Developments in maintenance management

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Evolution of Maintenance Systems

Maintenance management has undergone an evo'u-tion over the past years and very rapidly so in the past decade. Few years back when there was no systematic approach to maintenance all the equipments used to be operated till it fails. The resulting maintenance is totally unplanned with higher down time and cost. Maintenance system took a turn for the better when, maximising the reliability became the main objective. Certain culture of planning was induced in maintenance and the resulting time based prevensive maintenance system improved the reliability levels to a great extent. As the industry grew, and the machines became faster, need for a better system and more uptime was felt. It also became almost impossible to maintain the preventive maintenance schedules due to down time considerations. Moreover the technological developments had made the inspection more objective and possible to be conducted while the equipment is in operation. Under these circumstances emerged the present day condition monitoring system.

The best scenario would, of course, be to design the equipment for reliability with more influence on maintenance design and choice of material which will reduce the maintenance requirement to a minimum.

Key Factors for Effective Maintenance

Effective maintenance requires a systematic approach making use of the experience resulting in maximum availability of the equipement at minimum cost. The key factors for systemising the maintenance are as follows :

— Failure analysis

System on the basis of failure development period.

— Planning and scheduling.

— Systematic inspection and condition based maintenance.

— Maintenance assessment
Availability, reliability and organizational effectiveness.

— Decentralization, continuous improvement.

Failure Analysis

It is often said that the inspection and lubrication are the heart and soul of maintenance. Every maintenance system has refined the inspection techniques to make it more objective. The most effective maintenance system is to be chosen considering cost, availability of facilities, and criticality of the equipment. The most suited technique for an equipment can be determined by carrying out a failure analysis.

The failures can be categorised as below.

I	OBSERVABLE FAILURE	(a) REGULAR FAILURE (b) RANDOM FAILURE
II	NON OBSERVABLE	(a) REGULAR FAILURE (b) RANDOM FAILURE

Observable Regular Failure :

As the name suggests this type of failure is regular or in other words follows a set pattern. It occures at regular interval and more over the defect that causes the failure is visible. The visibility of defect can either be through an instrument or senses, without dismantling the equipment. Thus the defect and its progress can be detected by objective or subjective inspection technique. Since these

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defects are visible condition based maintenance system are best suited.

Observable Random Failure :

Unlike regular failures these do not follow any set pattern, though the defect can be detected. In this case even though the defects are visible it becomes difficult to fix up the frequency of inspection, whether it is subjective or objective. Past history and failure data are very critical in fixing up the frequency. Condition based maintenance system is adopted for preventing break down due to this type failure, also.

Non Observable Regular Failure

These failures though regular in nature, unlike observable failures the defect causing the failures are not visible. The invisibility of these failures can be due to the nonavailability of either an instrument or facility. It may be true that suitable instruments for detecting the defects may not be manufactured at all, or else even if it is available in market the facility many not be available to the maintenance personnel. Since these failures follow a predictable pattern, though invisible, the approximate failure period can be predicted, provided proper records are available, The most suitable technique for preventing the total break down in this case is obviously Time based preventive maintenance system, wherein the part is replaced before the estimated failure period.

Non Observable Random Failure

These are the most undesirable of all failures since the defects are neither visible nor follows any predictable pattern. There is no technique for preventing a break down due to these and the maintenance personnel should be well prepared all the time for the eventuality. In any maintenance system it is the endevour to make these defects visible by inovative methods of inspection.

Failure Development Period

While carrying out the failure analysis the available facilities and capabilities are to be considered. Or else a failure classified as observable failure will for all practical purpose be a non observable one.

Once the failure analysis is carried out for each equipment, there arises the question of right frequency of inspection. Failure development period, which is the period from the time of detecting the defect to the time of failure, is the guide line to decide the frequency of inspection. As is evident since this period depends on the time of detecting the defect, it is advantageous to detect the defect at the earliest. It is obvious that the frequency of inspection should be less than the failure development period, to avoid a break down.

