ISSN: 0379-5462
IPPTA: Quarterly Journal of Indian Pulp and Paper Technical Association
Vol. 29, E4, 2017, pp.11-15

IMPROVEMENT IN EQUIPMENT RELIABILITY & MAINTENANCE PLANNING THROUGH PREDICTIVE MAINTENANCE – A CASE STUDY AT YASH PAPERS LTD.

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Abstract :

In today's world of competition "PRODUCTIVITY" is the catch word, be it manpower or machines. Be it designers or users, everyone is targeting on providing highest productivity in their plant. Taking productivity into consideration re-engineering & best maintenance practices is becoming very important now a day. Main aim is to reduce overall cost of the product by best use of technology which can lead to increase in profitability.

***Re-Engineering** : Even if it is best designed plant or even if the user is trying his best to use his machines into maximum of productivity then also there is always some scope for improvement which comes from re-engineering. Everything which is designed & manufactured when put into field test or into actual use always suggests some sort of improvements. If monitoring properly the same can lead to re-engineering and increasing productivity therefore.*

***Best Maintennace Practices** : Maintenance is one of the important elements in any of the industries. Better the maintenance, better the productivity. Best maintenance practices leads to increase MTBF & minimize MTTR. If the combinations of both are met then the same results in near to zero down time of the machines and leading to maximum productivity.*

Maintenance Practices -

1. *Reactive Maintenance – Maintain when it breaks. Also called breakdown maintenance.*
2. *Proactive Maintenance – Inspect beforehand and maintain before it breaks.*
   a. *Preventive Maintenance – Maintain in regular interval of time.*
   b. *Predictive Maintenance – Inspect and analysis, then accordingly maintain post planning.*

We need our machines running trouble free and that is possible only if we diagnosis problem in early stage. That is why maintenance practices have now moved from reactive/ preventive to predictive mode in order to minimize maintenance time and cost. Few of the predictive maintenance methods which will be discussed by which we can monitor the machine health are - Basic of Condition Monitoring, Vibration technology and its advantage, Wireless testing technology in field of vibration, Automatic diagnosis system, Noise Analysis, Thermography, Oil Analysis, Setting up automatic reliability program.

What the key element in all above is "MAINTENANCE PLANNING". With maintenance planning the maintenance people can work out the overall reduction in maintenance cost by working out which maintenance method is suitable for which machine and optimization of use of store inventory. For any of the maintenance to take care the optimization of the resources (manpower, inspection machinery, best maintenance tools and fixture and spares inventory) used in maintenance can only lead to reduction in maintenance cost and improvement in productivity.

INTRODUCTION

Maintenance is one of the important aspects in any of the industries. Reduction in maintenance time and cost is directly related to increase in profits. Increase in MTBF of the equipment leads to increase in overall reliability of the same.

PLANT AVAILABILITY

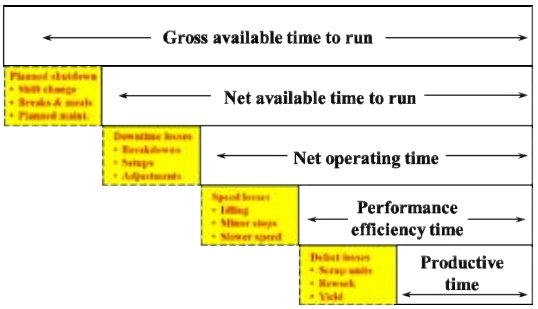
Plant availability draws significant attention due to present day high downtime costs & tough competition in the market. The downtime costs of capital intensive single stream modern process industries like cement, paper, power, petrochemicals, sugar etc. is quite high. It is seen that the average availability of these process industries is around 80% as against 95% of the world benchmark (Source FICCI 2010). A study reveals that just a modest 5% increase in machine availability could lead to 30% increase in profitability. The average availability of different process industries is given below (Source FICCI 2010).

