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NUMEICAL SIMULATION OF HYDRODYNAMIC LUBRICATION BY SMOOTHED PARTICLE HYDRODYANMICS METHOD

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ABSTRACT

Smoothed particle hydrodynamics method(SPH) method allows us to treat fluid flow with large deformation of liquid-air boundary, fragmentations and collision with solid wall.

Boundary conditions are required to solve Reynolds' equation for hydrodynamics lubrication. Especially, oil film rupture at the outlet of lubricated area has been an intense subject of interest [1]. It is difficult to know exactly the position at which oil film rupture will occur and the pressure in the area of oil film rupture [2].

To avoid the problems with boundary conditions, we applied SPH to the hydrodynamic lubrication. Time evolution of oil film profile can be obtained. Film rupture spontaneously develops at the outlet.

METHOD

The classical geometry of hydrodynamic lubrication shown in Fig. 1 is simulated. The motion of an incompressible fluid is governed by the Navier-Stokes equations,

$$\frac{D\boldsymbol{u}}{Dt} = -\frac{1}{\rho}\nabla p + \frac{\eta}{\rho}\nabla^2\boldsymbol{u} + \boldsymbol{F}_{ST}$$

Surface tension is incorporated as a body force $\boldsymbol{F}_{ST}$. According to the Akinci's model, $\boldsymbol{F}_{ST}$ is a combination of inter particle forces and forces based on surface curvature [3]. Calculating mothod for vector operaters in Navier-Stokes equation and solid wall boundary contion are same as Adami's way [4]. Numerical models is computed using the same operating conditions as described in the literature(Fig.3(a) in ref. [1]).

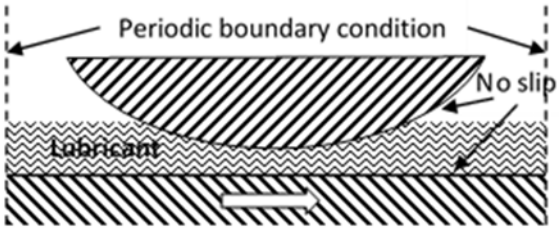

Fig.1 Model geometry

RESULTS

Figure 2 shows a snapshot and pressure profile. Positive pressure by SPH agrees with solution of Reynolds eq.. Fluctuation in outer region is attributed to surface tension model.

REFERENCES

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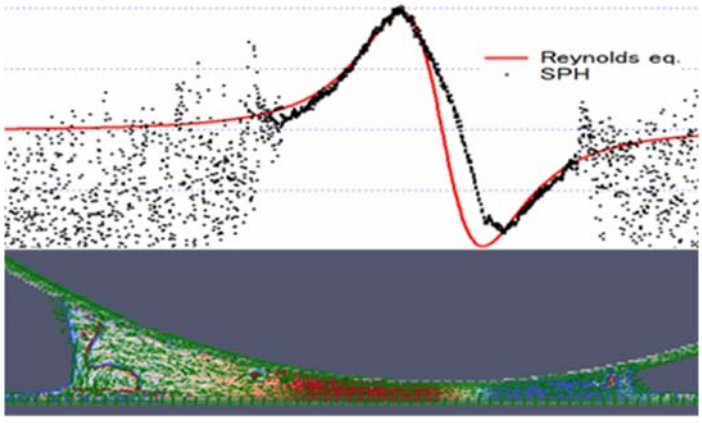

Fig. 2 Snapshot with arrows of velocity vector and pressure profile