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Impact of Bearing Vibration on yarn quality in Ring Frame

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Abstract: *This digital generation makes everything vibrates in the world, some vibrations are good and useful and the rest fall under the dangerous category. In spinning industry, the impact of vibration is affecting the quality of yarn. The vibration of the tin roller shaft is measured in ring spinning machine LR G5/1 equipped with 1008 spindles. The vibration of the tin roller shaft is measured in various position of the machine (near gear end, middle portion of the machine and from the off end of the machine). The vibration of the bearing also noted with respect to the cop position (¼ stage, ½ stage and ¾ stage). With the help of accelerometer which consists of piezoelectric sensor used to measure the vibration and to measure the acceleration of the frequency spectrum. This sensor is placed on the bearing with the help of magnetic attachment to analyse the vibration by using FFT analyser.*

[1]. Introduction

In modern days the ring spinning operates at the maximum speed up to 25000 rpm. The ring frame also consists of 1008 to 1220 spindles per machine. The effect of tin roller bearing vibration on yarn quality can be studied by measuring the vibration of tin roller shaft bearing at different points during the running condition. A vibrating machine consumes more power than the normally running machines. i.e., consumes extra one unit than the other machines. When it is converted for one year it leads to more loss for industry. Also when there is a fault in the bearing, the friction increases in the shaft and it consumes more power to rotate than the normal speed. The power consumption in a spinning mill can be given in the following figure 1.

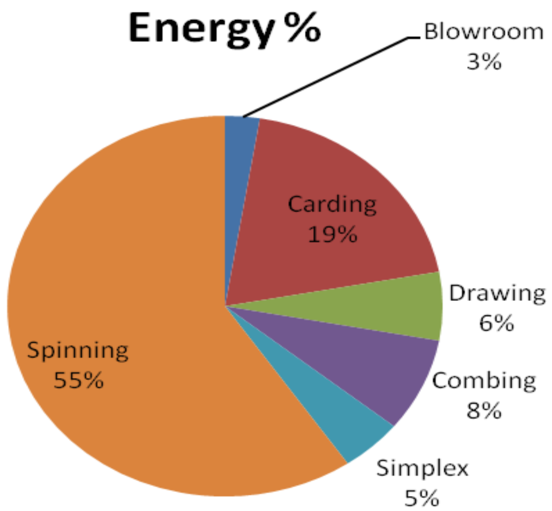


Figure 1. Power consumption of various departments in spinning mill.

The ring spinning department consumes 55% of total energy consumed by the spinning mill. Vibration produced by rolling bearings can be complex and can result from geometrical imperfections during the manufacturing process, defects on the rolling surfaces or geometrical errors in associated components. Noise and vibration is becoming more critical in all types of equipment since it is often perceived to be synonymous with quality and often used for predictive maintenance. Unfortunately though, many bearings fail prematurely in service because of contamination, poor lubrication, misalignment, temperature extremes, poor fitting/fits, shaft unbalance and misalignment. All these factors lead to an increase in bearing vibration and condition monitoring has been used for many years to detect degrading bearings before they catastrophically fail, with the associated costs of downtime or significant damage to other parts of the machine

Bearing vibration is therefore becoming increasingly important from both an environmental perspective and because it is synonymous with quality. Rolling contact bearings represent a complex vibration system whose components i.e. rolling elements, inner raceway, outer raceway and cage interact to generate complex vibration signatures. Although rolling bearings are manufactured using high precision machine tools and under strict cleanliness and quality controls, like any other manufactured part they will have degrees of imperfection and generate vibration as the surfaces interact through a combination of rolling and sliding. The components of bearing can be given in the figure 2.

