

MEASUREMENT OF SOFT EHL FILM THICKNESS WITH GREASE

Engineering plastic materials like polyamide and polyacetal are widely used for worm wheels and other tribological elements under EHL conditions with grease. Low elastic modulus of those materials results in lower contact pressure than steel-to-steel contacts, and EHL of those contacts is called “soft EHL”.

An ultrathin-film optical interferometry system was used to measure the film thickness, where a steel ball was made contact with a transparent polycarbonate (PC) disk having similar elasticity to the engineering plastic materials. The ball and the disk were driven by respective motors to change entrainment speed from 0.1 to 1 m/s under a load of 10N at room temperature 25°C.

Four sample oils a to d are listed in Table 1. The viscosity-pressure coefficients were estimated by applying the H-D formula to the measured film thickness in the hard EHL experiments. Three sample greases A, B and C were made with the same base oil and different thickeners as shown in Table 2.

The central film thickness with sample oils is given in Fig.1 in the dimensionless parameters. All data fall on a straight line representing the H-D formula for soft EHL

$$H_c = 7.32U^{0.64}W^{-0.22} \{1 - 0.72 \exp(-0.28k)\}$$

This implies that the film thickness in the present conditions has nothing to do with the piezo-viscous effect.

Figure 2 compares the central film thickness with the Table 1 Sample oils

Sample oil	a PAO	b PAO	c *N-oil	d *P-oil
Viscosity @25°C, mPa·s	125	79.4	121	75.1
α @25°C, GPa ⁻¹	15	14	26	20

*N-oil: naphthenic oil, P-oil: paraffinic oil

Table 2 Sample greases

Sample grease	A	B	C
Base oil	PAO		
Viscosity @25°C, mPa·s	49.5		
Thickener	Li-St	Li-OHSt	Urea
Concentration, mass%	12	9.5	11
Penetration (60w)	296	297	294
Additive	None		

three sample greases and their base oil as a function of

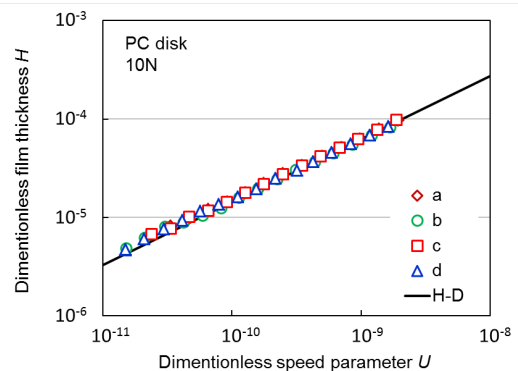


Fig.1 Dimensionless representation of central film thickness with different oils

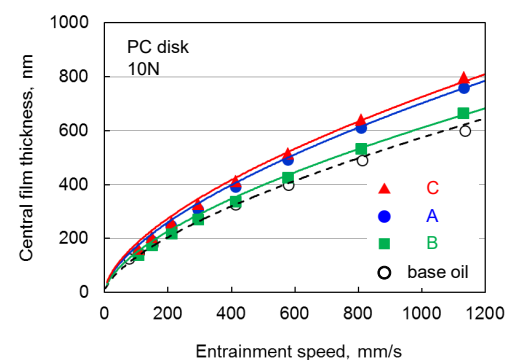


Fig.2 Film thickness with different greases

speed. With all sample greases, the film thickness is larger than that with their base oil alone and, although their base oil and consistency grade are the same, difference among the sample greases are found, the order being C>A>B, due to their different thickeners.

The curves in Fig.2 represent the predicted film thickness. This will be discussed based on separately measured rheological parameters of the sample greases.

Kochi, Ichimura, Yoshihara, Dong and Kimura: Film thickness and Traction in Soft EHL with Grease, Tribology Online, 12, 4(2017), 171.