REVIEW OF CONTAMINATED LUBRICANTS IN BEARING AND DETERMINATION OF FLASH TEMPERATURE IN ANSYS

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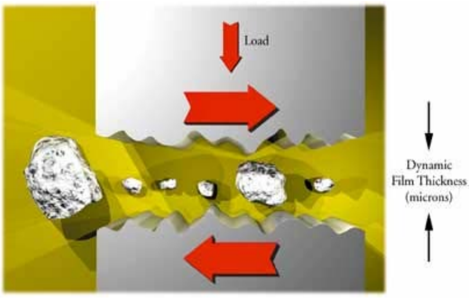
Abstract—*The study of contaminated lubricants in bearings began almost 70 years ago. While a fairly large volume of literature has been devoted to the subject of Contamination, there seems to be very little information available that can be directly applied to the design of bearings For instance, design guides are available for assessing the allowable minimum Film thickness for a specified shaft diameter and operating speed as well as required Roughness. However there is no design recommendation for relating the level of filtration to the minimum Thickness. The appropriate level of filtration is a critical parameter in bearing design because - insufficient filtration may lead to the scuffing failure of the bearings - excessive filtration may lead to a significant rise in hydraulic resistance i.e pumping power consumption and/or the clogging and blocking of the filters which could interrupt supply flow rate It is impossible and indeed impractical to remove all particles[impurities] in the lubricant which Passes through a filter. If the abrasive particle size is larger than the minimum film thickness, then there is a very serious possibility of surface damage. It is this situation that this paper is concerned with*

Keywords— Lubricants; Formatting; Contaminated; Flash Temperatureg; Ansys

1. INTRODUCTION

An abrasive particle may penetrate into the bearing liner and lock itself in a partially Or fully embedded position. The contaminant may scratch the surface of the slider and depending on the

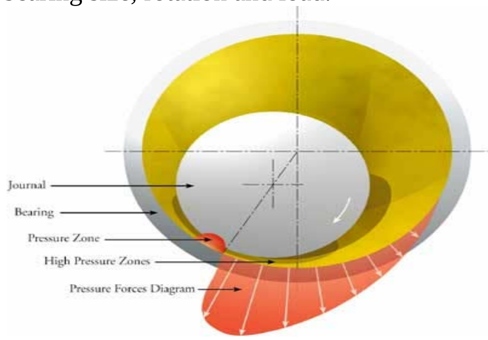
Lubricant properties, surface properties, and operating speed may drastically raise the local contact temperature leading to a surface failure. This failure mode is in the form of scuffing and is thought to occur when the local temperature exceeds a certain limiting value as characterized by the lubricant and Surface Properties. The local temperature is related to the so called flash temperature.



The present study models the rigid particle, larger than the minimum film thickness, which is fixed and embedded into the over-layer while in ploughing and adhesion mode of friction In contact with the sliding component. The flash temperature between the particle and the slider is computed as function of surface properties of the slider and over layer, operating speed and particle size. Scuffing failure is assumed to occur if the flash temperature exceeds certain critical value. Ansys is used to predict the flash temperature at the interface between layer -particle – Slider.

2. JOURNAL BEARING GEOMETRY

The study of journal bearing lubrication has been devoted to the understanding of the critical operating parameters of the bearing, namely the machined clearance and the film thickness needed for proper operation. There is a clear definition of the minimum film thickness that is prescribed by the bearing size, rotation and load.



However, it is equally important to consider particle size and the fluid cleanliness level required for journal bearing operation. Removal of clearance-sized particles is required for wear reduction and scuffing failure, and can be achieved by implementing high efficiency filtration to lubrication systems equipped with journal bearings.

3. WEAR AND SCUFFING FAILURE

There is a direct relationship between the minimum film thickness and the most damaging particle size. Particles of clearance-size can bridge the gap between the journal and the sleeve, causing bearing wear (Figure 1). Abrasive wear occurs when clearance-sized particles come between two surfaces that are under load, such as in the journal and the bearing. The clearance-sized particles can enter the journal bearing through a clearance space, an oil supply line, or through lubricant supply holes or grooves. They are then carried into the contact area where the film thickness is at a minimum. The load of the bearing is transferred to the particles and these particles are pressed into bearing surfaces to act like cutting tools. This results in degradation of the surfaces, dimensional changes of the surfaces [scuffing failure], and the release of wear metals.

