https://doi.org/10.36375/prepare_u.iei.a163

Innovative low-cost vibration monitoring system to unleash the power of condition monitoring

Brahmadeo Kamble, Manish Patil, Kunal Joshi
Godrej Electronics & Electricals
Godrej & Boyce Mfg.co.ltd
Pirojshah nagar, Vikhroli-West, Mumbai,400079 ,M.S., INDIA
Corresponding author's email: brahma@godrej.com

Abstract - This case study deals with the technical solution and economic impact of machine condition monitoring implemented on Okuma CNC Machine, RMC mixer, and CTX 310 CNC machine
It presents an overview of the measuring techniques used to detect machine problems and very briefly describes condition monitoring system tailored to the special requirements of CNC machines and RMC mixer gear boxes.

Keywords
IIOT, Vibration monitoring, condition monitoring, Predictive analysis,

INTRODUCTION

In today's cost competitive market, it is very important to manufacture products at lowest possible cost. This can be achieved by reducing operating costs. Cost incurred due to unplanned downtimes, industrial accidents, premature failures of components due to forced deterioration are major concerns for industry.
As per CII "METRICS OF CONCERN TO MANUFACTURERS", Workplace injuries, Capacity utilization, Downtime vs operation time has scored more than 35%. To reduce the overall maintenance cost, we started searching for solutions to detect failures at early stage and take timely corrective action. We came across vibration as one of the ways to detect the changes in equipment condition. Equipment vibration patterns change due to incorrect operation parameter settings, hardness of the component being processed, cutting tool wear out, machine axis collision with job and equipment wear out, etc.
Measuring vibration is totally non-invasive way of doing condition monitoring so we decided to explore this technology instructions.

VIBRATION MONITORING

A. Definition

Vibration is a mechanical phenomenon whereby oscillation occur about an equilibrium

B. Need of innovation

As per our current operations methodology, though we carry out scheduled preventive maintenance activity than too complaints occur at functional failure. (Point F in Fig.1)

Aim is to move from present breakdown maintenance scenario to predictive maintenance by detecting potential failure. (Point P in Fig.1).

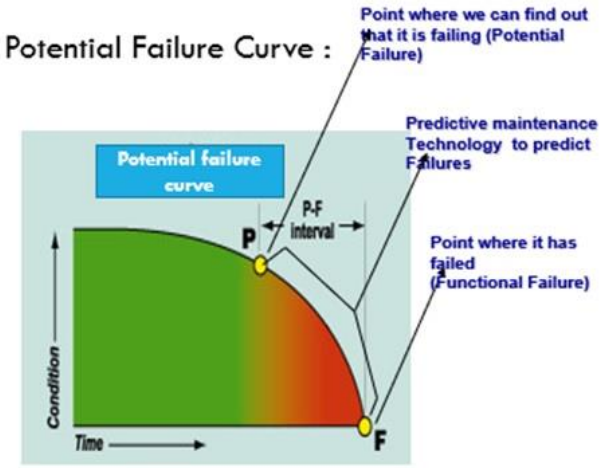

Fig. 1 Graph of Time Vs Condition

TRADITIONAL VIBRATION MONITORING

Vibration sensor available in the market measures the vibration and gives output in electrical quantity like 4-20MA current for voltage from 0-10V. This output needs to be further analyzed using signal analyzer device. Signal Analyzers needs to be integrated with IT system to enable real time notification and record the data.
Historian and analytics can be on premise or on cloud.

LIMITATIONS OF TRADITIONAL VIBRATION MONITORING

A. Economics:

Cost of implementation for single system goes from 60,000 to 200000 depending on features extracted from vibration signal.

B. Network Bandwidth:

Data generated by vibration system is huge due to higher sampling frequencies and DFT (Discrete Fourier Transform) size which results in more network bandwidth utilization.

C. Speed of execution:

The overall process of integration is time consuming and very costly as multiple parties are involved.

https://doi.org/10.36375/prepare_u.iei.a163

OBJECTIVE OF INNOVATION

To develop integrated vibration monitoring system consisting of Sensor, analyser, Local database and notification system in One package. It should be economically viable, plug and play, user friendly GUI and less use of network bandwidth.

