Plain Bearing Used Grease Debris Analysis

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Abstract

Due to normal friction and wear, even in properly lubricated moving machine elements, it is not uncommon to find small amounts of debris in used lubricants. The wear debris analysis technique has been applied for monitoring machine condition for quite sometimes. However, most of the works reported to date have been focussed for oil - lubricated machinery. Actually, very little primary material of the application of used grease analysis technique for plain bearings is to be found in the periodical literature.

The identification of the cause of damage or failure in plain bearings is crucial before remedial action can be taken to prevent further. The first step is a visual examination of the wear debris and/ or contaminants suspended in the used grease samples. In addition, this step can then be followed up by visualization of the damaged parts, if applicable. Once failure has been initiated, the origin mechanism may lead to other failure mechanisms and it is essential to identify the original cause. In this particular work, “systematic used grease wear debris analysis” is proposed. Preliminary results will be presented and discussed.

Keywords : Plain bearing, Debris analysis

1. Introduction

There have been several publications in the study of effects of wear variables on systematic sliding wear of materials [1-5]. However, only few research publications report on the analysis of journal bearing wear behaviour [6-7]. In addition, as there are wide ranges of parameters and also rather complicated standards wear testers. Hence, the simple studies of sliding wear behavior of journal bearing materials are conducted in this particular work, utilization of conventional lathe. The structure of “conformal” contact tribosystem accommodates the characteristics of journal bearings. Principally, the journal bearing of an engine or industrial machine elements comprise the sleeve with the bearing material on the inner surface of the steel housing. The counterpart is the journal made from hardened steel of good quality. The paper introduces the experimental investigations of specimens in the form of partial bearing material lubricated with grease and a journal made of steel. The generated wear debris of different lubrication regimes i.e. boundary and mixed lubrication are examined.

2. Test Rig

In this section, the investigations of the journal bearing wear debris characteristics are conducted. The narrow sleeve specimen is used throughout for the simulation of journal bearing wear. The load of the bearing is applied via a deadweight arm mechanism permits the bearing mean pressure up to 5 MPa. The schematic diagram of the test rig and test rig arrangement is shown in Figure 1. The rotational speed is set within the range of 300 to 1000 rpm.

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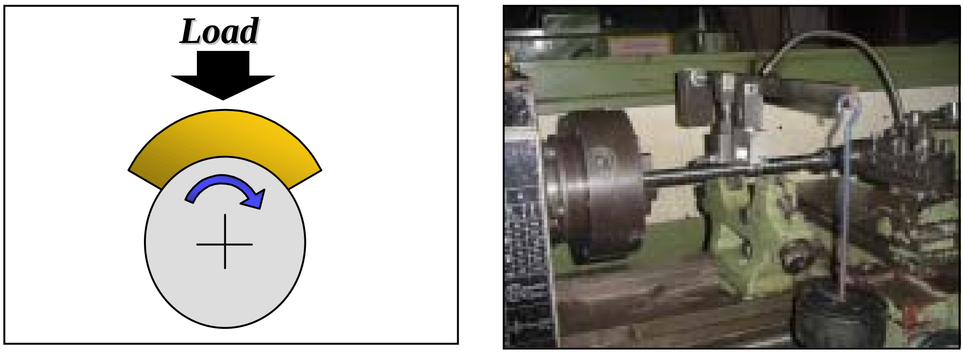
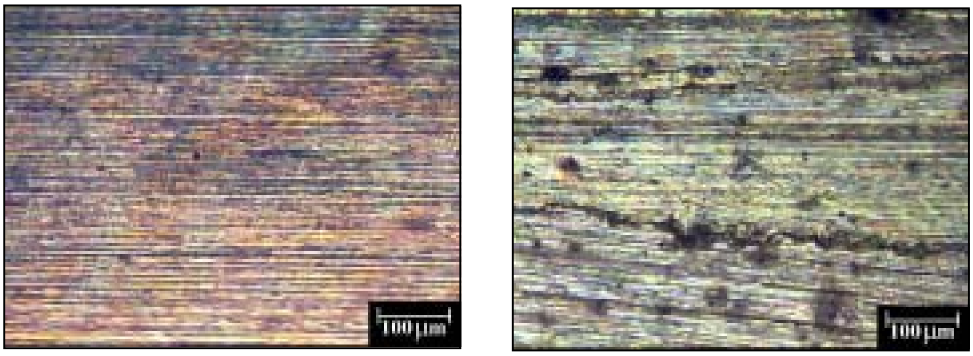


