International Journal of Advance Research in Science and Engineering
Vol. No.5, Special Issue No. 01, March 2016
www.ijarse.com
IJARSE
ISSN 2319 - 8354

# OEE IMPROVEMENT THROUGH TOTAL PRODUCTIVE MAINTENANCE

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**ABSTACT**

*Ever since the people have started producing goods & articles to satisfy the needs of the society (end user) the maintenance of production equipment has been gaining prime importance in industries. The continuous production results in to the wear & tear, natural edging & thereafter physical decaying of equipments. This calls for up keeping of the equipment to ensure trouble free production & continuous supply of goods to the society.*

*Down the memory line, many instance of using a wide variety of maintenance practices can be found in the industrial sector across the globe. The benefits accrued from selecting & maintaining a suitable maintenance practice may be summarized as follows one by one.*

1. *Improved uptime of the equipments*
2. *Reduced scrap & wastage*
3. *Improve employee performance*
4. *Better product quality*
5. *Reduced unit cost of production*
6. *Lesser investment in maintenance*
7. *Happy employees & satisfied customers*
8. *Better return on investment*

*But however, the ever changing technological development have laid way to the emergence of innovative maintenance concepts over the past two to three decades. Among such concepts TPM (Total Productive Maintenance) has been widely accepted & implemented throughout the world. The major distinguishing characteristics of TPM are, overall process improvement, empowering of operating personnel, increasing effectiveness of individual equipment & enhancing the overall plant effectiveness. Here, in this dissertation work, an attempt is being made to implement the concept & practice of TPM in a manufacturing industry & there by to improve the overall plant effectiveness of that industry.*

***Keywords:*** **CBN-** ***Condition Based Maintenance, DT- down Time, FLS- Full Lot size, IT- Idle time, PM – planned Maintenance, RE- Rate Efficiency***

## I. INTRODUCTION

An attempt is made to improve the Overall Equipment Effectiveness of the plant & machinery of M/s Rathod industry , Kolhapur by applying TPM & SET-UP reduction techniques.

Since long the company is facing a variety of technical as well as managerial problems. The important among them have been listsed as follows.

- Production related problems
- Skilled labour problems
- Plant maintenance problems
- Communication problems
- Data collection & retrival problems

From the above problems we have taken the plant maintenance problem as a mezor problem, as it affects plant efficiency.TPM is the best technic as it improves plant efficiency , machine efficiency & OEE of the machines.

### 1.1 Literature review

R.C.Leachman(1) in his paper has advocated the need for using the various techniques of TPM used for closed loop measurement of equipment efficiency & equipment capacity.

As per the author, the true machine efficiency must be measured in terms of "earned" utilization which must be computed using "theoretical " processing times.

Thus if "S" is theoretical processing time & "T" is the total length of the observation period then OEE =overall equipment effectiveness=S/T.

Bill Keeter(2), in his paper has advocated that the reliability engineering methods as a part of TPM can be used as a tool for continuous process improvement.the various tools like weibull analysis, reliblity block diagrams ,root call failure analysis can be effectively employed to reduce down time ofequipments to improve the productivity.

P Sharma & others(3) in their papers have stressed upon the importance of enhancing OEE through TPM

As per the author it includes maximizing equipment effectiveness, improving quality, increasing safty & reducing costs.

A.R. Mileham & others(4) , in their paper have advocated that change over is catagarized as an availability loss under TPM. A simple way to raise the availability, hence to raise OEE is to reduce the number of change over that occurs.

### 1.2 WHY TPM?

TPM is a maintenance program for maintaining plants & equipments it markedly increasing production as well as morale & job satisfaction of employees.

## II. OBJECTIVES OF TPM

- Avoid wastage in a quickly changing economic environment
- Producing goods without reducing product quality

- Reduce cost
- Goods send to the customers must be non defective

## III. CHARACTRISTICS OF TPM

- TPM is aimd at the overall pursuit of production efficiency improvement to its maximum extent
- A characteristics of TPM is "Jisho-Hozen by operators(operator must preserve their own equipment)"
- TPM consist of small group activities in which all members participate.

## IV. TPM CORE ACTIVITIES

- Equipment improvement / focused improvement( Kiazen)
- Autonomous maintenance( Jishu Hozen)
- Early Management( 5 S)
- Planned maintenance
- Quality maintenance
- Education & training
- Administrative & support department activity
- Safe & environmental management

### 4.1 Pillar 1-5S

Cleaning & organizing the work place helps the team to uncover problem

| Japanese Term | Equivalent ' S ' term |
|---|---|
| Seirion | Sort |
| Seiton | Systematize |
| Seiso | Sweep |
| Seiketsu | Standardize |
| Shitsuke | Self-Discipline |

Table 4.0 Parameters of pillar 1-5S

**4.2 Pillar 2-Jishu-Hozen-** Preparation of Employees-Train the employees about TPM

- Initial clean-up of machines
- Fix tentative Standards
- General Inspection
- Autonomous Inspection
- Standardization
- Autonomous management

### 4.3 Pillar 3-Kaizen

The following tools are used in kaizen

- PM analysis
- Why-Why analysis
- Summary of losses
- Kaizen register
- Kaizen summary sheet
- It is aimed to have the trouble free machines & equipments producing defect free products for total customer satisfaction. Following 4 types are considered
- Preventive maintenance
- Breakdown maintenance
- Corrective maintenance
- Maintenance prevention

### 4.4 Pillar 4-Quality Maintenance-

To delight the customer through defect frees manufacturing. Quality Maintenance hat preclude quality defects based on the basic concept of maintaining perfect equipment to maintain perfect quality of products.