Industry		Average Availabilty (%)	Benchmark (%)
Paper		85 – 95	96
Power		77 – 90	95
Petroleum Based		75 – 80	95
Sugar		75 – 90	95.5
Cement	Lime Stone Crusher	50 – 70	95
	Raw Mill	65 – 95	
	Kiln	80 – 98	
	Cement Mill	70 - 99	

Source: FICCI 2010

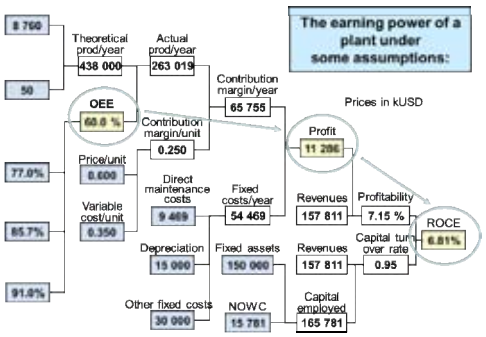
OVERALL EQUIPMNET EFFECTIVENESS (OEE)

Overall equipment effectiveness quantifies how well a manufacturing unit performs relative to its designed capacity, during the periods when it is scheduled to run.



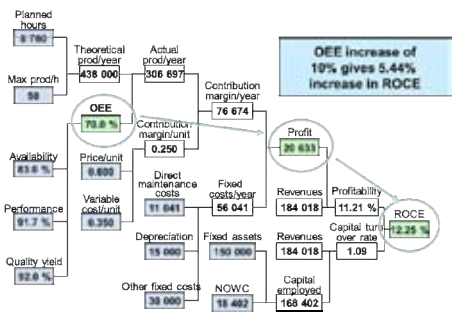
Below is some assumptions to show how profit can be enhanced by increase in OEE

INFLUENCE OF OEE ON EARNING POWER



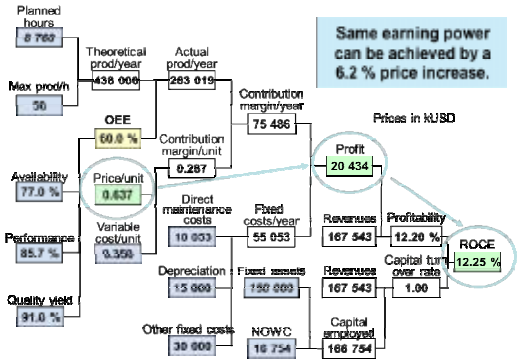
With Overall Equipment Effectiveness 60% we get ROCE (Return on capital employed) 6.81%

HIGHER OEE SUBSTANTIALLY INCREASES EARNING POWER

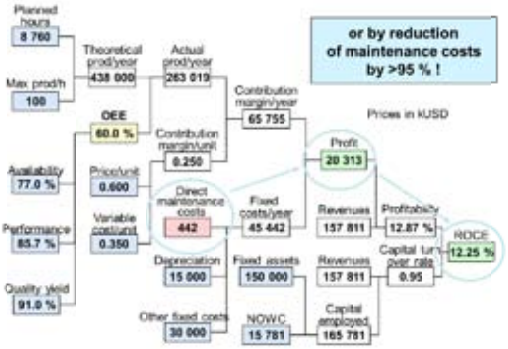


With 10% increase in OEE we can increase ROCE to 12.25% which can be either achieved by increasing price by 6.2% or by reducing maintenance cost by 95%.

SAME EARNING EITHER REQUIRES PRICE INCREASE OR



REDUCTION IN MAINTENANCE COSTS OF 95%!



MAINTENANCE PERFORMANCE

Maintenance performance of Indian process industries is not encouraging as compared to world class maintenance practice. The management approach towards maintenance of machines has been traditional – but proactive maintenance practices are slowly realized. The cost of maintenance per annum is about 5 – 8 % of the sales turn over in our process industries (Source: FICCI 2010)

In view of the above factors such as less availability of plant & machineries, low capacity utilization & very high maintenance & labor cost, it is now the high time to implement CM techniques in order to optimize operational reliability, availability, process efficiency, product quality and safety in process plant.