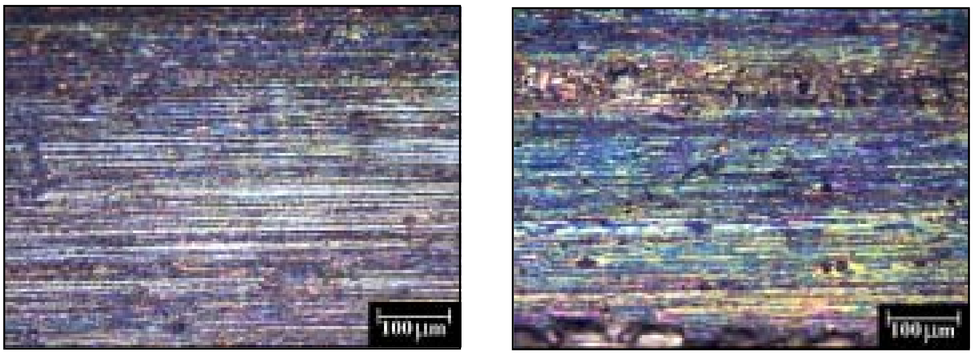
(a) Schematic diagram (b) Arrangement of test rig

Figure 1 Test rig arrangement.



(a) Mild worn surface feature (b) Severe worn surface feature

Figure 2 Worn surface of sleeve material (Brass).



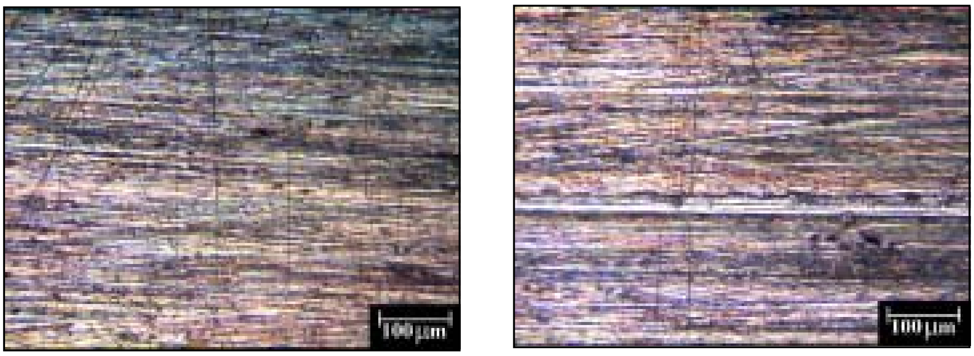
(a) Mild worn surface feature (b) Severe worn surface feature

Figure 3 Worn surface of sleeve material (Bronze).

The materials of sleeves are aluminum, bronze and brass. The journal is made of mild carbon steel with diameter of 25 mm. The mineral base oil with lithium soap grease (NLGI No.2) without EP additive as the lubricant of the bearings. The test lubrication regimes can be either dry, boundary or mixed lubrication regime. After each test, the used grease is collected and consequently wear debris is extracted and analyzed under light microscope or high power magnification through Scanning Electron Microscope (SEM). In addition, worn surface are also assessed microscopically.

3. Results of Experimental Investigation

The investigations of bearing material were made on three friction pairs. i.e. steel-bronze bearing



(a) Mild worn surface feature (b) Severe worn surface feature

Figure 4 Worn surface of sleeve material (Aluminum).

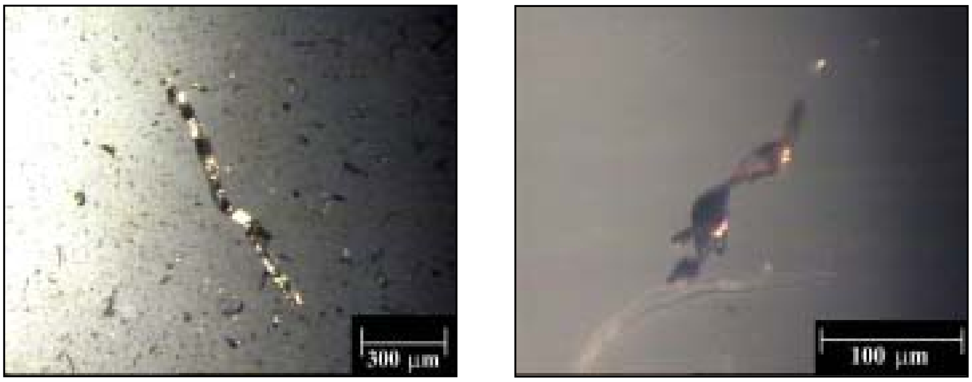


Figure 5 Elongated wear particles during running-in period.

