Strategy to Achieve Zero Breakdown Through TPM

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ABSTRACT

The paper focuses on maintenance practices being followed at JK Paper Mills to achieve zero breakdown. The methodology followed is known as Total Productive Maintenance (TPM). This also discusses the role and responsibilities of operators and maintenance crew, changes in training methodology, work practices and application of Autonomous Maintenance by operational crew instead of traditional maintenance department.

INTRODUCTION

Globalization and open economic policy have forced the organizations to give a fresh look at their existing operations, both in terms of practices and efficiency. Radical changes/ improvement in both is the order of the day for the very existence. Aspirational goals and superlative operational performance can only keep the threat of extinction at bay.

In a typical process industry, the production function is given prime importance and the maintenance function is given fairly low priority in the organizational efficiency. However, tremendous emphasis has been put on maintenance in the recent past and significant changes and developments have taken place in this field including high technology and modern scientific approach. Total Productivity Maintenance is one such scientific approach, which is not only innovative and methodical but also a highly focused approach to the whole concept of equipment maintenance.

Total productive maintenance

TPM aims at :-

- Maximizing overall equipment effectiveness (OEE) by eliminating various losses.
- Improving equipment reliability and maintainability
- Achieving the most economical Life Cycle Cost (LCC) of equipment.
- Developing equipment conscious operators and
- Creating an enthusiastic work environment.

TPM brings a radical change in workplace and provides a mechanism for achieving zero breakdowns, zero defects and zero accidents. The focus centers on Overall Equipment Effectiveness (OEE), which is a product of equipment availability rate, performance rate and quality rate. The whole concept of Autonomous Maintenance (Jishu Hozen) is based on how to enhance these parameters significantly so as to provide a cutting edge to the organizational performance.

Availability rate

Equipment availability is an important factor for measuring OEE. Machine stoppage for any reason adversely affects availability and therefore, loss of production. The rate of availability is calculated as under.

$$\text{Availability in \%} = \left[\frac{\text{Total calendar hours-stoppage hours}}{\text{Total calendar hours}} \times 100\right]$$

Performance rate

Standard production: Rated capacity of the machine for a given product.

Actual production: Actual quantity produced.

The ratio of actual production to standard production is the performance rate and is calculated as under.

$$\text{Performance rate in \%} = \left[\frac{\text{Actual production}}{\text{Standard production}}\right] \times 100$$

Quality rate

It is measured as the ratio of accepted product conforming to quality standards to that of total quantity produced and calculated as under.

$$\text{Quality rate in \%} = \left[\frac{\text{Total quantity produced-quantity not conforming to qlty.}}{\text{Total quantity produced}}\right] \times 100$$

OEE in % = Availability rate X Performance Rate X Quality rate

To increase availability, elimination of equipment breakdowns is important. TPM system has a direction for this. It encompasses all the key aspects of

maintenance (reactive, preventive, productive, corrective and so forth). It emphasizes the role of machine operators and their involvement in upkeeping the machine condition. Machine operators accept new responsibilities, such as daily maintenance checks, minor adjustments, lubrication and minor part changes and thereby owning the equipment. This paper focuses on approach of J.K. Paper Mills towards zero breakdowns.

JKPM initiated TPM during July 2000. Initially, three machines were selected, namely Chipper, Paper Machine-I and Wills cutter-I. These machines are called model machines for TPM implementation. At model machines, engineers of process, maintenance and respective departments heads carried out autonomous maintenance activity. This involves thorough cleaning of machines, identification of abnormalities, developing and implementing counter measures for the abnormalities. While performing this activity executives become more familiar with autonomous maintenance.

After successful implementation of autonomous maintenance activity at these model machines, similar TPM activity was extended to other machines where, all employees were involved in autonomous maintenance activity under the guidance of executive who had gained experience at model machines. These activities were focused on bringing equipment to its basic conditions. This is the first step towards Zero breakdowns. Following six key activities are followed on TPM guidelines in pursuit of our Zero breakdowns.

Bring equipment to basic conditions

Cleaning, lubrication, tightening etc. are the basic conditions for any equipment. Equipment deterioration is of two types, accelerated and natural. These deteriorations lead to breakdowns. The acceleration deterioration arises when equipment's basic conditions are not maintained where as natural deterioration occurs due to equipment inherent life span, corrosion, changes in the properties of material etc. To prevent accelerated deterioration, we have to restore equipment basic condition, by eliminating various hidden abnormalities, which are generally classified in to seven categories. The examples of abnormalities are given in Table 1.

During thorough cleaning activity, we has identified more than 32000 abnormalities of which about 70% are rectified immediately and remaining during plant shutdowns. Fig. 1 shows categorywise number of abnormalities identified till March 2003.

