PERFORMANCE IMPROVEMENT OF JOURNAL BEARING UNDER VARIOUS CONDITIONS

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ABSTRACT

Bearings used in sugar mills are designed to endure high loads and operate at low speeds. A temperature increase was observed in the sugar factory, when it is operating in the polluted or contaminated environment. An experiment was conducted to investigate the effect of temperature on the stainless steel bearings with different oil flow rates conditions. By replicating the operating conditions are found in a sugar mill, the factors contributing to the temperature increase in the bearing were identified. A test rig was employed to simulate the combined effects of various operating conditions such as self-load, speed, dirt, and lubricants. It was observed that insufficient internal lubrication supply can lead to failure the journal bearings. The results of this investigation indicates that the Q3 oil flow rate gives better thermal effect on journal bearing as compared to the other flow rate.

Keywords: *Journal bearing, Lubrication, temperature rise, flow rate.*

INTRODUCTION

A bearing is a machine component that supports and limits the motion of a moving item. They are typically divided into two types: sliding contact and rolling contact bearings. In sliding contact bearings, a lubricant is introduced or supplied between mating surfaces minimizes friction and wear and, in some situations, for the purpose of dissipation of heat created when the bearing is in contact with the mating surface. Rolling motion is used to reduce friction in rolling bearings. Journal bearings are typically used where different applications and operating conditions are required.

The causes for failure of a journal bearing are surface unevenness, misalignment, lack of lubrication, dirt, improper surface finish, contaminants, etc. Sugar mill bearing are known to works at low speed and high load. Lubricating oil contains impurities such as bagasse, oil, sugar cane juice, and soil. These contaminants flow with the oils into the journal and bearing surfaces.
This research includes problems such as the temperature rise of bearings and decline in the performance of the journal bearings used in sugar factories. Note that this temperature rise occurs in stainless steel bearings.

In this research, a case study from the sugar mill sector was used to observe and comprehend the behavior of stainless steel bearings working under oil as a lubricant at different flow rates. The experiment was carried out on stainless steel bearings at a sugar mill size. In this topic the behavior of the plain journal bearing is being observed under various flow rates of oil is being used as lubrication for the bearings. Different flow rates are used so as to get a better idea about the condition and flow rate under which the stainless steel bearing performs the best and gives a better result and less rise in temperature in the bearing.

Experimental Details

This study utilized a case study within the sugar mill industry to observe and understand the behavior of a journal bearing. A testing setup specifically designed for downsized journal bearings was created to match the environment and operating conditions of sugar mill bearings. The test rig setup was developed to replicate the conditions found in the sugar industry and investigate the behavior of journal bearings under these specific operating conditions. The materials used for the shaft and bearing were EN8 and brass, respectively. The experiment employed oil as a lubricant with varying flow rates to conduct tests on the journal bearings. A Gulf engine oil with SAE 40 grade was utilized, which has a viscosity of approximately 16.34 cSt at 100°C.

The journal bearing used in the experiment had an outer diameter of 40mm, an inner diameter of 30mm, and a length of 40mm. The shaft diameter was 30mm, and it rotated at speeds ranging from 400 to 600rpm. The total duration of the test run was 10-15 minutes. The shaft was driven by a 1.5 HP AC electric motor using a two-pulley and V-belt arrangement. The self-load on the shaft was 73.54 N. A frequency converter (VFD) was employed to control and maintain the shaft's rotational speed at various frequencies. Due to voltage fluctuations during testing, the VFD and the RTD probe (temperature sensor) were damaged and malfunctioned. Consequently, a 3 Phase Starter was used instead of the VFD to start and stop the motor, which was also 3 Phase. The starter ensured that the motor ran at a constant speed. As the RTD probe was also damaged, a contactless thermometer was used for temperature measurement.

To ensure shaft alignment, double-row self-aligning deep groove ball bearings (DGBB) were utilized. Two bearing housings supported the shaft and restricted axial and rotational motion of the bearing during experimental work. Lubricating oil flowed into the bearing through gravity. The housing was pierced with a hole on top, where a beaker was attached on either side of the shaft to supply oil to both bearings. The temperature of both bearings was measured using a non-contact thermometer with an accuracy of at least ±1°CThe figure 1 shows the test rig.

Fig no. 1 Journal Bearing Test Rig.

RESULT AND DISCUSSION

Bearing failures in sugar mills are primarily caused by the continuous temperature rise of the bearings when operating in contaminated lubricating oil. In this study, the STAINLESS STEEL bearings are supplied with three different flow rates they are Q1, Q2 and Q3.

Flow rate (Q1) = 76.74 min per 200 ml. (Oil)

Flow rate (Q2) = 52.44 min per 200 ml. (Oil) Flow rate (Q3)
= 28.44 min per 200 ml. (Oil)

I. Flow rate (Q3) = 28.44 min per 200ml. (OIL). Both lubricant reservoirs were filled with 200-300 ml of oil. The nob of the beaker was then adjusted to the Q3 flow rate position. Then we measured the atmospheric temperature is 32.8°C as the initial temperature.