### 4.5 Pillar 5-Training

Education is give to operators to upgrade their skills. The goal is to create factory full experts.

### 4.6 Pillar 6-Ofiice TPM

It must be followed to improve the productivity efficiency in the administrative functions & identify & eliminate losses. Twelve major losses are

- Processing loss
- Cost including in areas such as procurement accounts, marketing ete.
- Communication loss
- Idle loss
- Set-up loss
- Accuracy loss
- Office equipment breakdown
- Communication channel breakdown
- Time spent on retrieval of information
- Non availability of correct online stock status
- Customer complaints due to logistics
- Expenses on emergency purchases

## V. OVERALL EQUIPMENT EFFECTIVENESS (OEE)

It is frequently taken as important measure of performance of a business. An OEE rating may be used to compare different sites within an individual business group & may influence strategic investment the important decision Measure of OEE means measure of Rate Efficiency (RE), Quality Efficiency (QE) for the given production time (PT) against the total time (T).

To improve the OEE, Rate Efficiency, Quality Efficiency & PT/T must be improved. The end objective of TPM is to improve OEE of the entire plant.

OEE comprises the following components

### 5.1 Rate Efficiency-

The basic purpose of this is to express the ratio of observed machine processing rate to the theoretically achievable machine rate. It is the ratio of theoretical time to complete the reported work divided by the reported production time. Rate Efficiency is calculated by using the following equation.

$$\sum_{I=1}^{N} (Wsi)x(ThPTi)/PT$$

Where, Wsi= The number of units that were started into step i during the observation.

**ThPTi=** The theoretical processing time for step I,

**PT**- Reported processing time during the observation period

As production time increases, the number of units processed in a time given increases automatically RE increases.

### 5.2 Quality Efficiency (QE)

The factor accounts for efficiency losses resulting from the output of the product that does not meet quality requirements. In practice some quality problems are detectable immediately, resulting in immediate scrapping of the product or immediate rework of the product. If rework is explicitly & rigorously measured, one could account for it in the quality efficiency factor. In practice, many factories do not account for local rework. To cope with a lack of rework data, we may review as not quality loss rather as a rate efficiency loss.

Quality Efficiency (QE) for the equipment during observation period is given by

$$\sum_{I=1}^{N} (WFi)x(ThPTi)/PT$$

$$\sum_{I=1}^{N} (WSi)x(ThPTi)/PT$$

WFi = Total number of good units produced during processing step I WSi =

Total number of units started into process step I during the observation period.

Quality Efficiency may be increased by reducing the defective products, rework tracking etc.

### 5.3 Overall Equipment Effectiveness (OEE)

Combining the expressions of availability & utilization losses with expressions for machine rate efficiency & quality efficiency, we obtain the expression for OEE as

**OEE** = (PT/T)x REx QE

## VI. PROBLEM OBSERVED

There are 5 CNC M/Cs in the Rathod Industry, Shiroli M.I.D.C., Kolhapur. During the month of Nov 2015-Apr 2014, we observed the following problems for CNC Turning Centre (Jyoti DX-250). So we considered the the above CNC M/C for OEE analysis

- IR module fail
- Fuse burnt.
- Relay & turret contactors problem due to incorrect turret clamping.
- Loose connection due to faulty profibus DP.not indexing
- Out voltage low.
- Hydraulic oil leakage.
- Noise in the hydraulic motor
- Turret

By considering the above problems we have taken the details of CNC Turning Centre (Jyoti DX-250) for the 6 months from November 2014 to April 2015.

During the above mentioned period we found the following losses w.rt. CNC Turning Centre (Jyoti DX-250) & same as declared as Idle time in the following table.

