iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 Issue: VI Month of publication: June 2023

DOI: https://doi.org/10.22214/ijraset.2023.54403

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Tribological Performance of Brass Journal Bearing Working Under Contaminated Conditions

Sanket Laxman Patil[1], Kumarom Mahesh Kasve[2], Bhavesh Shashikant Pagar[3], Dinesh Chaudhari[4], Vinay Kumar[5], Vishal N. Sulakhe[6]
[1, 2, 3, 4]Student, [5]Assistant Professor, [6]Head of Department, Mechanical Department, Sandip University, Maharashtra, India

Abstract: Bearings for sugar mills are known to withstand high load and low speed operations. A temperature rise was detected in the warehouse of a sugar factory, when working in the polluted or contaminated environment of the sugar industry. Therefore, an experiment was conducted on brass (CuZn) plain bearings when lubricated with water with different flow rates.
In this study, the rise in temperature of a plain bearing in a sugar factory was analyzed. By simulating the operating conditions in a sugar mill the causes for rise in temperature in the bearing were identified and commissioning in a plain bearing test rig that takes into account the combination of operating conditions (self-load, speed, dirt, lubricants, etc). Insufficient supply of internal lubricant can lead to plain bearing failure. This affects the production costs of the industry and can also endanger human lives. The brass journal bearing gives the best performance under the Q3 flow of water and also have lesser rise in temperature.
Key words: flow rate, contamination(water), lubricant, temperature rise.

I. 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 minimises 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, water, sugar cane juice, and soil. These contaminants flow with the oils onto 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 brass journal bearings.

In this research, a case study from the sugar mill sector was used to observe and comprehend the behaviour of brass journal bearings working under water as a lubricant at different flow rates. The experiment was carried out on brass journal bearings at a sugar mill size. In this topic the behaviour of the plain journal bearing is being observed under various flow rates of water and 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 brass journal bearing performs the best and gives a better result and less rise in temperature in the bearing.

II. EXPERIMENTAL DETAILS

In this work, a case study from the sugar mill sector was used to observe and comprehend the behaviour of a journal bearing. The testing setup for the journal bearing with downsizing has been created and tailored to fit the environment and operating conditions of the sugar mill bearing. The conditions in the sugar industry have been created and a test rig setup has been developed to study the behaviour of journal bearing under these operating conditions. EN8 and brass were employed as shaft and bearing materials in this study. Water is used as a lubricant with various flow rates to perform the test on the journal bearings. Normal tap water was used for the lubricating purpose. The bearing used has an outer diameter of 40mm, an inner diameter of 30mm, and a length of the bearing is 40mm. Shaft diameter and rotation speed is 30mm and 400-600rpm. The total test run for 10-15 minutes is performed. Equipped with two pulleys and a V-belt arrangement, used a 1.5 HP AC electric motor to drive (rotate) the shaft, and at the shaft had a self-load is 73.54 N. A frequency converter ensures that the shaft rotates at different speeds. Variable Frequency drive(VFD) was used to control and maintain the frequency of the shaft.

The frequency controller ensures that the shaft keeps rotating smoothly at various frequencies. A Resistance Temperature Detector (RTD) was used to measure and record the temperature of the journal bearing whose range was from -100 ^{0}C TO 300 ^{0}C. During the testing that was being performed due to voltage fluctuation the VFD and the RTD probe got damaged and malfunctioned, so instead of VFD the use a 3 Phase Starter to start and stop the motors the motor was also 3 Phase, the starter drove the motor and make the motor run at a constant speed. As the RTD probe was also damaged, so for temperature measurement we used Contactless thermometer. Double-row self-aligning deep groove ball bearings (DGBB) ensure shaft alignment. Two bearing housings are used to support the shaft and limit the axial and rotational motion of the bearing during experimental work. Water flows into the bearing by gravity. To supply the water to the bearings the housing is pierced with a hole on top where a beaker is mounted on either sides of the shaft so that the water is being supplied to both the bearings. The temperature of both bearings is measured with a non-contact thermometer with an accuracy of at least ±1°C.
The fig no.1 shows the test rig that is developed for the experiment.

Fig no. 1

III. 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 brass journal bearings are supplied with water as a lubricant with three different flow rates namely Q1, Q2 and Q3.