By using the starter the motor was started and was rotating at the default the speed. A shaft with self-load of 75 N is automatically subjected to the test bearing. Shaft rotates continuously without load until the bearing temperature becomes stable.

TIME	TEMPERATURE (DRIVEN)	TEMPERATURE (DRIVER)
3min,1425rpm	49	51
5min,1418rpm	51	53
7min,1410rpm	54	56
10min,1404rpm	56	58

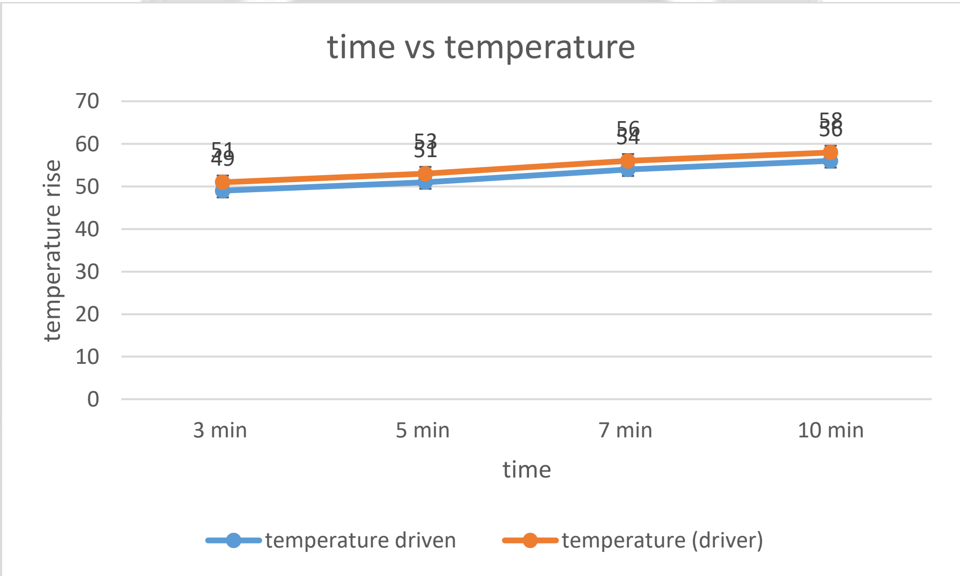

Fig. No. 2 Temperature Rise vs Time.

The shaft was rotated for 10 min under the Q3 flow and the temperature of the brass bearing was measured and noted at four intervals after recording the atmospheric temperature at the initial stage. The temperature of driver as well as driven brass bearing was recorded after 3 min, 5 min, 7 min and 10 min. the temperature rise in the bearing is shown in the table along with the graph. The fig no 2 shows the temperature rise of driver and driven bearing with respect to time.

II. Flow rate (Q2) = 52.44 min per 200ml. (oil). Both lubricant reservoirs were filled with 200-300 ml of oil. The nob of the beaker was then adjusted to the Q2 flow rate position. Then we measured the atmospheric temperature is 32.7°C as the initial temperature. By using the starter the motor was started and was rotating at the default the speed. A

shaft with self-load of 75 N is automatically subjected to the test bearing. Shaft rotates continuously without load until the bearing temperature becomes stable.

The shaft was rotated for 10 min under the Q2 flow and the temperature of the brass bearing was measured and noted at four intervals after recording the atmospheric temperature at the initial stage. The temperature of driver as well as driven brass bearing was recorded after 3 min, 5 min in the bearing is shown in the table along with the graph. The fig no 3 shows the temperature, 7 min and 10 min. the temperature rise rise of driver and driven bearing with respect to time.

TIME TEMPERATURE (DRIVER) TEMPERATURE(DRIVER)	TEMPERATURE(DRIVEN)	
3min,1115rpm	55	57
5min,1102rpm	58	60
7min.992rpm	61	64
10min,980rpm	63	66

