International Journal of Mechanical, Industrial and Aerospace Sciences
ISSN: 2517-9950
Vol:6, No:9, 2012

The Effect of Rotational Speed and Shaft Eccentric on Looseness of Bearing

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***Abstract*—**This research was to study effect of rotational speed and eccentric factors, which were affected on looseness of bearing. The experiment was conducted on three rotational speeds and five eccentric distances with 5 replications. The results showed that influenced factor affected to looseness of bearing was rotational speed and eccentric distance which showed statistical significant. Higher rotational speed would cause on high looseness. Moreover, more eccentric distance, more looseness of bearing. Using bearing at high rotational with high eccentric of shaft would be affected bearing fault more than lower rotational speed. The prediction equation of looseness was generated by regression analysis. The prediction has an effected to the looseness of bearing at 91.5%.

***Keywords*—**Bearing, Looseness, Rotational speed, Eccentric

I. Introduction

BEARING is the important part in machinery and the installation of bearing into machine and equipment should be made troubles such as shaft misalignment or eccentric of shaft.

These troubles affected to bearing that may become loose on the shaft during operation. This problem has affected to the quality of using bearing including condition of use such as rotational speed. Lu W and Chu F [1] investigated rotor-bearing system that is installed and vibration characteristics of the system with pedestal looseness. Li X. [2] studied on mechanical loosening form caused by rotating machinery. Bearing in the bearing seat loosening or component loosening is one of kind of mechanical loosening forms. The bearing may be faulted by different parameters, including speed, looseness gap, imbalance mass and disk position [1], [3] . The faults of bearing should be produced the vibration and it is main results to measuring and detecting bearing fault.[1-4]. The rotational speed and eccentric of shaft are factors that made a vibration. This research was to study effect of rotational speed and eccentric factors which were affected on looseness of bearing.

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II. Experiment Setup

A. Equipment

This study was done by use ball bearing No. 6205Z. The bearing is 25.4 mm on inner diameter. The shaft used to insert in bearing is 25.4 mm. in diameter and 300 mm" in long. The experiments were run on testing machine that shown in Figure 1. The machine was consists of continuous variable transmission (CVT) can be variable speed between 1,500-3,000 rpm. In order to set the eccentric of shaft, the machine can be adjusting eccentric distance by slide mechanism to left or right. The data, looseness, were measured by digital dial indicator '*Mahr MarCator1075R*' with 1 micron resolution.

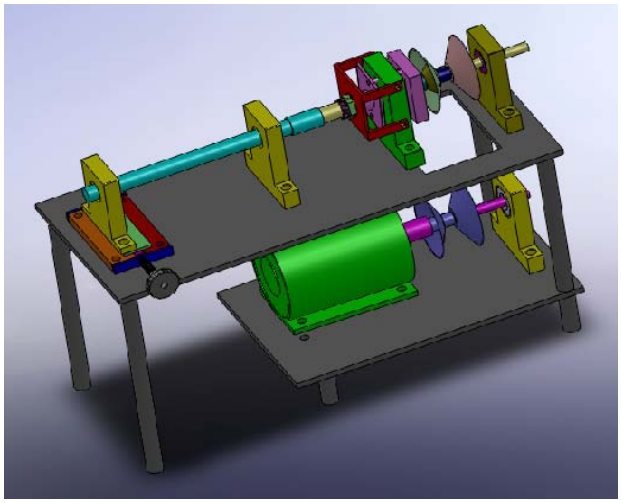

Fig. 1 Testing Machine

B. Experimental Procedure

The experiment was conducted by using two factors that consist of rotational speed (V), and eccentric distance (D). Rotation speed was set at three levels: 2,000, 2,300 and 2,600 revolution per minute. Eccentric distance was set up at five levels: 0.1 to 0.5 millimeter. The condition of experiment is shown in Table I. These factors were tested by plot study with twelve runs before running the actual experiment. The each condition was test run on 8 hours and not less than one million cycles. The details of experiment conditions are shown in Table II.

The actual experiment was run by five replicates which run randomly selected as shown in Table III. Then, the response of each trial were measured for looseness that using defection distance value. The measuring was done on three times measuring of each specimen. Data was collected and used to analysis by statistical methods to finding the effect of factors.