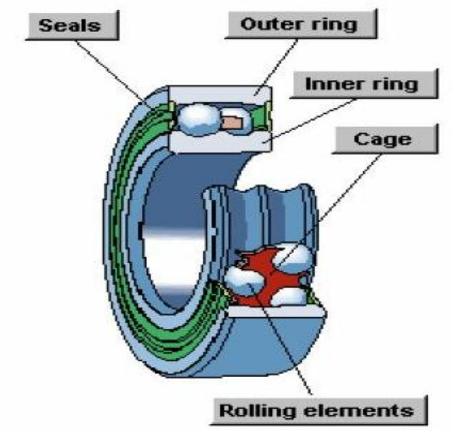


Figure 2 Components of bearing

Nowadays, although the amplitudes of surface imperfections are in the order of nanometres, significant vibrations can still be produced in the entire audible frequency range (20Hz - 20kHz). The level of the vibration will depend upon many factors including the energy of the impact, the point at which the vibration is measured and the construction of the bearing. Rolling element bearings are among the most significant components in the vast Majority of machines and exacting demands are made upon their carrying capacity and reliability. The continued research and development of rolling element bearing Technology has enabled engineers to calculate the life of a bearing with some substantial accuracy, thus enabling bearing life and machine service life to be accurately coordinated. Fatigue and surface distress usually describe the limits for reliable operation of a rolling element bearing. Under different operating conditions, the bearings have different life spans and in general bearing failure is caused by surface distress and is indicated by temperature rise. This leads to bearing damage in due course, resulting in micro-pitting, smearing, indentation and plastic deformation, besides surface corrosions. When measuring vibration, there are several methods that can be used which are overall vibrations, FFT spectrum, Acceleration Enveloping, phase, and SEE Technology (Acoustic Emissions) and high Frequency detection (HFD). The frequency component in the spectrum will change when a mechanical part such as rolling element bearing either wear or break up. In fact, each fault in a rolling element bearing produces vibration with distinctive characteristics that can be measured and compared with reference ones in order to perform the faults detection and diagnosis. Vibration analysis is probably the most important tool to diagnose a problem in a machine and has become accepted and proven worldwide in industries.

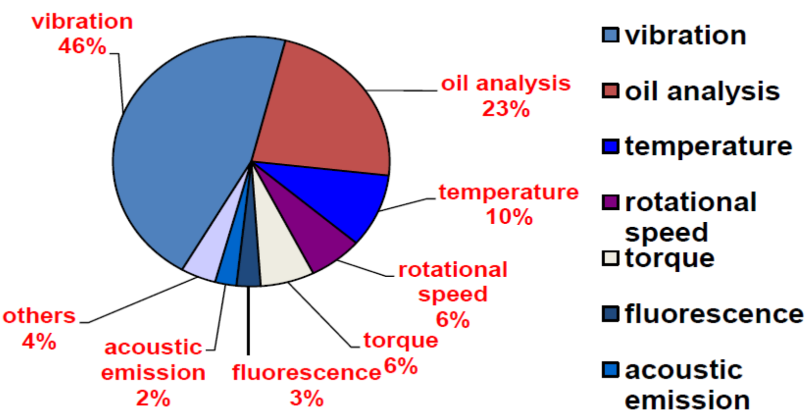
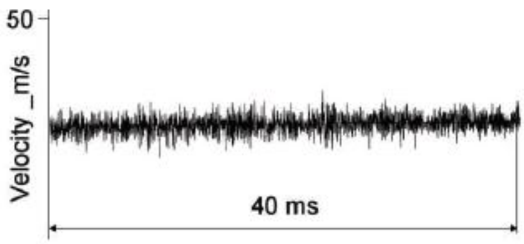


