CONDITION MONITORING OF ROTATING EQUIPMENTS BY VIBRATION ANALYSYS

PROJECT REPORT

Submitted in the partial fulfillment of the requirements for the degree of

BACHELOR OF TECHNOLOGY
In
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CERTIFICATE

This is to certify that **MARVIN RANJIT, KEVIN ANTONY, VINCENT JOSELIN, VISHAKH C** has satisfactorily completed his project titled, "**CONDITION MONITORING OF ROTATING EQUIPMENT BY VIBRATION ANALYSIS**" at Fertilizers And Chemicals Travancore Ltd(FACT),Kochi as a part of partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Mechanical Engineering** from Amal Jyothi College of Engineering, Kanjirappally, affiliated to APJ Abdul Kalam Technological University Kerala.

Prof. Subin P George Project Guide	Mr. Nibu B Koikaran Assistant Inspection Manager FACT, KOCHI
Prof. Tony Varghese Project Co-Ordinator	Prof. Toms Philip Head of Department

Seal

DECLARATION

We, MARVIN RANJIT, KEVIN ANTONY, VINCENT JOSELIN, VISHAKH C, hereby declare that the project report entitled “Condition Monitoring of Rotating Equipment by Vibration Analysis” submitted in partial fulfillment for the award of the Bachelor of Technology in Mechanical Engineering for the year 2015-2019 for the evaluation to be held in April 2019 is our own work and has been carried out. This project work is original and hasn’t been submitted earlier to this university or to any other university for the fulfillment of the award of any Degree/Diploma Certificate. All the information sources used for the project report have been acknowledged within the report.

Date: 15/5/2019

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ABSTRACT

Advancement of technology and rapid growth of industries has made maintenance of industrial equipment's very important. In the earlier stage of industrial growth maintenance was done on the equipment when it broke down and interrupts production at the plant. Also in those days the speed of machine where much less compared to these days. This increase in speed has led to the faster detoriation of the equipment. Thus, it became necessary to improve the method of maintenance. Then came the method of scheduled maintenance which have the disadvantage of doing the inspection on a machine which is operating satisfactorily may cause problem due to frequent disassembly. After dismantling the whole machine parts, it may be working. satisfactorily, but it will increase the down time of machine. Research on these aspects has led to the development of a predictive maintenance program which helps the maintenance engineer to schedule the repairs to be done when the fault is minor. This helps to reduce the damage to the machine from forced failure. This method may be applied by measuring the velocity, displacement and acceleration of the vibration produced due to rotation of rotor in the equipment. In my project I am going to do condition monitoring of rotating equipment using vibration analysis at Fertilizers and Chemicals Travancore FACT Ltd, Kerala. The project basically in its form, tries to find out the vibration level from each machinery and then compare with the various previous measure baseline readings/standards. The measurement is in vibration velocity. The ISO 10816-1 table is used to know the allowable levels of vibration velocity.

Analysis was done with the use of vibration signature graph when the velocity was above the allowable level the possible cause which will lead to the breakdown of the equipment was bought to the of maintenance department. Thereby they will take necessary and thus can save the loss of time due to major breakdown. Root cause of the failure and proper to prevent this from happening again will be given.

CHAPTER 1

INTRODUCTION

Machinery distress very often manifests itself in vibration or a change in vibration pattern. Vibration analysis is therefore, a powerful diagnosis tool, and troubleshooting of major process machinery would be unthinkable without modern vibration analysis. It is natural for machines to vibrate. Even machines in the best of operation condition will have some vibration because of minor defects as a result of manufacturing tolerances. Therefore, each machine will have a level of vibration which may be regarded as normal or inherent.

When machinery vibration increases or becomes excessive, some mechanical trouble is usually the reason for it. Machinery vibration levels just do not increase or become excessive or no reason at all. causes it unbalance, looseness etc. Each mechanical defect generates vibration in its own unique way. This makes it possible to positively identify a mechanical problem by simply measuring and studying its vibration characteristics.

The success of process industry Often depends on the continued, safe and productive operation of rotating machinery. An effective maintenance program is vital to this kind of success. The quality of the company's maintenance program determines how long the machines will how safe they are for the people working around them. The benefits of a good maintenance program

1. Prolonged machinery life.
2. Minimizes unscheduled down time.
3. Eliminates unnecessary overhaul.
4. Eliminates standby equipment.
5 Provides efficient operations.
6. machinery safety.
7. Improves quality performance.
8. Improves customer satisfaction.

1.1 TYPES OF MAINTENANCE SYSTEM

Based upon the above factors we can classify the various systems as:

- Breakdown maintenance or repair maintenance.
- Preventive maintenance or scheduled maintenance.
- Predictive or Condition based maintenance.

BREAKDOWN MAINTENANCE

With this a machine is allowed to run until complete failure. Inefficiently or product spoilage forces a shutdown. The number of breakdown actually shows the efficiency of the maintenance action. It has a lot of disadvantages:

- It occurs untimely.
- Machine requires extensive repairs.
- Some can catastrophic, requiring total replacement of machine.

PREVENTIVE MAINTENANCE

Preventive maintenance is sometimes called "historical maintenance. This is where histories of each type are analysed and overhauls are scheduled to acquire before the statically expected problems occur. Compared to previous case, a program disassembly and inspection in the distinct advantage of lessening the frequency of breakdown repairs and permitting shutdown.

PREDICTIVE MAINTENANCE

This is also called condition based maintenance, which is based on the determination of machines' condition while in operation The technique is On the fact that most machine components will give some type of warning before they fail. To sense the symptoms by which the machine is warning requires several types of Non-destructive testing such as Oil analysis, wear particle analysis, vibration analysis temperature measurement etc.

	Breakdown maintenance	Preventive maintenance	Predictive maintenance
Breakdown	Highest	Small	Almost negligible
Downtime	High	Low	Low
Product output	Low	High	High
Waste index		High	Low
Maintenance level		High	Low
Maintenance cost	High	Low	Low
Reliability of equipment	Low	High	Very high
Availability of plant	Low	High	Very high
Control of spares	Low	High	High

Table 1.1: Comparison table

1.2 ORGANIZING OF PREDICTIVE MAINTENANCE PROGRAM

There are 9 essential steps in building a predictive maintenance program:

l. PLANT SURVEY

The first step is to determine the feasibility of a RMP. Ideally these should be based on an analysis of the plants machinery performance in terms of Availability, Reliability, down time etc. Such information is seldom available, however the feasibility of applying condition based maintenance judges on the number type of machines plus the extensive experience of RMP consultants.

