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# "STUDY OF EFFECT OF GREASE CONTAMINATION ON BALL BEARINGS USED IN FOUNDRY"

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**Abstract:** *Now a days most of the industrial machine uses bearing. Bearing is a machine element that constraints relative motion and reduces friction between moving parts. Thus the efficient and proper functioning of bearings hugely depends on good health of bearing. In deep groove ball bearings contamination of lubricant grease by solid particles is one of the main reason for early bearing failure. To deal with this problem condition monitoring of bearing i.e vibration measurement techniques are used for on time monitoring of machining performance.*

*In this paper, an experimental setup was prepared. Firstly frequencies for standard bearing is calculated by formulas and experimental investigation has been reported related to the vibration behaviour of contaminated ball bearing operating at cont. speed at particular frequencies. The level of contamination is varied by percentage weight and size of contaminant. Vibration signature are analysed in terms of acceleration values at particular defect frequencies and also in terms of overall RMS values. The result shows significant variation in RMS acceleration values on varying the level of concentration. The results are validated with the help of ANSYS.*

**Keywords:** *Solid contaminant, Ball Bearing, Healthy grease, Particle size, Frequency spectrum.*

## 1. Introduction:

A bearing is a machine element that constrains relative motion and reduces friction between moving parts to only the desired motion. Early detection of the defects in bearings, therefore, is crucial for the prevention of damage to the other parts of a machine. The main sources of bearing induced vibrations are the defects in bearing components. Vibration based condition monitoring has been the most widely used technique. The objective of this article is to investigate the effect of contamination of lubricant by solid particles on the ball bearings. Silica particles at three concentration levels and different particle sizes was used to contaminate the lubricant. Experimental tests have been performed on the ball bearings lubricated with grease, and the trends in the amount of vibration affected by the contamination of the grease were determined. The contaminant concentration as well as the particle size is varied. Vibration signatures were analysed in terms of root mean square (RMS) values. From the results, some fruitful conclusions are made about the bearing performance. The results show significantvariation in the RMS velocity values on varying the contaminant concentration and particle size

According to N Tandon [3] in his research paper stated different condition monitoring techniques to detect the defect in rolling bearing.N. Tandon and ect. all have been studied the grease used in the ball bearings of electric motors. According to him, the lubricating grease often gets contaminated either from external particles or particles generated within these bearings. According to Mr. M. M.Maru [9] explains in his work, the effect of contaminant concentration on vibration is distinct from that of the particle size. The vibration level increased with concentration level, tending to stabilize in a limit. On the other hand, as the particle size increased, the vibration level first increased and then decreased.

## 2. Experimental Setup and Preparation of Sample

An Experimental set up is prepared for analysis of defective bearings. Figure 1 and 2 shows the set up for analysis of defective rolling contact bearings. It contains different parts such as motor, supporting frame, shaft, separable pedestal bearing. Different kinds of defective rolling contact bearings can be taken for analysis. FFT is used to take readings of vibration.

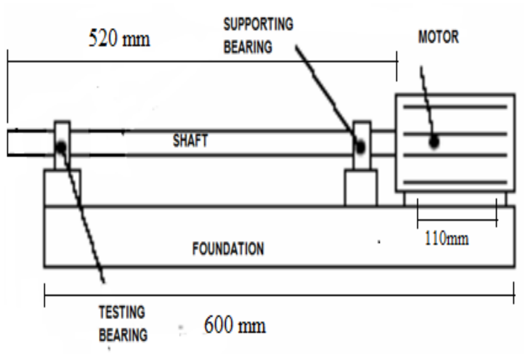



**Fig. 1: Block dia of setup**

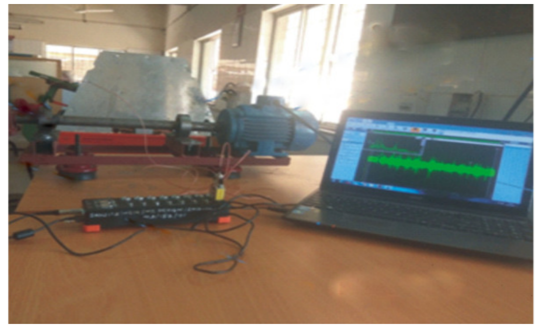


**Fig. 2: Actual Setup**

## 2.1 Bearing selection

In this project work SKF 6206 deep groove ball bearing is used. Geometry of bearing is shown in fig. and geometrical specification are given in table no. 1

