Advanced modelling of lubricating gaps in positive displacement machines

Abstract

The lubricated gaps represent the main sources of loss of hydraulic axial piston pumps. In the latest years, the interest in lubricated interfaces has grown, led by the precision in machining and the new trend of micro shaping and texturing surfaces that improve the performance of the components. The state of the art simulation models available in this framework have reached a high level of detail and high fidelity with the reference tested case, however, these models are often complex and require different co-simulating tools and highly skilled users.
This work aims to implement into the commercial software Simcenter Amesim®, widely used by the mechanical industry, an easy-to-use model that integrates some of the latest advancements in the study of lubricated interfaces. The goal was to develop a detailed model that could help to explore different solutions and take a new insight into this topic but also be friendly to the less experienced user.
Two different interfaces were studied: the cylinder block-valve plate and the piston-cylinder interface. The cylinder block – valve plate interface is the more advanced of the two and allows the simulation of the self-adjusting gap heights based on the external loads acting on the bodies. Furthermore, it considers a simplified version of the ElastoHydroDynamic lubrication and a customized asperities contact module. Concerning the piston-cylinder interface model, it exploits the latest trends in this topic like the average Reynolds equation, efficient solution scheme for the Reynolds equation (Precondition Conjugate Gradient) and contact module up to date.
This model has undergone a rigorous validation process to verify the correctness of all the terms of the Reynolds equation.
The cylinder block – valve plate interface model has been instead verified with the difference method, contrasting the results coming from the computational model with the measurements taken on the test rig using two distinct cylinder blocks with different sealing lengths.
The model has been also used to contrast the maps of the lubricating regimes with the wear marks on the tested valve plate.