Flow rate(Q1) = 20.23 min per 200 ml. (WATER)
Flow rate (Q2) = 13.38 min per 200 ml. (WATER)
Flow rate (Q3) = 3.46 min per 200 ml. (WATER)

1) Flow rate(Q3) = 3.46 min per 200ml. (WATER). Both lubricant reservoirs were filled with 1000 ml of water. The nob of the beaker was then adjusted to the Q3 flow rate position. Then the atmospheric temperature was recorded which was 32.8°C as the initial temperature. After that 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 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.

TIME	TEMPERATURE (DRIVER)	TEMPERATURE(DRIVEN)
3min, 1420rpm	45.6	45.2
5min,1380rpm	48.4	47.6
7min,1337rpm	50.2	49.9
10min,1308rpm	51.8	51.2

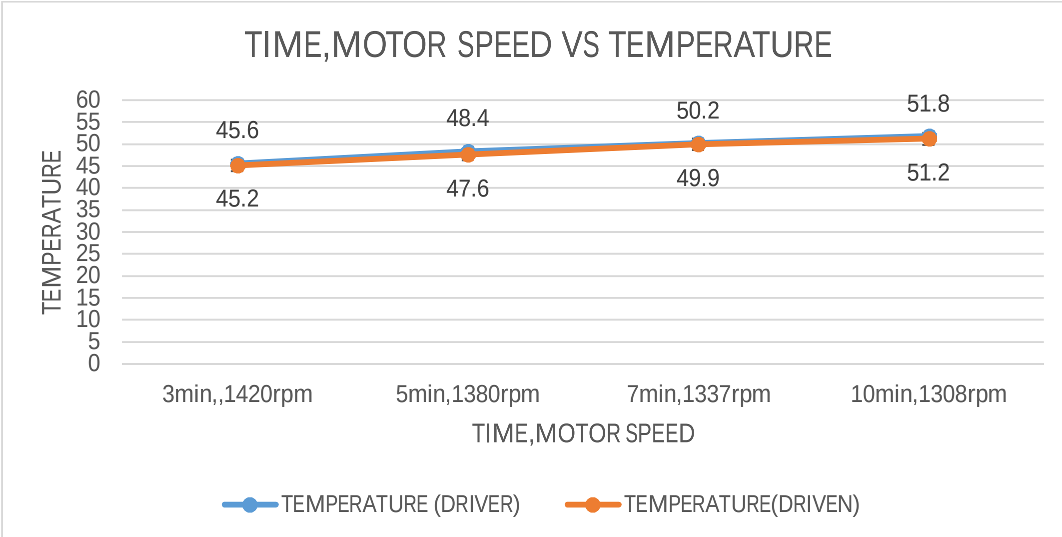

Fig no.2

2) Flow rate(Q2) = 13.38 min per 200ml. (WATER). Both lubricant reservoirs were filled with 1000 ml of water. The nob of the beaker was then adjusted to the Q2 flow rate position. Then the atmospheric temperature was recorded which was 32.8°C as the initial temperature. After that 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, 7 min and 10 min. the temperature rise in the bearing is shown in the table along with the graph. The fig no 3 shows the temperature rise of driver and driven bearing with respect to time.

TIME	TEMPERATURE(DRIVER)	TEMPERATURE(DRIVEN)
3min,1287rpm	54.3	53.5
5min,1240rpm	57.7	56.8
7min,1160rpm	61.4	59.6
10min,1109rpm	63.7	61.8