TECHNICAL SOLUTION

Used MEMS 3 Axis Accelerometer sensor to detect oscillations in device under test and transmitted this data to digital signal processor (DSP) to carry out signal analysis. DSP is connected to single board PC which stores vibration data in local DB. Single board PC provides Wi-Fi and Lan connectivity and it is capable for sending email notification. It hosts light web server which is used for system level configurations and live monitoring.

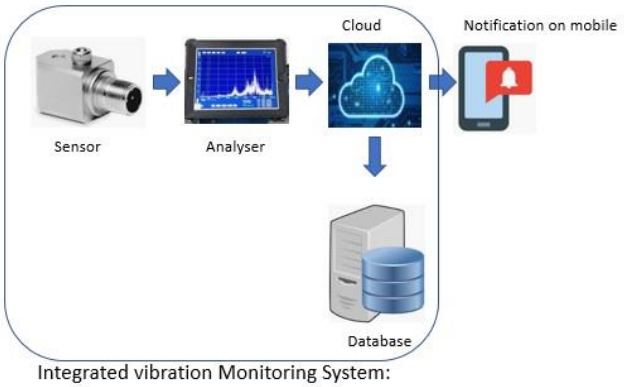

Fig. 3 Integrated vibration monitoring system

LIVE MONITORING

Three axis vibration signal energy data is displayed in the chart format. This page also has provision to log the data and download it in .CSV format for further analysis.

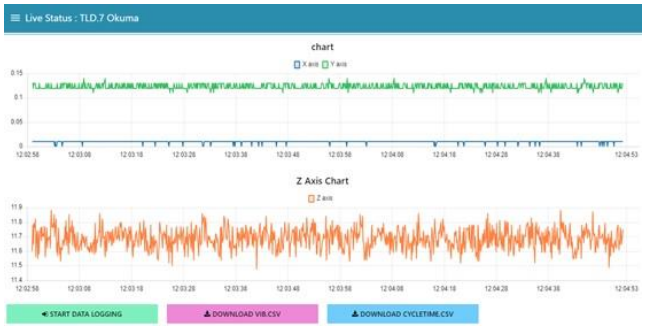

Fig. 4 Live monitoring

PROCESS MONITORING SETTING

It is divided into two parts, namely KPI rule settings and KPI rule configuration settings.

We are capturing vibration signal energy and calculating average signal energy, standard deviation for all three axes. This data can be used to set patterns to detect various machine conditions. Following table depicts sample setting. This system allows to set multiple rules which makes it more user friendly to end user.

KPI rule configuration settings:

On board analytics enables detection of unique machine conditions. This is completely user configurable. It has features to set logical operations on rules defined in KPI rule setting. It has provision to add customized notification messages.

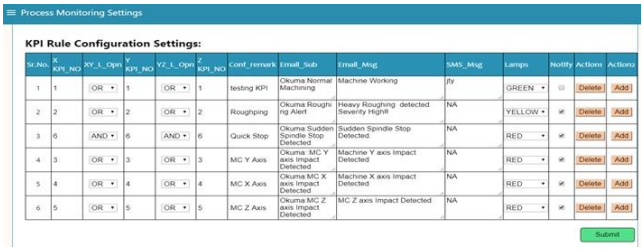

Fig. 5 Integrated vibration monitoring system

BENEFITS

A. Economically viable (BOM Cost INR 10100/-.)
B. Real time trend.
C. SMS / Email Alert.
D. Data download in csv file.
E. Settable notification settings.
F. Password protected dashboard
G. It is plug and play.

HORIZONTAL DEPLOYMENT

A. System has been installed on DMG CTX320 turning centre and integrated with machine OEE monitoring software from M/s Zyfra.
B. System has been installed for Compressor condition monitoring.

ECONOMIC IMPACT

Overall estimated saving from four implementation is INR 26 Lakh.

CONCLUSION

The saving potential of condition monitoring in the manufacturing industry is dramatic.
Vibration monitoring has helped us in achieving following objective.
A. Eliminate secondary failures
B. Reduce fault Diagnostic time
C. Reduce production losses
D. Improve operator behaviour
E. Increase safety of the Man and Machine
All the above help in reducing the overall maintenance cost there by resulting in improved operating cost.