Bearing Health Analysis on RPM

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ABSTRACT: In bearings faults are one of the main reasons for the problems in rotating machines. In order to reduce the unnecessary cost and the increased security of the workers and machine every industry wants an efficient maintenance technique. Thus, it becomes necessary to diagnose and detect the faults in bearings for the reliable and safe operation. This study is centred around the characterization of bearings on different rpm and faults. A test rig has been taken with two different bearings in two of the three cases and in the third case similar type of bearings at the driven and non-driven end of the test rig. After performing the experiment, comparison has been done on the basis of data received from omnitrend.

Keywords: Bearing faults, Faults diagnosis, machine vibration, RPM

INTRODUCTION

The main function of bearing is to reduce friction for rotating shaft which rest on these bearings. There are various type of bearings which are used as per application. Criteria like load and rpm are used to select a bearing e.g. ball bearing, roller bearing etc. Bearings can be changed effortlessly and advantageously when it's broken. Vibration inside the bearing leads to variable defects; it even leads to failure of the machine and bearing. Geometrical irregularities can occur due to vibration and these blemishes are the reasons of irregularities during manufacturing of the bearing or during tearing and wearing. During rotation of the bearing as the surface of the bearing comes in contact with the other surface it leads to generation of the impulse resulting generation of the resonance in the machine and bearings. And the impulse will keep on occurring. On the bearing house vibration transducer can be used to check the impulse created by the vibration. During the rotation of the bearing vibration can be evaluated by using the transducer with the Vibs-canner. The vibrating signals are then demodulated and the vibration in the time domain and frequency domain can be calculated and results are taken on different rpm and different bearings on driven and non-driven ends. We have done comparison between different rpm and different characteristic of bearings on both the end and by comparing them we have got some frequencies where we have noticed alarming velocity and displacement of vibration. Then we can find the alarming conditions in the bearing with the help of the software.

EXPERIMENTAL SETUP AND DATA ACQUISITION

We have two main components one is the machine and the other one is the Vibs-canner and they are connected with each other and we acquire signal on the transducer due to the bearing vibration. Different readings are taken at the driven and non driven ends by using different combinations of bearings at various speeds and particular load. On the apparatus to get the vibration signals from different stations accelerometers are used.

After the collection of the signals generated from the vibration few salient features are produced and fed to the software named as Omnitrend. The data are collected for different conditions and different bearings at different rpm. The sensor takes the vertical and the horizontal response on the driven and non driven end.

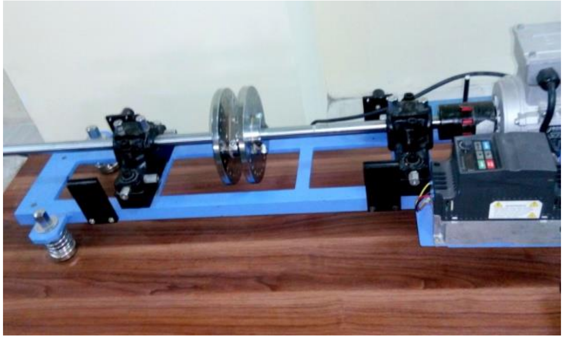


Figure 1.1 Bearing Fault Simulator System

Two types of bearings are used:

1) Healthy bearing (2205)
2) Faulty bearing (2205)

The following cases are considered for acquiring training data:

1) Faulty-Faulty (Driven-Non Driven End)
2) Faulty-Healthy (Driven-Non Driven End)

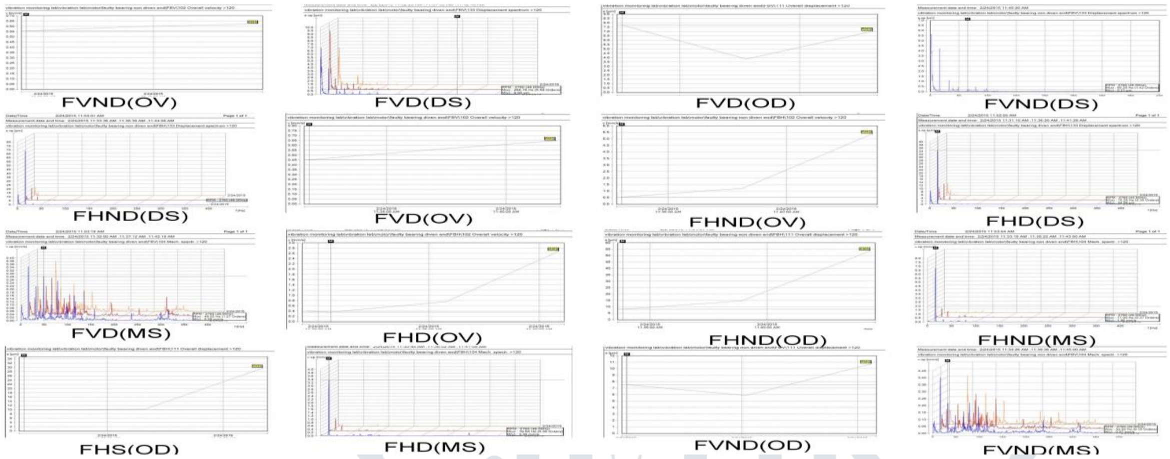
Parameters of Bearing used for experiment:

Bearing name	2205 Self-aligning Ball Bearing
Model	2205
Categories	Self-aligning Ball Bearings
Inside diameter	25 mm
Outside diameter	52 mm
Thickness B	18 mm
Size (mm)	25x52x18 Inside diameter x Outside diameter x Thickness

(a) (b)

Figure 1.2 (a)Faulty Bearing (b) Healthy Bearing

Vibration responses are obtained at various speeds and with loading condition with considerations of all cases in a phased manner. Following abbreviations are used for the data recording, **FVND**- faulty vertical non driven, **FHND**- faulty horizontal non driven, **FVD**- faulty vertical driven, **FHD**- faulty horizontal driven, **HVND**- healthy vertical non driven **HHND**- healthy horizontal non driven, **HVD**- healthy vertical driven, **HHD**- healthy horizontal driven, **OV**- overall velocity, **DS**- displacement spectrum, **OD**- overall displacement ,**MS**- mach spectrum



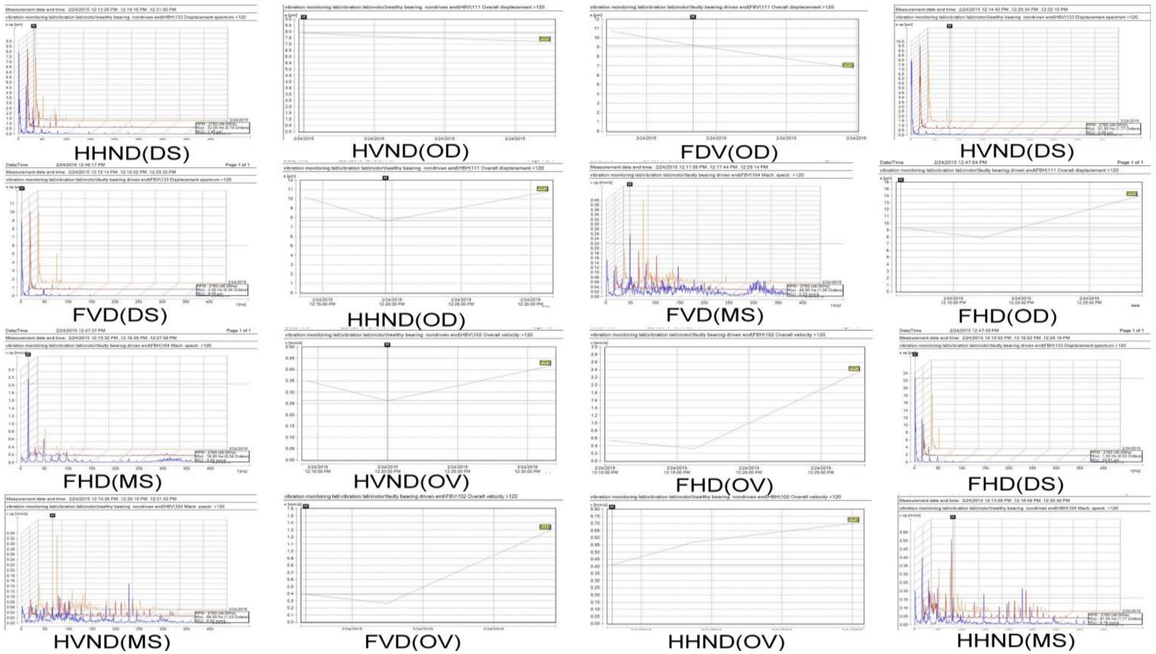
FVND(OV) FVD(DS) FVD(OD) FVND(DS)

FHND(DS) FVD(OV) FHND(OV) FHD(DS)

FVD(MS) FHD(OV) FHND(OD) FHND(MS)