By rectifying abnormalities we have restored equipment basic conditions. This resulted in reduction

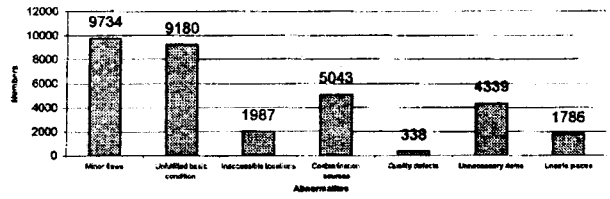

Fig. 1: Classification of Abnormalities

Table 1

Abnormalities	Examples
Minor Flaws	• Contaminations like dirt, dust and bad paint. • Damaged/crushed/bend parts • Slackness of belts, chains • Abnormal phenomena like noise, vibration, smell
Unfulfilled basic conditions	• Insufficient lubricant, leakage of oil, contaminated lubricant. • Loose, long, crushed nut bolt, washers
Inaccessible locations	• Fixed machine covers, machine parts difficult to approach, gauges difficult to read due to orientation/layout
Contamination sources	• Leaks/ spills/ overflows- of air, gases, steam, water • Flashes/chips, and non-conforming products • Contaminants brought in by people, fork-lift trucks
Quality defect sources	• Product damages during manufacturing, variations in dimensions.
Unnecessary items	• Pumps/fans/compressors, columns, tanks, Pipes, valves • Temperatures/ pressure gauges, vacuum gauges, ammeters • Wiring, piping, switches, plugs, cutting tools, jigs, dies, frames • Sharp projections
Unsafe places	• Too steep, irregular, corrosion, missing handrails • Broken covers/ladders not properly fixed • Toxic gases/chemicals

of number of breakdowns. Fig. 2 below indicates month wise breakdown trend. Breakdown data of 2000-2001 is the benchmark indicating the status prior to TPM.

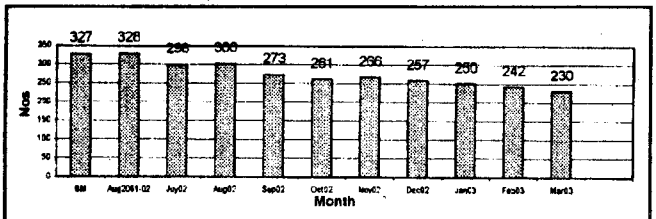

Fig. 2: Breakdowns due to poor basic conditions

Eliminating accelerated deterioration by complying with conditions of use

Any equipment is designed to work at certain operating conditions like pressure, viscosities, temperature, speed etc and if the equipment is operated at abnormal conditions, it will lead to accelerated deterioration and (generally) shorten their lifespan with unexpected breakdowns. To eliminate deterioration, as per guidance of process engineer, operators ensure strict adherence of the set operating conditions fixed by section in charges along with maintenance engineers.

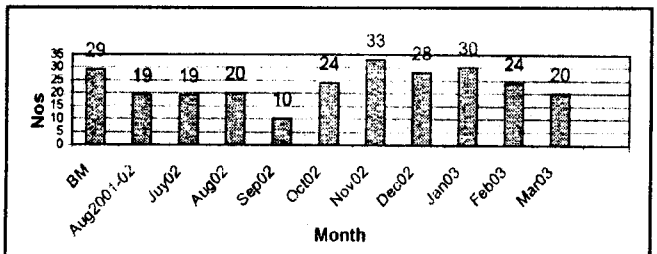

Fig. 3: Breakdowns due to abnormal operating conditions

Fig. 3 indicates month wise number of breakdowns resulted due to abnormal operating conditions. Monitoring and maintaining the set conditions have achieved the reduction in trend on number of breakdowns.

Restore equipments to its optimal condition by arresting deterioration

It is very important to monitor and measure the degree of natural deterioration. This deterioration is a gradual form of deterioration due to equipment inherent life span, changes in the properties of material, corrosion etc. It is natural that over a period, some parts of equipment will deteriorate due to wear & tear.

At JKPM, to optimize equipment conditions, various pipelines, tanks, spare parts etc are replaced with better material. In some areas, Condition Based maintenance system adopted to analyse degree of deterioration and remedial action was planned. Actual replacement initiated during planned shutdowns.

Eleminating environmental conditions causing accelerated deterioration

If shop floor environment is filled with dirt, dust, pulp, powder etc and equipments parts are covered with such contaminants, it is difficult to inspect (oil level gauges, loose bolts, V-belts & chains conditions) and environment like this will be perfect breeding ground for accelerated deterioration.

TPM activity is focused to expose these parts, identify sources of contaminations and take counter measures (through kaizens) to eliminate these sources. AT JKPM, about 500 numbers of such sources are identified and rectified through kaizens. Places where it is difficult to inspect, difficult to lubricate are also made accessible through Kaizens. Table 2 below shows different sources of contaminations identified at various locations of the plant.

Lengthen equipment lifetime by correcting design defects

Operating equipments under stressful conditions, such as high speed, high load and frequent stops and start-ups, results in breakdown due to shaft breakage, bearing damage etc. ensuring the correct load, temperature and conditions of use are not enough to eliminate such breakdowns. It is necessary to change such design defects, like dimension of the shaft or bearings etc. Without correcting design defects it will be difficult to eliminate such breakdowns. Fig. 4 below indicates breakdowns of equipments at JKPM due to design defects. By rectifying design defects, breakdown came down drastically. At JKPM every failure is considered a valuable learning aid that teaches us about the weaknesses. A through failure analysis helped us in lengthening equipment life cycle.

