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Study of Total Productivity Maintenance and It's Implementation

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ABSTRACT: Total productive maintenance is one of the most valuable strategies to follow for those who want to be competitive over the coming "world class competition" decades. Total productive maintenance (TPM) is a maintenance program, which involves a newly defined concept for maintaining plants and equipment's. The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction. After carrying out several visits and direct observations of machines on the production shop floor and analyzing previous machine utilization records at Kasturi Metals Pvt. Ltd., it was found that machines were not operating up to its full production capacity due to problems associated with it. A Case Study conducted on machines of the production shop floor is used to illustrate need for implementation of TPM. Thus by the application of TPM it was found that the stepwise implementation of TPM in the company marked improvements in availability, performance efficiency and quality rate and thereby leading to increase in OEE of model machine and which will further lay down foundation for companywide implementation of TPM.

I. INTRODUCTION

Total productive maintenance (TPM) is a systematic process for optimizing overall equipment effectiveness by minimizing the unavailability of machinery due to breakdown and slowness. TPM involves machine operators as partners with maintenance. TPM embraces various disciplines to create a manufacturing environment wherein everyone feels that it is his or her responsibility to keep the equipment running and productive. Aside from eliminating equipment downtimes and improving equipment productivity, TPM has the following goals:
a) Improvement of personnel effectiveness.
b) Reduction of operational costs.
c) Sense of ownership.
d) Customer satisfaction.

1.1 Problem Definition

After carrying visits and observations of machines on the production shop floor and analyzing previous machine utilization records at Kasturi Metal & Composites Pvt. Ltd, at MIDC, Amravati, Maharashtra (India) it was found that steel wool scrubbing machine was not operating up to its full production capacity due to various problems associated with it, which are affecting the Overall Equipment Effectiveness (OEE) of machines on the production shop floor and thereby effecting overall plant efficiency. Hence there was need to implement Total Productive Maintenance strategy to overcome from the regular problems and overcome it to achieve improvement in overall equipment effectiveness (OEE).

1.2 Objectives of the Study

a) To minimize the production delay.
b) To save the time loss during changeover from one job to other on machine accounts for setup loss & break downs of machines due to improper cleaning and lubrication of machine parts which accounts for availability loss.
c) To minimize performance loss due to lack of planned maintenance schedule for machines.
d) To minimize frequent tool breakage due to operator inefficiency which accounts for performance loss.

1.3 Methodology used for the study

In order to overcome problems mentioned in previous section a brief study was carried out and implementation of TPM methodology to improve OEE was finalized. To start with TPM, few machines were selected. These machines were selected on the basis of most important activities performed on the production shop floor which included various important operations. Hence these

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machines were selected for TPM study and stepwise TPM procedure is applied:
1. Selection of critical machine
2. Implementation of 5S on model machine
3. Implementation of AM, PM and KK models on selected machines
4. Training and awareness programs for employees.

II. METHODOLOGY

The plant survey was done and structured so as to improve operations through Total Productive Maintenance (TPM) implementation, with main focus on machine operations, management support, skills-training for operators and human resource input for its success. TPM is concerned more with more equipment efficiency and, hence need for analysing prevailing maintenance system. The case study organisation had a human resource department that deals with personnel issues across the firm, however team integration was not visible to handle TPM related productivity issues. Thus low TQM level was witnessed in terms of quality deployment. The research study evaluated the impact of TPM when practised together with an innovative human resource element to yield positive results. The sweets manufacturing line within the confectionary plant was singled out for the study, to compare TPM results with previous period performance. Interviews were conducted with the managers, supervisors, operators and technicians on gathering key information and aspects to be addressed by TPM and achieve acceptable levels of TQM.

Implementation Stages

Stage A: Preparatory stage

Step 1 - Announcement by management to all about TPM introduction in the organization:

A successful TPM program can never come about without the support of management from the top down. In many cases, management must overcome resistance to change on the part of operators and other employees, and skepticism of the merits of TPM. Clearly announcing your company's intentions, and then regularly talking about the benefits of TPM implementation, can go a long way towards breaking down those barriers.

