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A Review of Experimental Studies on the Effect of Viscosity grade on Mechanical Vibration Behavior of deep groove Ball Bearing

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Abstract

This paper intends to review and summarize the recent researches of Experimental Studies on the Effect of Viscosity grade on Mechanical Vibration Behavior of deep groove Ball Bearing by using lubricants without additives. The most common viscosity grades, namely ISO (10,22,32,64and 68) are considered as working lubricant viscosity grade, by many authors studying how a change in lubricant viscosity can affect the mechanical vibration of a rolling bearing. The rms vibration of ball bearing reduced by increasing the lubricant viscosity while enhancing the maximum load it can carry. The rms vibration reduction of ball bearing is investigated at constant load input by varying frequency.

Keywords: Lubrication, ball bearing, Viscosity, Vibration, Lubricants

Introduction

The word Tribology was first reported in a landmark report by scientist Sir Jost in 1966. The word is derived from the Greek word tribos meaning rubbing, so the literal translation would be "the science of rubbing."' Its popular English language equivalent is friction and wear or lubrication science, alternatively used. The latter term is hardly all-inclusive. Dictionaries define tribology as the science and technology of interacting surfaces in relative motion and of related subjects and practices. Depending on some aspects, lubrication in mechanical systems can occur in different regimes: full film, mixed or boundary lubrication. Full film lubrication can be further divided into elastic-hydrodynamic lubrication (EHL), which occurs in non-conformal contacts under high pressure, and hydrodynamic lubrication (HD), occurring under low pressure and usually in conformal contacts [8-11].

Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the Loads (forces) applied to the parts, which are shown in the following flow diagram as below:

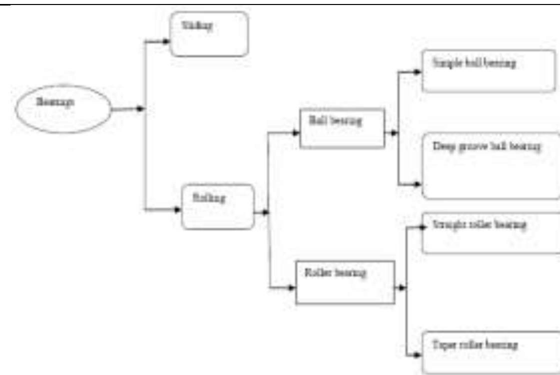

Figure -1 Classification of bearing

Among the group of mechanical components operating under EHL condition, there are the rolling bearings. This machine element type is one of those more sensitive for development of faults related to lubrication deficiency. From the total of faults found in this type of component, 50–80% is related to deficient lubrication, resulting from inadequate lubricant use, lack or excess of lubricant, lubricant aging, and presence of solid or liquid contaminant. In the face of high percentage of rolling bearing failures, the development of techniques for detection and diagnosis of faults in rolling bearings, due to lubrication deficiency, is a fundamental contribution to the preservation of machine precision. In terms of

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monitoring of rolling bearing performance, vibration measurements are among the most used techniques. Nowadays, a lot of works on detection of localized defects in rolling bearing elements through vibration analysis can be found in the literature [12-17].

Literature review

The following literature review describes important research regarding the Vibration Behavior of ball Bearing Using Different Lubricants:

Juha Miettinen et al. (2000) investigated was to clarify how the contaminants in the grease influence the acoustic emission of the rolling bearing. The results showed that the AE measurement indicated very clearly the lowest contaminant concentration included in the study that was as low as 0.02 weight-%. Small size contaminant particles generated a higher AE pulse count level than large size particles. The AE time signal analysis method proved to be a suitable method to indicate the hardness of the contaminant particles. Cleaning the bearing of contaminants and re-greasing with a clean grease reduced the AE level of the bearing [1].

Ricardo Serrato et al. (2005) investigated the effect of lubricant contamination by solid Particles on the mechanical signature of roller bearings. The experimental tests made use of roller bearings NU205, lubricated with mineral oil of two different viscosity grades. All The experimental tests were performed with constant load on the bearing (10% of nominal load). The mechanical signature was obtained by processing and analyzing the bearing vibration signals for all the lubrication conditions and several bearing rotational speed. Through the RMS analysis of the vibration signals, it was possible to identify specific frequency bands excited by the presence of Contamination [2].

M. M. Maru et al. (2006) investigated the effect of lubricant contamination by solid particles on the dynamical behavior of rolling bearings, in order to determine the trends in the amounts of vibration affected by contamination in the oil and by the bearing wear itself. Experimental tests were performed with radial ball bearings lubricated by oil bath. Quartz powder in three concentration levels and different particle sizes was used to contaminate the oil. Vibration signals were analyzed in terms of the root mean square (rms) values. The results show that changes in the rms values of vibration in the high-frequency band, from 600 to 10,000 Hz, were associated to the changes in oil lubrication in the bearing contacts, caused by oil contamination and wear damage on the bearing surface [3].

