INCREASING PRODUCTIVITY THROUGH AUTOMATION

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ABSTRACT

There are many productivity improvement techniques like method study and work measurement, cost reduction, modernization, investment in machine and equipment, re-engineering etc. automation is about speed, accuracy, precision of the process. There are many systems where we can apply automation for better and accurate result. Automation is one of the most effective methodologies for cost cutting by elimination waste as scrap, reducing man power, reducing time, controlling quality and improving overall performance of any machine, system or process in any industry with the complete assurance of large annual profit margins. This paper talks about concept of automation, tools and technique to be used for improving productivity, process of implementation of automation and its advantages.

Introduction:

In today's Global scenario manufacturing Efficiency and Agility is not an option, but it is strategic requirement. The production cost is increasing rapidly and the labor cost, raw material cost, power cost, etc.; are not in our control of manufacturer. Hence to increase the productivity and reduce the production cost one can only have controls on:-

1) Manpower Cost – by reducing manpower.
2) Utility Cost – by power saving.
3) Quality Improvement – through good control.
4) High Production – Through state of art machine.
5) Keeping proper record – through systems.

All these can be possible only by implementing automation.

What is Automation?

Monitoring and controlling of any process with the help of latest technologies like software, ladder and logic controls, robotics, ERP system and incorporating central computer is called Automation. The use of control systems and information technologies to reduce the need for human work in the production of goods and services, save money (on production and materials costs) and making money (in profits) can also defined as automation. Workflow automation uses software to control which eliminating repetitive tasks, gaining efficiency, minimizing errors and reducing costs. No matter what the size of business, be assured that automation will add increased productivity and efficiency.

Need of automation:-

Some of the reasons for need of automation are such as to achieve more with less, Elimination of human error, Cleaner Technology, Consistency of product, Minimize Energy consumption, Easy diagnosis of fault, Reduction in resources, reduction in peaks load, reduction in Effluent, Environment protection, Improve safety and health reduce maintenance (chemicals , water, energy etc.;) reduce manpower, data collections and consolidation, effective application for complex tasks, trending and report generation, reduce errors, increase speed, increase productivity - More automation equals more job capacity, shorter delivery times and optimized business operations, reduced turnaround and fulfillment times add to overall productivity, Remove the human element against market- standard job, reduce waste, expand capabilities – Automating all parts of the workflow will increase capacity, improve throughput and optimize equipment use Workflow automation results in expanded capabilities and increased revenue.

Methodology for implementation

- It is very important to identify the needed and the feasibility of the systems to be automated.
- The production cost, the complicity of the machines, the utility requirement of the machines, quality parameters of the products are most important factors to consider while planning for automation.
- Select the system which has flexibility, ease of programming, adaptability to change, expandability, enhance ability of function, Ruggedness in system, service, Service backup.
- Performance factor for automation are response time, reliability,maintainability, availability and capability etc.

Tools for automation:-

Plc – A programmable logic controller, plc, or programmable controller is a digital computer used for automation of typically industrial electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures.

Sensors – a sensor is a transducer that converts a physical stimulus from one form into a more useful form to measure the stimulus.

Actuators – hardware devices that convert a controller command signal into a change in a physical parameter.

Drives- whenever something must be moved, a motor is usually at the source of most automated equipment. There are many types of AC and DC motors.

SCADA – SCADA (supervisory control and data acquisition) is a system that operates with coded signals over communication channels so as to provide control of remote equipment (using typically one communication channel per remote station.

Networking – Network automation is the use of IT controls to supervise and carry out every-day network management functions. These functions can range from basic network mapping and device discovery to network configuration management and the provisioning of virtual network resources.

Effect on Productivity.

Automation affects the productivity in following aspects:-

a) Increasing production by avoiding manual delays.

b) Improving productivity by achieving the optimum efficiency of the machine.

c) Avoiding reprocessing and improving the productivity.

d) Automation improves the power saving possibilities and hence the cost of product goes down.

e) By avoiding manual error it improves the quality of product and hence productivity.

f) Automation can give useful data of the machines which increases the possibility of analyzing the cause of low or poor productivity.