MAINTENANCE PRACTICES

Most commonly used maintenance practices in the industries are following.

1. Reactive Maintenance/ Breakdown Maintenance : Maintain only when it breaks. This is the most commonly used and oldest maintenance practice. It is usually preferred as it doesn't involve any additional expertise/ equipment.

2. Preventive Maintenance : Maintenance in regular interval of time. It is type of maintenance which is done in regular interval of time. Car servicing is the best example of preventive maintenance. Lubrication/ oil change at a regular interval in plant is part of preventive maintenance.

3. Predictive Maintenance : Inspect beforehand and maintain before it breaks. Inspect and analysis, then accordingly maintain post planning. In this practice the equipment are inspected with testing equipment and the data collected is analyzed. Based on the same maintenance activity is planned.

4. Proactive Maintenance : Uses a variety of technologies to extend operating lives of machines, root out design problem, and increase efficiency leading to enhance productivity.

Maintenace Strategy	Advantages	Disadvantages	Resources/ Technology Required	Application Example
Reactive	No prior work/ expertise required	Disruption of production, reduction in efficiency, injury or death.	Maintenance tools labor & spares.	Office copier
Preventive	Work can be schedule at some interval& breakdown avoided.	Labor cost, may replace healthy component.	Maintenance tools labor & spares	Bike and car services, lubrication
Predictive	Impending failure can be detected & work scheduled& breakdown avoided.	Labor cost, cost for detection equipment & services.	NDT Techniques like vibration.	Vibration & oil analysis of large gear box
Proactive	Increase in life & efficiency of machine	Service Cost for analysis	Testing equipment as flow meters.	Improving pump/ blower efficiency

One cannot say without facts that which practice is profitable or which is not. At some places reactive maintenance may be cheaper than the preventive or predictive maintenance. That is why selection of the right kind of maintenance practice for the equipment is most important.

For that equipment which is directly related to the production the best practice is Predictive Maintenance or called Reliability Centered Maintenance as the same directly impacts in increasing the reliability of the equipment. In broader aspect we call it Condition Monitoring i.e. monitoring the condition of the machine, analyzing the fault and accordingly maintaining the same.

PREDICTIVE MAINTENANCE TECHNIQUES

The most commonly used techniques used for Predictive Maintenance are the basic Non – Destructive Techniques –

S. No.	Predictive Maintenance Techniques	Problem Predicted Before Hand
1.	Visual Inspection	Abnormal leakage, sound, temperature, smell detected by human sense organs.
2.	Vibration Analysis	Imbalance, Misalignment, Deteriorating, defective or poor – fitting bearing, gear defects, bent shafts, foundation problem, crack rotor, fluid flow issues, resonance, change in shape etc.
3.	Thermal/Infrared Testing	Abnormal temperature profile.
4.	Ultrasonic Testing	Internal Crack detection, stresses development in material.
5.	Ultrasonic Thickness Testing	Thickness variation.
6.	Magnetic Particle Testing	Sub surface Crack detection.
7.	Liquid Penetrant Testing/ DP	Surface crack detection.
8.	Radiographic Testing	Internal crack detection.
9.	Motor Current Signature Analysis	Abnormalities in motor.
10.	Sound Analysis	Abnormality in equipment and bearing.
11.	Oil Analysis	Abnormality in bearing, gear teeth.

BENEFITS OF PREDICTIVE INSPECTION

1. Problem with the equipment is detected prior hand before it is failed.

   The technique is predictive. The testing and analysis predicts the problem much before it leads to failure.

2. Exact root cause of the problem can be found out.

   Rather than beating round the bush during maintenance, exact route cause of the problem is detected with predictive maintenance and accordingly the repair can be planned.

3. Maintenance planning can be done based on the inspection report.

   Once the equipment are tested, the problem & the criticality of problem associated with the same is detected. Based on that report plant personals can schedule their maintenance planning and accordingly plan shutdown.