Eliminate unexpected breakdown by developing equipment conscious operators

Even when equipments are extremely reliable, unexpected breakdowns may still occur as a result of

Table 2

Source of contaminations	Numbers of locations
Steam leakages	215
Water leakages	105
Oil & grease	128
Powder spillages	24
Wood chips spillages	12
Dust (wood, coal)	15
Pulp	31

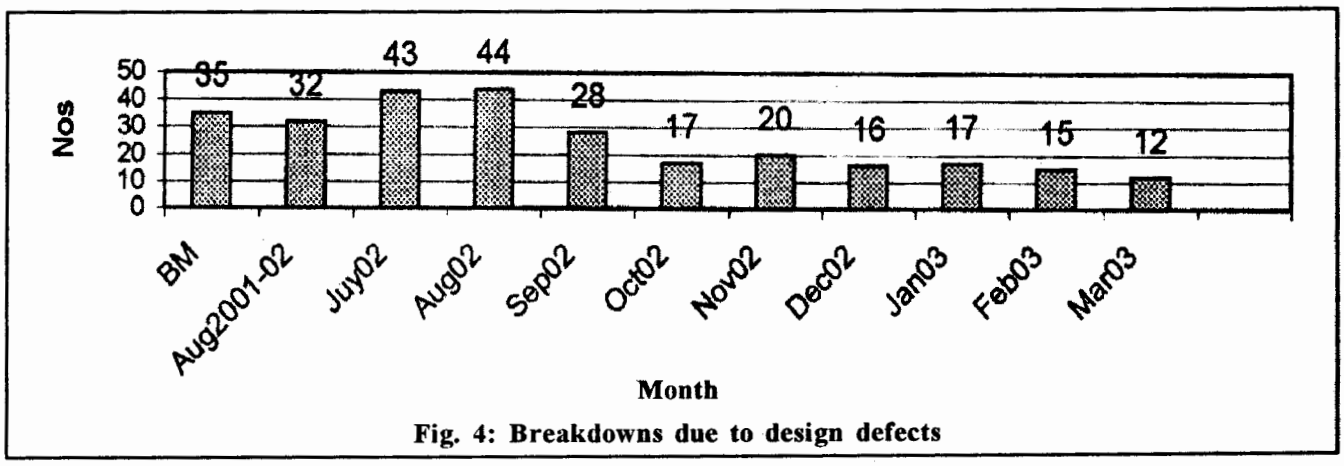

Fig. 4: Breakdowns due to design defects

operating and repair errors. Equipment conscious operators play a critical role in eliminating errors. To develop equipment conscious operator, training on following four skills were imparted.

Ability to identify abnormalities

Any operator can recognize an abnormality, once it results to a breakdown. Where as equipment conscious operator can forcecast impending breakdown through daily and periodic checks of equipments, which he performs as a ritual. This develops his capability to identify abnormalities or malfunctions of equipment before they lead to eventual breakdown.

Ability to respond to abnormalities

Being able to identify abnormalities is not enough, he should be able to discover the cause for abnormalities and rectify the same. If he cannot rectify the problems due to complexity of maintenance skill required on that specific case, then he should be able to report the problem accurately to his superiors or to the maintenance staff.

Ability to set optional equipments conditions

Operator should be able to understand and distinguish normal and abnormal operating conditions. He should have the capability to determine (quantitatively) the conditions or the criteria that indicates whether the equipment vital parts are functioning normally or not. He should have ability to understand the relation between equipment set operating conditions and quality of the output.

Ability to maintain equipment basic conditions

Operator should be able to perform daily and periodic preventive maintenance activities like cleaning (to eliminate dust and dirt) lubrication (to prevent wear and burnouts) and tightening of bolts nuts etc (to prevent malfunctions & breakages). All operators should cultivate these four abilities to maintain equipment basic condition. Maintaining equipment basic condition means eliminating the causes of accelerated deterioration. The above creates opportunity for maintenance department technicians to focus on specialized maintenance activities to improve reliability and maintainability of equipment. They are trained to acquire new skills. They develop a culture of performing a job precisely with accuracy. To develop equipment conscious operator, JKPM developed various skill development modules to train the operators and maintenance technicians. This training is inclusive of both on the job and off the job.

CONCLUSION

Zero breakdown is no longer a hypothesis nor it is an elusive or difficult task and J.K. Paper Mills is slowly but surely progressing towards zero breakdown. Initial teething problems are nearly solved. Executives and workmen are witnessing the improvement and are convinced with TPM system. This system also helps developing operators, process engineers and maintenance technicians. This partnership helps for a long-term approach to machine performance, rather than just fixing problems. Additionally records reveal that about 18% reductions in lubrication consumption, increasing trend in number of kaizens, reduction in number of accidents have been a reality. All these also contributed to remarkable improvement in housekeeping and creating enthusiastic work environment.

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