NUMERICAL SIMULATION OF HYDRODYNAMIC LUBRICATION BY SPH METHOD

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ABSTRACT
Appropriate boundary conditions are required to solve Reynolds' equation for hydrodynamic lubrication. Especially, oil film rupture at the outlet of lubricated area has been an intense subject of interest [1]. It is difficult to predict exactly both the position at which oil film rupture will occur and the pressure in the area of oil film rupture.

To correctly solve the problem of boundary conditions, we applied Smoothed Particle Hydrodynamics (SPH) method [2] to hydrodynamic lubrication. Spontaneous film rupture can be simulated with SPH. However, nonphysical fluctuations in pressure profiles may develop and prevent a simulation for a long time [3]. Actions of surface tension on inside particles, and a discontinuity in between free-surface and the nearby particles cause fluctuations.

To avoid the occurrence of nonphysical fluctuations, we developed a new way to calculate surface tension which includes an accurate detection of free-surface particles [4] and rearrangements the particles for the smoothness of the free-surface by an optimized particle shifting scheme [5].

Pressure profiles by SPH simulation with the newly developed surface tension calculation show a good agreement with the FEM approach [1], see Fig. 1. The method also allows to compute hydrodynamic lubrication cases with a smaller amount of lubricant, therefore under starved condition as shown in Fig. 2.

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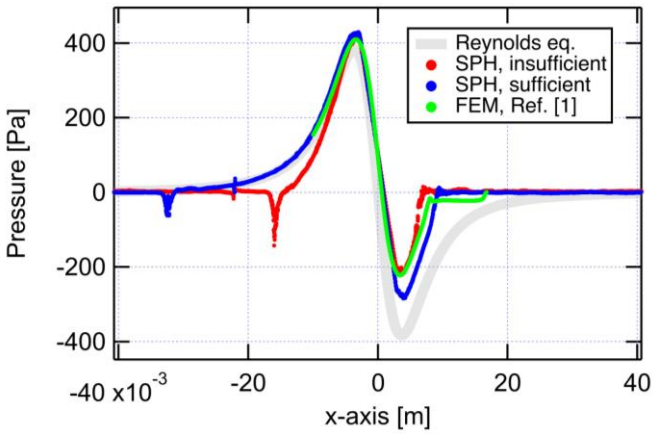

Fig. 1 Comparison of pressure profiles

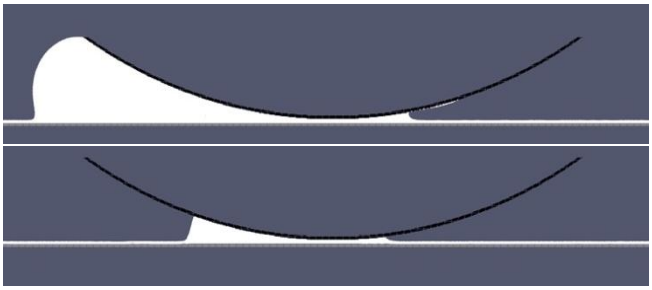

Fig. 2 Snapshots of hydrodynamic lubrication with sufficient (upper) and insufficient (lower) lubricant film, model geometry and condition are same with the Fig.3(a) of ref. [1].