Advantages:-

There are some advantages for use of automation in industries are shown:-

a) Automation is a need for today's competitive market where quality, cost, and availability is playing major role.

b) Through Automation only we can achieve these parameters and compete in the market.

c) Automation increase Productivity and growth.

d) Workflow automation adds increased capability to any print business, making it possible for you to focus on what you do best.

e) Able to produce more jobs. Workflow automation results in more job capacity for shorter delivery times and optimized business operations.

f) Workflow automation will help you reduce costs with labour savings. And, you will save supplies and toner by avoiding re- do's and makeovers. Good for your bottom line, good for the planet.

g) Automating parts of your workflow will increase capacity, improve throughput and optimize equipment use. All this add up to expanded capabilities and increased revenue.

More advantages of the Automation:-

Condition monitoring (or, colloquially, CM) is the process of **monitoring** a parameter of **condition** in machinery (**vibration**, temperature etc.), in order to identify a significant change which is indicative of a developing fault. It is a major component of predictive maintenance.

Machine **condition monitoring is important** because it provides information about the health of a machine. You can use this information to detect warning signs early and help your organization stop unscheduled outages, optimize machine performance, and reduce repair time and maintenance costs.

Vibration Analysis is the main conditions monitoring techniques for the machinery maintenance and fault diagnosis. This technique has its unique advantages and disadvantages associated with the monitoring and fault diagnosis of machinery. When this technique is conducted independently, only a portion of machine condition monitoring program provides useful reliable information, bringing significant costs benefits to industry. The objective of this research is to investigate the correlation between vibration analysis and fault diagnosis. This was achieved by vibration analysis and investigating different operation conditions of an experimental electrometer. The electrometer was initially run under normal operating conditions as a comparative test. A series of tests were then conducted corresponding to different operating condition. Our varieties were speed of electrometer at three levels, respectively 500, 1000 and 1500rpm. Then we did three faults in our electrometer, there were misalignment, looseness and bad bearing. We coupled our electrometer to the variable blade fan and applied several load on that by changing the number of blade of fan. We have chosen 2, 6 and 10 blades fan to apply three different loads on our electrometer. Vibration data was regularly collected numerical data produced by vibration analysis were compared with vibration spectra in normal condition of healthy machine, in order to quantify the effectiveness of the vibration condition monitoring technique. The results from this paper have given more understanding on the dependent roles of vibration analysis in predicting and diagnosis machine faults.

Traditional predictive maintenance not only leads to wasteful machine downtime but also premature replacement of parts. Successfully implementing a condition monitoring program allows the machine to operate to its full capacity without having to halt the machine at fixed periods for inspection.

Vibration characteristics can be distinctively divided into two types:-
a) Forced Vibration

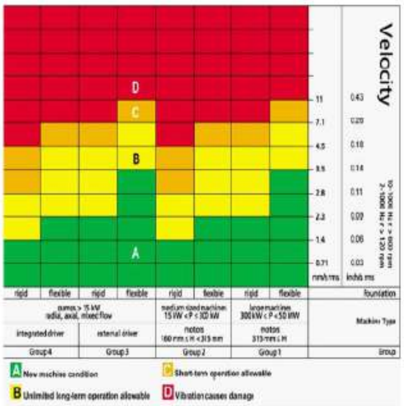
b) Free Vibration. Typical forced vibration related to problems such as mass unbalance, misalignment and excitation of electrical or mechanical nature. Free vibration is a self –excited phenomenon that is dependent on the geometry, mass, and damping of the system and typically caused by structural, acoustic resonance and by aerodynamic or hydrodynamic excitation.

Vibration Signals carry information about exciting forces and the structural path through which they propagate to vibration transducers. A machine generates vibrations of specific color when in a healthy state and the degradation of a component within my result u a change in the character of the vibration signals.

INTRODUCTION

The task involved vibration measurements taken on Motor, Gearbox & Pulley then analysis of the same by comparing with the condition Monitoring standards ISO 10816-3 attached below for reference.

A) ISO 10816-3 FOR ROTATING EQUIPMENTS



Predictive condition monitoring are becoming an important issues, since up to 1/3rdof all maintenance cost was wasted as a result of unnecessary or improperly carried out maintenance during the last years.

The implementation of the signal processing algorithms can be done using different computation techniques.

