Abstract

In the theory of lubrication, a slight pressure will build-up in parallel sliding surfaces due to couette velocity variations which may collapse when an external load is applied. To produce stable hydrodynamic film between parallel sliding surfaces, one of the feasible techniques is to provide surface textures. Therefore, an attempt has been made to predict the hydrodynamic lubrication performance of parallel sliding contacts with textured surfaces. Effect of shape, size, height and orientation of textures on the hydrodynamic lubrication performance of parallel sliding surfaces is studied under various practical conditions like fluid inertia, fluid-solid interfacial slip and turbulent flow regime.

The momentum equations retaining fluid inertia terms are solved by two methods such as, the first-order perturbation method and the velocity profile method. The modified Reynolds equation is solved using finite difference method with Gauss-Seidel iterative scheme. It is evident from the results that fluid inertia effect is influential in altering the performance parameters depending on the shape, size, height and orientation of textures, and multi-textures (number of textures in transverse direction).

In the analysis of fluid-solid interfacial slip, slip velocity terms are introduced in modified Reynolds equation, where those are calculated using two-component slip length model. Fluid-slip is assumed to occur at the grooves of texture surface when shear stress value is greater than threshold critical shear stress of the fluid. The results depict that parallel sliding surfaces are able to carry load even at zero texture height. Improvement in the performance parameters of parallel sliding contacts is observed with fluid-slip condition; however, it also depends on height of the textures.

Furthermore, present study of lubrication in textured parallel sliding surfaces has been extended to the turbulent regime, where Ng and Pan model is used to incorporate turbulent flow in pressure governing equation. It has been noticed from the analysis that hydrodynamic lubrication performance of parallel sliding surfaces may improve depending on the Reynolds number, the shape, size, height and orientation of textures, and multi-textures. In turbulent flow regime, friction parameter shows higher value as compared to laminar flow which is undesirable.