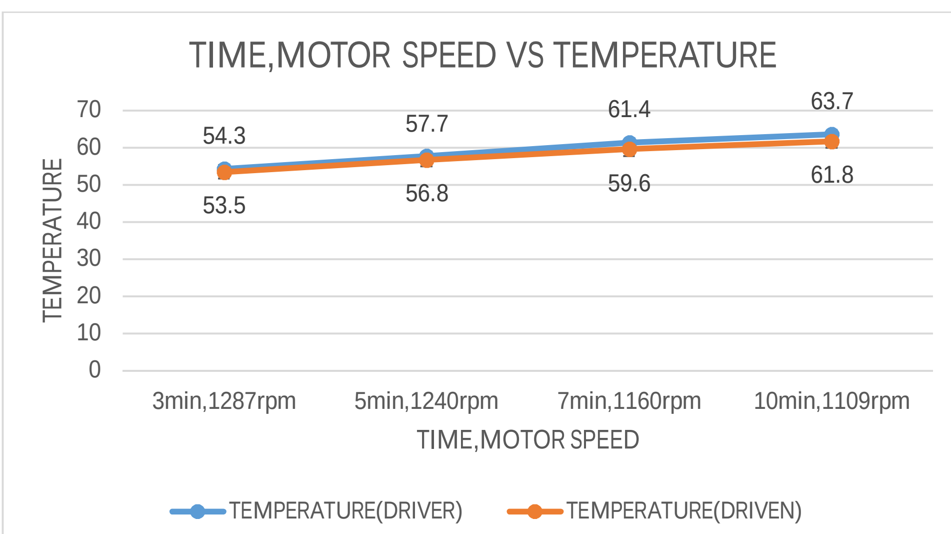

Fig no 3

3) 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 the atmospheric temperature was recorded which was 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,1098rpm	61.3	59.8
5min,086rpm	64.2	62.6
7min,1056rpm	67.6	65.7
10min,1040rpm	70.4	69.3

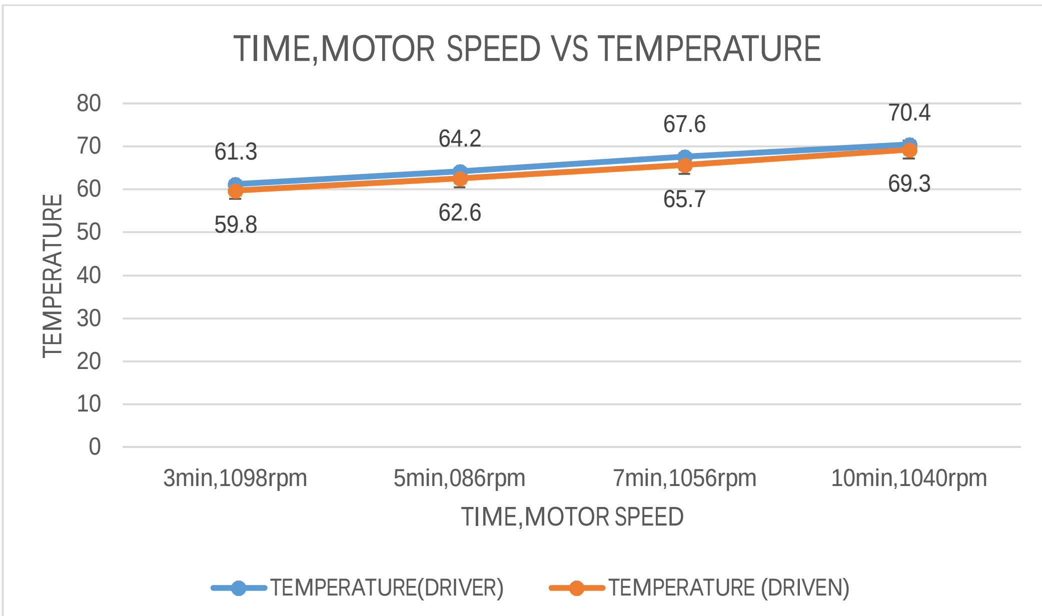

Fig no 4

IV. CONCLUSION

1) While comparing the performance and temperature rise of brass journal bearing under Q1 flow rate of water as a lubricant with the Q2 flow rate for water as a lubricant it is observed that bearing performed better when the flow rate was Q2, also the temperature rise in the bearings is considerably less.
2) In the comparative study of Q2 flow rate and Q3 flow rate of water as a lubricant it is being observed that the performance of the brass journal bearing is better under Q3 flow rate.
3) It is being observed that the brass journal bearing is performing the best and also the rise in temperature is less when the flow rate is Q3 when water is used as lubricant as compared to Q1 and Q2 flow rates.