2.MACHINE SELECTION

The aim here is to recover a manageable number of machines taking into account manpower requirements, production schedules, downtime cost etc.

3. SELECT OPTIMUM CONDITION MONITORING TECHNIQUES

This Stage concerned with the WHAT, HOW, WHEN and WHERE of condition monitoring.
WHAT TO MEASURE?
A parameter does exist which is indicative of the machine condition and failure progression.
HOW TO MEASURE?
Instruments and techniques are available capable of monitoring parameter.
WHEN TO MEASURE?
The monitoring techniques must provide a useful failure detection period that is lead-time between confirmation of machine problem and eventual catastrophic failure. This fact will determine the frequency of monitoring.
WHERE TO MEASURE?
Where to measure is of major importance in obtaining early detection of machine defects.

4. ESTABLISH PREDICTIVE MAINTENANCE SYSTEM

Having established the optimum techniques for monitoring each item of the plant these are all merged to achieve a rational monitoring program encompassing inspection schedules.

- Designing a simple data handling system.
- Data collection.
- Data recording.
- Data analysis.
- Reporting.

5. SET AND REVIEW ACCEPTABLE CONDITION DATA & LIMITS

The objective of this step is to establish the normal levels of the condition monitoring parameters which represent an acceptable machine Condition. This can Only be established on the basis of experience and historical data. However, in the initial Stages, where no such data is available machine manufactures recommendation and appropriate general severity charts may be used to provide guidelines.

6. MACHINE BASELINE MEASUREMENTS

Since the mechanical condition as the machinery is not known initially it is necessary to establish this through application of selected condition techniques and comparison of observed measurements against the pre-established acceptable limits.

7. PERIODIC CONDITION MEASUREMENT (Collection Recording trend analysis)

These steps represent the routine monitoring program established in step 3 and 4. The objective of this program is to detect a significant deterioration in the machine condition through trend analysis of the measured data when upon the machine undergoes further condition analysis.

8.CONDITION ANALYSIS

This is an in depth analysis of the machine condition often involving the joint application of a number of techniques. The objective is to confirm a fault exists and to carry out fault diagnosis i.e. Type of fault, location and corrective action required.

9. FAULT CORRECTION

Having diagnosed the fault, it is the responsibility of the maintenance department to schedule corrective action. At this stage it is essential to establish the cause of fruit, correction required. The predictive maintenance program can be expanded by adding instruments or by integrating your program into a more system to include automated data collectors, computers and software's. For very critical machines 24 hours monitoring and automatic surveillance systems' may be required.

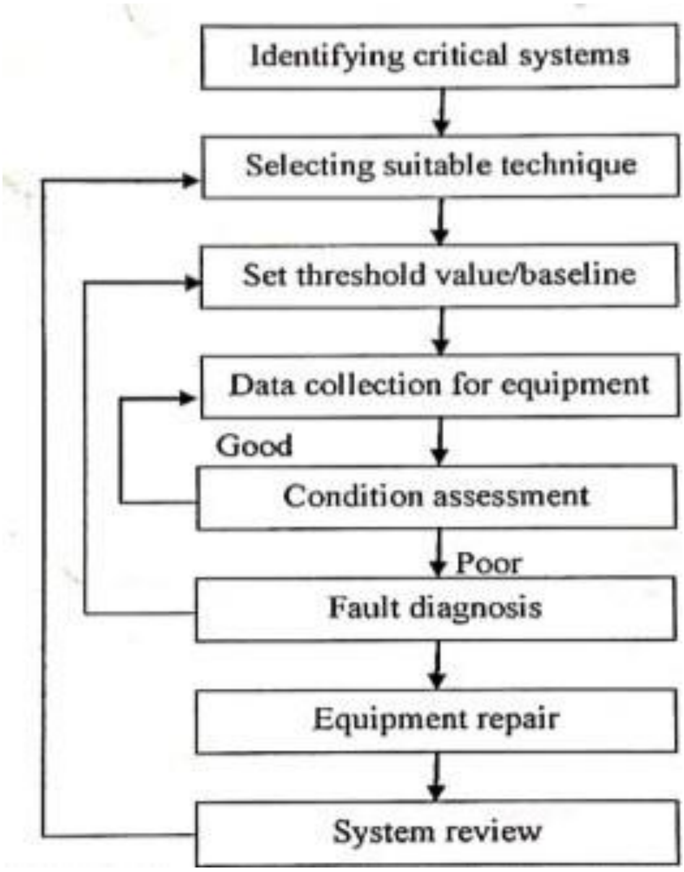


FIG: 1.1: Process Involved in Condition Monitoring

1.3 VIBRATION MONITORING

Vibration is the motion of a machine or machine part, back and forth from its position of rest. Vibration is essentially the heartbeat of all mechanical equipment. The analysis of signals, produced during the operation of machinery, provides important information about the condition of the machinery. Vibration analysis can the machine problems like imbalance, misalignment, mechanical looseness, bent shaft, bad bearings, gear damage, electrical trouble, or faulty aerodynamic behaviour. Since excessive vibration in machinery can cause problems, it is essential to detect vibration well in advance to make suitable repair or adjustment scheme.

Some of the more common problems which are known to produce vibration are as follows:

a) Imbalance of rotating parts
b) Eccentric components
c) Misalignment of couplings and bearings
d) Bent shafts
e) Component looseness
f) Worn, or damaged gears
g) Bad drive belts and drive chains
h) Bad anti-friction bearings
i) Torque variations
j) Aerodynamic forces
k) Hydraulic forces

All of these causes can be reduced to or more, of five different types of problem. is, parts will either unbalanced, misaligned, loose, or reacting to some external force. The cause of vibration must be a force, which is changing either its magnitude or in its direction.

