Setting Up a Vibration Monitoring Programme for Manufacturing Industries

Okeke C.
Department of Electrical/Electronics Engineering, Michael Okpara University of Agriculture, Umudike. Abia State, Nigeria

Obasi R. U.
Department of Electrical/Electronics Engineering, Michael Okpara University of Agriculture, Umudike. Abia State, Nigeria

Nwaorgu O.A.
Department of Electrical/Electronics Engineering, Michael Okpara University of Agriculture, Umudike. Abia State, Nigeria

ABSTRACT

Vibration analysis finds practical applications in condition monitoring of critical plant items, rotating electrical machines plants, testing of repaired equipment and the troubleshooting of process machines. Its major benefits are found in prolonged equipment life, reduced maintenance and repair cost, reduce need for standby machines, minimal equipment breakdown, and encourage predictive maintenance instead of routine overhaul of machines. More importantly there is a less noise generation in machines subjected to vibration analysis as the incipient faults are detected and fixed early enough before a major breakdown occurs.

Keywords: Critical plant items, Monitoring, Rotating Electrical machines, vibration Analysis.

1.0 INTRODUCTION

Rotating electrical machines are prone to mechanical defects that eventually cause break down and unnecessary components repair. Experience has shown that, all mechanical failures are preceded by increase in vibration which can be detected by periodic vibration checks. Monitoring the performance characteristics of electrical machines has proven to be effective in detecting faults while they develop. Some of the observed defects are, unbalance rotating members, Misalignment, looseness and bad bearings etc. These characteristics were obtained either through computer simulations [1] or through the use of vibration spike energy detector model 811 developed by international research and development (IRD) mech-analysis (UK) Ltd [2]. This rugged industrial instrument measures machinery vibration in terms of three observable quantities.

The measured quantities are:

(i) Displacement: Displacement measurements is used for measuring the condition of slower speed machinery, particularly where displacement standard have been established.

(ii) Velocity measurements: This measurement provides a combined effect of vibration, displacement and also the frequency. It can be applied universally regardless of machine speed or type of trouble. Velocity is the best measure of vibration severity.

(iii) Acceleration: Acceleration measurement is widely used where vibration occurs at high frequencies. These measurements are well suited for investigating vibration from sources where the frequency of vibration is many times shaft revolution per minute. Here, mechanical defects can be detected while the machine runs and an effective routine maintenance put in place, with minimal operational loss or production down time [3].

2.0 CAUSES OF EQUIPMENT FAILURE

The causes of rotating electrical machine failures are traced to the following:

(a) Moisture ingress which constitutes 30% of all failures.

(b) Motor burn-out due to overloading 23%

(c) Bearing failure 17%

(d) Burnt-out of winding due to other causes 12% [4].

To minimize the above causes of failure, an action plan is required as follows:

(i) Make electrical machine terminal boxes water – tight

(ii) Check electric motor overload settings and set at motor full load current. Avoid contact of shaft/couplings/guards with rotating parts.

(iii) Lubricate bearing frequently.

(iv) Establish preferred diagnostic procedures.

3.0 CONDITION MONITORING EQUIPMENT SELECTION ADVISE

(a) For vibration monitoring: Use IRD 811M vibration meter or any equivalent.

(b) For Dynamic Balance measurement: Use IRD 800M Microprocessor Balancer.

(c) For Machine Diagnosis: Use SPM ELS-12 Electronic Stethoscope.

(d) For thickness measurement: Use Krautkramer DM3 ultrasonic meter.

(e) For Electric motors check: Use SPM EMC – 11 electric motor checker.

4.0 VIBRATION MONITORING PROGRAMME

All establishments with large numbers of rotating machines have to set up a vibration monitoring programme. The first step is to identify key machines such as critical plant items and troublesome machines.

The second step is to decide on measurement intervals such as monthly measurement or frequent measurement. We start with frequent measurement, and then if readings are steady, the interval can be increased.

5.0 VIBRATION MEASUREMENT POSITIONS

A typical electric drive consists of electric motor coupled to the mechanism of grinding machine, pump etc. The equipment shown in figure1 and labeled A to D indicates the bearing positions. Measurements are taken at points A, V and H in the given arrow directions. The directional arrows labeled A, V and H are explained as when movements is made in the directions, thus for direction A-

Axial movement, the likely cause of high vibration can be attributed to misalignment or bent shaft. For direction H-Horizontal measurement, the cause of high vibration is due to unbalance in the motor and faulty bearing.
And in V- vertical measurement, the likely cause of high vibration is traceable to loose mountings and weak base [7].

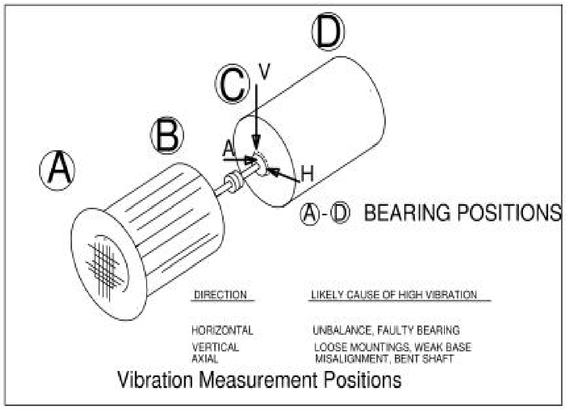

Figure 1 Vibration measurement positions.

6.0 VIBRATION MEASUREMENT UNITS (METRIC)

Table 1: Vibration measurement units (Metric)

	IRD 811 UNIT	OTHER UNITS
Displacement	μ m pk-pk	μ m pk = 0.5, μ m pk-pk
Velocity	mm/sec pk	mm/sec Rms
Acceleration	g pk	m/s^2 pk , m/s^2 Rms

7.0 VIBRATION MONITORING IMPLEMENTATION PLAN

To implement the above plan in a factory,

(i) The factory has to be split into units and then allocate responsibility for each unit to a responsible engineer.

