EXPERIMENTAL STUDY OF BOUNDARY LAYERS FORMATION IN CONCENTRATED CONTACTS

M. HARTL, I. KRUPKA, M. LISKA
Brno University of Technology, Faculty of Mechanical Engineering, Technicka 2, 616 69 Brno, CZECH REPUBLIC; e-mail: hartl@fyzika.fme.vutbr.cz

Keywords: thin film, boundary lubrication, elastohydrodynamic lubrication

ABSTRACT

Recently we introduced a new measurement technique for the study of very thin lubrication films down to a few nanometers in a point contact between a steel ball and a transparent disk [1]. This technique based on the colorimetric interferometry combines powerful film thickness mapping capabilities with high accuracy. The aim of this paper is to examine the boundary layers formation for several liquids of known molecular structure such as e.g. hexadecane, n-tetradecane and octamethylcyclotetrasiloxane (OMCTS) that have been previously studied by the force balance method.

Figure 1: Variation of film thickness with speed for hexadecane

Figure 1 shows the variation of central and minimum film thickness with rolling speed for purified hexadecane. It can be seen that this simple hydrocarbon maintains a constant inlet viscosity down to approximately 2 nm.

Figure 2: Variation of film thickness with speed for OMCTS

Figure 2 shows film thickness results for OMCTS. This fluid exhibits a deviation from linearity on a log (film thickness) vs. log (rolling speed) in the thin film region, with a thicker film than predicted from EHD theory. Because EHD film thickness is determined by the viscosity of the fluid in the contact inlet, it is obvious that viscosity of OMCTS remains at the bulk value down to approximately 0.1 m/s. However, below this speed the discretization of both central and minimum film thicknesses can be observed. The central film thickness begins to deviate from the theory at about 8 nm and the interval of the discretization is approximately 2 nm. If we take into account the molecular diameter of OMCTS that is about 1 nm, it corresponds to approximately two molecular layers.

Figure 3: Variation of film thickness with speed for n-tetradecane

Figure 3 shows a film thickness plot for n-tetradecane. Again, there is a good agreement between both central and minimum film thicknesses and EHD theory for thicker films. However, below the rolling speed of about 0.2 m/s the film is thicker than theory predicts. This effect can be attributed to the presence of immobile layers. These layers appear to be homogeneous within contact area with average immobile layer thickness approximately 0.6 nm. N-tetradecane also shows the discretization of film thickness.

REFERENCES