ENHANCING OVERALL EQUIPMENT EFFECTIVENESS THROUGH TPM

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ABSTRACT

In Total Productive Maintenance small group activities are interwoven in each other. Autonomous maintenance is one of the most important pillars of TPM. Autonomous maintenance aims to educate the participants in the concepts & philosophy of autonomous maintenance and to give them opportunity to develop their skills & confidence. In the present work, workings of the selected machines were carefully studied in an industry. Data for past one year have been analyzed. The analysis has revealed that there are 98% good components, 2% rework losses, where the nine most common causes were identified for the machine stoppages. The OEE was 65% and the six big losses represent 35% loss of the product time.

Based on the findings, it was recommended to implement a TPM to improve the OEE of the plant.

Keywords: Total productive maintenance**,** Autonomous Maintenance, Breakdown time, Availability, Overall Equipment Effectiveness.

1. INTRODUCTION

TPM is a unique Japanese System, which has been developed from the PM concept. The company organization is so built up that there is overlapping at several levels from small group of senior executives down to small group of Shop floor workmen. Each autonomous small group is totally responsible for maintenance and all other jobs of their area. As Shown in Fig-1.

In this competitive world total elimination of waste is required for the survival of the corporation. Therefore, wastes generated due to the failure shutdown of facilities, which have been built, with huge investment and wastes such as defective products should be absolutely eliminated. Requirements for product quality become stringent, and not even one defective product would be allowed. Quality-assured delivery of total quantity is now taken for granted.

The small lot production of various kinds of products and shortening of production lead-time has been strongly required to meet diversified customer needs. That is to say, TPM aims to reduce the 6 major equipment losses to zero has been recognized as necessary for corporate survival.

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1.1 TPM CORE ACTIVITIES

- There are following eight core activities of TPM
- Equipment improvement / Focused improvement (KAIZEN)
- Autonomous maintenance (JISHU HOZEN)
- Early management (5S)
- Planned maintenance
- Quality maintenance
- Education and training
- Administrative and support department activity.
- Safety and environmental management.

1.2 DEVELOPMENT OF TPM IN AN ORGANIZATION

The following steps are taken to Develop TPM in an organization

- Preparatory stage:
- Introduction stage
- Implementation stage
- Stabilization stage

1.3-AUTONOMOUS MAINTENANCE

Japanese name of autonomous maintenance is JISHU HOZEN. This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs. The operators are responsible for upkeep of their equipment to prevent it from deteriorating. . Autonomous maintenance includes any activity performed by the production department that has a maintenance function and is intended to keep the plant operating efficiently and stable in order to meet production plans.

1.3.1 Policy

Following policies are adopted for developing JISHU HOZEN

Uninterrupted operation of equipments.

Flexible operators to operate and maintain other equipments.

Eliminating the defects at source through active employee participation.

Stepwise implementation of JH activities.

1.3.2 JISHU HOZEN Targets

Targets of the JISHU HOZEN are given below

Reduce oil consumption by 50%

Reduce process time by 50%

Increase use of JH by 50%

1.4 OVERALL EQUIPMENT EFFECTIVENESS AND VARIOUS LOSSES

Following are the various losses in any organization

- Equipment failure losses
- Setup and adjustment losses
- Idle and minor stoppage losses
- Reduced speed losses
- Defects in process
- Defects in products or rework losses

Overall Equipment Effectiveness (OEE)

OEE = Availability x Performance Efficiency x Rate of Quality product

OEE is just a number for relative comparison of equipment performance. The real benefits come from using the factors of OEE, which lead to root cause analysis and eliminating

the causes of poor performance. It's all about collecting, trending,

Performance Efficiency is given by

Performance efficiency =Rate efficiency x Speed efficiency.

Rate efficiency (RE): Actual average cycle time is slower than design cycle time because of jams, minor recorded stoppages, small problems and adjustment losses etc. Hence output is reduced due to this.

Speed (rate) efficiency (SE): Actual cycle time is slower than design cycle time because of high vibration etc. and hence output of the machine is reduced.

Rate of quality products (yield):It is the percentage of good parts out of total produced.

Relationship between various losses and overall equipment effectiveness is shown in Fig.2

LITERATURE REVIEW -

Competitive pressures and changing production-management paradigms have increased the importance of reliable and consistent production equipment and have led to the popularity of TPM. Academics need to lead the efforts to improve equipment-management Practices. Research that evaluates the various decisions in TPM development will help to drive maintenance investments to improve equipment productivity.