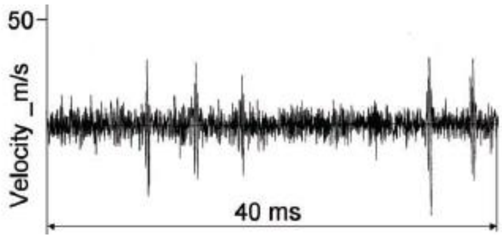
Figure 3 Causes of bearing failure

Detection Methods of Bearing Failure

In majority of the cases every initial problem starts in the bearings and propagates to the rest of the members of the machine. A bearing devoid of lubrication tends to wear out fast and fails quickly, but before this is noticed it damages the remaining components in the machine and an initial look would seem as if something had gone wrong with the other components leading to the bearing failure. Such is the criticality of the bearings in any machinery. From the figure we can understand that the major cause for bearing failure is due to vibration (46%). Contamination is a very common source of bearing deterioration and premature failure and is due to the ingress of foreign particles, either as a result of poor handling or during operation. By it is very nature the magnitude of the vibration caused by the contamination will vary and in the early stages may be difficult to detect but this depends very much on the types and nature of the contaminants. Contamination can cause wear and damage to the rolling contact surfaces and generate vibration across a broad frequency range. In the early stages the crest factor of the time signal will increase, but it is unlikely that this will be detected in the presence of other sources of vibration. Roller bearings are very sensitive to dirt or foreign matter, because of the very high unit pressure between the rollers and raceways. Due to the rolling action of the balls dirt particles will easily enter in to the bearing. With grease lubricated bearings, the vibration may be initially high as the bearing "works" and distributes the grease. The vibration will generally be irregular but will disappear with running time and generally for most applications does not present a problem.



Signal from a good bearing



Signal from a damaged bearing

The following table gives a details about the causes and % of failure rate of bearing

Table 1 The causes and % of failure rate of bearing

Causes	Failure rate in %
Dirt	45.4
Misassembly	12.8
Misalignment	12.6
Insufficient lubrication	11.4
Over loading	8.1
Corrosion	3.7
Improper journal finish	3.2

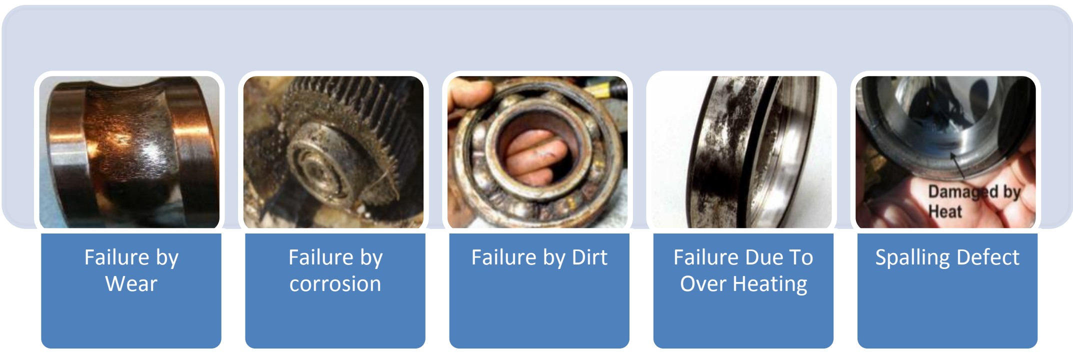
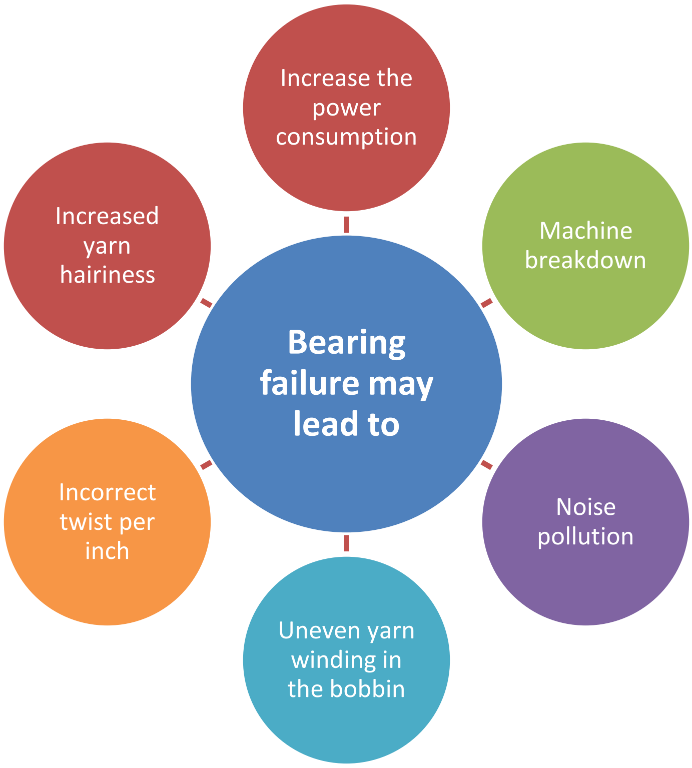