GENERAL INFORMATION ON CONDTION MONITORING:

Introduction to Condition Based Monitoring

Condition Based Monitoring System (CBMS) is proven technology to be less costly than the failure. A simple Consequence of Failure Analysis (CFA) is made to justify preventive maintenance activities.

Define the need for corrective maintenance (Condition Based Monitoring) as a part of preventive maintenance. Correcting the machine problem is defined as planned and scheduled maintenance. Preventive maintenance activities are primarily condition-based.

Practicing this maintenance philosophy the level of planned and scheduled corrective maintenance will increase production to over 80% and total maintenance volume and costs will go down 20% to 30%.

Over the years of our experience in the field of condition monitoring and Laser Shaft Alignment technology helped to serve the need of the machinery availability for uninterrupted continuous production. Condition Monitoring through Predictive maintenance would be helpful tool in achieving the above goal.

For suitability of Indian plant conditions, we are constantly adopting our experience and our expertise.

Need of Condition Monitoring:

- The need to predict equipment failures
- The need for a holistic view of equipment condition.
- The need for greater accuracy in failure prediction.
- The need to reduce the Effect of Maintenance cost.
- The need to improve equipment and component reliability.
- The need to optimise equipment

Benefits of Condition Monitoring:

- Increase in Overall Equipment efficiency (OEE).
- Increase in Life Cycle Profit (LCP) of the Equipments.
- Reduced maintenance costs.
- Extended the machine availability.
- Total Productive Maintenance (TPM) can be achieved.
- Uninterrupted production is possible.

PREDECTIVE MAINTENANCE

INTRODUCTION TO MAINTENANCE:

Survey of Machinery Maintenance Practices

Presented here is an overview of maintenance programs and techniques as practiced in the early 1990s in a wide variety of industrial areas. Most of the information presented here was collected from shore side industrial plants, but it is equally applicable to maintenance of shipboard mechanical systems. While the emphasis is on predictive maintenance, other disciplines are described and evaluated.

Machinery maintenance practices have greatly changed and evolved over the last 15 years, and it is instructive to study this development. We will first look at the basic goals of any maintenance system

Maintenance Program Goals

The most important goal of any maintenance program is the elimination of machine breakdowns. Very often a catastrophic breakdown will cause significant peripheral damage to the machine, greatly increasing the cost of the repair. Complete elimination of breakdowns is not at present possible in practice, but it can be approached by a systematic approach to maintenance.

The second goal of maintenance is to be able to anticipate and accurately plan for maintenance needs. This means spare parts inventories can be minimized and overtime work largely eliminated. Repairs of mechanical systems are ideally planned for scheduled plant down times.

Goal number three is to increase plant production readiness by significantly reducing the chance of a breakdown during operations, and to maintain system operational capacity through reduced down time of critical machines. Ideally, the operating condition of all the machines would be known and documented.

The last goal of maintenance is to provide predictable and reasonable work hours for maintenance personnel.

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Components of a Maintenance Program

- Run-to-Failure Maintenance
- Periodic Preventive Maintenance
- Predictive Maintenance
- Benefits of Predictive Maintenance
- Pro-active Maintenance
- Benefits of Pro-active Maintenance

Run-to-Failure Maintenance

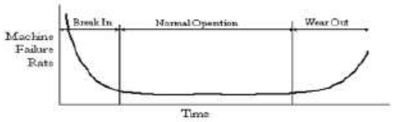
Run-to-failure maintenance is sometimes called "crisis maintenance" or "hysterical maintenance" for good reason. This has been the dominant form of maintenance for a long time, and its costs are relatively high because of unplanned downtime, damaged machinery, and overtime expenditure.

In this mode, management and the maintenance department are controlled by the vagaries of their machines, and the actual status of the overall plant machinery is only vaguely known. This makes it nearly impossible to plan for maintenance needs, and what is worse, impossible to predict the state of overall system readiness.

Run-to-failure should be a very small part in a modern program, but there are some instances where it does make sense. An example is a plant, which employs a great number of similar machines that are not expensive to replace or to repair. When one breaks down, others are scheduled to take up the slack and production is not affected very much.