**Table 1: Geometrical properties of ball bearing (6206)**

| Property | Value |
|---|---|
| Bearing outside diameter, (D) | 62mm |
| Bearing bore diameter, (d) | 30mm |
| Bearing width, (B) | 16mm |
| Ball diameter, (BD) | 9.6mm |
| Contact angle, (β) | 0 |
| Number of balls, (n) | 9 |

## 2.2 Sample preparation

Silica contaminant particles are used for deliberately contaminating the lubricant of the bearings. The required contaminants of different size ranges were obtained using standard sieves. The samples are prepared by varying weight percentage of contaminant of that weight of grease and sizes of contaminant. The quantity of grease taken is 5gm. The Silica particle is taken in the sizes of 150μm, 250μm and 355 μm. Each size is added in the grease in different concentration levels as 5%, 10% and 15%. Every time a new bearing is taken for study. In this way total 9 sample bearings are taken for study. Grease which is initially in the bearing is removed with the help of kerosene and newly prepared contaminated grease sample is filled in it

The grease weight is selected by considering a standard empirical relation. The relation is given as, **G=0.005DB0.005*62*16**

**G=4.96 gm =5 gm(say)**

Where G is grease quantity (gm), D is the bearing outside diameter (mm), and B is bearing width (mm). [4]. By the calculation made above, the quantity estimated is 5gm.

**Fig. 2.1: Bearing samples**

### 2.3 Frequency equations required

**Table 2: Frequency equations required [12]**

| Characteristic frequency (Hz) | Symbol | Equations |
|---|---|---|
| Shaft Rotational Frequency | Fs | N/60 |
| Inner race defect frequency | Fid | $n/2*fr[1+(bd/pd)*\cos\beta]$ |
| Outer race defect frequency | Fod | $n/2*fr[1-(bd/pd)*\cos\beta]$ |
| Ball defect Frequency | Fbd | $Pd/2bd*Fr[1-(bd/pd)^2*(\cos\beta)^2$ |

Where,

N:-rotational speed of shaft in RPM, n:-No. of balls, Fr:-Shaft Rotation Frequency, bd:-Ball Diameter,β -Contact angle,Pd:-PitchDiameter

**Table 3: Fault frequencies at 1440 speed**

| Sr. No. | (N) RPM | (Fs) Hz | (Fid) Hz | (Fod) Hz | (Fbd) Hz |
|---|---|---|---|---|---|
| 1 | 1440 | 24 | 130.53 | 85.46 | 110 |

### 2.4 Experimental procedure

The amount of grease applied to the bearing for lubrication is 5 g (the grease quantity is based on ball bearing geometry calculation). 5 % of grease quantity, which is 0.25 g of Silica particles, is added as contaminant. Similarly, 10 % of grease quantity and 15 % of grease quantity (0.5 and 0.75 g, respectively) of Silica particles are added as contaminants. The test is followed in a sequence of three steps. In the first step, the bearing is running in healthy grease in order to stabilize the grease temperature. In the second step, the test was continued in healthy grease to collect the vibration data at different speeds. In the third step, the contaminated grease was applied to the bearing. A separate bearing is used for each concentration level of the test. The above procedure is repeated for all concentration levels. Finally, vibration results of the defective bearings in healthy grease were compared to vibration results of the bearings in contaminated grease. Data were recorded and analyzed with respect to peak values and the root mean square (RMS) values

### 3. Results and Discussion

By running all the sample bearings at constant running condition, the vibration signatures are obtained. All the collected signatures are analysed for vibration amplitude in terms of acceleration value.

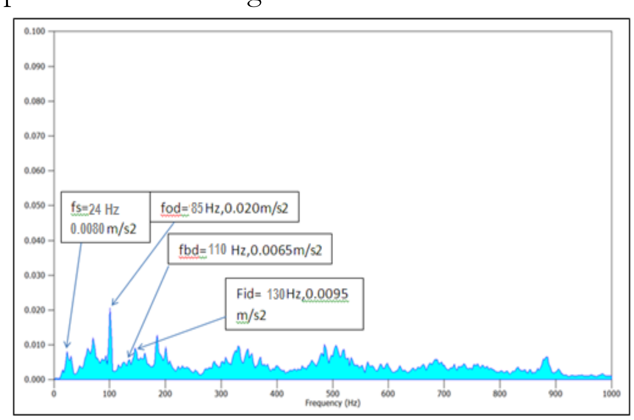



**Fig. 3.1: Acceleration-Frequency plot for healthy bearing sample running at 1440 RPM**

Fig. 3.1 indicates the signatures obtained for healthy bearing with contaminant free grease. It indicates all the frequencies are at minimum level this is happen because there is no medium present in grease which produces the vibrations in the same bearings.