4. TYPICAL CONTAMINANTS

While oil contamination takes many forms, the following three classifications cover the majority of industrial problems:

Dirt - Dust and solid contaminants creep in from the surrounding atmosphere. Contaminants could include metal chips from machining, rust and wear products from seals, bearings and gears, core sand from castings, weld spatter from welding, paint flakes from painted surfaces and soot from diesel engines.

Water - The most troublesome sources are often condensation, cooler leaks, gland leakage and seal leakage.

Sludge - This forms primarily as a result of oxidation of the oil itself, especially at high temperatures. Accumulation of fine particles may also fill clearance spaces by silting, resulting in erratic operation and sticking of hydraulic system valves and variable flow pumps.

[a] Moisture Affects Components

1) In a lubricating system, the two most harmful phases are free and emulsified water.
2) According to SKF, as little as 1/10th of a percent water in oil can reduce the life expectancy of a journal bearing by as much as 75 percent.
3) For rolling element bearings, the situation is even worse.
4) The main cause of this shortened life cycle is the weakening of the oil film strength. The weakened film leaves the component more susceptible to abrasive, adhesive and fatigue wear

[b] Moisture Affects the Lubricant

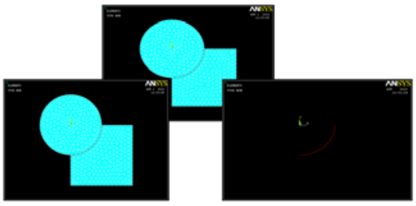
1. Not only does water have a direct harmful effect on machine components, but it also plays a direct role in the oxidation (aging) of lubricating oils.

2. The presence of water in lubricating oil can cause the progress of oxidation to increase tenfold, resulting in premature aging of the oil, particularly in the presence of catalytic metals such as copper, lead and tin.

3. Where free water accumulates in a system, microorganisms can grow. These microbes feed on the oil and decompose to form acids, which promote further oxidation of the oil.

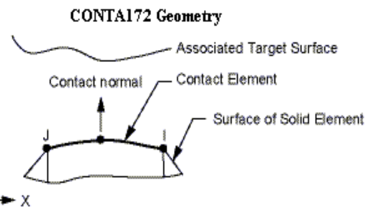
5. MODELING AND ANALYSIS

Two areas are created in the Ansys both of which represents the contaminated particle (steel) with size 40 microns and the half of the bearing geometry made of Bronze. The figure given below shows the contaminated particle in the oil meant for lubrication is penetrated into the bearing inner surface.



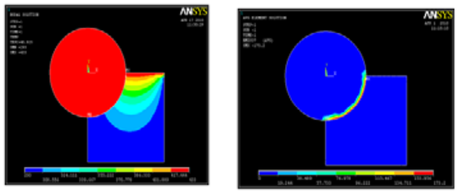
Contact Pair Contact Element

The problem is treated as thermal contact problem so its must to create a contact pair between the contaminated particle and the bearing surface. The target surface is bearing surface and the contact surface is a particle.



Contact 172 elements are created at the surface contact between the target and the contact surface. The contact properties and the boundary conditions, thermal loads are given as input to carry out the contact analysis in order to find the flash temperature at the contact region.

6. RESULTS AND DISCUSSION



Nodal Temperature Contact Temperature

The maximum contact temperature at the interface of the bearing and the particle from Ansys is 173 degree K. But the critical temperature between the bronze bearing and the steel particle from experiment is 230 degree K which is less than the calculated flash temperature from Ansys. As 173 is less than the critical temp 230 degree K, scuffing failure is not taking place at the interface between bearing and particle, so the selected filter size of 40 microns is justified. From the results obtained, it's been concluded using Ansys also filter size is fixed based on scuffing failure.

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