Periodic Preventive Maintenance

From run-to-failure, we progress to periodic preventive maintenance, which is sometimes called "historical" maintenance. This is where the histories of each machine type are analyzed and periodic overhauls are scheduled to occur before the statistically expected problems occur. It has long been known that most groups of similar machines will exhibit failure rates that are somewhat predictable if averaged over a long time. This gives rise to the so-called "Bathtub Curve" which relates failure rate to operating time, as follows:



If this curve applied to all machines of the group, and if the shape of the curve is known, preventive maintenance could be used advantageously, but unfortunately, this is not the case in practice.

Preventive maintenance also includes such activities as changing lube oil and filters, periodic cleaning and inspecting, etc. Maintenance activity may be scheduled on the basis of calendar time, machine operating hours, number of parts produced, and so on. Preventive maintenance became very popular in the early 1980s when small computers began to be used for planning and tracking maintenance work.

In a famous study of preventive maintenance by United and American Airlines, it was found that for a large class of rotating machines, the failure rate greatly increased just after the periodic overhauls -- in other words, the overhaul reduced the reliability of the machines. It is as if the machine reverts to the beginning of the bathtub curve after each overhaul.

From this study and subsequent observations, it was found that periodic overhauls result in 20 % to 25 % of startup failures. About ten percent of these can be attributed to defective new bearings.

It is obvious that preventive maintenance is an inefficient use of resources for most machines; however, there are cases where it can be used to good effect. Examples are machines which exhibit wear related to use such as rock and ore crushers, and machines that are subject to corrosion such as equipment handling caustic substances.

Predictive Maintenance

The next improvement in maintenance technology was the advent of predictive maintenance, which is based on the determination of a machine's condition while in operation. The technique is dependent 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 us requires several types of non-destructive testing, such as oil analysis, wear particle analysis, vibration analysis, and temperature measurements. Use of these techniques to determine the machine condition results in a much more efficient use of maintenance effort compared to any earlier types of maintenance.

Predictive maintenance allows plant management to control the machinery and maintenance programs rather than vice versa. In a plant using predictive maintenance, the overall machinery condition at any time is known, and much more accurate planning is possible.

Predictive maintenance utilizes many different disciplines, by far the most important of which is periodicvibration analysis. It has been shown many times over that of all the non-destructive testing that can be done on a machine, the vibration signature provides the most information about its inner workings.

Certain machines, which would affect plant operations adversely if they were to fail, can be subjected to continuous vibration monitoring, in which an alarm is sounded if the vibrationlevel exceeds a predetermined value. In this way, rapidly progressing faults are prevented from causing catastrophic failures. Most modern turbine-driven equipment is monitored in this way.

Oil analysis and wear particle analysis are important parts of modern predictive programs, especially in critical or very expensive equipment. Thermography is the measurement of surface temperature by infrared detection, and is very useful in detecting problems in electrical switchgear and other areas where access is difficult.

Motor current signature analysis is another technique that is very useful in detecting cracked or broken rotor bars while the motor is in operation, and electrical surge testing of motor stators is used for detecting incipient electrical insulation failure.

Benefits of Predictive Maintenance

The major benefit of predictive maintenance of industrial mechanical equipment is increased plant readiness due to greater reliability of the equipment. The trending over time of developing faults in machines can be carefully done so as to plan maintenance operations to coincide with scheduled shutdowns. Many industries report from two to ten percent productivity increases due to predictive maintenance practices. Similar percentages of increased mission readiness are expected in shipboard systems.

Another benefit of predictive maintenance is reduced expenditures for spare parts and labor. Machines that fail while in service often cost ten times as much to repair than if the repair were anticipated and scheduled.

A great many new machines fail soon after startup due to built-in defects or improper installation. Predictive techniques can be used to assure proper alignment and overall integrity of the installed machine when first brought into service. Many plants base the acceptance of new machine installations on a clean bill of health as determined by vibration measurements.

Predictive maintenance reduces the likelihood of a machine experiencing a catastrophic failure, and this results in an improvement in worker safety. There have been many cases of bodily injury and even death due to sudden machine failures.

Pro-active Maintenance

The latest innovation in the field of predictive maintenance is so-called pro-active maintenance, which uses a variety of technologies to extend the operating lives of machines and to virtually eliminate reactive maintenance. The major part of a pro-active program is root cause failure analysis, which is the determination of the mechanisms and causes of machine faults. The fundamental causes of machine failures can thus be corrected, and the failure mechanisms can be gradually engineered out of each machinery installation.

