7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

In-situ Formation of Oleophobic Boundary Layer for Lubrication Enhancement at Limited Lubricant Supply Conditions

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Lubrication with limited lubricant supply (LLS) is an inspired strategy to enhance the environmental friendliness of machine operations. The key issue to implement LLS is to make the good use of the available amount for effective lubrication. This paper addresses the oil replenishment of a bearing running at LLS. A new idea to change the lubrication track to oleophobic by using additive-formed boundary layer is derived. Experimental results show that the oleophobic track would reduce oil leakage and retain more oil for lubrication. The adsorption layer is formed in-situ and recovers if it is removed.

Keywords : Limited lubricant supply, Ionic liquid, Oil replenishment, Slider bearing, Hydrodynamic lubrication

1. Introduction

Machines in general are lubricated by excessive lubricant while only the actual contact area of tribo-pairs requires lubrication. Excessive lubricant causes both energy loss, i.e. temperature rise, and friction loss which pose both financial loss and environmental impact in a long run. Reducing the amount of lubricant supply to the tribo-pair leads to early occurrence of the LLS condition, however the amount of lubricant would be more exact. This is particularly important in mini device application where requires precise design. To optimize LLS lubrication, good oil replenishment to the bearing is one of the key issue. This study evaluates a new idea of using additive-formed boundary layer to enrich the oil replenishment, and elucidates the mechanism starting from the oleophobic modification of the lubrication track using ionic liquid as an additive in the lubrication oil. The change in surface properties leads to the increase in the contact angle of the specimen oil, which is directly related to the dewetting capability. Thus, oil droplets of taller height are formed, which attribute to thicker lubricating film in the tribo-pairs.

2. Methods

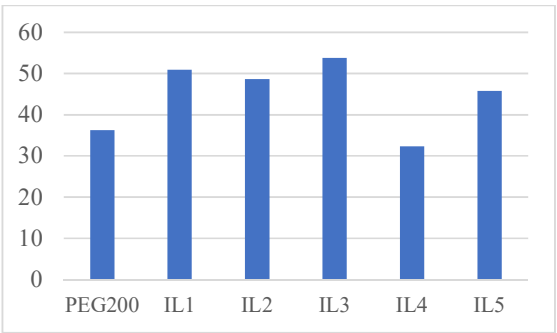

Figure 1: Contact angle of specimen oils on glass surface.

The idea is to use ionic liquid as additive, which forms oleophobic adsorption film on the lubrication track of a bearing. Five sets of measurements and experiments (lubricant with ionic liquid additives) in total were conducted and compared with lubricant without the ionic liquid additives.

Different ionic liquids were evaluated. They were mixed with the base oil, PEG200. A droplet of each specimen oil, including the base oil and its mixtures with ionic liquids, was formed on a clean glass surface. Contact angles were measured and shown in Fig. 1.

Lubrication tests under LLS were conducted with an optical slider bearing tester. The film thickness of the five lubricants with ionic liquid additives were measured and compared with that of the base oil.

3. Discussion

The lubricants with ionic liquid additives were applied on glass slides for 12 hours. Adsorption films were formed on the glass surface that changed the surface energy [1]. Different levels of change in surface energy result in various contact angles, which would affect to formation of oil droplets of different sizes, i.e. different heights, on the glass surface. In the LLS lubrication test, oil droplets were formed on the lubrication track and provided significant amount of oil supply to the bearing. The droplet height slightly affects the contact time at the inlet of the bearing contact and that small changes contribute to the changes in the film thickness [2].

4. References

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Acknowledgements
The work described in this paper was fully supported by the Research Grants Council of Hong Kong (Project No. CityU 11216619).