USING ULTRASOUND TO MEASURE THE INLET MENISCUS POSITION AND STARVATION RATIO OF A ROLLING ELEMENT BEARING CONTACT

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EHL**;** Fluid lubrication**;** Rolling contact fatigue**;** Starvation

ABSTRACT

When there is inadequate lubricant present at a rolling element bearing contact inlet, starvation occurs, leading to impaired separation and wear. This contributes to reduced efficiency and rolling contact fatigue, a primary bearing failure mechanism. The current absence of an in-situ measurement technique is due primarily to the difficulty in observing and quantifying a lubricant film at a contact inlet as the film occurs deep within the inner workings of the bearing.

In this work, an ultrasonic technique is developed to measure the resonant frequency of lubricant films and thus determine film thickness on a bearing inner raceway leading into a contact, the method of which is published in [1]. The technique was applied to a fully metallic, cylindrical rolling element bearing. As ultrasonic waves can propagate through solid and liquid media, no direct access to the raceway is necessary and so the measurement is fully in situ.

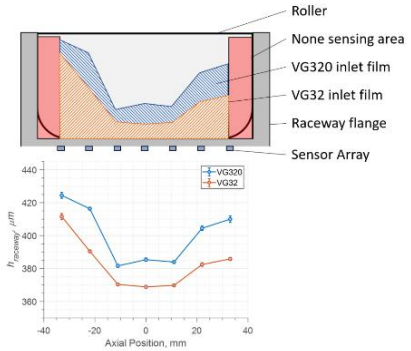

Fig.1 Mean raceway thickness leading into the rolling contact inlet at different axial locations when the bearing was lubricated with VG320 and VG32 oils

Oil lubricated results show a generally increasing inlet film thickness with both speed and oil viscosity suggesting the fully flooded condition was met, but with a non-uniform shape to the inlet film, with a thinner centre region and thicker oil bands towards the roller faces due to oil reflow, see Fig.1.

Grease was monitored during just the churning stages, where there is macroscopic flow of grease from the track to the un-swept areas. The subphases of channelling and clearing were observed, see Fig.2. This is thought to be the first direct observation of the grease channelling phases within a fully metallic bearing.

A Volume Fill Model is introduced which determines the position of the inlet meniscus from measured raceway thickness and theoretical roller thickness. Starvation results agree well with the interferometry and fluorescence analysed deep groove ball bearing measurements from [2].

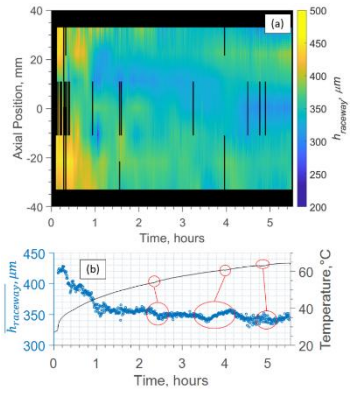

Fig.2 - Film thickness during churning at 31,000 $\mathbf{nd_m}$. Plot (a) cross axis change (b) mean film thickness decay

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