Abstract

The friction of interfacial surfaces greatly influences the performance of mechanical elements. Friction has been investigated experimentally in most studies. In this work, the friction is predicted by means of numerical simulation under an elastohydrodynamic lubrication (EHL) rough contact condition.

The classical Multigrid technique performs well in limiting computing time and memory requirements. However, the coarse grid choice has an important influence on code robustness and code efficiency to solve the rough problem. In the first part of this work, a coarse grid construction method proposed by Alcouffe et al. is implemented in the current time-independent EHL Multi-Grid code. Then this modified solver is extended to transient cases to solve the rough contact problem.

The friction curve is usually depicted as a function of "Λ ratio", the ratio of oil film thickness to root-mean-square of the surface roughness. However this parameter is less suitable to plot friction variations under high pressure conditions (piezoviscous elastic regime). In the second part of this work, the friction coefficient is computed using the modified EHL code for many operating conditions as well as surface waviness parameters. Simulation results show that there is no single friction curve when the old parameter "Λ ratio" used. Based on the Amplitude Reduction Theory, a new scaling parameter depends on operating condition and waviness parameters is found, which can give a unified friction curve for high pressure situation.

For more complex rough surfaces, a power spectral density (PSD) based method is proposed to predict friction variations in the third part of this work. The artificial surface roughness is employed to test the rapid prediction method firstly. Good agreement is found between the full numerical simulation and this rapid prediction. Then the rapid prediction method is applied to analyze the friction variation of measured surface roughness. A comparison is also made between predictions and experiments.

Both the new scaling parameter and the friction increase predicted by the PSD method show good engineering accuracy for practical use.

Keywords: *Elastohydrodynamic lubrication, Numerical simulation, Piezoviscous elastic regime, Amplitude Reduction Theory, Friction variation*