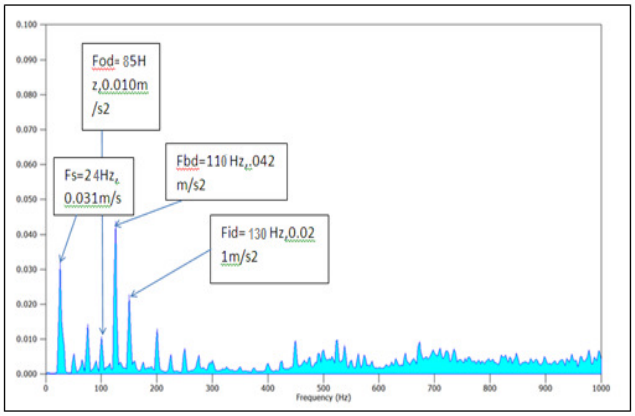



**Fig. 3.2: Acceleration-Frequency plot for bearing sample S1C1 running at 1440 RPM**

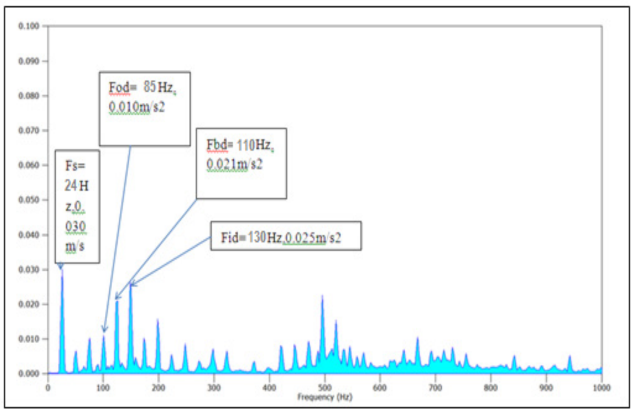



**Fig. 3.3: Acceleration-Frequency plot for bearing sample S1C2 running at 1440 RPM**

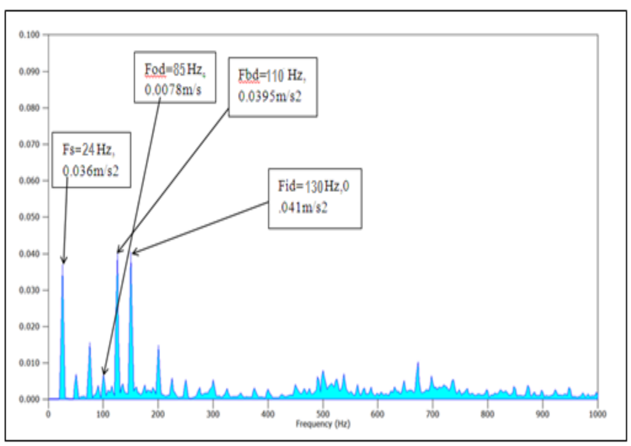



**Fig.3.4: Acceleration-Frequency plot for bearing sample S1C3 running at 1440 RPM**

The fig. 3.2, 3.3, 3.4 indicates the signatures obtained when the contaminant material used is silica, size of particle taken as 150 μm, with concentration levels changed as 5%, 10%, and 15% respectively. With the help of arrows the Acceleration values are shown at particular defect frequencies. The conclusion is, as the concentration level is increased, there is an increase in acceleration value at some of the defect frequencies, also there is considerable increase in RMS acceleration value.

It shows that, as the concentration level is increased, the acceleration value at some of the defect frequencies goes on increasing and some of defect frequencies decreasing. i.e. the acceleration value at outer race defect frequency is goes on decreasing and the acceleration values for inner race defect frequencies and ball defect frequencies are goes on increasing. This is happening because at smaller particle size at higher concentration levels the particles may not come in vicinity of outer race.

