machine on a conveyor belt. They pass a variety of nozzles, which fill the packages with liquids of different texture and temperature. First, we address the induced domain deformations that are on the one hand strictly translational, prescribed and periodic in nature and on the other hand affect only a portion of the domain boundary, thus leading to large relative movement. Second, the flow field and the temperature field within the packaging machine are of interest. During the filling process, we face multiple phases – the filled product and surrounding air – and we have to account for the resulting interfaces in the numerical method.

These types of moving interface problems can be handled either with an interface capturing or an interface tracking approach [1]. Interface capturing employs an implicit description of the moving boundary – leading to a flexible, yet comparably less accurate description –, whereas interface tracking explicitly deforms the computational mesh – a more accurate yet also more tedious approach. In this work, the developed methods are embedded in a Deforming-Spatial Domain/Stabilized Space-Time (DSD/SST) finite element framework [2], which allows to write the variational form of the underlying problem directly over deforming domains.

The domain deformation itself is implemented as an efficient and accurate interface tracking approach in the novel Virtual-Ring Shear-Slip Mesh Update Method (VR-SSMUM); an extension of the Shear-Slip Mesh Update Method (SSMUM) [3]. For the multiphase flow, we will apply the level set method to keep track of the interface. Finally, test cases related to packaging machines in 2D and 3D are presented.

REFERENCES

[1] S. Elgeti, H. Sauerland. Deforming Fluid Domains Within the Finite Element Method: Five Mesh-Based Tracking Methods in Comparison. *Archives of Computational Methods in Engineering*, Vol. **23**, pp. 323–361, 2016.

[2] T.E. Tezduyar, M. Behr, J. Liou. A new strategy for finite element computations involving moving boundaries and interfaces – the deforming-spatial-domain/space-time procedure: I. The concept and the preliminary tests. *Computer Methods in Applied Mechanics and Engineering*, Vol. **94**, pp. 339–351, 1992.

[3] M. Behr, T.E. Tezduyar. The Shear-Slip Mesh Update Method. *Computer Methods in Applied Mechanics and Engineering*, Vol. **174**, pp. 261–274, 1999.