For successful diagnostics and troubleshooting of rotating machinery, the Vibration Analyst must ensure accurate and repeatable quality data collection, and have a detailed understanding of the machinery design and operating dynamics to accurately interpret typical fault patterns and symptoms.

1.4 MACHINE CLASSES ACCORDING TO **ISO 2372**

According to the severity of vibrations in machines, the machines can be classified into the following classes which are appropriate for most applications:

Class 1: The individual parts of engines and machinery are integrally connected with the machine in its normal operation (production motors upto to 15 kW).

Class 2 : They are medium sized machines with an output of 15 to 75 kw rigidly mounted on machines or engines whose output reach up to 300 kw.

Class 3: Large prime movers and other large machines with rotating masses mounted as rigid and heavy foundation and are relatively stiff in direction of vibration.

Class 4: Large prime movers and other large machines with rotating masses on foundations which are relatively soft in the direction of vibration. For e.g. Turbo generators.

Class 5: Machines and mechanical drive systems with unbalance able inertia effects due to rotating parts, mounted on foundations which are relatively stiff in the direction of vibration.

Class 6: Machines and mechanical drive systems with unbalance able inertia effects due to rotating parts mounted on foundations which are relatively soft in direction of vibration.

These 2 types (class 5 and class 6) vary widely in their construction and influences of inertia and therefore vary widely in their vibration characteristics making them difficult to be classified as the first 4 classes

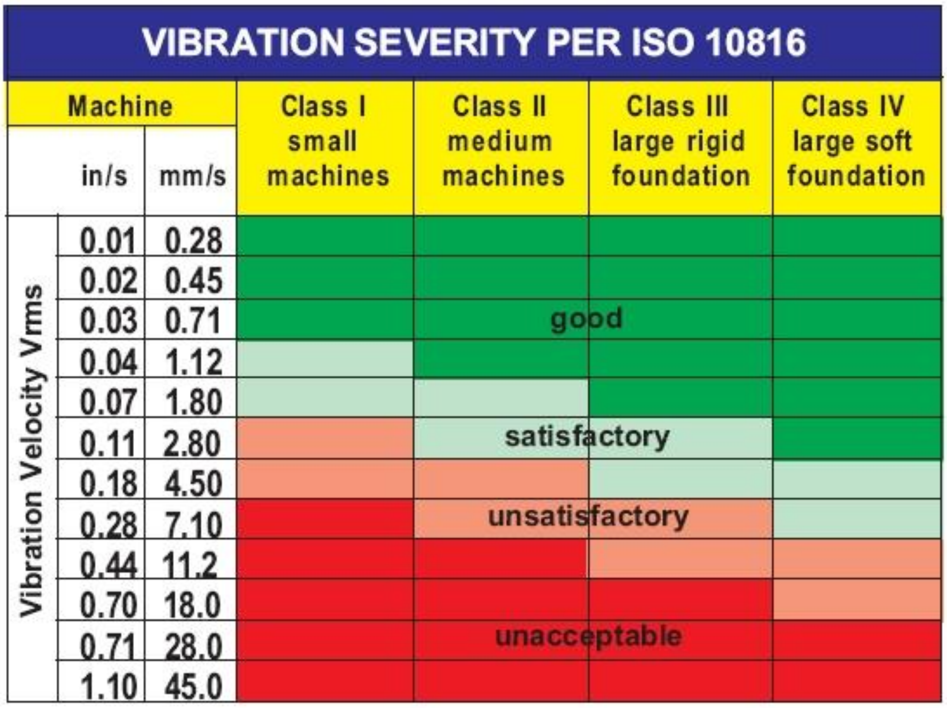


FIG 1.2: Vibration Severity Chart

CHAPTER 2
LITERATURE REVIEW

Sadettin Orhana, Nizami Akturkb, Veli Çelika, Vibration for defect diagnosis of rolling Clement bearings as a predictive maintenance tool:
Vibration monitoring and analysis in rotating machineries offer very important information about anomalies formed internal structure of the machinery. The information gained by vibration analysis enable to plan a maintenance action. In this study, the vibration monitoring and analysis case studies were presented and examined in machineries that were running in real operating conditions. Failures formed on the machineries in the course of time were determined in its early stage by the spectral analysis. It was shown that the vibration analysis gets much advantage in factories as a predictive maintenance technique.

P.D. McFadden, J.D. Smith, Vibration monitoring of rolling element bearings by the high frequency resonance technique — a review.
It is shown that the procedures for obtaining the spectrum of the envelope signal are well established, but that there is an incomplete understanding of the factors which control the appearance of this spectrum. Until the envelope spectrum can be fully explained, use of the technique is limited.

Andrew K.S. Jardine, Darning Lin, Dragan Banjevic, A review on machinery diagnostics and prognostics implementing condition-based maintenance.

Condition-based maintenance (CBM) is a maintenance program that recommends maintenance decisions based on the information collected through condition monitoring. It consists of three main steps: data acquisition, data processing and maintenance decision-making. Diagnostics and prognostics are two important aspects of a CBM program. Research in the CBM area grows rapidly. This paper attempts to summarize and review the recent research and developments in diagnostics and prognostics of mechanical systems implementing CBM with emphasis on models, algorithms and technologies for data processing and maintenance decision-making. Realizing the increasing trend of using multiple sensors in condition monitoring, the authors also discuss different techniques for multiple sensor data fusion. The paper concludes with a brief discussion on current practices and possible future trends of CBM.

Lawrence Mann, Anuj Saxcnn, Gerald M. Knapp (l.ouisiana State University. Baton Rouge. Louisiana, USA). Statistical-based or condition-based preventive maintenance.

The focus of preventive maintenance (PM) programs in industry is shifting from a pure statistical basis to online condition monitoring. Examines the shortcomings of statistical-based PM which are contributing to this shift, and the potential benefits of and current research issues within condition-based PM. Notes that statistics and quality control techniques Will continue to play a critical role in this evolution.

Bin Lu, Innovation Center, Eaton Corp., Milwaukee, WI, USA ; Yaoyu Li ; Xin Wu ; Yang , A review of recent advances in wind turbine condition monitoring and fault diagnosis.