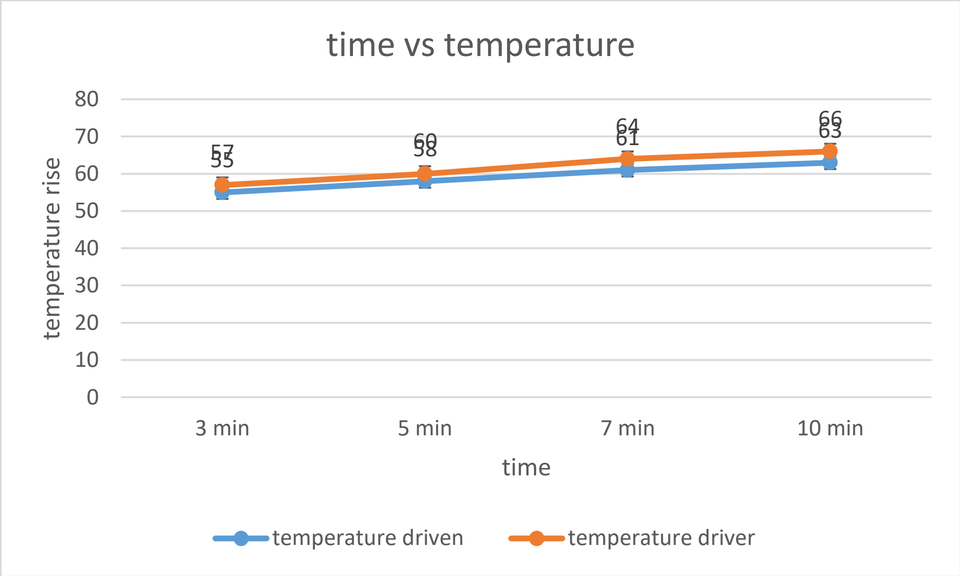

Fig No. 3 Temperature Rise vs Time.

III. Flow rate(Q1) = 76.54 min per 200ml. (OIL). Both lubricant reservoirs were filled with 200-300 ml of oil . The nob of the beaker was then adjusted to the Q1 flow rate position. Then we measured the atmospheric temperature is 32.7°C as the initial temperature. By using the starter the motor was started and was rotating at the default the speed. A shaft with self-load of 75 N is automatically subjected to the test bearing. Shaft rotates continuously without load until the bearing temperature becomes stable.

The shaft was rotated for 10 min under the Q1 flow and the temperature of the brass bearing was measured and noted at four intervals after recording the atmospheric temperature at the initial stage. The temperature of driver as well as driven brass bearing was recorded after 3 min, 5 min, 7 min and 10 min. the temperature rise in the bearing is shown in the table along with the graph. The Fig no 4 shows the temperature rise of driver and driven bearing with respect to time.

TIME TEMPERATURE (DRIVER)	TEMPERATURE(DRIVEN)	
3min,1115rpm	56	59
5min,1102rpm	59	61
7min.992rpm	63	66
10min,980rpm	65	69

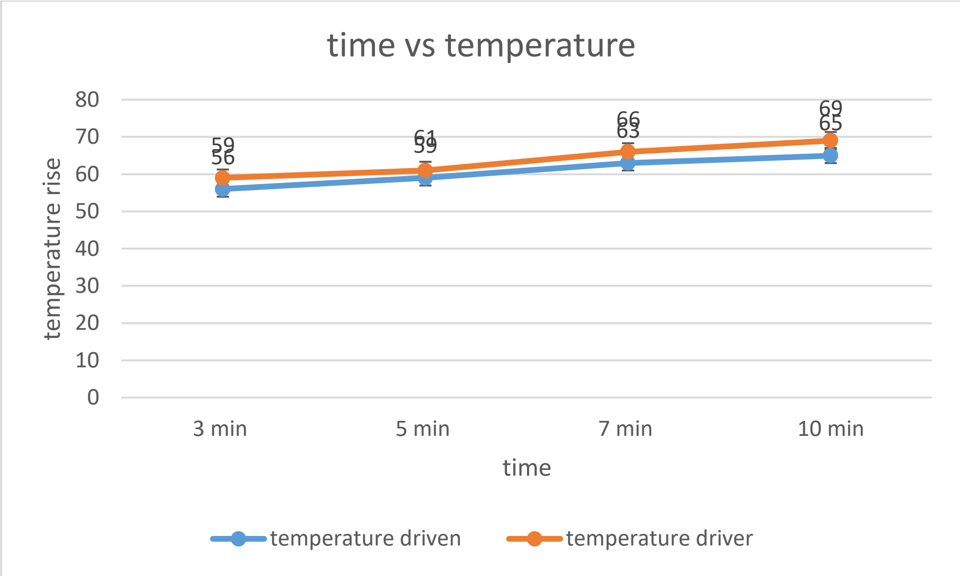

Fig No. 4 Temperature Rise vs Time.

CONCLUSION

The temperature effect on the performance of journal bearing are analyzed and observed through experimental with water conditions are given below:

1. The performance of the general bearing is observed and analyzed with the experimental work it is observed that, the flow rate Q2 is better than Q1, as under Q2 flow rate of oil there is considerably less temperature rise in the stainless steel bearing and also better performance was observed as compared to the Q1 flow rate of lubricating oil.
2. Study tells us that the Q3 flow rate for lubricating oil is better than Q2 flow rate. The stainless steel have better performance when the flow rate is Q3 also there is lesser rise in temperature as compared to Q2 oil flow rate.
3. The comparative study of Q1, Q2 and Q3 flow rates show that the stainless steel bearing perform the best when the flow rate in Q3. Also the rise in temperature is significantly less when the flow rate is Q3.

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