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Numerical analysis of axial compression impact on the hydrodynamics of open-cell foams

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eX-Poro-HydroDynamique lubrication (or XPHD lubrication) presents a different scientific approach to dealing with tribological problems. It's an innovative inter- and multidisciplinary research topic which offers a promising sliding solution for various applications, such as bearings, thrust bearings, various guide components, etc. Its applications in both biological systems, and industrial systems : soft porous squeeze damping or soft porous lubrication are very broad and important. XPHD lubrication is a lubrication mechanism of biomimetic inspiration which features an additional parameter to the system "the porous media". It consists of self-sustained fluid films generated within compressible porous layers (CPL) imbibed with liquids in replacement for using the fluid film only as in the classic lubrication system. Soft and porous structures imbibed with liquids generate a high load support under compression, the load support is generated through the resistance to flow inside the porous material. During compression, the resistance to flow and load support increase, the greater the compression level, the lower the porosity and corresponding permeability. The main objective of this work is to understand the behavior of the fluid flow inside the porous structures when subjected to axial compression stress. In the scientific literature, the works studying the flow in compressible materials are essentially experimental because of their very complex geometrical shape [1], [2], [3], the CFD (Computational Fluid Dynamics) simulations offer an economical solution to study the performance of this new concept of lubrication. To create the geometry, the morphological structure of foam samples is reconstructed at different levels of compression rates from 3D X-ray microtomography. This is achieved by using a commercial software (Avizo) that allows to process 3D images and create FE/CFD models suitable for numerical analysis [4]. The numerical simulations of flows will be performed with the solvers icoFoam and simpleFoam of the OpenFOAM [5] framework for steady-state incompressible laminar and turbulent flows, making it possible to study different fluids and porous materials. The performed simulations were made with an open-pore polyurethane foam with 96% porosity using five compression rates for creating the different geometries. For the fluid we used water and a hydraulic oil ISO VG 46 to see the impact of the viscosity on the flow. The analysis of the simulations shows the impact of the solid compression on different parameters, such as the decrease in permeability as function of the compression rate, the anisotropy of the flow within the compressible structure and the actual increase in the tortuosity generated by the compression of the solid and the variation of the porosity.

Participation

In-Person

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