The state-of-the-art advancement in wind turbine condition monitoring and fault diagnosis for the recent several years is reviewed. Since the existing surveys on wind turbine condition monitoring cover the literatures up to 2006, this review aims to report the most recent advances in the past three years, with primary focus on gearbox and bearing, rotor and blades, generator and power electronics, as well as system-wise turbine diagnosis. There are several major trends observed through the survey. Due to the variable-speed nature of wind turbine operation and the unsteady load involved, time-frequency analysis tools such as wavelets have been accepted as a key signal processing tool for such application. Acoustic emission has lately gained much more attention in order to detect incipient failures because of the low-speed operation for wind turbines. There has been an increasing trend of developing model based reasoning algorithms for fault detection and isolation as cost-effective approach for wind turbines as relatively complicated system. The impact of unsteady aerodynamic load on the robustness of diagnostic signatures has been notified. Decoupling the wind load from condition monitoring decision making will reduce the associated down-time cost.

CHAPTER 4
MATERIALS AND METHODOLOGY

Instrument used: IRD Mechanalysis 811

Fig 4.1: IRD Mechanalysis 811

This is a compact, portable instrument used to measure vibration amplitude. It consists of a control and indicator input unit signal cable, accelerometer and a straight extension probe for accelerometer.

4.2 METHODOLOGY

l. Machine analysing

The first step involves analysing the machine thoroughly. It involves analysing the machine design & operating characteristics such as rpm, bearing type, gears etc.

2. Purpose of analysis

If excess vibrations are found in the machine, then machine trouble shooting is required.

3. Selection of measuring parameter

Usually for the frequency range below 600 CPM (10 Hz) displacement is selected as the measuring parameter. For the frequency range of 600 — 120000 CPM (10 Hz-2000 Hz) velocity is taken as the measuring parameter. For frequency range above 120000 CPM (2000 Hz) acceleration is taken as the measuring parameter. The vast majority of machine failures are due to fatigue which is directly related to vibration velocity. But there are two other causes, say stress and force, that are directly related to vibration displacement and acceleration respectively.

4. Transducer position and direction

Usually the readings are taken near the bearing surface. The systematic diagram for pump & motor combination is given below

For the pump/fan, readings are taken at the points A & B at three mutually perpendicular directions i.e., horizontal, vertical and axial. These points are located between the coupling and the pump. For the motor, the readings are taken at the points C & D which are located at front and rear end of the motor.

5. Measuring instrument

IRD811 is a portable Digital Vibration Meter cum Bearing Health Checker. It has an ergonomic design and rests comfortably in the hand. It can measure vibration amplitude in Displacement, Velocity & Acceleration. Bearing condition is measured in Spike Energy.

6. Measurement procedure

- Attach the accessories of the IRD 811 instrument
- Select the appropriate amplitude range using the range selector.
- Set the measuring parameter as velocity
- Take the reading at appropriate points.

7. Observations

We will be analysing the values i.e. horizontal, vertical, axial readings obtained at the points A, B, C, D. In general, if horizontal readings are higher than other two readings then it indicates unbalance problems. It can be verified by obtaining vibration reading at 1 •rpm from spectrum analysis. If this reading is higher than other rpm readings, then it is verified.

Similarly, in general if vertical readings are higher than other two readings then it indicates bearing/foundation problems. It can be verified by obtaining spike energy reading with the help of the instrument. If this reading is high along with vertical reading, then it indicates bearing problem otherwise it will be foundation problems.

If the axial readings are very higher than other two readings, then it indicates misalignment problems. It can be verified by obtaining vibration reading at I *rpm and 2* rpm from spectrum analysis. If I * rpm reading is high, then it indicates angular misalignment and if 2* rpm reading is high then it indicates offset misalignment.

8. Recommendation

Based on the observations, recommendations are given to the respective electrical /mechanical maintenance department for rectifying the problems.

9. Result

After correcting the problem, we will analyse the machine for a second time and we will take all the three readings again at those four points. If these values lie within the limit then there won't be any problem and the machine is in good state but if the values is not within the limit, again the entire analysing is carried out once again till it satisfies the limits followed in the company.

CHAPTER 5
CASE STUDY

Till this January 19 have taken vibration readings on more than 20 rotating equipment and out of majority are pumps. Some of them have unacceptable vibration limits while some are within the satisfactory limit and some in good state. Equipment's which arc having unacceptable vibration limits are shut down and instructions were passed for its maintenance. At the same time inspection duration have been shortened for those lying in satisfactory limits.
Below are some of the machinery on which problems arc found and corrective actions are carried out to its operating working conditions.

5.1 Case study on P-1313 B

Specifications

Pump No.	<u>P-1313 B</u>
P.O no. and date	<u>6030-01-008-113A 30.4.86</u>
Name	Mist eliminator circulation pump
Make and year	Kirloskar Brothers KPP 32/13
Supplier	Kirloskar Brothers
Type	Centrifugal
Serial No.	1370187074
Value	Rs.38220
Wt. of pump with motor	150kg
Section	1000
Section/Discharge dia.	50/32mm
Seal type/make	Single mech seal/BSPGX Sealol Hindustan
Fluid handled	S/O Ammonium nitrate 69 Ammonium carbonate

Seal fluid	Pumped liquid
Power transmission type	Flexible coupling Rathi Engg. Model RRL 100
Specific Gravity	1.0
Viscosity	0.9
Operating temp. normal	17^0C
Suction pressure	$1.85kg/m^2$
Discharge pressure	$3.43kg/m^2$
Differential head	15m
NPSH available acquired	23.8/1.9m
Capacity normal	$8.6m^3/hr$
Capacity rated	$10\ m^3/hr$
No.of stages/cylinders	1
BHP rated	1.02Kw
RPM	2820
Efficiency	42%
Type of impeller	Enclosed
Imp.Dis max/min/Rated	139/100/116
Material of imp/plunger	ASTM A-35/6 CF-8
Material of shaft	ASTM A-276 TYPE 410
Material of casing	ASTM A-351 Gr CF-8
Material of sleeve	ASTM A-276 type 304
Material of casing meaning	ASTM A-276 type 304
Material of imp. Wearing	ASTM A-276 type 304
Bearing details	Ball bearing SKF 2x7206 BG or EQ

	Cylindrical roller bearing SKF NK 305
Oil seal details	Drive side 251Dx370Dx7THK syn rubber With steel spring driving for bearing Housing:1251Dx3QTHR
Type of motor	Induction motor
Motor power	1.5Kw
Motor RPM	2820
Voltage	415V
Phase	3
Frequency	50Hz
Vapour pressure	.15kg/m^2 Abs
Casing mounting/split/type	Foot/radial/single volute

1. Machine analysing

As per the requests of hyam plant engineers we will be analyzing the above machine whether a's running as per the requirement or not. Before that we have to study about the machine, its operating such as RPM, bearing used, couplings etc. its historical data including the baseline reading of machine.