V. ACKNOWLEDGMENT

The authors thank to Dr. Vinay Kumar for his excellent advice and continued encouragement during our work review. I really appreciate their vast knowledge and their joy in providing supervision and advice. We also express our sincere gratitude to the Workshop and the Faculty of Mechanical Engineering Department, School of Engineering and Technology, Sandip University, Nashik for providing the necessary approvals for the work and as well as the means to carry out the work do this investigation

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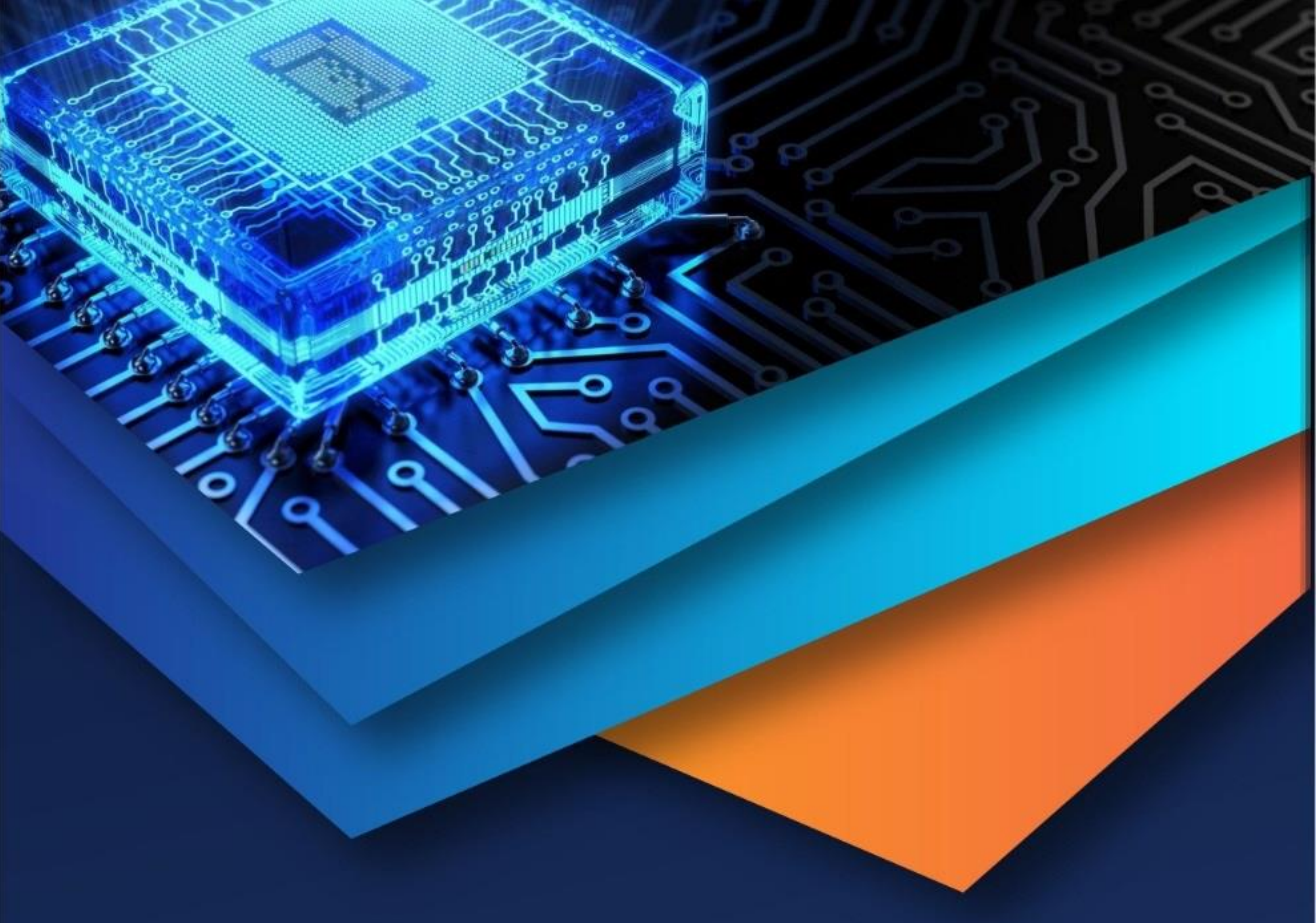

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