1.Failure/Breakdown loss

2.Cutting blade loss

3. Minor stoppages

4. Scheduled down time loss

5. Management loss

6. Measurement & adjustment loss

7. Operating motion loss

8. Energy loss

9. Setup adjustment loss

## VII. RESULTS

### 7.1 OEE Calculations

Before TPM ( 20-11-2013 to 24-4 2014)

| Part name | Prod.Time (PT) | Idle time | Max. Time | Time to be saved | Actual prod. (FLS) | Theoretical production | Qty. Rej. | OK Qty. | TPU | TPL | ThPTi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Turbo ED | 350 | 130 | 90 | 40 | 70 | 117 | 4 | 66 | 3 | 350 | 4.0 |
| Differential case RH | 350 | 130 | 90 | 40 | 76 | 85 | 5 | 71 | 4.1 | 350 | 4.30 |
| Differential case LH | 355 | 125 | 90 | 35 | 180 | 254 | 6 | 174 | 1.4 | 355 | 1.69 |

**Table 6.0 Observations of OEE**

T= total time =480 mins

OEE is calculated for the product Turbo Ad

**1.Turbo Ad**

PT=350 mins, TPU=3mins, FLS=70 qty, TPL=350 mins

ThPTi= (TPU+(TPL/FLS))/2= (3+(350/70))/2=4mins

When PT=120 mins, TPU=3 mins, FLS=33 qty, TPL=120mins

ThPTi=3.33mins

When PT=337 mins, TPU=3 mins, FLS=109 qty, TPL=337mins

ThPTi=3.05mins

When PT=100 mins, TPU=3 mins, FLS=24 qty, TPL=100mins

ThPTi=3.58mins

When PT=280 mins, TPU=3 mins, FLS=70 qty, TPL=280mins

ThPTi=3.50mins

### 7.2 Rare Efficiency (RE)

It is calculated by using the following equation.

$$\sum_{i=1}^{N} (Wsi)x(ThPTi)/PT$$

= (70X4/350)+(33X3.32/120)+(109X3.05/337)+(24X3.56/100)+(70X3.35/280)

Avg RE=(0.80+0.91+0.99+.086+0.87)/5=0.89= 89%

$$\textbf{QE} = \frac{\sum_{i=1}^{N} (WFi)x(ThPTi)/PT}{\sum_{i=1}^{N} (WSi)x(ThPTi)/PT}$$

=(66x4)/(70x4)+(30x3.32)/(33x3.32)+(104x3.05)/(109x3.05)+(23x3.58)/(24x3.58)

Therefore avg. QE= ( 0.924+0.909+0.954+0.958+0.957)/5= 0.944

=94.4%

**4 OEE**

= (PT/T)x REx QE

Avg. PT=350+120+337+100+280=1187/5=237.4 mins

= (237.4/480)x0.94x0.89=0.414

Therefore OEE for the product turbo AD =41.4%

After TPM (20-11-2013 to 24-4 2014)

| Part name | Prod.Time (PT) | Idle time | Max. Time | Time to be saved | Actual prod. (FLS) | Theoretical prod | Qty. Rej. | OK qty | TPU | TPL | ThP Ti |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Turbo ED | 390 | 90 | 90 | 00 | 124 | 130 | 2 | 122 | 3 | 390 | 3.08 |
| Differential case RH | 390 | 90 | 90 | 00 | 90 | 95 | 2 | 88 | 4.1 | 390 | 4.21 |
| Differential case LH | 390 | 90 | 90 | 00 | 265 | 279 | 2 | 263 | 1.4 | 390 | 1.44 |

**Table 6.1** Observations of Rate efficiency

T= total time =480 mins

Prior to the implementation of TPM the industry was having lesser OEEs because of so many losses &in sufficient production practices.

Before implementing the TPM technical the OEE for CNC turning center Jyoti DX-250 was 41.4, after the TPM implementation there is a considerable improvement in OEE =78.3%

## VIII. CONCLUSION

It can be observed & understood that TPM TECHNIQUE HELP immensely in augmenting the OEEs of equipments in manufacturing industry 7 there by the maintaining aspects can be simplified & standardize to improve the revenue earnings of the industry.

TPM enables manufactures to achieve world class status more specifically, it can provide benefits in the following 4 key areas.

- **Equipments:** Reduced equipment down time & maintenance costs plus better management of life cycle
- **Personnel:** Labour efficiencies & increased productivity by improving visibility into operations & empowering operators
- **Process:** increased productivity by idendifying bottlenecks
- **Quality:** increased rate of quality by reducing scrap

Presently the concept of TPM is applied toCNC m/cs in the industry, the same can be applied to all conventional m/cs & special purpose m/cs to reap maximum benefits by reducing breakdown time & idle time of the m/cs.

## REFERENCES

[1]. Leach man Robert C, "Closed loop measurement of equipment efficiency & equipment capacity"January,2002

[2]. Keetr bill," Using reliability engineering methods as a tool for continuous process",18th International maintenance conference<IMC-2003

[3]. Sharma P & others,Enhancing Overall equipment effectiveness through TPM"

[4]. S. Nikajima,1988,introduction to TPM, productivity press,Inc. Cambridge,MA

[5]. Nachi-Fujikoshi[ed],1990, training for TPM, productivity press,Inc. Cambridge,MA

[6]. Paul Barringer," Process reliability & six sigma",PE,www.barringer.com

[7]. Lung berg.O, Measurement of overall equipment effectiveness as a basis for TPM activates,IJOPM,1998,18(5),495-507

[8]. Ellis Richard, "Asset utilization: A metric for focusing reliability efforts "the RE group, Pearland,TX.