POINT	POSITION	VELOCITY Pk(mm/s)	BEARING CONDITION(gSe)
A	H	5.6	
	V	2.4	
	A	2.4	
B	H	6.0	
	V	5.8	
	A	3.0	
C	H	7.0	
	V	6.4	
	A	3.8	
D	H	8.0	
	V	9.0	
	A	8.0	

Table 4.1: Vibration measurements

2. Purpose of analysis

Analysis is carried out to determine whether there is excess vibrations in the machine which may tend to damage machine permanently. If there is a chance for it then we have to take precautionary measures for it and have to suggest the rectification methods which are apt the current situation.

3. Selection of measuring parameter

Usually for the frequency range below 600 CPM (10 Hz) displacement is selected as the measuring parameter. For the frequency range of 600 — 120000 CPM (10 Hz-2000 Hz) velocity is taken as the measuring parameter. For frequency range above 120000 CPM (2000 Hz) acceleration is taken as the measuring parameter.

4. Transducer position and direction

For the pump, readings are taken at the points A & B at three mutually perpendicular directions i.e., horizontal, vertical and axial. These points are located between the coupling and the pump. For the motor, the readings are taken at the points C & D which are located at front and rear end of the motor.

5. Measuring instrument:

IRD 811

6. Measurement procedure

a. Attach the accessories of the IRD 811 instrument.

b. Select the appropriate amplitude range using the range selector.

c. Set the measuring parameter as velocity.

d. Take the reading at appropriate points.

The obtained result is shown in the data sheet.

6. Observation

Overall vibration values i.e. both horizontal, vertical, axial readings on both pump and motor are high along with the spike. Values remain 3 to 4 times higher than the expected and are significantly greater than the baseline readings of the machine. This usually happen when the motor bearings are damaged and gets prolong for a long time.

7. Recommendation

As the machine condition is extremely bad and there is no substitute for that machine, soft foot to be done corrected and alignment to be re-done.

8. Result

After soft foot correction and re-alignment, we have taken the readings and it was observed to be within the limits.

POINT	POSITION	VELOCITY Pk(mm/s)	BEARING CONDITION(gSe)
A	H	2.2	
	V	1.0	
	A	1.0	
B	H	3.0	
	V	3.2	
	A	1.0	
C	H	2.0	
	V	1.2	
	A	1.0	
D	H	2.2	
	V	1.4	
	A	2.0	

Table 4.2: Vibration measurements

5.2 Case study on P-5603 A

Specification

Pump No.	P-5603 A
P.O no. and date	6030-01-504-1144 28.5.86
Name	Bottom product pump at salt extracting column
Make and year	NIKK ISO – SUNDSFRAND LMV 322-15/84JCD
Supplier	Mitsubishi
Type	Sundyne pump (high speed centrifugal)
Serial No.	
Value	
Wt. of pump with motor	150kg+330kg
Section	5000
Section/Discharge dia.	3”/2”
Seal type/make	Double seal/BDPGL CRANE
Fluid handled	1% organic salts-14%(RV) tic solution
Seal fluid	
Power transmission type	
Specific Gravity	1.081
Viscosity	1.80
Operating temp. normal	59^0C
Suction pressure	2.14kg/m^2
Discharge pressure	18.90kg/m^2
Differential head	155m
NPSH available acquired	27.9/3.3m

Capacity normal	2.9+2.6m^3/hr
Capacity rated	5+2.6m^3/hr
No.of stages/cylinders	1
BHP rated	11kW
RPM	8400
Efficiency	31.5%
Type of impeller	Open
Imp.Dis max/min/Rated	105mm
Material of imp/plunger	SCS14
Material of shaft	SCM440
Material of casing	SCW49
Material of sleeve	SVS316
Material of casing meaning	
Material of imp. Wearing	
Bearing details	Ball bearing JIS6JO8C3-2 nos Journal bearing LBC3(BS24937)-2 nos
Oil seal details	ORING PACKING MATC EPR-3 nos NBR-3nos
Type of motor	With special shaft extrusion
Motor power	1.5Kw
Motor RPM	2960
Voltage	415V
Phase	3
Frequency	50Hz
Vapour pressure	.15kg/m^2 Abs

1. Machine analysing

As per the requests of hyam plant engineers we will be analyzing the above machine whether a's running as per the requirement or not. Before that we have to study about the machine, its operating such as RPM, bearing used, couplings etc. its historical data including the baseline reading of machine.

POINT	POSITION	VELOCITY Pk(mm/s)	BEARING CONDITION(gSe)
A	H	7.0	
	V		
	A	4.6	
B	H	11.0	
	V		
	A	4.2	
C	H		
	V		
	A		
D	H		
	V		
	A		

Table 4.3: Vibration measurements

2. Purpose of analysis

Analysis is carried out to determine whether there is excess vibrations in the machine which may tend to damage machine permanently. If there is a chance for it then we have to take precautionary measures for it and have to suggest the rectification methods which are apt the current situation.

3. Selection of measuring parameter

Usually for the frequency range below 600 CPM (10 Hz) displacement is selected as the measuring parameter. For the frequency range of 600 — 120000 CPM (10 Hz-2000 Hz) velocity is taken as the measuring parameter. For frequency range above 120000 CPM (2000 Hz) acceleration is taken as the measuring parameter.