Figure 4 Types of Bearing Failure



Experimental set up

To study the vibration in ring spinning machine LR G5/1 machine equipped with 1008 spindles has been selected. The count processed in the machine 40's N_e combed hosiery. The roving hank of the feed material is 1.2. The machine operates with a slow speed of 13,000 rpm and with a high speed of 20,000 rpm. The twist per inch given to the yarn is 25.3. The vibration of the tin roller shaft is measured in various position of the machine (near gear end, middle portion of the machine and from the off end of the machine). The vibration of the bearing also noted with respect to the cop position (¼ stage, ½ stage and ¾ stage). The measurement of vibration is done by using accelerometer which consists of piezoelectric sensor. This sensor is placed on the bearing with the help of magnetic attachment to analyze the vibration by using FFT analyzer. The accelerometers are used to measure the acceleration of the frequency spectrum. Figure 5 shows the accelerometer that are used and their specifications that are listed in the table 2.

Figure 5 Accelerometer

Defects are analyzed with the help of accelerometer along with DIGITAL STORAGE OSCILLOSCOPE device for spectrum and waveform analysis to detect the roller bearing defect in the Ring frame. Vibration measurement data will be collected by CMVA65 Micro log Data Collector/Analyzer and various Micro log plots will be manipulated for analysis and to generate FFT (Fast Fourier Transformation) spectrum reports from the Micro log data collector

Table 2 Accelerometer Specifications

COMPANY	**ABRO**
MODEL NO	**102-1A**
SERIAL NO	**AB1234**
OPERATING RANGE	**100mV/g**

DSO (Digital Storage Oscilloscope) FFT analyser was used to take the vibration readings. This analyzer shows the vibration signals with the help of accelerometer sensor. This vibration signals will be can be converted in to either in the form of analog or digital by using MATLAB software. The voltage signal from the accelerometer is measured using the digital storage oscilloscope which can be recorded in the form of image and it is for spectrum analysis purpose. Figure 6 shows the DSO running condition image while running the setup and the table gives the settings that are made in the DSO.

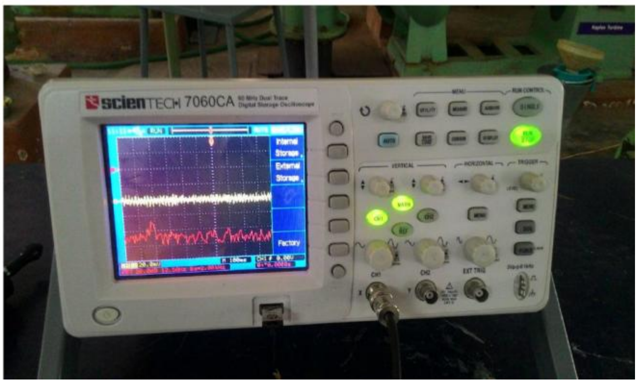


Figure 6 Digital Storage Oscilloscope

CHANNEL 1	**20mV**
FFT	**20db**
SAMPLING RATE	**2 KHz**
OPERATING VOLTAGE RANGE	**-0.6 s to 0.6 s**

Bearing Specification

- Bearing type : 45NPPB
- Number of balls : 9
- Inner diameter : 45 mm
- Outer diameter: 85 mm
- Thickness: 19 mm
- 24 tin roller bearing used in one machine

The process of measurement and setup has been given in the following figure.