4. Increase in equipment availability

   With prior inspection the maintenance is focused and specific repair or replacement takes place. Rather than equipment failing and damaging many of the spares overall unplanned breakdown time is reduced which in turn increases production time.

5. Less damage of spares.

   Since the breakdowns are avoided the tendency of damaging of spares reduces and the same is repaired before it breaks.

6. Reduces labor costs

   When repairs are scheduled, the amount of time needed for repair is reduced because of a smaller number of component replacements instead of entire equipment replacement. Also, the frequency of repair for critical failure of equipment will be reduced and the amount of “critical callouts” will be greatly reduced.

7. Reduce overall maintenance cost.

   Instead of replacement of the entire piece of equipment due to critical failure, a repair is made prior to failure and cost is minimized to the price of the component and the labor needed for the repair.

8. Improvement in efficiency post correction of problem detected.

   The equipment which is running with any of the problem associated with them may not be providing proper efficiency. Post analysis when the correction of the problem associated with them is eliminated then the efficiency of the equipment enhances.

9. Power saving post correction of the problem detected.

   If the equipment are having mechanical problem like unbalance, misalignment or looseness then the same will be taking more power. Post correction of these problems the overall power consumption of the equipment reduced.

10. Increases safety

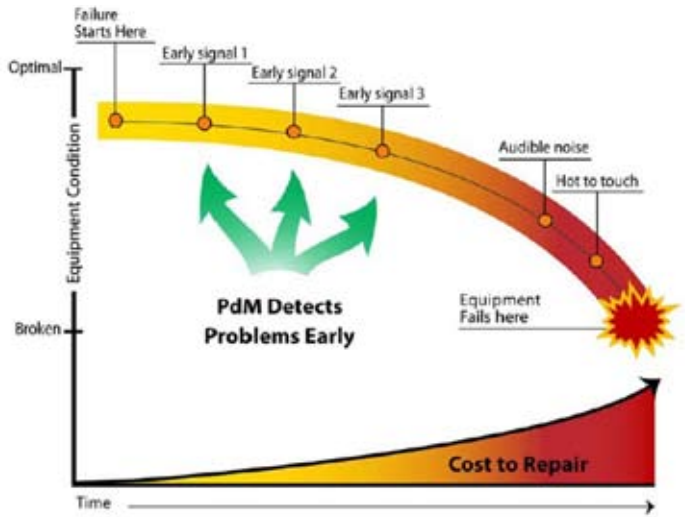
    Predictive maintenance would allow potential problems to be fixed before failure occurs, which would create safer driving conditions for employees and customers.

11. Increase in Overall profit

    With less maintenance on good components and quicker repair of faulty components, repairs can be more effectively handled, thereby reducing repair time.

12. Increases efficiency of employee time

    By identifying the precise repair task needed to correct deficiencies, as well as the parts, tools and support needed to correct the problem can dramatically increase effective “wrench time.”



EXPERIMENTS

We at Yash Papers are mainly offering Condition Monitoring Services through Vibration Inspection and Analysis. Schedule of inspection of equipment testing is made and detailed analysis of the same is done and report is made.Below are the few of the real time case studies of the same and the savings made out of that.

CASE STUDIES

Reduction in downtime

Post implementation of Predictive Maintenance in Yash Papers Ltd. we have found reduction in downtime and thereby increase in availability of the plant. The data of reduction is shown in below table.

S. No.	Area	Reduction In Downtime % Post Predictive Maintenance
1	Paper Machines & Pulp Mill	3.95 %

Above is the data of Yash Paper Mills of 2017.

Reduction in spare cost

Post implementation of Predictive Maintenance in Yash Papers Ltd. we have found reduction in mechanical spare consumption and thereby increase in profitability of the plant. The data of reduction is shown in below table.

S. No.	Area	Mechanical Spare Consumption Reduction % Post Predictive Maitenance
1	Total Plant	17 %

Above is the data of Yash Paper Mills of 2017.

