ELASTOHYDRODYNAMIC LUBRICATON OF ISOTHERMAL POINT CONTACTS AT ZERO ENTRAINMENT VELOCITY

Y. Zhao[a, b], P.L. Wong[b*], J.H. Mao[a]
*meplwong@cityu.edu.hk
[a]Theory of Lubrication and Bearing Institute,
Key Laboratory of Education Ministry for ModernDesign and Rotor-Bearing System,
Xi'an JiaotongUniversity, Xi'an 710049, China
[b] Department of Mechanical and Biomedical Engineering, City University of Hong Kong,
Hong Kong, China.

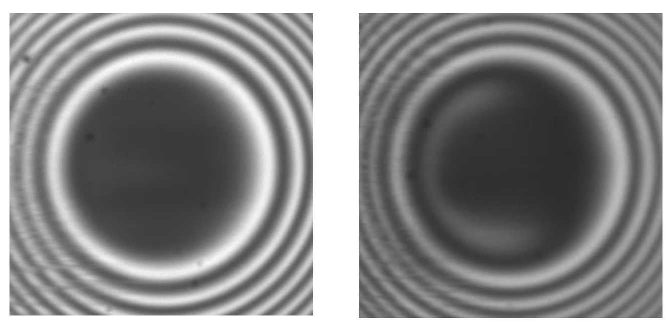
KEYWORDS
Boundary slippage; EHL; Zero-entrainment-velocity.

ABSTRACT
The paper presents a new lubrication mechanism based on boundary slippage to facilitate hydrodynamic lubrication for surface contacts running at zero entrainment velocity (ZEV) conditions. ZEV experiments were devised and it was observed that effective elastohydrodynamic lubrication (EHL) films were generated with low speeds at ZEV conditions.

INTRODUCTION
Theoretically, no hydrodynamic lubricating effect can be generated without any entrainment of lubricant into the bearing contact. The contacts between the adjacent rolling elements in a retainerless bearing (or termed as full complement bearing) run under ZEV conditions. The contact surfaces slid against the other with the same speed but in opposite directions. The resultant entrainment is null, which leads to serious friction and wear problems. To solve the lubrication problemof ZEV contacts, Cameron [1] proposed a lubrication mechanism termed as "thermal viscosity wedge" which is based on temperature differences between the two moving surfaces. The effect of "thermal viscosity wedge"was verified by Yang et al. [2]. However, the necessary thermal criterion may not be fulfilled, especially when the running speed is not high enough. Thus, another lubrication mechanism is needed for isothermal conditions. Inspired by Cameron's thermal viscosity wedge, the two bounding surfaces are made different in oil affinity. While the oleophilic surface drags oil into the contact, the opposite running surface cannot dragit out due to its oleophobicity. Thus, net entrainment of oil to the ZEV contact can be realized.

Boundary slippage [3] has been applied to reduce friction of hydrodynamiclubricated contacts.However, its application to the lubrication ofZEV EHL contact has never been mentioned.

RESULTS
Effective hydrodynamic lubrication for ZEV point contacts was successfully realized using the boundary slippage concept.The experiments were carried out on an optical EHL test rig. Theball and disk were run under ZEV conditions. The glass disk was initially treated using a commercialoleophobic coating.The surface of steel ball is oleophilic. Thus, the tests were conducted with anoleophobic/oleophilic surface contact. PAO40 was adopted as the lubricant. The affinity of different surfaces with PAO40 was represented by the contact angle and the contact angle hysteresis. The interference images of the lubricated contact werecaptured. Figure 1(a) shows that no hydrodynamic lubricating film is formed at ZEV using no oleophobic treated contact, but a classical horseshoe-shapedEHL film was obtained witholeophobic-coated glass disk and steel ball contact, as in Fig. 1(b).The typical EHL film signifies that effective hydrodynamic lubricationisrealized even the entrainment velocity is apparently "zero".



(a) Untreated glass disk/steel ball (b) Oleophobic-coated glass disk/steel ball

Fig. 1 EHL contacts of steel ball/glass disk at ZEV conditions (speed: 100 mm/s, p_o: 0.46 GPa, PAO40)

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