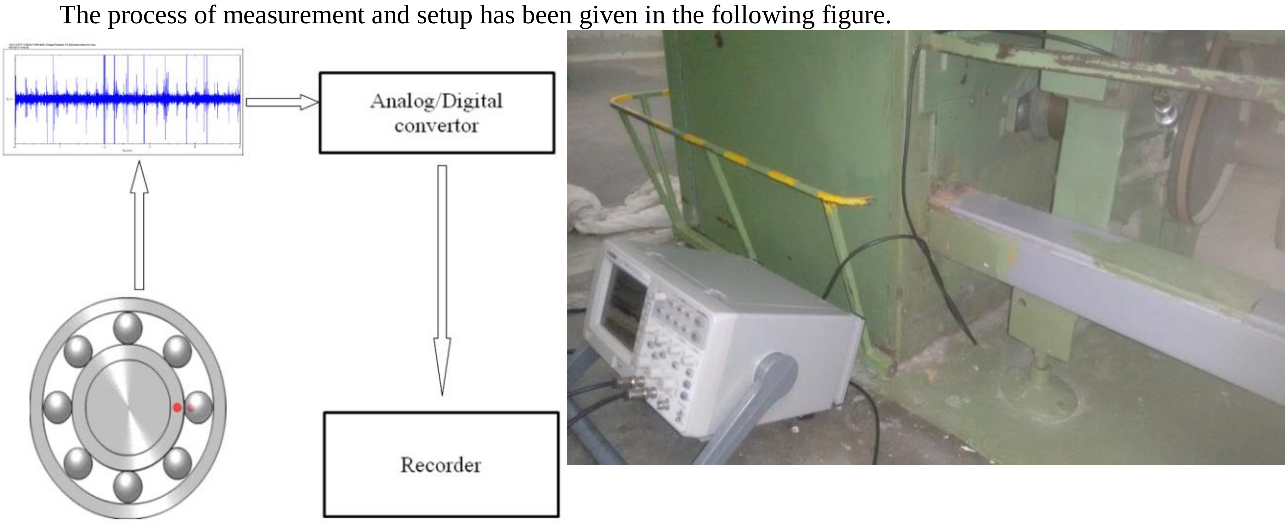


Figure 7 Experimental Setup

The calculation of vibration has been done by using the following formula

1. Fundamental train (cage) frequency:

$$N_f = ½ * N * \left[1 - \left[\left(\frac{d}{p}\right) cos\Phi\right]\right] \div 60$$

2. Ball spin frequency:

$$N_b = ½ * N * \left(\frac{p}{d}\right) * \left[1 - \left[\left(\frac{d}{p}\right)^2 \cos^2 \emptyset\right]\right] \div 60$$

3. Outer race frequency:

$$N_o = ½ * N * n \left[1 - \left[\left(\frac{d}{p}\right) cos\Phi\right]\right] \div 60$$

4. Inner race frequency:

$$N_i = (N * n) - ½ * N * n \left[1 - \left[\left(\frac{d}{p}\right) cos\Phi\right]\right] \div 60$$

Where,
Nf – Fundamental Train Frequency
Nb –Ball Spin Frequency
No – Outer Race Frequency
Ni – Inner Race Frequency
A – Perfect Condition
B – Average Condition
C - Below Average Condition
D- Failure Condition

Comparison results of ring frame machines

S.no	Frame no	Year	Count	Analytical result (Hz)				Experiment result (Hz)				Grade
				Nf	Nb	Ni	No	Nf	Nb	Ni	No	
1	2	2007	40's chy	7.820	33.23	132.93	70.38	6	29	129	64	A
2	3	2002	40's chy	8.37	27.20	142.31	75.34	7.813	27	138.2	69.82	A
3	4	2003	40's com	8.53	36.24	161.6	76.7	6	32.71	133.3	69.34	A
4	8	2004	40's com	8.61	36.59	146.38	77.5	5	26	119	62	A
5	9	2005	40's com	8.57	36.4	145.7	77.1	7.813	31.74	130.9	64.45	A
6	10	2006	40's com	8.26	35.11	140.4	74.3	8	27	124	62	A
7	17	2006	30's chy	8.31	32.82	141.4	74.8	7.324	30.27	122.6	65.9	A
8	21	2006	34's chy	8.13	34.5	138.20	73.18	7.324	30.27	127.4	69.34	A
9	23	2003	34's chy	7.78	33.08	132.35	70.08	7.324	30.76	130.09	66.41	A