(ii) In each unit, select the key 10 most important machines and rank them 1-10

(iv) Arrange the machines in baseline standards, starting with No1 item and set a model for it. And then continue with remaining items.

(v) Introduce a record system and allocate responsibility at supervisory level and monitor vibration on monthly basis. Measurements obtained should be compared with standards. Any measurement outside the standard indicates a problem and has to be fixed. The standards are indicated in Table 2.0.

8.0 A BASIS FOR COMPARATIVE EVALUATION OF VIBRATION IN MACHINERY

Table 2: Tolerance based on BS 4675: 1976 ISO 2372

TOLERANCE BASED ON B.S. 4675 : 1976 I.S.O 2372						
A BASIS FOR COMPARATVE EVALUATION OF VIBRATION IN MACINERY						
Velocity (mm/s) RMS (1)	**Velocity (mm/s) Peak (2)**	**Class I M/C Small**	**Class II M/C Medium**	**Class III M/C Large**	**Class IV M/C Turbo**	**Class V M/C Recip Machinery**
0.28	0.40					
0.45	0.64	A				
0.71	1.00	-----	A			
1.12	1.58	B	-----	A		
1.80	2.54	-----	B	-----	A	
2.80	3.96	C	-----	B	-----	A
4.50	6.37	-----	C	-----	B	-----
7.10	10.00	D	-----	C	-----	B
11.20	15.80		D	-----	C	-----
18.00	25.40			D	-----	C
28.00	39.60				D	-----
45.00	63.70					D
A = Good B = Acceptable C = Still Acceptable D = Not Acceptable						
NOTE : RESILIENTLY MOUNTED MACHINES MAY BE CONSIDERED NORMAL UP TO TWICE THE DESIGNATED CLASS VIBRATION LEVEL						

Source; Reliability Engineering Port sunlight Laboratory, Quarry Road East Bebington wirral, Merseyside L633JP.

8.1 TENTATIVE GUIDE TO VIBRATION TOLERANCES FOR MACHINE TOOLS

Table 3: Tentative guide To vibration tolerances for machine tools

TENTATIVE GUIDE TO VIBRATION TOLERANCES FOR MACHINE TOOLS	
TYPES OF MACHINES	Displacement of vibration as read with pickup on spindle bearing housing in the direction of cut.
***Grinder**	**Tolerance Range**
Thread Grinder	0.25 to 1.5 microns
Profile or Contour Grinder	0.76 to 2.0 microns
Cylindrical Grinder	0.76 to 2.5 microns
Surface Grinder (vertical reading)	0.76 to 5.0 microns
Gardner or Besly Type	1.30 to 5.0 microns
Centreless	1.00 to 2.5 microns
***Boring Machine**	1.50 to 2.5 microns
***Lathes**	5.00 to 25.0 microns
These values come from the experience of IRD personnel who have been trouble shooting machine tools for over 30 years with the IRD equipments. They merely indicate the range in which satisfactory parts have been produced and will vary depending upon size and finished tolerance	

8.2 VIBRATION SEVERITY GUIDELINES (VELOCITY) CHART BASED ON ISO 2372

Table 4: Vibration severity guidelines (velocity) chart based on ISO 2372

	Machine Up to 15KW mm/sec pk	**Machine 15 to 75 KW mm/sec pk**
Good	0 - 1	0 - 1.6
Acceptable	1 - 6.5	1.6 - 10
Not Acceptable	Above 6.5	Above 10
Vibration Severity Guidelines. Velocity Based, on ISO 2372.		

9. CONCLUSION

This work presents a guideline for manufacturing industries with large numbers of induction motors or rotating machines to set up in-house condition monitoring programme for their operations.

An effective condition monitoring programme based on vibration analysis reduces the frequency of equipment failure and production machine down time as well as cost of maintenance and repairs. The ability to predict equipment failure long before it happens allows for good planning and replacement decisions.

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BIOGRAPHY

Engr. C. Okeke, B.Eng, M.Eng, MNSE, holds a Bachelors Degree in Electrical/Electronics Engineering, Enugu State University of Science and Technology, Enugu, Nigeria in 1998. A Masters Degree in Electrical/Electronics Engineering, majoring in Electronics and Communication from the same University in 2006. He is a member of Nigerian Society of Engineers (NSE) and Council for the Regulation of Engineering in Nigeria (COREN). He is a member of International Research and Development Institute (IRDI) and also a member of International Association of Engineers (IAENG). His research area is in Communication Systems and control. Engr. Chukwuma Okeke is currently lecturing in Michael Okpara University of Agriculture, Umuduke, Abia State, Nigeria.

Richard U. Obasi,. PGD, HND. Holds a Post graduate Diploma in Electrical/Electronics Engineering, Federal University of Technology Owerri in 2011, and Higher National Diploma in Electrical Power Engineering/ Machine from the Federal Polytechnic Bauchi in 1985. He is a member of Nigerian Association of Technologist in Engineering (NATE) and a member of Council for the Regulation of Engineering in Nigeria (COREN). His research area is in Electrical Power and Machines. He is currently a Principal Technologist in Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

Okezie A. Nworgu was born in Umuahia, Abia State, Nigeria. He obtained B. Eng Degree in Electronic Engineering from University of Nigeria, Nsukka. In 2004, he obtained M.Tech. degree in Electrical Engineering from Rivers State University of Science and Technology, Nigeria. He is currently a lecturer in Electrical Engineering department of Michael Okpara University of Agriculture, Umudike, Nigeria. His research interests are power systems and Renewable energies.