TABLE I
EXPERIMENT FACTORS

Factors	Level
Rotational Speed (rpm)	2,000 2,300 2,600
Eccentric (mm.)	0.1 0.2 0.3 0.4 0.5

TABLE II
EXPERIMENT CONDITIONS

Bearing No.	6205Z
Rotational speed	2,000 2,300 2,600 rpm
Run Time	8 Hrs.
Rotational Cycle	>1,000,000 Cycle

TABLE III
EXPERIMENTAL DESIGN

Eccentric Distance *(mm)*	Rotational speed
0.1	2,000
0.1	2,300
0.1	2,600
0.2	2,000
0.2	2,300
0.2	2,600
0.3	2,000
0.3	2,300
0.3	2,600
0.4	2,000
0.4	2,300
0.4	2,600
0.5	2,000
0.5	2,300
0.5	2,600

TABLE IV
EXPERIMENTAL RESULTS
a)ROTATIONAL SPEED 2,000 RPM

Eccentric Distance *(mm)*	Looseness Distance (mm)					
	1	2	3	4	5	Average
0.1	0.005	0.004	0.005	0.003	0.005	0.0044
0.2	0.007	0.005	0.010	0.010	0.005	0.0074
0.3	0.015	0.010	0.010	0.010	0.010	0.0110
0.4	0.015	0.015	0.010	0.015	0.010	0.0130
0.5	0.015	0.015	0.020	0.015	0.016	0.0160

b)ROTATIONAL SPEED 2,300 RPM

Eccentric Distance *(mm)*	Looseness Distance (mm)					
	1	2	3	4	5	Average
0.1	0.010	0.015	0.010	0.010	0.010	0.0110
0.2	0.012	0.010	0.012	0.012	0.012	0.0116
0.3	0.013	0.013	0.014	0.014	0.014	0.0136
0.4	0.017	0.017	0.017	0.016	0.017	0.0168
0.5	0.018	0.019	0.019	0.019	0.019	0.0188

c)ROTATIONAL SPEED 2,600 RPM

Eccentric Distance *(mm)*	Looseness Distance (mm)					
	1	2	3	4	5	Average
0.1	0.014	0.013	0.014	0.015	0.014	0.0140
0.2	0.017	0.016	0.017	0.017	0.017	0.0168
0.3	0.017	0.019	0.019	0.019	0.019	0.0186
0.4	0.020	0.020	0.020	0.021	0.021	0.0204
0.5	0.024	0.024	0.024	0.023	0.023	0.0230

TABLE V
ANOVA RESULT FOR LOONSENESS OF BEARING

	df	Mean Square	F	P
Rotational speed	2	.000423	195.57	.000
Eccentric Distance	4	.000218	98.84	.000
Rotational speed *Eccentric Distance	8	.000003	1.76	0.104
Error	60	.000002		
Total	74			

R Squared =93.03 % (Adjusted R Squared = 91.50%)

III. RESULTS AND DISCUSSION

The main findings of this experiment were factors that affected to looseness of bearing.

A. Main Study

The results of experiment were showed in table IV and were tested by normality test of data. The result of normality test was showed that the experiment results were significantly normality. That means the experimental results were appropriate.

B. Main Effect of Factors

The result of analysis of variance (ANOVA) for looseness was carried out in Table V. The ANOVA indicated that factors affected to looseness were rotational speed and eccentric Distance as showed significantly different at the level of .01.

It means that the rotational speed and eccentric distance were most influencing factors to looseness of bearing.

Furthermore, ANOVA revealed that factors interaction was not found between rotational speed and eccentric distance.

Main Effect of factors, as shown in Fig 3, indicated that increasing rotational speed at high, the looseness was high too. Moreover, more eccentric distance can be more looseness values. It means that high rotational speed and high eccentric distance can be produced more damage of bearing than lower.

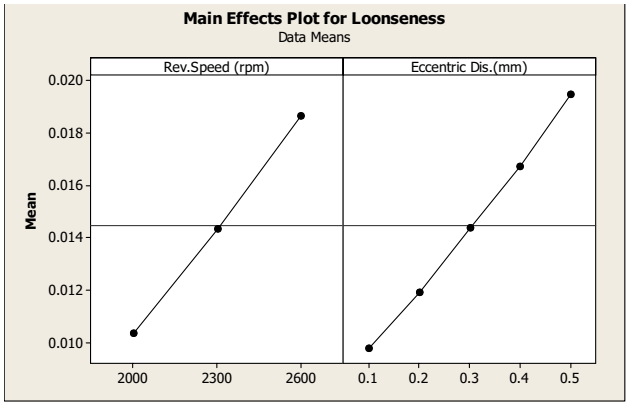

Fig. 2 Main Effects of Factors

C. Effect of Rotational speed

Rotational speed was indicated by ANOVA as most important factor that affected to looseness of bearing. The Least Significant Different (LSD) method was used to test of different between levels of rotational speed. The LSD result for rotational speed was showed that it was significantly difference for both levels. The level comparison is presented in Fig. 3. This means the more rotational speed could be produce more looseness. Moreover the high rotational speed with high eccentric distance would cause on poorest condition for using bearing.