• It has been known for a long time that imbalance and misalignment are the root causes of the majority of machine faults. Both of these conditions place undue forces on bearings, shortening their service life. Rather than continually replacing worn bearings in an offending machine, a far better policy is to perform precision balance and alignment on the machine, and then to verify the results by careful vibration signature analysis.

VIBRATION LIMITS AS PER ISO 10816-3 STANDARDS

(Velocity in mm/sec-RMS)

Machine class: 1 Individual part of engines and machines integrally connected with the complete machine in its normal operating condition. (Production electrical motors of up to 15 kW are typical examples of machines in this category.)

Below mentioned are standard vibration levels for class I machines.

Standard Vibration Level	Machine Condition
Up to 1.8 mm/sec.	Normal
1.8 to 4.5 mm/sec.	Marginal
Above 4.5 mm/sec.	Critical

Machine class: 2 Medium-sized machines, (typically electrical motors with 15 to 75 kW output) without special foundations, rigidly mounted engines or machines (up to 150 kW) on special foundations.

Below mentioned are standard vibration levels for class II machines.

Standard Vibration Level	Machine Condition
Up to 2.8 mm/sec.	Normal
2.8 to 7.1 mm/sec.	Marginal
Above 7.1 mm/sec.	Critical

Machine class: 3 Large prime movers and other large machines with rotating masses on rigid and heavy foundations, which are relatively stiff in the direction of vibration measurement

Below mentioned are standard vibration levels for class III machines.

Standard Vibration Level	Machine Condition
Up to 4.5 mm/sec.	Normal
4.5to 11.2 mm/sec.	Marginal
Above 11.2 mm/sec.	Critical

Machine class: 4 Large prime movers and other large machines with rotating masses on foundations, which are relatively soft in the direction of vibration measurement (for example turbo generator sets, especially those with lightweight substructures)

Below mentioned are standard vibration levels for class IV machines.

Standard Vibration Level	Machine Condition
Up to 7.1 mm/sec.	Normal
7.1 to 18.0 mm/sec.	Marginal
Above 18.0 mm/sec.	Critical

Machine class: 5 Machines and mechanical drive systems with unbalance able inertia effects (due to reciprocating parts), mounted on foundations, which are relatively stiff in the direction of vibration measurement.

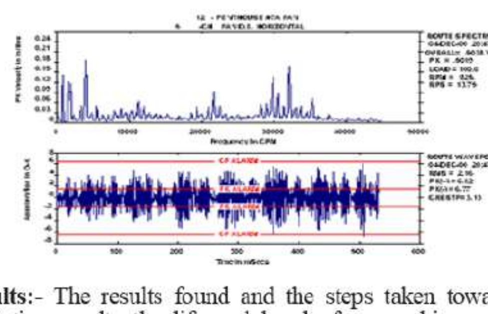
Below mentioned are standard vibration levels for class V machines.

Standard Vibration Level	Machine Condition
Up to 11.1 mm/sec.	Normal
11.1to 28.0mm/sec.	Marginal
Above 28.0 mm/sec.	Critical

Machine class: 6 Machines and mechanical drive systems with unbalancable inertia effects (due to reciprocating parts), mounted on foundations which are relatively soft in the direction of vibration measurements; machines with rotating slack coupled masses such as beater shafts in grinding mills; machines, like centrifugal machines, with varying unbalances capable of operating as self-contained units without connecting components; vibrating screens, dynamic fatigue-testing machines and vibration exciters used in processing plants.

Below mentioned are standard vibration levels for class VI machines.

Standard Vibration Level	Machine Condition
Up to 18.0 mm/sec.	Normal
18.0 to 45.0mm/sec.	Marginal
Above 45.0 mm/sec.	Critical



Results:- The results found and the steps taken towards the predictive results the life and hassle free machine operating without any breakdowns and increase the productivity.

Note:- We can share reports of the same for reference.

References:- 1) Google; 2) Literature. 3) Experience in Condition monitoring. 4) Bearing life expectancy.
5) Mr. Sunil, Mr. Kulvinder., literatures and handbook.