Proceedings of the Canadian Society for Mechanical Engineering International Congress
32nd Annual Conference of the Computational Fluid Dynamics Society of Canada
Canadian Society of Rheology Symposium
CSME-CFDSC-CSR 2025
May 25–28, 2025, Montréal, Québec, Canada

Development of a Finite Element Model for Solving 2D Navier-Stokes Equations in Deep Surface Textures Causing Cavitation

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ABSTRACT

This study investigates the cavitation effect in a partially textured parallel slider, focusing on deep textures where cavitation naturally occurs due to the geometry and operational conditions. The proposed model employs the Navier-Stokes equations under steady-state conditions, providing a more accurate representation of flow dynamics by incorporating convection effects, which are neglected in the Reynolds equation. Cavitation is modeled using a barometric formulation. Unlike models based on transport equations, the proposed approach does not rely on experimentally correlated parameters, making it more versatile and suitable for a broader range of applications. The solution is implemented using a two-dimensional finite element method program, employing an uncoupled pressure-based approach to effectively link velocity and pressure fields. Preliminary results indicate that cavitation reduces surface shear by lowering viscous drag, thereby decreasing friction. However, this reduction in friction comes at the expense of diminished load-carrying capacity, as deep textures generate less hydrodynamic lift under cavitating conditions.