Abstract

In the theory of lubrication, a slight pressure develops in parallel sliding contacts due to couette velocity, and it collapses under application of external load. Therefore, there is always a need to search for an advanced and efficient lubrication technique which can support additional load. This can be achieved by introducing deterministic texture on any of the sliding surfaces that develops hydrodynamic pressure. The present work is taken up with the objective to study the hydrodynamic performance of parallel sliding lubricated contact with positive deterministic surface textures. Towards this objective, an experimental as well as a computational framework based on CFD is developed. The experiments are performed using an in-house developed thrust bearing test rig, where a texture free runner rotates parallel to the stationary texture pad and operating under combined hydrostatic and hydrodynamic lubrication. Overall improvement in performance is reported while comparing the results with those from a reference untextured surface.

One of the early factors to be considered while designing surface texturing is to choose the optimum texture geometry for significant hydrodynamic effect as it controls the friction and load carrying capacity. In the present work, a cost-effective yet precise manufacturing technique called photochemical machining has been used for fabricating different texture geometry with adequate controlling of texture dimensions. Four types of texture shapes, namely circular, elliptical, square and triangular cross-sections are fabricated to investigate the effect of texture shape. For each of these shapes three different sizes and three different heights are produced, which gives information regarding effect of texture size and height. Further, two groups of specimens with the same set of texture shape combinations, arranged in regular and zigzag array are inspected to evaluate the influence of distribution pattern. Two specific texture shapes, namely elliptical and triangular cross-sections with three different orientations for ellipse and four different orientations for triangle are studied to get optimum orientation angle in terms of significant hydrodynamic effect. The study is further extended to observe the influence of texture height ratio (THR) as a function of film thickness variation on the hydrodynamic lubrication performance.

To facilitate the calculation of hydrodynamic performance parameters under numerical analysis, a finite volume based three-dimensional computational fluid dynamics model is developed using Fluent V15.0. The numerical approach solves the Navier-Stokes equations in cylindrical polar coordinate system considering the mass conserving Schnerr-Sauer cavitation model. Finally, the numerical solutions from the CFD analyses are compared with the experimental results. Good correlation is found between them.