

Skin-pass Rolling as a Fluid-Structure-Contact Interaction Problem

Moritz Billen, Norbert Hosters and Marek Behr

RWTH Aachen University, Schinkelstraße 2, 52062 Aachen, Germany

Skin-pass rolling is the final step in producing aluminum sheets. During rolling, a lubricant is used to prevent the metal from sticking and to extend the lifetime of the roller. However, the lubricant also affects the surface of the sheet because some of it becomes trapped and takes part in the forming process.

From a modeling perspective, skin-pass rolling is a surface-coupled multi-physics problem. The interaction between the lubricant, the deforming aluminum, and the direct contact between the roller and the sheet cannot be ignored. This makes accurate fluid-structure-contact interaction models necessary.

In this work, we develop a partitioned approach in which the structural and fluid solvers are called one after the other. The roller is treated as rigid, the aluminum sheet is modeled with an elasto-plastic material law, and the fluid is described by the incompressible Navier-Stokes equations. To avoid instabilities caused by trapped fluid pockets, a Robin-Neumann coupling scheme is applied between the two solvers [1].

Contact changes the topology of the fluid domain, which is commonly handled through remeshing. Instead, we use the surface-reconstruction virtual region mesh update method, which is more cost-efficient. It adds a layer of inactive elements around the fluid domain that can be activated or deactivated based on boundary motion. Elements near the interface are updated to maintain a conforming boundary [2].

References

- [1] T. Spenke, M. Make and N. Hosters. *Int. J. Num. Meth. Engng.*, 24(4), 979-997, 2023.
- [2] F. A. González, S. Elgeti and M. Behr. The surface-reconstruction virtual-region mesh update method for problems with topology changes *Int. J. Num. Meth. Engng.*, 24(9), 2050-2067, 2023.