4. Transducer position and direction

For the pump, readings are taken at the points A & B at three mutually perpendicular directions i.e., horizontal, vertical and axial. These points are located between the coupling and the pump. For the motor, the readings are taken at the points C & D which are located at front and rear end of the motor.

5. Measuring instrument:

   IRD 811

6. Measurement procedure

a. Attach the accessories of the IRD 811 instrument.

b. Select the appropriate amplitude range using the range selector.

c. Set the measuring parameter as velocity.

d. Take the reading at appropriate points.

The obtained result is shown in the data sheet.

6. Observation

Overall vibration values i.e. both horizontal, vertical, axial readings on both pump and motor are high along with the spike. Values remain 3 to 4 times higher than the expected and are significantly greater than the baseline readings of the machine. This usually happen when the motor bearings are damaged and gets prolong for a long time.

7. Recommendation

As the machine condition is extremely bad and there is no substitute for that machine, indication of unbalance suggest cooling fan of motor to be removed and replaced.

After removal of fan, we have taken the readings and it was observed to be within the limits.

POINT	POSITION	VELOCITY Pk(mm/s)	BEARING CONDITION(gSe)
A	H	1.0	
	V		
	A	.8	
B	H	1.4	
	V		
	A	.8	
C	H		
	V		
	A		
D	H		
	V		
	A		

Table 4.4: Vibration measurements

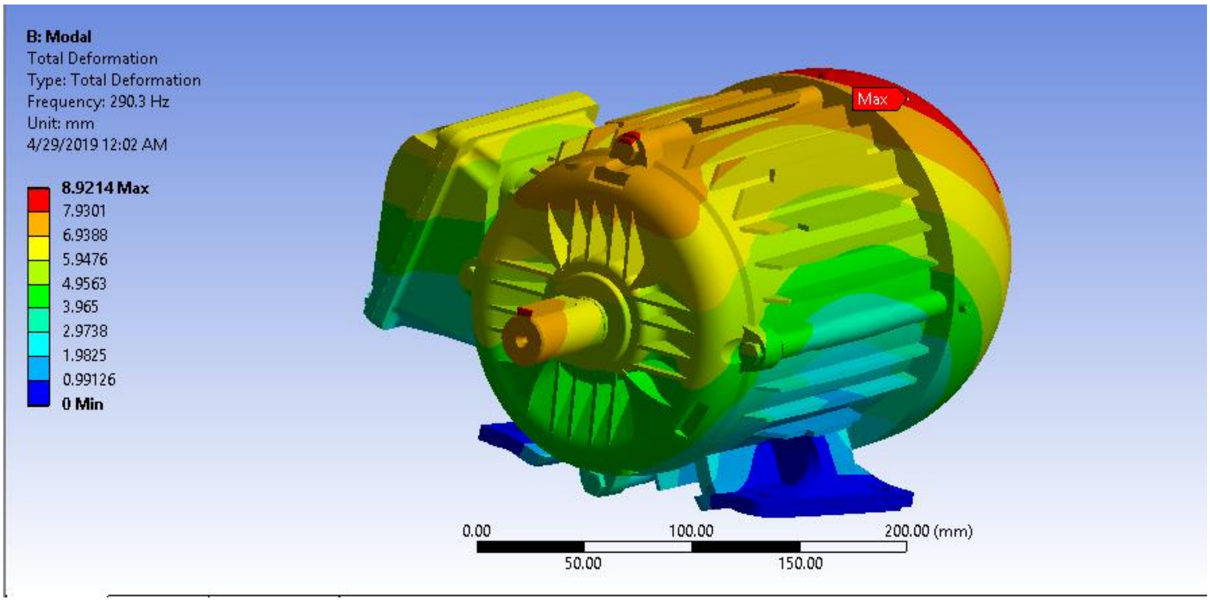
After attachment of new fan, we have taken the readings and it was observed to be within the limits**.**

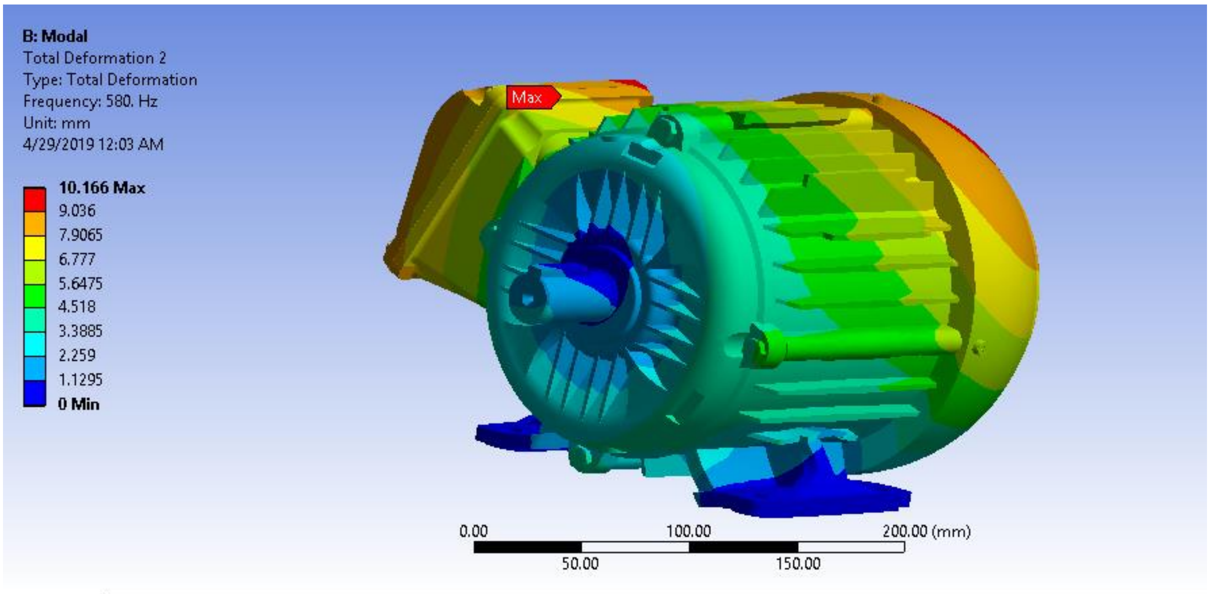
POINT	POSITION	VELOCITY Pk(mm/s)	BEARING CONDITION(gSe)
A	H	2.2	
	V		
	A	1.6	
B	H	3.2	
	V		
	A	1.2	
C	H		
	V		
	A		
D	H		
	V		
	A		