If the defect is detected at an early stage the failure development period is maximum resulting in maximum interval between inspections and better planning. More and more sophistication is brought into the inspection technique to achieve early detection of the defect. For example the defect in the roller bearing can be detected by (a) sense of touch and sound (b) using an Engineer's stethascope (c) By means of shock pulse meter or vibration analysis. By the time the defect is detected by sense of touch and sound it would have progressed considerably and the bearing failure is imminent with in a short time. Engineer's stethascope is a step forward wherein the defect is dedected little earlier. Shock pulse meter which detects the defect by sensing the shock pulse or the spike energy generated by the defect is a further refinement and by using it the defects can be detected at a very early stage.

The above example illustrates how refinement of the inspection technique can help in achieving more failure development period. Unfortunately all the defects can not be detected by objective inspection techniques using instruments, and still many of the defects can be detected only by subjective inspections.

In any maintenance system it unavoidable to use the regular inspection by listening, touching and seeing, whatever be the level of sophistication achieved. The basic elements of cleaning, lubrication and elementry subjective inspection are essential for the maintenance to be effective.

Planning And Scheduling :

Planned maintenance is all maintenance planned and prepared with tools, spares etc,, latest by the day before it is executed. If the jobs are identifical early enough there will be enough time to do the planning and scheduling.

The application of failure analysis in planning is better understood by considering a familier situation of a group of centrifugal pumps. Here the case of a mill, where condition monitering facility for detecting the bearing defect is availiable, is considered.

Failure Analysis of Centrifugal Pump :

Observable Failure		Non Observable Failure	
Regular (CBM)	Random (CBM)	Regular (T.B P M.)	Random (B.Down)
Bearing Failure	Gland Leak	-Sleeve Wear	-Breakage Due
	Oil Leak	-Casing Wear	To Foreign
	Sealing Lime Jam	-Wear Plate Wear	Material
		-Impeller Wear	
		-Base Push Wear	
		-Couplim Type	

Once the above analysis is done for all the equipments the observable random failures are all grouped for subjective inspection activity. Once the frequency of inspection is decided, which in most of the cases will be very high since the FDP is not known, inspection activity charts and scheduling charts are prepared.

In case of non observable regular failure since the FDP is known preventive maintenance activity chart and the schedule are prepared.

(1) Subjective inspection activities

(2) Subjective inspection schedules

(3) Tune based P. Maint Activities

(4) Tune Based P. Maint Schedule.

Once the above schedules are prepared only the OBSERVABLE REGULAR FAILURE which is prevented by condition based maintenance is to be planned.

Condition Based Maintenance

This includes maintenance activities that are based on the actual need for maintenance and is executed as planned maintenance at a time when there is an opportunity. If imlpmented systematically and judiciously condition based maintenance will result in a very high percentage of planned maintenance.

Generally while discussing the condition monitoring system, only the techniques involved in monitoring the conditions of the bearing are discussed. It may be partly because much headway has been made, technologically, in this field and partly because the bearings are critical and vulnerable. It is advantageous to make more defects visible by adopting different condition monitoring techniques so that most of the defect, can be detected at an early stage and their progress monitored.

Few of the condition monitoring techniques are wear debris analysis, thermography, ultrasonic leak & crack detection, thickness measurement, remote visual inspection etc. The most common condition monitoring techniques is the vibration analysis for which there are a number of instruments developed. There are also several models of shock pulse meters for detecting the defects in a antifriction bearing by sensing the shock pulses being generated by the rolling elements.

There are enough technical data available regarding the analysis of vibration and shock pulse readings that they are no more considered high technology. The shop floor managers generally prefer shock pulse meter since the analysis is much easier. Not much skill is required for taking either shock pulse or the vibration readings. But of course the analysis of readings require the technical knowhow. In many cases continuous monitoring systems are available with computers so that the conditions are monitered, recorded and alarms given when the condition deteriorates.

