Hydrodynamic Lubrication

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[29-I-02] Slip Length in Shear Flow over a Textured Surface
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Hydrophobic textured surfaces are studied for their low wettability and their capacity to create a “slippery” of the fluid on the surface during lubrication. The present work is part of a project dedicated to the creation of nano-textured surface with cavities to make the surface more hydrophobic and reduce friction in lubricated systems. To this end, the flow between two parallel surfaces is numerically addressed by computing two dimensions numerical simulations. One of the surfaces is moving with a uniform rectilinear motion while the other is fixed, with a cavity in the middle. Different nondimensional parameters are defined to carry out a parametric study and finally to understand what are the phenomenological mechanisms involved. The steady-state flow is laminar and monophasic with a low Reynolds number. The influence of the creation of a vortex inside the cavity is discussed as well as its behavior along with value of the different normalized parameters. The reduction of the wall shear stress caused by a vortex in the cavity, with respect to a Couette flow, looks like the creation of a slip length. The slip length is defined as the distance between the wall and the point where the speed of the fluid would become zero by extrapolation of the speed profile in the case where the fluid does not adhere to the wall. Two methods are used to calculate the slip length: one is based on the wall shear stress and the other one on the average speed of the fluid flow. The slip length phenomenon is regularly encountered in the literature, particularly in the case of hydrophobic textured surfaces. When the sleep length is calculated according to these two methods, the obtained results differ. This difference shows that the sleep length often used in the literature is a macroscopic representation of local effects that are not necessarily slippery. The speed profiles and the streamlines are then discussed to propose an explanation for this difference.