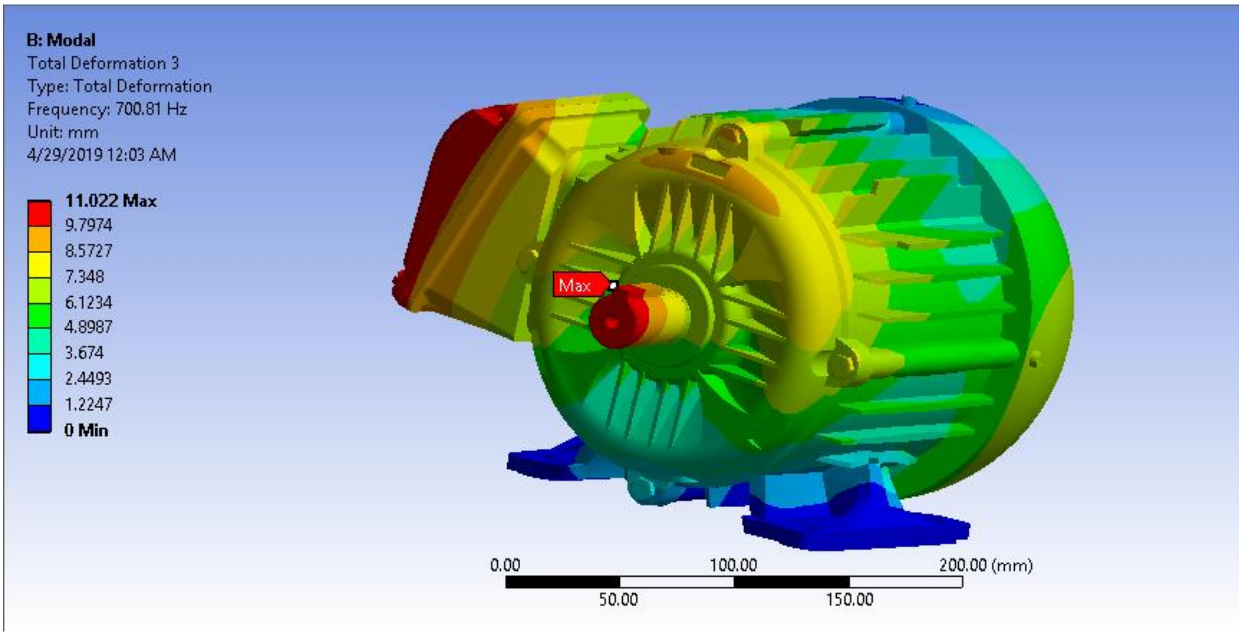
Table 4.5: Vibration measurements

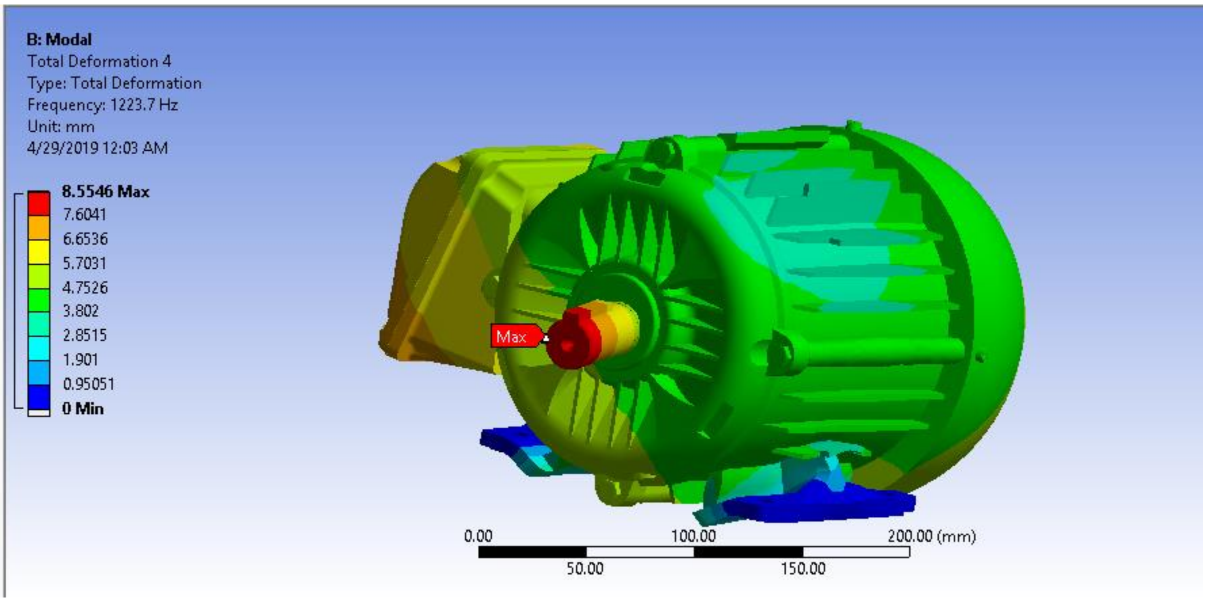
CHAPTER 6

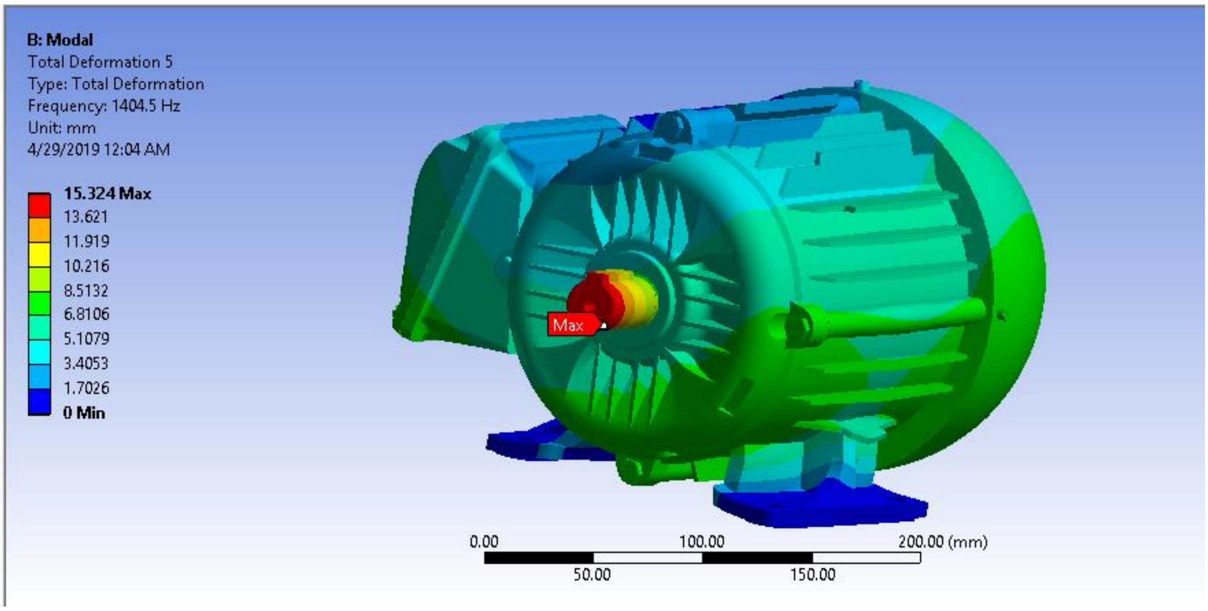
RESULTS

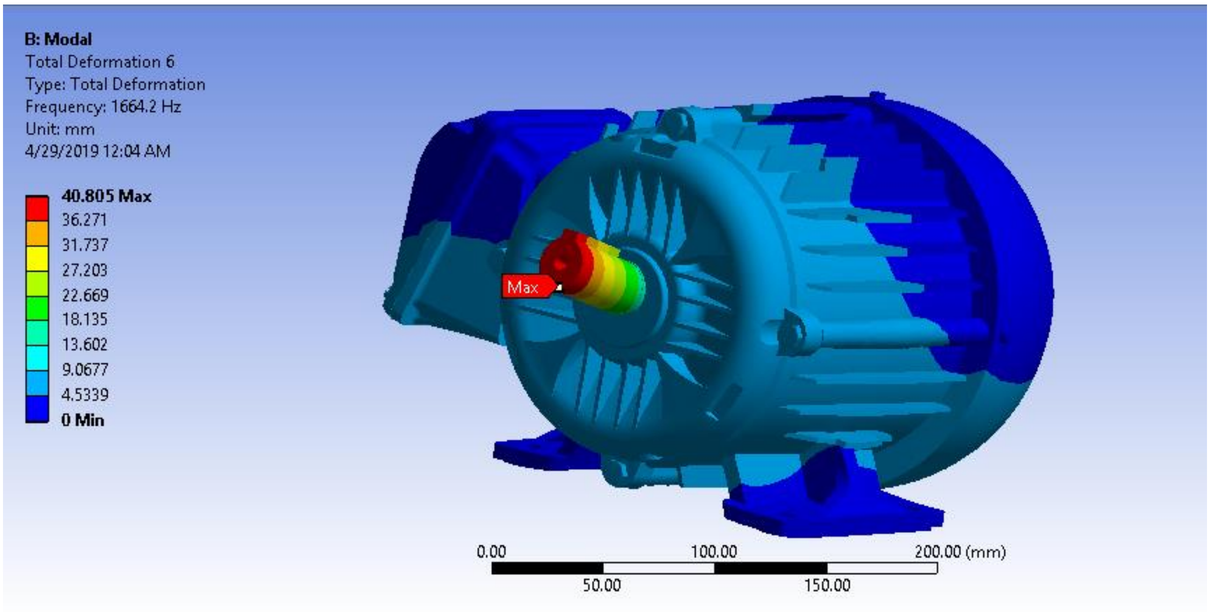





B: Modal
Total Deformation 3
Type: Total Deformation
Frequency: 700.81 Hz
Unit: mm
4/29/2019 12:03 AM
11.022 Max
9.7974
8.5727
7.348
6.1234
4.8987
3.674
2.4493
1.2247
0 Min
Max
0.00
100.00
200.00 (mm)
50.00
150.00


B: Modal
Total Deformation 4
Type: Total Deformation
Frequency: 1223.7 Hz
Unit: mm
4/29/2019 12:03 AM
8.5546 Max
7.6041
6.6536
5.7031
4.7526
3.802
2.8515
1.901
0.95051
0 Min
Max
0.00
100.00
200.00 (mm)
50.00
150.00


B: Modal
Total Deformation 5
Type: Total Deformation
Frequency: 1404.5 Hz
Unit: mm
4/29/2019 12:04 AM
15.324 Max
13.621
11.919
10.216
8.5132
6.8106
5.1079
3.4053
1.7026
0 Min
Max
0.00
100.00
200.00 (mm)
50.00
150.00


B: Modal
Total Deformation 6
Type: Total Deformation
Frequency: 1664.2 Hz
Unit: mm
4/29/2019 12:04 AM
40.805 Max
36.271
31.737
27.203
22.669
18.135
13.602
9.0677
4.5339
0 Min
Max
0.00
100.00
200.00 (mm)
50.00
150.00

CHAPTER 6
CONCLUSIONS

Condition monitoring by using vibration analysis will help us to identify even the minute problems in the equipment thereby help us to prevent the machine from failure and to increase the machine life. Here at FACT shutdown maintenance is carried out in majority of the plants. By applying this technique to all the machines in the industry it will helps in keeping the plants in running condition all the time

I have come across many problems like bearing failure, problems with couplings, soft foot, unbalance, alignment problems, flow disturbance etc. Among this at any machinery the frequently occurring problem is the bearing failure. It is caused mainly due to erosion, wear and tear, surface deposition. Bearings are the critical parts in the rotating equipment as forces are transmitted through this. So continues monitoring and correction is required.

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