FHS(OD) FHD(MS) FVND(OD) FVND(MS)

Figure 1.3 Faulty-Faulty comparison at 500, 750 and 1000 rpm



HHND(DS) HVND(OD) FDV(OD) HVND(DS)

FVD(DS) HHND(OD) FVD(MS) FHD(OD)

FHD(MS) HVND(OV) FHD(OV) FHD(DS)

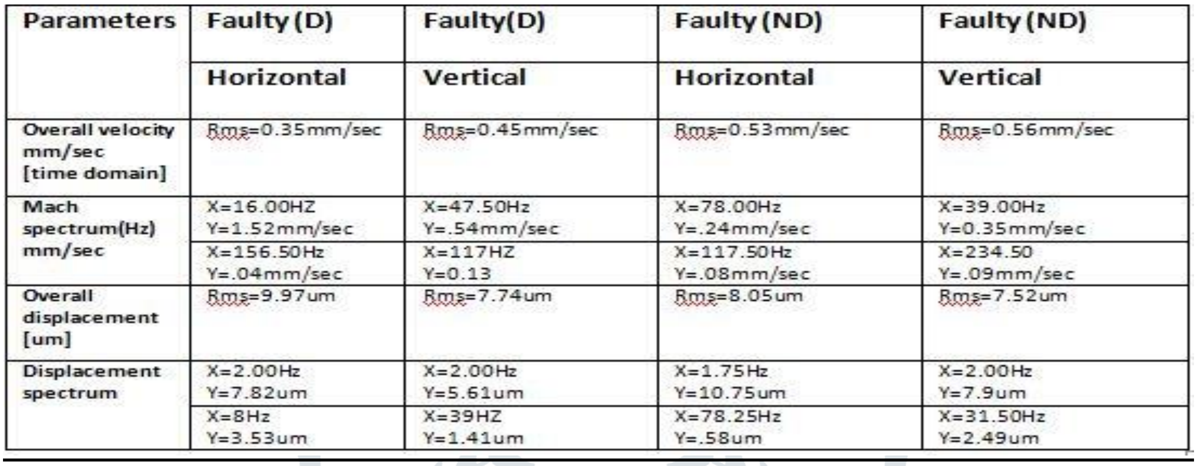
HVND(MS) FVD(OV) HHND(OV) HHND(MS)