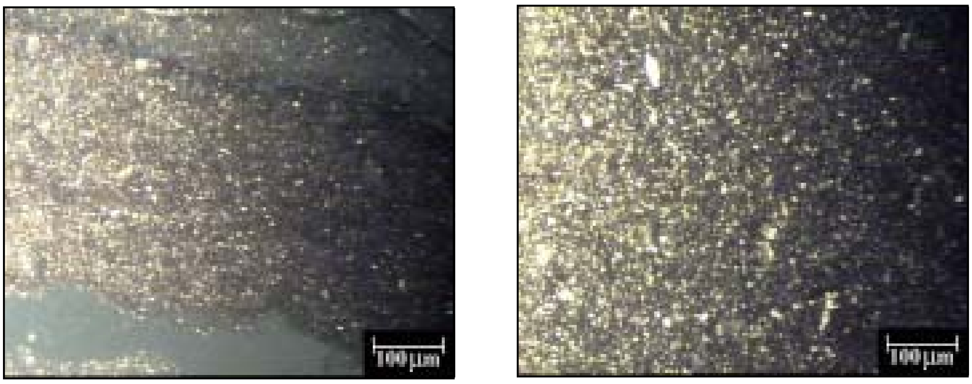


Figure 6 Normal rubbing wear particles in mixed lubrication regime.

materials, steel-aluminum bearing materials, and steel-brass bearing materials. The journal was made of S45C carbon steel and hardening up to 55 HRC. The operating surface of the journal was ground to the surface roughness parameter of Ra ≈ 0.6 µm.(the roughness of operating surface of sleeve Ra ≈ 2 µm.). After each test series, the journal and sleeve were disassembled from the test rig, the used grease are collected and the specimens are degreased with an proprietary solvent. The roughness and weight of specimens are measured. At the beginning of each series of investigations the same parameters of initial conditions of measurements were used.

The comparison of the worn surfaces of three combination friction pairs is shown in Figures 2 to 4.

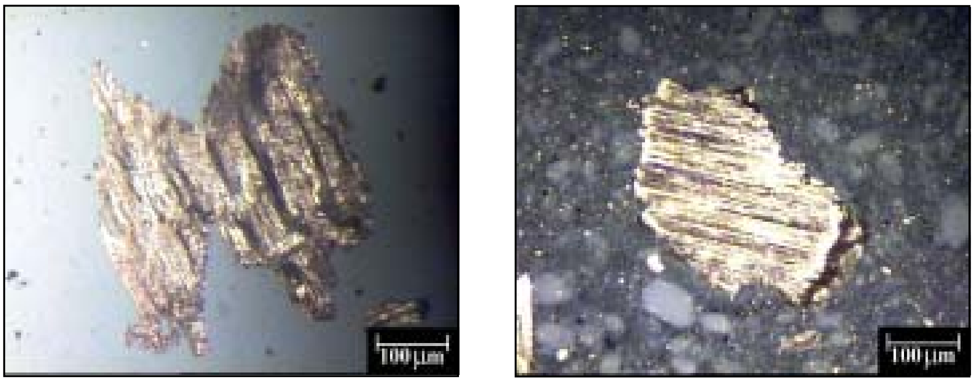


Figure 7 Severe adhesive wear particles in boundary lubrication regime.

For the analysis of wear debris characteristics, it has been found out that in this particular test conditions, three different regimes of lubrication were taken place, namely, run-in period, boundary and mixed lubrication. Typical debris feature from each regime is shown in Figures 5 to 7 respectively.

4. Conclusions

1. All sleeve materials exhibit similar characteristics and at the same values of bearing parameters i.e. during run - in, mild and severe wear mode.

2. Similar worn surface feature presented for the test condition prevailed, namely, mild and severe adhesive worn surfaces.

3. Wear debris features correlated well with the worn surface characteristics of bearing sleeves.

4. There appears that journal bearings are much less sensitive to damage or wear caused by hard abrasive contaminants than roller element bearings.

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