Power Consumption

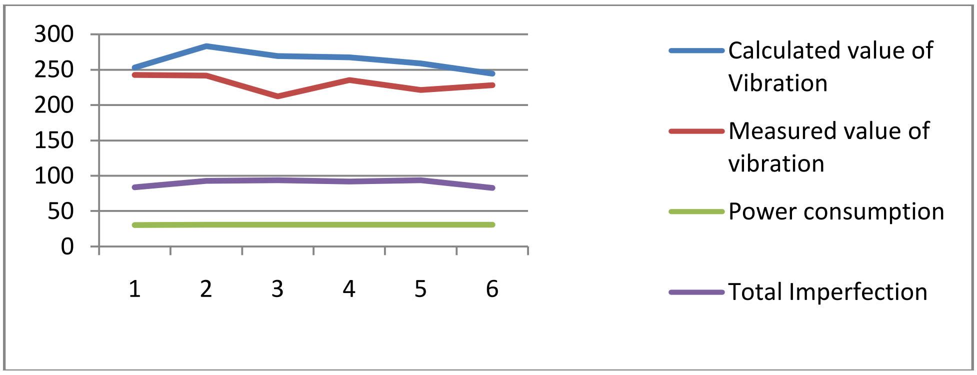
Frame no	Count	Power (unit per hour)
02	40's	30.6
03	40's	30.3
04	40's com	30.8
08	40's com	30.8
09	40's com	30.7
10	40's com	30.8
17	30's	37.4
21	34's	36
23	34's	36.7