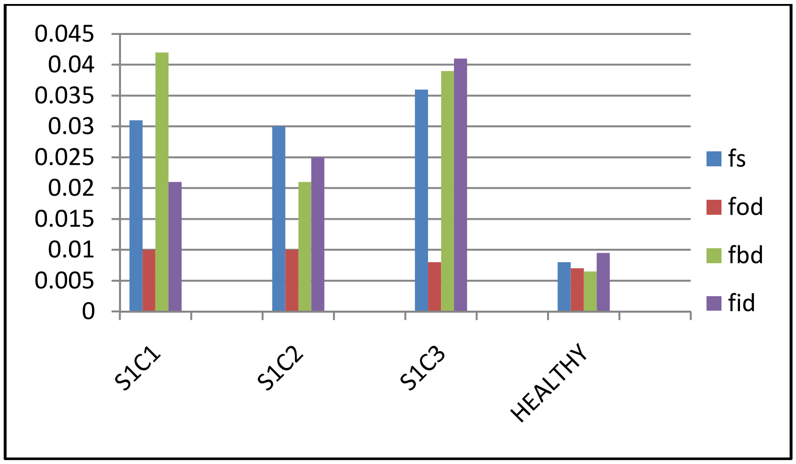



**Fig. 3.5: Acceleration Vs. Contaminant Concentration forbearing sample S1C1, S1C2, S1C3**

Size of the particles taken for experimentation are 150µm,250µm,355µm with concentration levels varied as5%,10%,15%of weight of grease respectively. The graph shows that with an increase of concentration level, acceleration of some defect frequency increased and some decreased

For the same bearing sample if the concentration and size of silica changed, the acceleration value also goes on changing for every defect frequency. As the particle size and concentration is increased, there a considerable decrease in acceleration value at Inner-race defect frequency is observed. This may be happening because at higher speed the particles are thrown in outward direction because of the centrifugal force and hence they are not coming in contact of inner-race. The exactly opposite phenomenon is observed in case of outer-race defect frequency, as the speed is increased, the acceleration value also went on increasing.

## 4. Validation with Ansys

### 4.1 Geometry Creation-

The Creo 2.0 is used to model the bearing with all intricate geometric details.

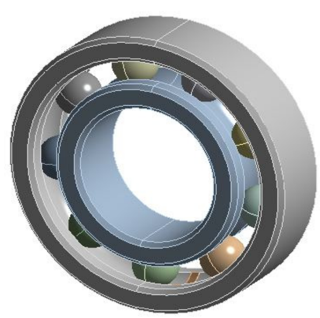


**Fig. 4.1: Solid model of the SKF 6206 Ball Bearing in Creo 2.0**

### 4.2 Validation of Experimental results with Analytical results

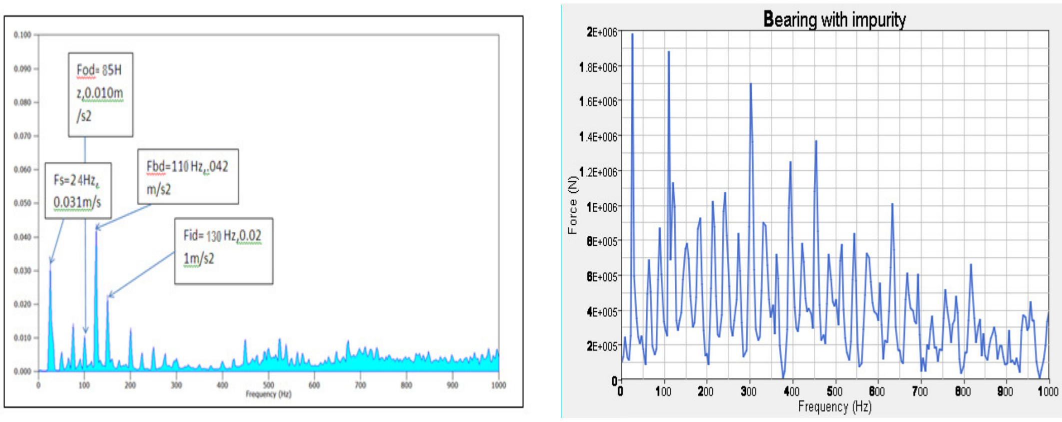
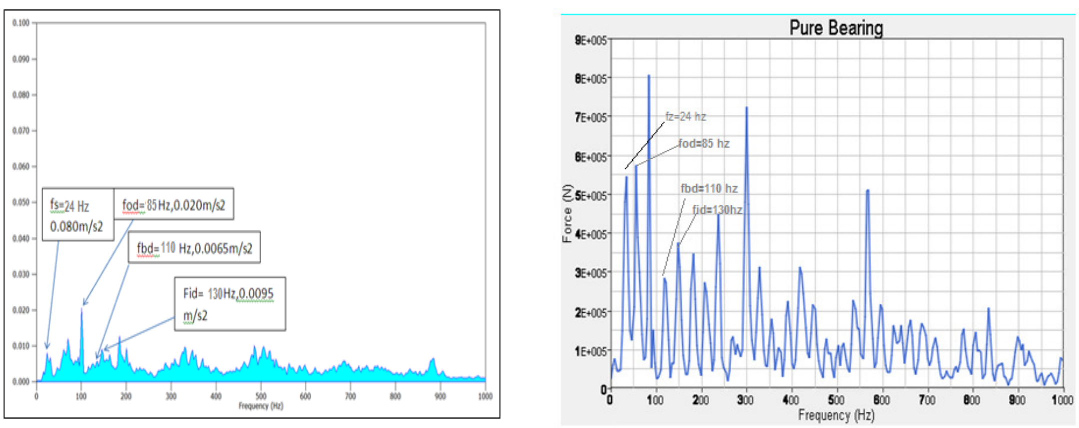



