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Combined Experimental and Numerical Study of PTFE Faced Thrust Bearings Considering Effect of Creep on Bearing Performance

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1. Introduction

Hydrodynamic thrust bearings are used in a wide range of rotating machinery applications such as hydroelectric generators and submarine engines.Polytetrafluoroethylene (PTFE) has been shown to be a promising pad face material due to its large temperature range and low coefficient of friction [1]. One of the restrictions on its more widespread adoption is lack of understanding of such bearings' long term transient Thermo-ElastoHydrodynamic Lubrication(TEHL) performance. This includes the through-life creep performance of the polymer face and its effect on film thickness and bearing thermal characteristics.

The work presented here combines a computational and experimental approach to modelling PTFE faced thrust bearings at a range of different operating conditions. The creep performance of the polymeris included in the simulation, and a prediction of bearing performance over the lifetime of the bearing is presented.

2. Theory

Thepressure in the fluid film isobtained bycoupling theReynoldsequation with a three dimensional finite element stress-strain model of the PTFE face [2]. The thermal characteristics are also included with the viscous losses resulting in heat generation. The energy equation then models the heat conduction and convection through the lubricating oil, pad face and backing steel[3].

From the initial solution to the TEHL problem a transient solution is used to consider the creep of the PTFE face material. The creep characteristics are obtained from experimental results (described below). This allows the bearing characteristics to be considered throughout its operational life, including the pressure and temperature profiles, and the evolution of the pad topography due to creep. The overall frictional performance of the bearing can also be described.

3. Experimental Creep Tests

Compressive creep experiments were conducted on PTFE samples and a creep determined as a function of temperature and pressure.The samples tested were of 10mm thickness, and 5mm diameter.The PTFE used in this study was a filled grade with 15% carbon black and 2% graphite mixture. The experimental test range considered was that of temperatures ranging from 40 to90^{0}Cand pressures of 4 to 12MPa.This data was used to derive a creep rate function, in terms of temperature and pressure. This relationship was then incorporated into the modelto allow long term creep performance of the pad to be investigated.

4. Results

Figure 1 shows typical transient creep for different temperatures and load. From Figure 1 it can be seen that after an initial large strain and primary creep region lasting for around 10 minutes there is a secondary creep rate which is almost constant.

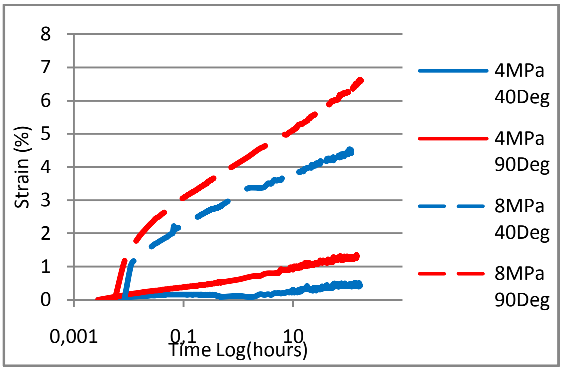

Fig.1 Creep behaviour of the PTFEat varying Loads and Temperatures

The model predicts the pressure and temperature profile across the pad face and allows comparisons to be made between initial geometry and once creep has occurred.

5. References

[1] Glavatskih S, Fillon M. THED analysis of thrust bearings with PTFE faced pads

[2]Dowson and Higginson (1977). *Elasto-Hydrodynamic Lubrication*. 2nd ed. Surrey: Pergamon Press Ltd.

[3]Pai (1956). *Viscous Flow Theory, I-Laminar Flow*. D. Van Nostrand Company Inc.