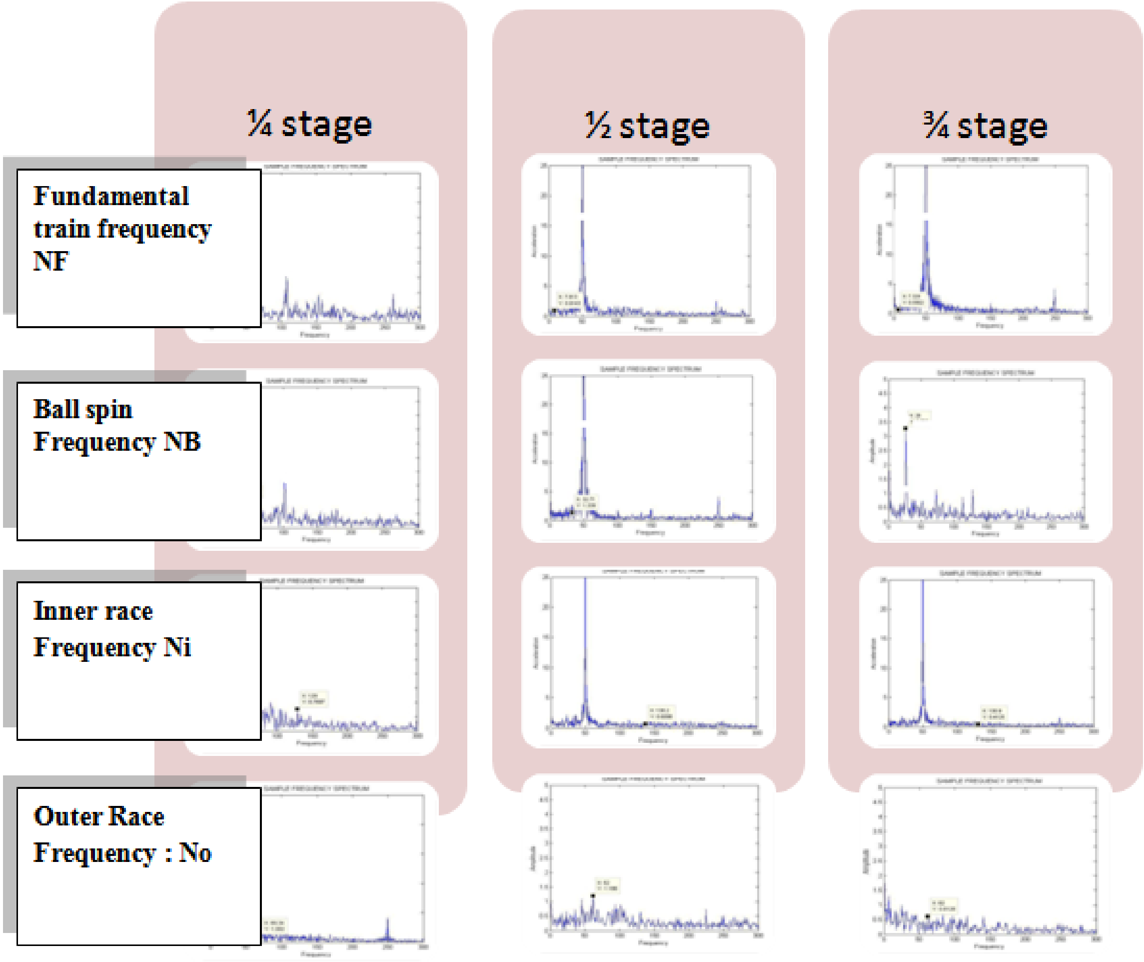
Quality of Yarn

Frame no	Count	LI%	Thin -50%	Thick +50%	Neps +200	Total
02	40's	10.17	0.4	29.3	53.4	83.1
03	40's	10.14	0.4	29	54.6	84
04	40's com	10.19	0.5	26.3	66.4	93.2
08	40's com	10.26	0.5	26.7	66.8	94
09	40's com	10.30	0.5	26.4	65.2	92.1
10	40's com	10.15	0.5	26.1	67.2	93.8
17	30's	9.53	0.1	29.1	40.1	69.3
21	34's	9.74	0.1	27.1	50.1	77.3
23	34's	9.88	0.1	27.1	50.6	77.8

Year of make	Calculated value of Vibration	Measured value of vibration	Power consumption	Total Imperfection
2002	252.93	242.18075	30.2925	83.9125
2003	282.875	241.0725	30.725	93.175
2004	268.875	211.92	30.725	93.91
2005	267.42	234.80825	30.6725	92.0675
2006	258.8225	220.8425	30.725	93.705
2007	244.4045	227.765	30.55	83.055

The table shows the average value of measured vibration frequency Calculated value of frequency, Power consumption, and total imperfection in the yarn. It is also represented graphically as shown below





[2]. Conclusion

By comparing the different experimental results the amplitude peak values are differ which depend upon the conditions of filling cops. At the ¼ condition cop filling its takes some little time (84 minutes) smaller vibration frequency. During the ½ condition at constant load and constant speed is maintained for long period of time (93 minutes). At this the vibration frequency response is little higher when compare to ¼ conditions. At ¾ stage of cop build up the vibration frequency attains maximum peak which indicates the higher load on the machine. As seen by the results the vibration frequency has a direct impact on the quality of yarn produced, which can be indicated by the testing of total imperfection of the yarn. It has been concluded that the year of make of machine has got less significant effect on vibration since the machine bearings has been properly maintained. The vibration has also has direct impact on power consumption during running of the machine. So we can conclude that the vibration of tin roller shaft bearing has got a direct impact on power consumption and total imperfection level of the yarn produced.

References

[1]. S. A. McInerny and Y. Dai, "Basic Vibration Signal Processing for Bearing Fault Detection" IEEE Transaction on education, Vol.-46, No-1, February- 2003

[2]. Braun S and Datner B 1977 Analysis of Roller/Ball Bearing Vibrations. ASME paper 77-WA/DE-5.

[3]. Harris T A, Rolling Bearing Analysis (4th Ed) , Wiley, New York, 2001

[4]. Binz, H., Yarn Spinning Innovation, Technology, *Evolution—Business and Technology Magazine from SKF*, May 15, 1997, http://evolution.skf.com/yarn-spinning-innovation/, Accessed Date: May 1, 2013.

[5]. Basu, A. and Gotipamul, R., Effect of some ring spinning and winding parameters on extra sensitive yarn imperfections. *Indian Journal of Fibre & Textile Research* (South India Textile Research Association) 30: 211–214, June 2005.

[6]. Ishtiaque, S.M., Rengasamy, R.S., and Ghosh, A., Optimization of ring frame process parameters for better yarn quality and production. *Indian Journal of Fibre & Textile Research* 29: 190–195, June 2004

[7]. Shiffler, D.A., Roll wraps in ring spinning. Part II—Effect of fibre and spinning variables. *Textile Research Journal* 9: 515–522, 1993