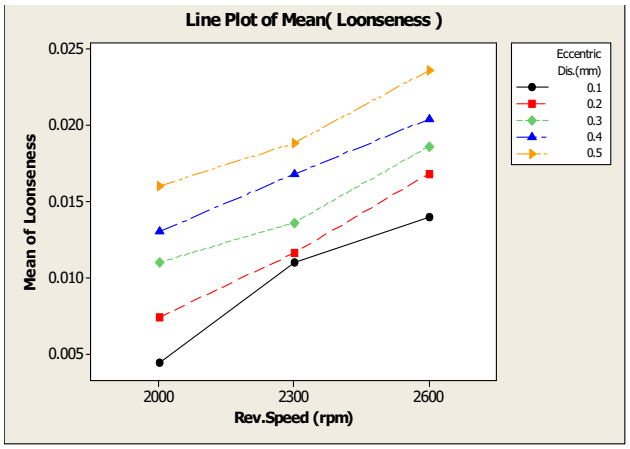

Fig. 3 Comparison of level of Eccentric distance

D. Effect of Eccentric Distance

Eccentric Distance was indicated by ANOVA as main factor that affected to looseness of bearing.

In order to test of different between levels of Eccentric Distance, the Least Significant Different (LSD) method was used. The LSD result for Eccentric Distance was showed that it was significantly difference for both levels. The comparison of levels is presented in Fig. 4. This means the less eccentric distance could be produce less looseness. On the other hand, the more eccentric distance would cause on poorer condition of using bearing.

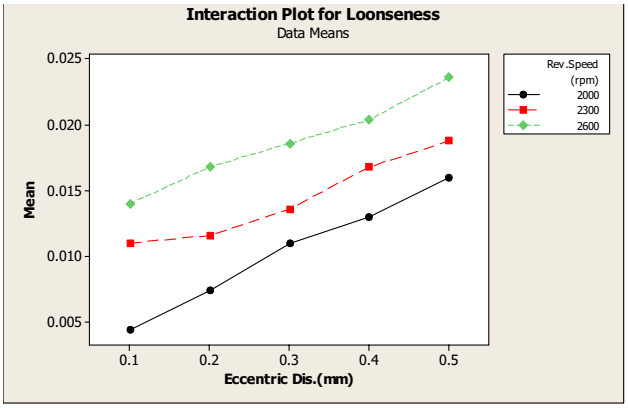

Fig. 4 Comparison of level of Eccentric distanc

E. The prediction Equation of Looseness

The analyze variable since in order to use the results to predict value by it has period of los to be dependent variable. The rotational speed (V) and the period of eccentric distance (e) are independent variable or variable that use in the process of analyze. The summary results is the decline equation in order to predict the looseness of bearing by regression analysis as follow eq.1

$$L = 0.0236\,(e) + 0.000014\,(v) - 0.0241 \quad (1)$$

Whereas

L = the looseness of bearing (mm.)
v = the rotational speed (revolution / minutes)
e = the eccentric distance (mm.)

The coefficient value of this equation has combine the decision R – Sq was 91.5% showed that this decline equation can describe the distribution of the period of looseness as the rotational speed (v) and the eccentric distance (e) has an effected to the looseness of bearing as the possible of prediction when the test combines two variability or the influence to the results as 91.5% and the other parts as 8.50% was occurred from the others variable.

IV. Conclusion

The experiment of effect of rotational speed and eccentric of shaft on looseness of bearing was done and investigated. It could be concluded that rotational speed and eccentric distance were mainly affected to looseness. Moreover, the interaction between rotational speed and eccentric distance was not found. Some concluding as following;

- Higher rotational speed would be cause of poorer.
- More eccentric distance, more looseness of bearing.
- Using bearing at high rotational with high eccentric of shaft would be affected bearing fault more than lower rotational speed.

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