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Experimental Investigation of Different Groove Geometry of Hydrodynamic Journal Bearing On Mechanical Vibrations

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Abstract: ***Hydrodynamic journal bearings are commonly used components in machinery for a wide range of applications. This work represents investigation of performance of hydrodynamic journal bearings with different groove geometry. In this work bearing with two helical, three helical groove and non groove (plain) are tested at radial load and RPM are varied within specified range and experimental vibration signals were obtained. Vibration signals analysis has been carried out in Frequency domain by FFT analyzer. Results of experimentation were in amplitude versus speed.***

Keywords: helical groove, Frequency domain, FFT analyzer

1. Introduction

Vibration is an effective tool in detecting and diagnosing some of the incipient features of machines and equipments. A vibration signature measured on external surface of a machine or structure contains a good amount of information, which, if properly interpreted can reveal the running condition of machine. A vibration signature taken from appropriate location in a machine can reveal presence of machine defects such as imbalance, misalignment, imperfect foundations, mechanical looseness, rubs, bearing defects, faults in transmission drives etc. There is trend of monitoring different machine components with the help of data generated by vibration by these components for ensuring their reliable and effective working. Bearing vibration analysis is becoming popular for monitoring bearing performance.

Bearings play a vital role in rotating machinery. They support radial loads, axial loads, thrust loads etc. and provide frictionless running of rotors. Journal bearings are widely used in different rotating machines. These bearings allow for transmission of large loads at mean speed of rotation. On the basis of way to provide the carrying capacity, we recognize radial hydrodynamic bearings and hydrostatic bearings. In hydrodynamic bearings lubricant is fed through a throttling hole and carrying capacity is produced as a result of hydro-dynamic pressure in the wedge shaped clearance between plain bearing and the shaft.

Hydrodynamic journal bearing is a critical component in various machines like rotors, turbines, pumps, hard disk etc. It comes under the group of machine elements working under elasto-hydrodynamic lubrication (EHL) conditions. Due to radial clearance journal bearings have self induced vibrations. Lots of efforts are made by researchers to study such vibrations and effects of vibrations on bearing performance and methods to reduce these vibrations. The journal bearing surfaces encountered in many studies were assumed to be smooth. However, the possibility of improving bearing performance by modifying bearing surface geometry has attracted attention of many researchers and they have performed several theoretical studies on hydrodynamic lubrication field for rough journal bearing surfaces in recent years.

2. Design of Experimental Setup

For the desired experimental analysis design the experimental setup as shown in fig. 1. For this setup we have used the speed control motor of motor of variable speed control. The coupling used L095 and shaft material for shaft EN24. The hydrodynamic bearing is made of brass. Shaft is designed on the basis of Strength Basis, torsional rigidity basis, Shaft design for fatigue life. The bearing is designed by using Raimondi and Boyd chart.

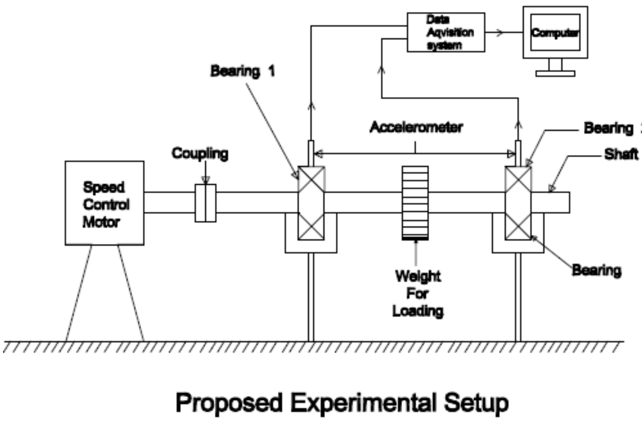

Figure 1: Proposed experimental setup

3. Experimental Set Up

For testing built the laboratory journal bearings test rig. It is modified specifically for this research to use in effect of different groove geometry on mechanical vibrations of the bearings, shown in Figure 2. The test rig consists of a rigid tubular steel base. On this steel frame motor is mounted and the shaft is coupled to the motor with the help of love joint coupling. Also on the frame there is special arrangement for the mountings of the hydrodynamic journal bearings equipped with oil supply. There was a circular oil groove at the center of the bearing wall to enable sufficient supply of oil on the contacting surfaces. The test device operates with a 180 V single phase electrical DC motor. There is arrangement for the continuous supply of the oil as shown in the figure. Also there is oil bath for the outlet oil.