TPM is designed to maximize equipment effectiveness improving overall efficiency by establishing a comprehensive productive-maintenance system covering the entire life of the equipment, spanning all equipment-related fields planning, use, maintenance, etc. and, with the participation of all employees from top management down to shop-floor workers, to promote productive maintenance through motivation management or voluntary small-group activities. TPM provides a comprehensive company-wide Approach to maintenance management, which is usually divided, into short-term and long-term elements. In the short-term, attention is focused on an autonomous maintenance program for the production department, a planned maintenance program for the maintenance department, and skill development for operations and maintenance personnel. In the long-term, efforts focus on new equipment design and elimination of sources of lost equipment time.

The concept of TPM originated in Japan's manufacturing industries; initially with the aim of eliminating production losses due to limitations in the JIT process for production operations [5]. Nakajima [3] is credited with defining the fundamental concepts of TPM and seeing the procedure implemented in hundreds of plants in Japan; the key concept being autonomous maintenance. TPM is a major departure from the ''you operate, I maintain'' philosophy [4].

TPM is a manufacturing-led initiative that emphasizes the importance of: (i) people with i 'can do' and continual improvement attitude and (ii) production and maintenance personnel working together in unison. In essence, TPM seeks to integrate the organization to recognize, liberate and utilize its own potential and skills [1].

The aim of TPM is to bring together management, supervisors and trade union members to take rapid remedial actions as and when required. Its main objectives are to achieve zero breakdowns, zero defects and improved throughputs by:

- Increasing operator involvement and ownership of the process.
- Improving problem solving by the team.
- Refining preventive and predictive maintenance activities.
- Focusing on reliability and maintainability engineering.
- Upgrading each operator's skills.

The TPM strategy includes: -

Maximizing equipment effectiveness. by improving quality, increasing safety and reducing costs.

Raising the morale of the team that is implementing TPM.

Establish an optimal schedule of clean up and PM to extend the plant's life span and maximize its uptime.

Many TPM operators have achieved excellent progress in instances such as:

Wiser assessments and improvements in, the performance of critical equipment, e.g. in terms of OEE and determining what are the reasons for any non-achievement.

Better understanding of the equipment's criticality and where and when is it financially worth improving.

More cooperative teamwork, e.g. less adversarial or competitive approaches between Production and maintenance workers

CASE STUDY

MODEL Machine selected for the implementation of TPM is Horizontal machining center for the following reasons.

- High value items (A-class) being machined i.e. magnetic frame of traction motor and the machining contribution per set is around Rs. 20,000/- per set.
- One of the most expensive machines.
- Low performance efficiency.
- High maintenance cost.
- Small Improvement in availability may lead to high profit to the industry.

2.1 SCHEDULED ACTIVITIES SHOULD BE CARRIED OUT ON THE MACHINE

Following activities should be carried out on the machine

(i) Before starting activities all member should be instructed for DOS and DO NOTS about the machine (safety guidelines).

- Do not stand on the telescopic cover of the axes.
- Do not stand at tool change position around ATC.
- Ensure electrical cabinet doors are always in close position.
- Do not keep hands in chip conveyor during running of machine.
- Switch off the machine during filling of oil at required areas.

(ii) All are guided to use their five senses to find six abnormalities.

(iii) Point related to forced deterioration are listed and explained.

(iv) Machine basic condition identified from the manual and explained.
(v) Some of the critical safety points discussed like doors limit switches, operator
Platform, guards tool loading door switches etc.

2.2 MAINTENANCE ACTIVITIES SHOULD BE CARRIED OUT ON THE MACHINE

Maintenance activities can be carried out by equipment operator are given below

- Cleaning
- Oiling
- Tightening
- Assist specialized maintenance staff during major repairs.
- Overall vibration measurement using data collectors, speed measurement using stroboscope, temperature measurement using non-contact thermometer, etc.

2.3 PROBLEMS- following main problems were observed due to which down time occurred.

- Oil filter choke
- Coolant working problem
- Table roller problem
- Oil leakage from table
- Chip conveyor non-functioning leading to bad condition around and inside the machine.
- There is play in the sliding portion and in the tool holding portion.
- There is loose bolts or nuts as well as absence of any bolt or nut from its position.
- Movement of the cylinder slow or does not move etc.
- Oil pressure of the hydraulic systems is not in level.