Figure 1.4 Faulty-Healthy comparison at 500, 750 and 1000 rpm

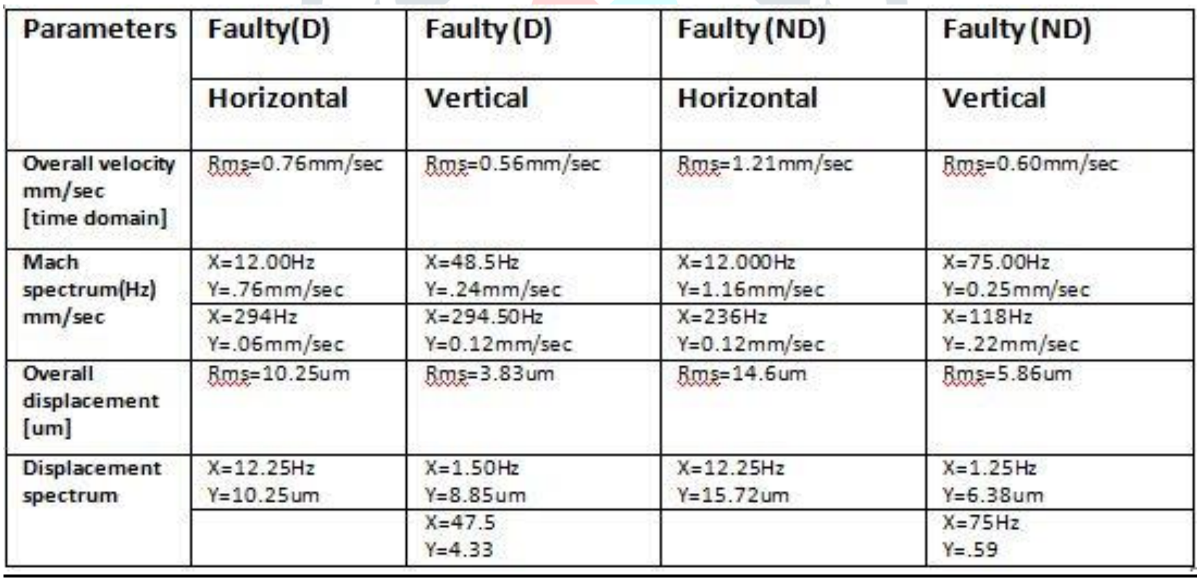
Result and discussion

While selecting the correct bearing, lubricant with sufficient amount of load on the shaft so the rolling element must rotate around the raceways but it can observe the skidding in many cases, sometimes skidding can be stopped by using small amount of grease, but after sometime same problem occurs. it have observed when the bearing gets started skidding occur and even on cold days due to lubricant viscosity. There can be lot of situations which leads to skidding but the point of focus is the unloaded portion skidding of the bearing. Skidding can be hazardous to the shaft and the bearing. Contact between the metals causes ample amount of wear, and leads to generation of heat. Due to the damaged bearing surface one can observe the peaks at the frequencies where defect occurs. Due to inconsistency of the vibration frequency it may notice the shorter and the broader peaks. Another matter of concern is loose fit i.e. sliding of inner race on the shaft or outer race on the housing. The damaged areas in the bearing cause vibration and sound. When the comparison between all the cases has been done it has been observed that when the faulty bearing is used on driven end it gives better result as compared to on the non-driven end and we also concluded that when we increase the frequency of rotation of the shaft, vibration and sound increases.

1.1 Table of Faulty-Faulty Bearing (Faulty – Driven, Faulty- Non-Driven) at 500, 750 and 1000 rpm



Parameters	Faulty (D)	Faulty(D)	Faulty (ND)	Faulty (ND)
	Horizontal	Vertical	Horizontal	Vertical
Overall velocity mm/sec [time domain]	Rms=0.35mm/sec	Rms=0.45mm/sec	Rms=0.53mm/sec	Rms=0.56mm/sec
Mach spectrum(Hz) mm/sec	X=16.00HZ Y=1.52mm/sec	X=47.50Hz Y=.54mm/sec	X=78.00Hz Y=.24mm/sec	X=39.00Hz Y=0.35mm/sec
	X=156.50Hz Y=.04mm/sec	X=117HZ Y=0.13	X=117.50Hz Y=.08mm/sec	X=234.50 Y=.09mm/sec
Overall displacement [um]	Rms=9.97um	Rms=7.74um	Rms=8.05um	Rms=7.52um
Displacement spectrum	X=2.00Hz Y=7.82um	X=2.00Hz Y=5.61um	X=1.75Hz Y=10.75um	X=2.00Hz Y=7.9um
	X=8Hz Y=3.53um	X=39HZ Y=1.41um	X=78.25Hz Y=.58um	X=31.50Hz Y=2.49um



Parameters	Faulty(D)	Faulty (D)	Faulty (ND)	Faulty (ND)
	Horizontal	Vertical	Horizontal	Vertical
Overall velocity mm/sec [time domain]	Rms=0.76mm/sec	Rms=0.56mm/sec	Rms=1.21mm/sec	Rms=0.60mm/sec
Mach spectrum(Hz) mm/sec	X=12.00Hz Y=.76mm/sec	X=48.5Hz Y=.24mm/sec	X=12.000Hz Y=1.16mm/sec	X=75.00Hz Y=0.25mm/sec
	X=294Hz Y=.06mm/sec	X=294.50Hz Y=0.12mm/sec	X=236Hz Y=0.12mm/sec	X=118Hz Y=.22mm/sec
Overall displacement [um]	Rms=10.25um	Rms=3.83um	Rms=14.6um	Rms=5.86um
Displacement spectrum	X=12.25Hz Y=10.25um	X=1.50Hz Y=8.85um	X=12.25Hz Y=15.72um	X=1.25Hz Y=6.38um
		X=47.5 Y=4.33		X=75Hz Y=.59

Parameters	Faulty (D)	Faulty (D)	Faulty (ND)	Faulty (ND)
	Horizontal	Vertical	Horizontal	Vertical
Overall velocity mm/sec [time domain]	Rms=2.69mm/sec	Rms=0.65mm/sec	Rms=5.38mm/sec	Rms=0.62mm/sec
Mach spectrum(Hz) mm/sec	X=16.50HZ Y=3.36mm/sec	X=16.50Hz Y=.35mm/sec	X=16.50Hz Y=6.80mm/sec	X=16.50Hz Y=0.40mm/sec
	X=294.50 Y=.18	X=114.5 Y=0.16		X=237.50 Y=.09
Overall displacement [um]	Rms=29.67um	Rms=7.03um	Rms=53.66um	Rms=10.75um
Displacement spectrum	X=16.25HZ Y=34.56mm/sec	X=1.50HZ Y=6.94mm/sec	X=16.25HZ Y=69.08mm/sec	X=1.75HZ Y=5.65mm/sec
		X=49 Y=.94		X=16.25 Y=4.24