**Fig. 4.2: Comparison between experimental results with analytical results for contaminated bearing sample S1C1**

**Table 4.2.1: Comparison between Experimental and analytical results of contaminated bearing**

| Defect Frequency Hz | Experimental values of Acceleration m/s² | Analytical Values of Acceleration m/s² |
|---|---|---|
| Fs=24 | 0.031 | 0.024 |
| Fod=85 | 0.010 | 0.05 |
| Fbd=110 | 0.042 | 0.034 |
| Fid=130 | 0.021 | 0.014 |




**a) Experimental graph for pure bearing b) Analytical graph for pure bearing**

**Fig. 4.3.2: Comparison between experimental results with analytical results for pure bearing sample**

**Table 4.2.2: Comparison between Experimental and analytical results of healthy bearing**

| Defect Frequency Hz | Experimental values of Acceleration m/s² | Analytical Values of Acceleration m/s² |
|---|---|---|
| Fs=24 | 0.0080 | 0.0069 |
| Fod=85 | 0.020 | 0.011 |
| Fbd=110 | 0.0065 | 0.0056 |
| Fid=130 | 0.095 | 0.086 |

### 5. Conclusion

In this work condition monitoring through vibration analysis of deep groove ball bearing is done to analyse the effect of solid contaminant in lubricant on bearing. For healthy bearing all frequencies are at lowest level since there is no contaminant in grease. Silica is used as contaminant. The results show that due to addition of the contaminant in grease, there is increase in vibration signature of ball bearing for constant speed. As grain size is increased, the corresponding acceleration values go on increasing up to specific limit then it starts decreasing. This is due to contaminant occupy corners present in the bearing by virtue of its weight, therefore it does not come in contact with rolling elements

**6. References**


1. V Hariharan, Condition Monitoring Studies On Ball Bearings Considering Solid Contaminants In The Lubricant, *Proc. Imeche* Vol. 224 Part C: J. Mechanical Engineering Science JMES1885
2. M.M. Maru and R.S. Castillo, Study Of Solid Contamination In Ball Bearings Through Vibration And Wear Analyses, *Tribology International*, 40 (2007) pp.433–440.
3. Abhay Utpat, R.B. Ingle, M.R. Nandgaonkar, "Study of vibration response characteristics of deep groove Ball Bearings with localized defect on its races", Journal of Mechanical Engineering,(ISSN-0039-2472), ), 62, 5-6 ,2011, pp-311
4. JuhaMiettinen., Influence Acoustic Emission Of Rolling Bearings Lubricated With Contaminated Grease, *Tribology International* 33 (2000), pp.777–787.
5. S. Raadnui and S. Kleesuwan, Electrical Pitting Wear Debris Analysis Of Grease-Lubricated Rolling Element Bearings, *Wear* 271 (2011),pp.1707– 1718
6. Mike Johnson, "Planning for Destruction: The Problem of Grease Contamination", Lubrication Excellence, 2004
7. P.Kamalesan, Vibration Studies On Ball Bearing Considering Solid Contaminant In Lubricants, *South Asian Journal of Engineering and Technology* Vol.2, No.23 (2016) ,pp.121
8. N. Tandon, Condition Monitoring Of Electric Motor Ball Bearings For The Detection Of Grease Contaminants, *Tribology International* 40 (2007) ,pp.29–36
9. GaganSingotia, Experimental, Study Of Various Solid Contamination In Ball Bearings, *IJERT* Issue 3, Vol.5 (September 2013), ISSN 2249-61
10. V. N. Patel, Vibration Studies of Dynamically Loaded Deep Groove Ball Bearings in Presence of Local Defects on Races, *Procedia Engineering*,64 ( 2013), pp.582 – 1591
11. Lingli Cui and Xue Chen , Dynamics Modelling and Analysis of Local Fault of Rolling Element Bearing, *Hindawi Publishing Corporation Advances in Mechanical Engineering*(2014)