3. DATA ANALYSIS

Data collected for the past one year. The operation is based on the two shifts per day every shift is for eight hours the planned down time per shift 15 min at the end of each shift for cleaning and tiding up the work area.
Working days in a month =25
Running time per day =16 hrs
Planned down time per day =30 min
Planned down time per month =12 hrs (aprox)
Setup and adjustment losses per day =1 hr
Setup and adjustment losses per month =25 hrs
Loading time per day =(running time – planned down time)
Loading time per month =400-12 =388 hrs
Loading time per year = 388X 12 = 4656 hrs
Operating time per month =
Running time – (planned down time + setup and adjustment losses + break down time)
= 400-25 X 1-12 –(down time)
Operating time per year =363 X12 – (down time)
=4356 – (down time)
Down time in year April 2002- March 2003 = 263 hrs
Availability = operating time /loading time
Availability = 4093 / 4656 = 87.84%

4. EVALUTATION FOR OVER ALL EQUIPMENT EFFECTIVENESS (O. E .E.)

Based on the data collected for one-year evaluation of overall equipment effectiveness given below.
O.E.E. =Availability x Performance efficiency x Rate of quality product
Design time of machine to complete job =5.5hrs
Actual time to complete the job =6 hrs
Speed efficiency = ideal cycle time/ actual cycle time= 5.5/6 =0.916
These losses occur due to machine running at slower speed than the designed speed because of vibration, improper maintenance etc.
Rate efficiency = processed amount x actual cycle time/ operation time
= 2x6/14.5 =82.76%
These losses occurs due to idle and minor stoppage, jam etc.
Performance efficiency = speed efficiency x rate efficiency
= O.827 x0.916 =75.75%
Rate of quality products = processed amount – defected amount/processed amount
There were no rejected products however approx. 2% losses occurred due to rework.
Rate of quality product = 98%
O.E.E.= availability x performance efficiency x rate of quality product
=0.8784 x 0.7575 X 0 .98 = 65 %

Cost of the six big losses –

The cost of components frame after machining is Rs. 80000
Casting cost of magnet frame is Rs.30000
Machining contribution = (80000-30000) =Rs.50000
Machining contribution on this machine = 40% of the total machining
=0.4X50000
=Rs.20000
Expected theoretical output 2.5 magnet frame per day
Added value per day = 2.5 x20000=Rs.50000
Expected out put is based upon on theoretical cycle time for the assembly process. In this output six big losses is not considered which is associated with the machinery. Therefore on the basis of measured OEE of 65%the actual added value per day can be calculated as
Actual added value per day =50000X 0.65 =Rs.32500
Thus the six big losses which is 35% of OEE represent a loss of added value Rs.17500 per day
Loss per hrs= 17500/16= Rs.1093.73
Average loading time per month =25X16 = 400 Hrs per year
Annual loss =1093.75X4800=Rs.5250000
It means we could get additional profit Rs. 5250000 by this machining center if it runs at 100% effectiveness as opposed to 65%effectiveness.
If the company reach to the world-class target of 85% OEE then the 20%increase of OEE would represent an earning capacity of
=20 x 5250000/35 =Rs.3000000 per year