1.2 Table of Faulty-Healthy Bearing (Faulty – Driven , Healthy- Non Driven) at 500, 750 and 1000 rpm

Parameters	Faulty (D)	Faulty (D)	Healthy (ND)	Healthy (ND)
	Horizontal	Vertical	Horizontal	Vertical
Overall velocity mm/sec [time domain]	Rms=0.54mm/sec	Rms=0.39mm/sec	Rms=0.41mm/sec	Rms=0.35mm/sec
Mach spectrum(Hz) mm/sec	X=16.00HZ Y=0.53mm/sec	X=40.00Hz Y=.35mm/sec	X=40.00Hz Y=.26mm/sec	X=40.00Hz Y=0.28mm/sec
	X=208Hz Y=.04mm/sec		X=216.50Hz Y=.05mm/sec	X=216 Y=.04mm/sec
Overall displacement [um]	Rms=9.34um	Rms=10.70um	Rms=10.16um	Rms=7.91um
Displacement spectrum	X=1.50Hz Y=15.02um	X=2.00Hz Y=8.50um	X=1.00Hz Y=6.16um	X=2.00Hz Y=7.71um
	X=16Hz Y=6.05um	X=40.25Hz Y=3.45um	X=40Hz Y=1.10um	X=40Hz Y=1.26um

Parameters	Faulty (D)	Faulty (D)	Healthy (ND)	Healthy (ND)
	Horizontal	Vertical	Horizontal	Vertical
Overall velocity mm/sec [time domain]	Rms=0.32mm/sec	Rms=0.26mm/sec	Rms=0.57mm/sec	Rms=0.26mm/sec
Mach spectrum(Hz) mm/sec	X=12.00Hz Y=.24mm/sec	X=48.5Hz Y=.16mm/sec	X=60.50Hz Y=.047mm/sec	X=60.50Hz Y=0.08mm/sec
	X=290.50Hz Y=0.06mm/sec	X=195Hz Y=0.14mm/sec	X=218Hz Y=0.16mm/sec	X=218Hz Y=.07mm/sec
Overall displacement [um]	Rms=7.88um	Rms=9.20um	Rms=7.67um	Rms=7.60um
Displacement spectrum	X=1.25Hz Y=8.43um	X=1.75Hz Y=9.25um	X=1.50Hz Y=7.58um	X=1.75Hz Y=8.86um
	X=12.25 Y=2.46	X=48.5 Y=.59	X=60.50 Y=1.28	

Parameters	Faulty (D)	Faulty (D)	Healthy (ND)	Healthy (ND)
	Horizontal	Vertical	Horizontal	Vertical
Overall velocity mm/sec [time domain]	Rms=2.36mm/sec	Rms=1.30mm/sec	Rms=0.71mm/sec	Rms=0.42mm/sec
Mach spectrum(Hz) mm/sec	X=16.00HZ Y=2.14mm/sec	X=49.00Hz Y=.26mm/sec	X=16.50Hz Y=.40mm/sec	X=228.0Hz Y=0.15mm/sec
	X=48.50 Y=.61	X=368.5 Y=0.07	X=228.5 Y=.22	
Overall displacement [um]	Rms=13.88um	Rms=6.76um	Rms=10.78um	Rms=7.2um
Displacement spectrum	X=1.50HZ Y=22.61mm/sec	X=1.50HZ Y=8.84mm/sec	X=1.00Hz Y=7.95mm/sec	X=1.00Hz Y=7.99mm/sec
	X=15.75 Y=11.62	X=81.50 Y=.28	X=16.25 Y=4.74	X=31.50 Y=.41

CONCLUSION

When two rough surfaces come in contact with each other under normal load then interlocking occurs at asperity interfaces and a tangential force is required to slide one surface relative to other and this can be only possible when tangential force is greater than the required shear force. [6] it has been found that 60% premature bearing failure is because of inadequate lubrication, poor fitting and due to contamination. So to resolve such problem there are very low friction self-aligning (spherical) bearings which have sliding layers made up of modern materials. Another option is to use solid lubricant like ultra-low friction Teflon (PTFE) fabric, molybdenum disulphide, PTFE based fluoro-polymer etc. in rolling element bearing. These self-lubricating materials provide sliding movement and also resist corrosion.

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