Proper understanding, commitment and active involvement of the top management in needed for this step. Senior management should have awareness programmes, after which announcement is made. Decision the implement TPM is published in the in house magazine, displayed on the notice boards and a letter informing the same is send to suppliers and customers.

Step 2 - Initial education and propaganda for TPM:

TPM relies heavily on full employee participation which can be achieved through education. A facility should offer formal sessions to communicate the importance of TPM activities, the benefits of TPM, and everyone's role in TPM. Training is to be done based on the need. Some need intensive training and some just awareness training based on the knowledge of employees in maintenance.

Step 3 - Setting up TPM and departmental committees:

TPM includes improvement, autonomous maintenance, quality maintenance etc., as part of it. When committees are set up it should take care of all those needs. TPM is a complex strategy of eight concepts that can often be difficult to implement when it is not a group effort. It will be important to establish a committee (or a few) to promote and sustain TPM while fostering communication between upper-level management and frontline workers.

Step 4 - Establishing the TPM working system and target: Each area/work station is benchmarked and target is fixed up for achievement.

Step 5 - A master plan for institutionalizing:

Next step is implementation leading to institutionalizing wherein TPM becomes an organizational culture. Achieving PM award is the proof of reaching a satisfactory level.

Stage B: Introduction stage

A small get-together, which includes our suppliers and customer's participation, is conducted. Suppliers as they should know that we want quality supply from them. People from related companies and affiliated companies who can be our customers, sisters concerns etc. are also invited. Some may learn from us and some can help us and customers will get the message from us that we care for quality output, cost and keeping to delivery schedules.

Stage C-TPM implementation

In this stage eight activities are carried which are called eight pillars in the development of TPM activity. Of these four activities are for establishing the system for production efficiency, one for initial control system of new products and equipment, one for improving the efficiency of administration and are for control of safety, sanitation as working environment.

Stage D - Institutionalizing stage (Continuous Improvement)

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By now the TPM implementation activities would have reached maturity stage. Now is the time to apply for preventive maintenance award.
• As in any Lean initiative the organization needs to develop a continuous improvement mindset.
• By all there activities one would has reached maturity stage.
• Now is the time for applying for PM award.
• Also think of challenging level to which you can take this movement.

III. TPM IMPLEMENTATION

Company Profile

Established in 1999, Kasturi Metal & Composite (P) Ltd. is the largest manufacturer and exporter of a wide assortment of Steel Fibers. The range includes Duraflex™ Steel Fibers for Concrete Reinforcement, Durabond™ Steelwool Fiber for Friction Industry, Durocrete™ Polypropylene Fibers for Concrete Reinforcement, Steel wool Rolls and Stainless Steel Scrubbers. Recently awarded as "Best Industry Award from Govt of Maharashtra, 2011 for conducting quality works and an ISO 9001:2008 certified company strictly abide by a quality control process to ensure that the customers get the preferred products. In light of this policy, we have established association with leading vendors of the markets, who provide quality raw material.

Kasturi Metal & Composites Pvt. Ltd. is an ISO 9001:2008 certified company strictly abide by a quality control process to ensure that the customers get the preferred products. In light of this policy, they have established association with leading vendors of the markets, who provide quality raw material. Moreover, they have a state-of the-art production unit, which are manned by experienced and well trained professionals. Further, they have a strong R&D unit, which ensures the incorporation of modern techniques and methodologies to ensure the quality production of products with minimal wastage. The R&D unit also ensures that the production processes are in line with government recommended environment safety measures.

TPM Implementation

The following is the brief description of each of the TPM implementation activities:

Master plan:

The TPM team, along with manufacturing and maintenance management, and union representatives determines the scope/focus of the TPM program. The selected equipments and their implementation sequence are determined at this point. Baseline performance data is collected and the program's goals are established.

Autonomous maintenance:

The TPM team is trained in the methods and tools of TPM and visual controls. The equipment operators assume responsibility for cleaning and inspecting their equipment and performing basic maintenance tasks. The maintenance staff trains the operators on how to perform the routine maintenance, and all are involved in developing safety procedures. The equipment operators start collecting data to determine equipment performance.

Planned maintenance:

The maintenance staff collects and analyzes data to determine usage/need based maintenance requirements. A system for tracking equipment performance metrics and maintenance activities is created (if one is not currently available). Also, the maintenance schedules are integrated into the production schedule to avoid schedule conflicts.