R. Serrato et al. (2007) characterize vibration behavior of roller bearings as a function of lubricant viscosity. Experimental tests were performed in NU205 roller bearings, lubricated with mineral oil of three different viscosity grades (ISO 10, 32 and 68). The mechanical vibration was determined through the processing and analysis of bearing radial vibration data, obtained from each of the lubrication conditions, during 2 h of test run for temperature stabilization and under several bearing shaft speeds. The applied radial load was 10% of the bearing nominal load. Through root mean square (RMS) analysis of the vibration signals, it was possible to identify specific frequency bands modulated by the change in lubricant viscosity, which was related to change in oil film thickness [4].

Pavle Boskoski et al. (2010) the detection of improperly lubricated bearings from vibration patterns is a difficult task especially when records from short operating periods are available. This problem has been addressed by applying both cyclostationary analysis and spectral kurtosis for the selection of a frequency band in which variations in vibration patterns are most expressed. The approach was evaluated on a test-set comprising 63 electrical motors with fault-free and 21with improperly lubricated bearing. The results reveal that improper lubrication is expressed as increase in the spectral components at bearing cage and ball spin frequency [5].

Nicoleta M. et al. (2012) The attenuation of the gear mesh noise /vibration by fluid film wave bearings relative to rolling element Bearings was experimentally investigated. Tests were performed on a gear box that can accommodate both rolling element bearings and wave bearings. It was found that at specific speeds and torques, the wave bearings could significantly reduce the noise/vibration compared to rolling element bearings [6].

Jafar Takabi et al. (2012) The evolution of temperature with time in a deep-groove ball bearing in an oil-bath lubrication system is studied both experimentally and analytically. The test apparatus is a radially –loaded ball bearing Instrumented to measure the transient temperature of the outer race, oil and housing. The mathematical model developed provides a comprehensive thermal analysis of the ball Bearing with provision for frictional heat generation. Experiments are performed for different speeds and loads to validate the model. The predicted temperatures under different loads and speeds are

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found to be enclose agreement with those measured experimentally [7].

Muthu Kumar et al. (2013) investigate the vibration suppression characteristics of ball bearing supplied with nano-copper oxide (CuO) mixed lubricant. CuO Nanoparticles were synthesized by chemical method and characterized using XRD and TEM to study the crystallanity and ultrastructure. The synthesized CuO nanoparticles were of the size range 5-8 nm. 0.2%, 0.5%, and 1% (W/V) of CuO nanoparticles was added to the lubricant (ISO VG 68) and was used for further analysis. The test rig setup consists of a ball bearing and loading arrangement operated by a DC motor. The bearing (New, Ball defect and Outer defect) vibrations were measured using base lubricant and CuO lubricant mixture. Our results show a reduction of 41% vibration amplitude while using 0.2% (W/V) CuO nanoparticles in outer case defected compared to base lubricant [8].

William Jacobs et al. (2013) experimentally investigated the formation of a lubricant film in a deep groove ball bearing and its effect on the bearing dynamics. The behavior of the lubricant film between the rolling elements. The influence of the bearing Temperature is analyzed as well. During a run-up at constant bearing temperature describes the formation of the lubricant film. Due to The formation of the lubricant film, the bearing stiffness increases by3.2%while the damping increasesby24%.During a warm-up of the bearing, the viscosity of the lubricant film decreases strongly [9].

Conclusions

1. The cleaning and re-greasing of a bearing that had been running with contaminated grease gave a reduction in the AE level of the bearing, to a level which was about one-half of the AE level with the contaminate grease, but after the cleaning and re- greasing the AE level was still much higher than it had been when the bearing was new and lubricated with the clean grease [1]
2. The presence of contaminant, in different concentration levels and particle sizes, Only affects the high Frequency bands of the vibration signal. Therefore, the signal RMS values for high frequency bands are good Vibration parameters for detection of problems of contamination [2].
3. Variations in oil viscosity in roller bearings, caused by either the use of different oils or temperature Variation, only affect the bearing vibration in HF band (600– 1 000 Hz) [4].
4. The presence of nano particle, in different concentration levels and particle sizes, Only affects the high Frequency bands of the vibration signal. Therefore, the signal RMS values for high frequency bands are Good vibration parameters for Detection of problems of contamination [5].
5. The experiments showed that under certain operating conditions, the fluid film Wave bearings can reduce the gear mesh vibration and noise compare to rolling Clement bearings [6].
6. The bearing damping is roughly unaffected by the speed. Whether the bearing stiffness and damping Increase or decrease due to the formation of a lubricant film is highly dependent on the temperature Conditions [8].

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