Ease in maintenance planning

With predictive maintenance in place one can easily do maintenance planning and plan their shut down accordingly.

S. No.	UI. NO.	INSPECTION DATE	SECTION	EQUIPMENT NAME	MACHINE CONDITION	RECOMMENDATIONS	CORRECTIVE ACTION TAKEN / TO BE TAKEN	TIME FOR CORRECTION	RESOUCES NEED FOR CORRECTION	RESPONSIBILITY
1	340PU0001	4-Sep-17	BOILER 4	WET SCRUBBERPUMP -1	Alert	1. To reduce the vibration of the system, it is recommended to carry out balancing of the pump impeller.	Dismantelling of pump. Replacing impeller with balanced impeller. Or replacing pump with spare pump.	1 hr.	Tools & tackles. Spare balanced impeller or spare pump.	
						2. It is also recommend check the alignment system and review the soft foot at motor base frame.	Alignment to be carried out.	2 - 3 hrs.	Shims for alignment.	
						3. It is also recommend check the tightness of all foundation bolts for any mechanical looseness in the system.	Inspect mechancial looseness.	30 mins.	Tools & tackles.	
						4. Both bearings fitment of motor need to be check.	Check motor bearing fitment.	30 mins.	Spare bearing or motor.	
2	350FN0201	3-Oct-17	BOILER 5	F.D. FAN	Alarm	1. Overall vibration reading are normal, but to reduce the further vibration of the system, it is recommended to inspect the bearing and also review the bearing clearance.	Check bearing & fitment.	30 mins.	Spare bearing or motor.	
						2. It is recommend to inspect the Fan bearing and bearings fitment need to be check with related to the bearing housing	Check bearing & fitment.	30 mins.	Spare bearing or housing.	

Above is the data of Yash Paper Mills of 2017.

Power Savings

Unbalance/ Misalignment power loss – It is proven by many studies that in a misaligned system there is a power loss of about 2 to 3 % and in unbalance system it is about 1%.

(Published in: Energy Conversion Engineering Conference, 1996. IECEC 96, Proceedings of the 31st Intersociety)

Suppose an equipment with unbalance & alignment problem is taking 110 A. Motor ratings 75 KW, FLA 135 A, 415 V & PF 0.8. (3^1/2 x PF x V x A)

- Initial Power Consumed – 63.25 KW
- Reduction in earning load post correction (Say 5%) – 104.5 A
- Post Correction Power Consumed – 60 KW
- Reduction in Power Consumption – 3.25 KW

Considering Electricity Cost @Rs. 5 per Unit

- Annual Power Saving – Rs. 1, 40, 400/-

Other Indirect Savings

1. Increase in equipment efficiency.
2. Increase in bearing and other spares life.
3. Increase in manpower efficiency.
4. Mechanical Maintenance cost.
5. Reduction in labor cost.
6. Bearing and other spares replacement cost.
7. Manpower safety
8. Peace of mind

RESULTS

SAVINGS

Post implementation of predictive maintenance technique it is observed that overall availability of the plant has increased thereby reducing spare cost and increase in overall profit.

TECHNICAL PAPERS

DISCUSSION

SMART MOVES

1. Installation of wireless/ online monitoring systems over inaccessible/ critical equipment.
2. Setting up automatic reliability program.
3. Automatic diagnostic system
4. Computerized maintenance planning (ERP)

CONCLUSION

Condition monitoring should be developed as a specialized service in all industries. This requires establishment of a cell with trained executives and techniques to provide exclusive reliable service on machine condition to all sections of the plant. It would be desirable to have integrated computerized maintenance management system incorporating linkages with spare parts management, material management etc. and also such system concerned on – line through internal LAN with all work stations. Many computer based maintenance system packages are available now as a separate package or a part of ERP package incorporating all features. The full potential use of highly versatile diagnostic tools and techniques should be explored to achieve higher machine availability.

REFERENCES

1. FICCI Plant Maintenance Summit 2010.