The pedestal jig bearing is used for the loading purpose. To operate the motor we have used dimmerstat and rectifier unit. Connect dimmerstat, rectifier and motor in series. With help of dimmerstst we can vary the speed of the motor.

The experiments were first conducted for the plain journal bearings for four different loadings. First check the amplitude of vibration at no load at different speed as 300 rpm, 900 rpm and 1500 rpm. Then we have done same for 3 kg, 5 kg and 8 kg loading conditions.

In this experiment first take non groove journal bearing. With the help of FFT analyzer measure the amplitude of vibrations at different speed and different loading conditions. When using the FFT analyzer use two accelerometers for the measurement of the amplitude of vibration. One is mounted on the bearing which is near to the motor which is called as drive and other is mounted on the bearing which is away from the motor i.e. drive end bearing. The accelerometer sensors are mounted horizontally as well as vertically. First take reading for the non groove journal bearing by mounting sensors horizontally at no load and then the readings were taken for vertically mounted sensors. Repeat the procedure for 3kg and 8kg loading. After that repeat the procedure for remaining two helical grooves and three helical groove journal bearings. Continuous oil supply is given to the bearings. And at different speed of the shaft we measure the amplitude of vibration.

Figure 2: Experimental setup

4. Results and Discussions

With help of FFT analyzer, readings of the hydrodynamic journal bearing at different speed and different loading condition were taken. The graphs are shown below are highest amplitude of vibration for no load, 3kg loading, 8kg loading.