Maintenance reduction:

The data that has collected and the lessons learned from TPM implementation are shared with equipment suppliers. This 'design for maintenance' knowledge is incorporated into the next generation of equipment designs. The maintenance staff also develops plans and schedules for performing periodic equipment analysis (burner pump, fuel filter, rotary cup atomizer, furnace tube and valve, etc.). This data from analysis is also fed into the maintenance database to develop accurate estimates of equipment performance and repair requirements. These estimates are used to develop spare parts inventory policies and proactive replacement schedules.

Holding the gains:

The new TPM practices are incorporated into the organization's standard operating procedures. These new methods and data collection activities should be integrated with the other elements of the production system to avoid redundant or conflicting requirements. The new equipment management methods should also be continuously improved to simplify the tasks and minimize the effort required to sustain the TPM program.

Overall Equipment Efficiency (OEE)

TPM initiatives in production help in streamlining the manufacturing and other business functions, and garnering sustained profits. The strategic outcome of TPM implementations is the reduced occurrence of unexpected machine breakdowns that disrupt production and lead to

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losses, which can exceed millions of dollars annually. OEE methodology incorporates metrics from all equipment manufacturing states guidelines into a measurement system that helps manufacturing and operations teams improve equipment performance and, therefore, reduce equipment cost of ownership (COO).

TPM initiatives are focused upon addressing major losses, and wastes associated with the production systems by affecting continuous and systematic evaluations of production system, thereby affecting significant improvements in production facilities. TPM employs OEE as a quantitative metric for measuring the performance of a productive system. OEE is the core metric for measuring the success of TPM implementation program. The overall goal of TPM is to raise the overall equipment effectiveness. OEE is calculated by obtaining the product of availability of the equipment, performance efficiency of the process and rate of quality products:

OEE = Availability (A) × Performance efficiency (P) × Rate of quality (Q);

Where, Availability (A) = [(Loading time-Downtime) ÷ Loading time] × 100,

Performance efficiency

(P) = [Processed amount÷ (Operating time ÷ Theoretical cycle time)]×100,

Rate of quality

(Q) = [(Processed amount-Defect amount) ÷ Processed amount]×100

This metric has become widely accepted as a quantitative tool essential for measurement of productivity in manufacturing operations. The OEE measure is central to the formulation and execution of a TPM improvement strategy. TPM has the standards of 90 percent availability, 95 percent performance efficiency and 99 percent rate of quality. An overall 85 percent benchmark OEE is considered as world-class performance. OEE measure provides a strong impetus for introducing a pilot and subsequently companywide TPM program.

A comparison between the expected and current OEE measures can provide the much needed impetus for the manufacturing organizations to improve the maintenance policy and affect continuous improvements in the manufacturing systems. OEE offers a measurement tool to evaluate equipment corrective action methods and ensure permanent productivity improvement. OEE is a productivity improvement process that starts with management awareness of total productive manufacturing and their commitment to focus the factory work force on training in teamwork and cross-functional equipment problem solving.

This study is done in the selected industry and the values chosen are meant for justifying the research initiatives. Finally, to evaluate the effectiveness of TPM implementation steps, OEE value of selected machine was calculated and analyzed before and after implementation of TPM in industry. In the process industry it is very much essential to maximize the production effectiveness; the effectiveness of a plants production depends on the effectiveness with which it uses equipment materials people and methods. This is done by examining the inputs to the production process and identifying, eliminating the losses associated with each to maximize the production. Major industry losses were identified are shut down (planned maintenance), production adjustment, equipment failure, process failures, normal production loss, abnormal production loss, quality defects, and reprocessing.

The bottle neck is steel wool scrubber machine for scrubbing process due to which productivity is going down most of the time and this plant was selected as equipment for OEE calculation.