The condition monitoring programme should aim at making the maximum number of defects visible so that the other types of maintenance to be carried out are minimum.

Assessment of Maintenance

The total result of a production system is the quantity of product at a certain quality level over a period of time at a certain cost. This is the total system performance. The total system performance depends on (1) capacity performance which inturn is a function of equipment capacity and process efficiency (2) Reliability performance which inturn is a function of basic equipment design and maintenance support.

Availability which is the main measure of maintenance performance is influenced by functional relia-

bility. Availability is measured in terms of mean down time. Mean downtime is dependent partly on equipment maintainability which is measured in terms of meantime to repair and partly on efficiency of the maintenance crew which is measured as mean waiting time. Meantime to repair depends mostly on ease of dismantling, repair accessability, need for special tools case of locating failures etc. The efficiency of the maintenance organization is measured by mean waiting time, which is a function of planning, supervision, tools, documentation, spare parts supply and motivation of personnel.

If maintenance is correctly performed the availability is maximum and the utilization of time and manpower is better. Manpower utilization is an indicator of management efficiency. Maintenance performance is not only design but also people related. People use systems and techniques and the opportunity is to make people interested, motivated and committed to maintain and continously improve.

Another important indicator of the effectiveness of maintenance management is the percentage of planned and unplanned maintenance jobs. Any system should aim at achieving 100% planned maintenance which is very difficult.

Mr. Christer Idhammar of IDCON INC, Summarises the world class maintenance in pulp and paper mills as follows.

- Equipment Efficiency for paper machine including availability, quality and speed is above 90% (availability 96%).
- Planned and scheduled maintenance work is 95%.
- The mill is clean and house keeping is very good.
- Stores is closed yet delivers the spares and materials to location of job.
- Fexible work force.
- High level of skills and motivation so that the supervisor's role is to plan and not to instruct and shepered.
- Fast access to technical documentation.
- No mechanies and Electricians on shift. Only Electronic specialist, are on shift.
- Operators are trained and initiate inspection,
- Training is instituted as continuous effort.
- Overall maintenance hours spent as follows. Unplanned 5%, planned 70%, continuous improvement 25%.

The maintenance efficiency is assesed to improve the performance continuously though in many cases in spite of assessment no improvement plan is developed. It is better to establish ones own realistic goals, key factors, improvement plan etc. other than depending on certain common bench marks.

Integration of Maintenance And Process :

The latest management approach encourages the flexible integration of maintenance and operations personnel into crews that both operate and maintain the equipment. Changing the present day compartmentalised system to an integrated system is not an easy task since it calls for changing the attitude of people. To make it a reality the managers should have a clear vision and a programme.

A good starting point for the change is the restructuring of the existing inspection system. Getting operators involved in frontline inspection and cleaning of equipment can be a very major step forward toward integration. The operators should be trained in the simple condition monitoring technique.

Ideally both the maintenance and operations personnel report to one area manager. Even if the two functions are totally integrated, obviously some personnel still have to be specialised in unique maintenance or process related tasks. Specialised maintenance function should have the following facilities.

- Mechanical, Electrical and Instrumentation work shop facilities.
- Centralised planning to support area planning.
- Specialists in reconditioning, Electronics, hydraulies.
- Resource to support area function.
- Monitoring of new materials and technologies.

Implementation of an integrated system will take a very long time of sustained committed effort.

Conclusions

The modern approach to maintenance can be summarised as follows :—

— The corrective maintenance action depends on the condition of a component, measured when the equipment is in operation.

— Equipment will not be shut for maintenance unless the condition shows that it is the most effective action to take.

— The operations and maintenance functions should be fully integrated.

Employees work with in a system and it is this system, not only their skills, that determine how they perform. And it is the responsibility of the management to improve the system.

Reference :

RESULT ORIENTED MAINTENANCE MANAGEMENT 92, BY IDCON INC.