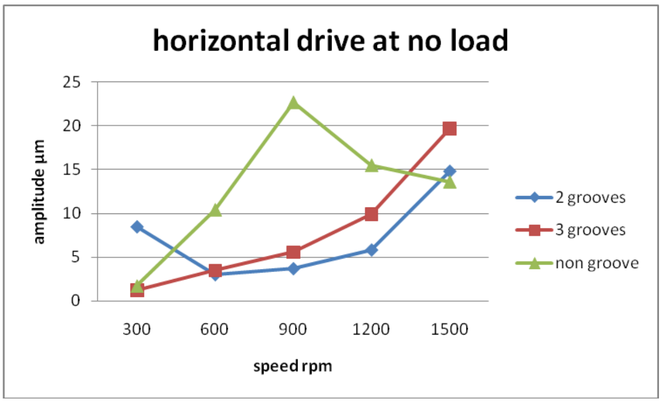

Figure 3: Horizontal drive at no load

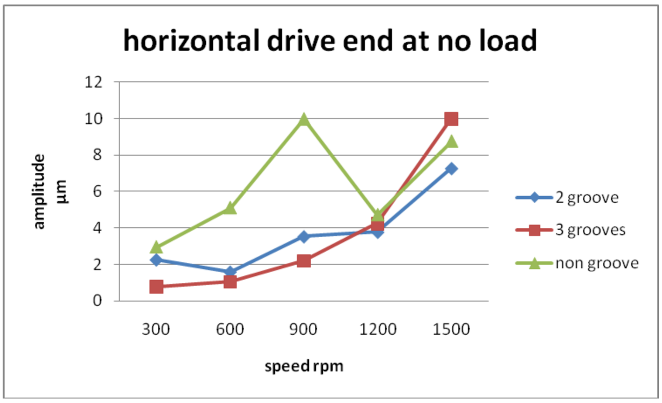

Figure 4: horizontal drive end at no load

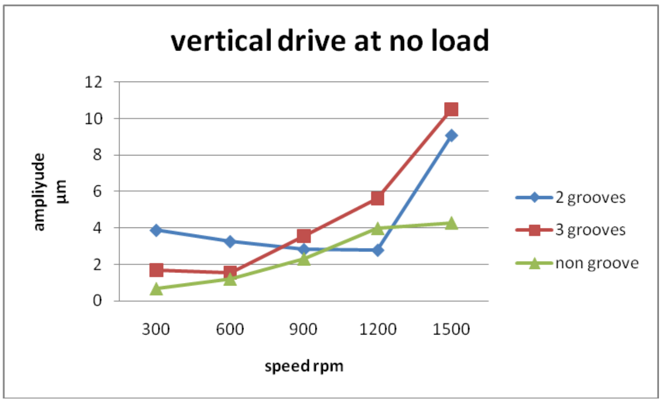

Figure 5: vertical drive at no load

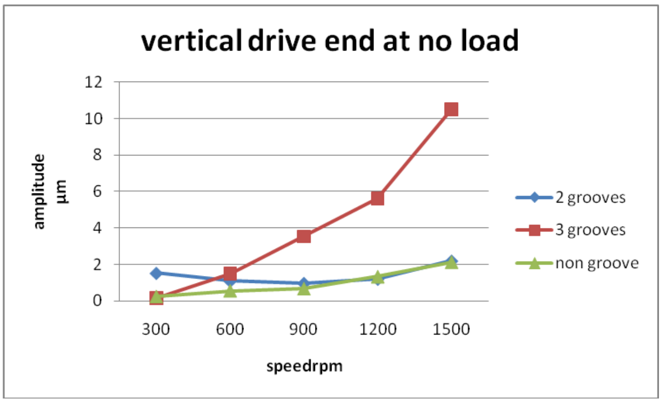

Figure 6: vertical drive end at no load

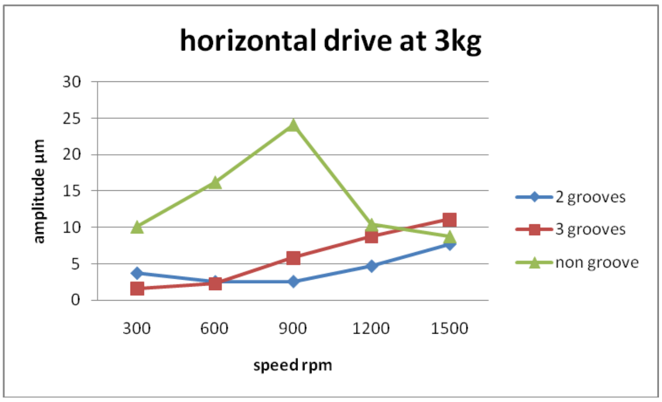

Figure 7: horizontal drive at 3kg load

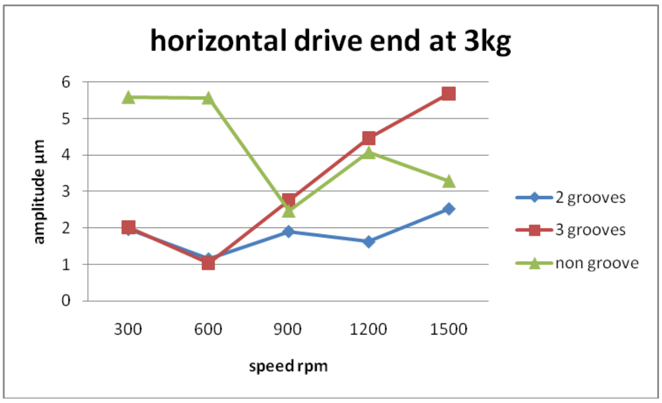

Figure 8: horizontal drive end at 3kg load

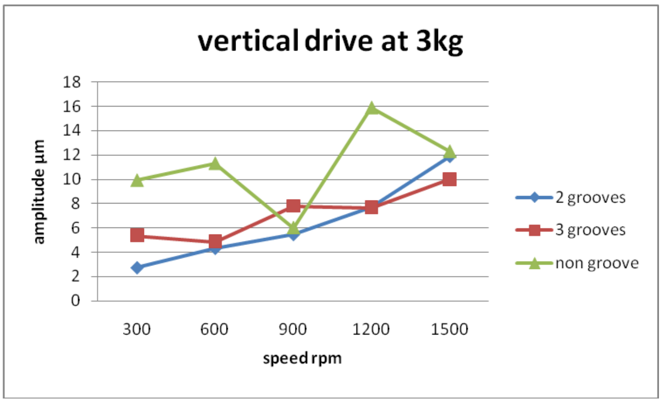

Figure 9: vertical drive at 3kg load

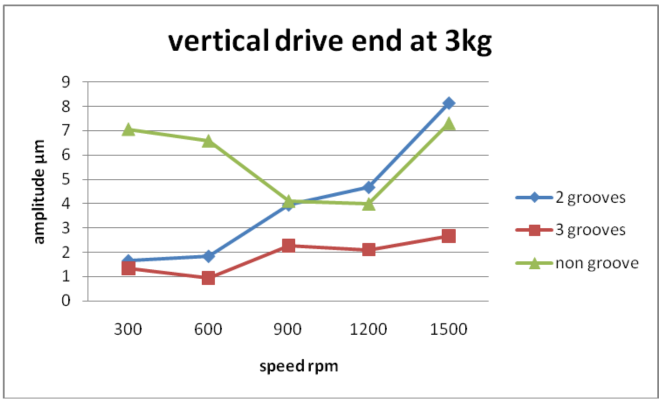

Figure 10: vertical drive end at 3 kg load

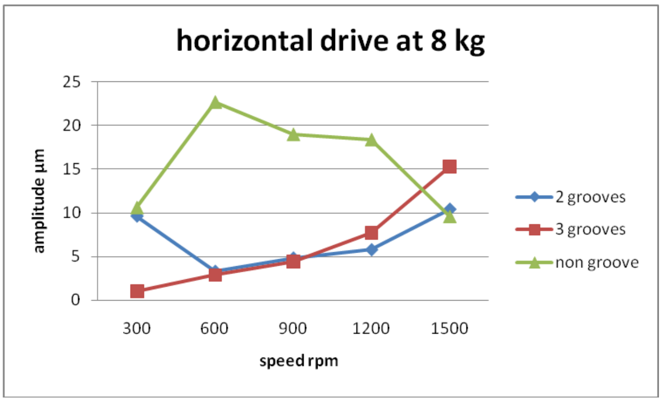

Figure 11: horizontal drive at 8kg load

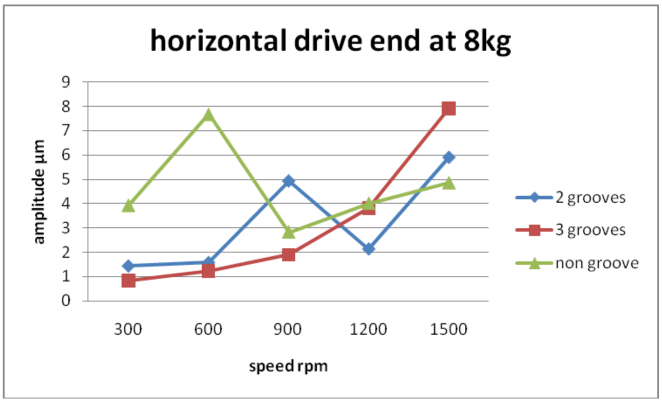

Figure 12: horizontal drive end at 8kg load

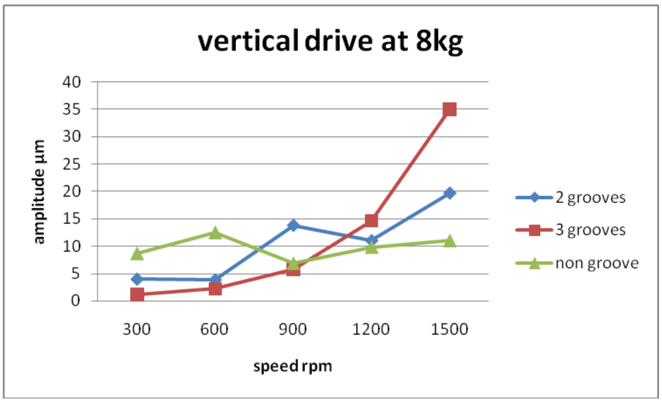

Figure 13: vertical drive end at 8kg load

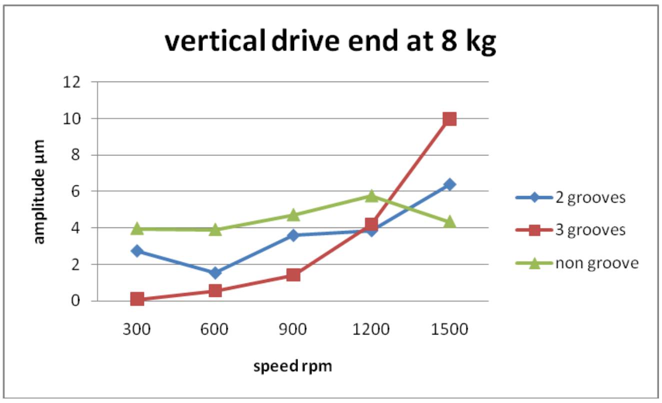

Figure 14: vertical drive end at 8kg load

5. Conclusions

- At no load condition for lower speed non groove i.e. plain journal bearing shows higher amplitude of vibration than other two helical groove and three helical groove journal bearings.
- Speed as well as load increase for non groove journal bearing it has less amplitude of vibration than other bearings.
- Also for speed above 1500 rpm at no load condition as well as at loading condition the non groove i.e. plain journal bearing shows less amplitude of vibration.
- At speed up to 1000 rpm two helical groove journal bearing has less amplitude of vibration than other bearings.
- As the load increases and speed up to 1000 rpm the amplitude of vibration for three helical groove journal bearing decreases.
- Initially both two helical groove and three helical groove journal bearing shows less amplitude of vibration for no load, 3kg and 8kg loading but for higher speed i.e. speed above 900 rpm they shows higher amplitude of vibration than non groove journal bearing.

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