Calculations on OEE of the steel wool scrubber machine for Jan, 2021 (before TPM implementation):

Mechanical breakdown = 22.43hrs

Electrical breakdown = 5.25hrs

Electronics/safety device breakdown = 1.40hrs

Total breakdown = 29.48hrs

Setup and other conditions = 4.05hrs

Total loss = 33.53 hrs (Summation of all above losses)

Total shift hours = 480hrs

Net loss (Total good hours-Total loss) = 480 hrs - 33.53hrs = 446.47hrs

(a) Availability rate = (Net loss ÷ Total good hours) × 100

= (446.47 ÷ 480) × 100 = 93.01%

Thus, availability rate is 93.01%.

(b) Percentage of quality =

(Total steel wool produced - Defected steel wool) ÷ Total steel wool produced

Defected steam = Total breakdown × Steel wool produced per hour

= (4100 - 318.1) ÷ 4100 = 92.04% Thus, quality rate is 92%.

(c) Performance rate = [Net loss - (Management loss + Start up loss] ÷ Net loss

= [446.47 - (90 + 15)] ÷ 446.47 = 83.20%.

Management loss = 90 hrs, Startup loss=15hrs. Thus, performance rate is 83.20%.

OEE = (Availability rate) × (Performance rate) × (Quality rate)

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OEE = (0.9301) × (0.8320) × (0.9204) = 71.22%
We know that, if OEE is less than 85% it indicates improvements are required urgently]

Thus Total loss and OEE is calculated for next two months

Table 1: Total loss for OEE calculation before implementation

Before TPM implementation	
Month	**Total loss**
January	33.53 hrs
February	42.30 hrs
March	38.35 hrs

Table 2: OEE values

Before TPM implementation	
Month	**OEE Value**
January	71.22%
February	65.11%
March	67.10%

After TPM implementation, OEE again calculated for the months April and May. The results are shown in Table 3 and 4.

Table 3: Total loss after TPM implementation

After TPM implementation	
Month	**Total loss**
April	22.12 hrs
May	17.12 hrs

Table 4: OEE values after TPM implementation

After TPM implementation	
Month	**OEE Value**
April	77.07%
May	80.59%

IV. RESULTS AND DISCUSSION

After implementation of TPM on the model machine total loss and OEE is recalculated. It is found that implementation of TPM made huge difference in the industry. We can note that total loss in the months of April and May are reduced to an high extent after implanting TPM. Also OEE of the selected machine is enhanced resulting into more hassle free production. By using 5S rating system, we explain how we improved every part of 5S and how training went with team members that they start following changes, resulting in good rating of 5S. Training was good because for eliminating communication gap, company supervisors start sharing problems with team members and taking their views for solving problem of components.

V. CONCLUSION

TPM has been widely known in manufacturing environment. This proactive maintenance strategy contributed to manufacturing performance improvements are highlighted by various researchers. Through TPM process focus, the cost and quality were improved significantly by reducing and minimizing equipment deterioration and failures. Cost of rework and repairs reduced due to very limited products rejected due to equipment failure. Thus, the overall effectiveness of equipment also improved significantly. Additionally,

equipment deterioration was eliminated as the equipment operated efficiently. Autonomous maintenance activities were carried out with total employee participation. The investment in training and education managed to boost operator's morale and the commitment towards company's goals.

A manufacturing facility has been studied and analyzed to study TPM implementation issues, the roadmap followed and the key benefits achieved from OEE as a result of TPM implementation. It can be seen that OEE on steel wool scrubber machine has shown a progressive growth, which is an indication of increase in equipment availability, decrease in rework, rejection and increase in rate of performance. As a result overall productivity of industry also increased. OEE value is encouraging and with the passage of time results will be quite good and may reach a world class OEE value of 85% -90%.

Through this study a medium scale manufacturing industry is studied and analyzed to assess maintenance and overall equipment effectiveness of machines. Thus after carrying out stepwise implementation of TPM in the company marked improvements in availability, performance efficiency and quality rate can be achieved thereby leading to increase in OEE of model machine and which will further lay down foundation for companywide implementation of TPM.

Based on the investigation conducted and by analyzing the different results we can come to conclusion that due to the lagging in implementation of TPM the industry was having less OEE than standard OEE values, which leads to many losses. There is lot of fluctuations are observed in the values of Availability, Performance rate, Quality rate as well as OEE of both industries. After implementation of TPM, the industry has got better OEE value compare previous. From this we can come to conclusion that Partial Productivity or productivity values are directly proportional to OEE.

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