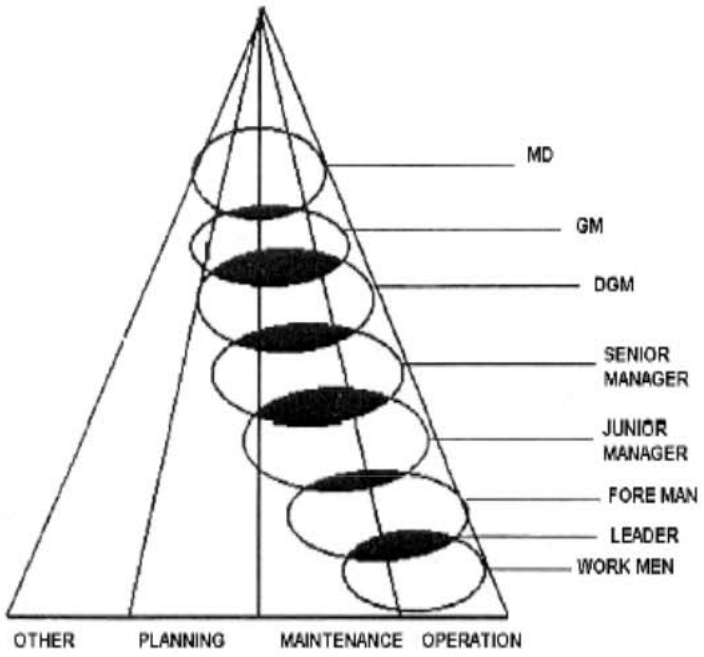

Fig -1: SMALL AUTONOMOUS GROUP CONCEPT

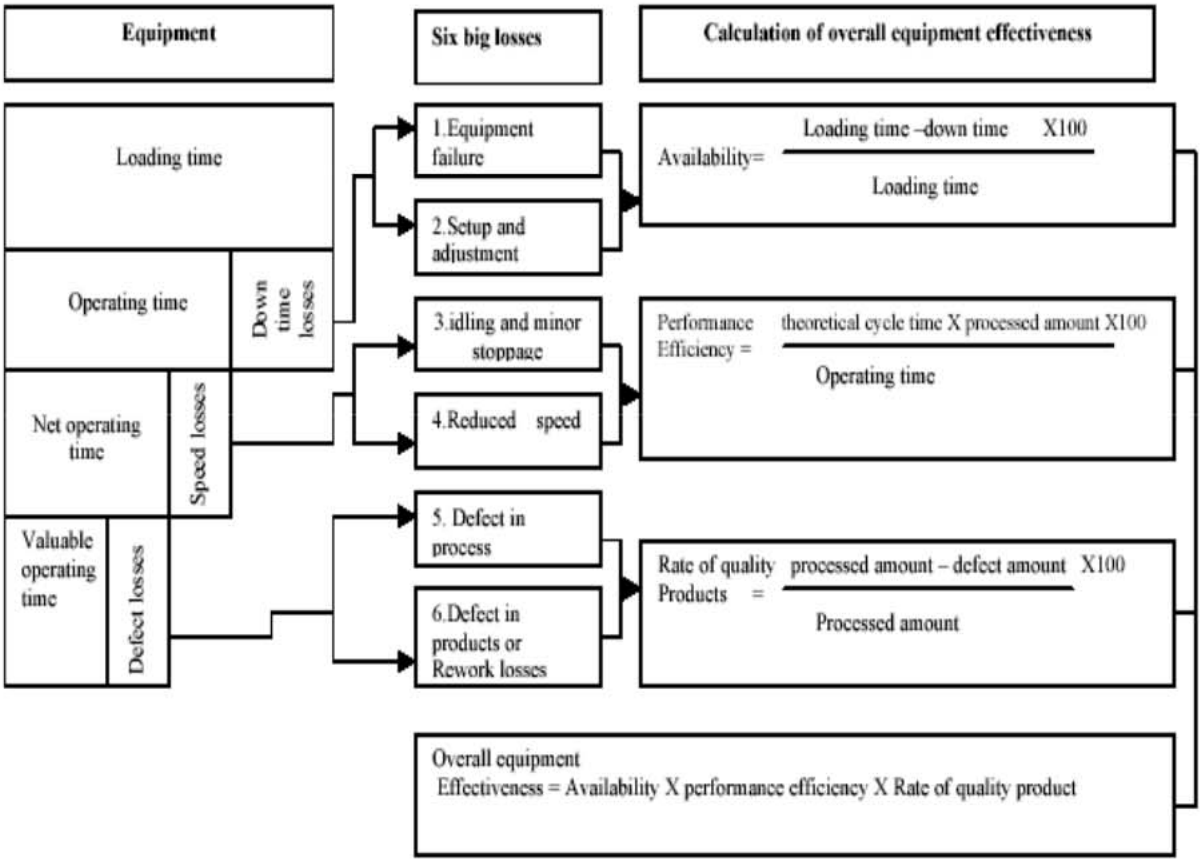

FIG.2: OVERALL EQUIPMENT EFFECTIVENES

DISCUSSION AND CONCLUSION -

Company's performance	World - class performance
87.84% availability	> 90% availability
75.75% performance efficiency	>95% performance efficiency
98% rate of quality	>99% rate of quality
65% OEE	>85% OEE

The process of recording information must remain simple, but effective for future data analysis .if provisions were made to highlight such problems and possible causes, then it may lead to the correction of common problems such as breakdowns and rework. Ultimately if possible, the aim is to eliminate such causes. Information provided by the trend analysis can provide a basis for forming- long-term plans. The maintenance department can plan spending requirements by using historical information to state the return on investments by contributing to the annual business plan of the company.

Therefore if the world-class performance of 85%OEE was achieved then 20%increase in OEE would have represent annual earning of 30lack.To achieve this target efficient maintenance is necessary, in order to establish autonomous maintenance teams, better Communication and team- work must be promoted. it is essential that the company devices an efficient data recording systems, so that up-to date and accurate information will be available to the management

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Information provided by the trend analysis can provide a basis for forming- long-term plans.

The maintenance department Can plan spending requirements by using historical information to state the return on investments by contributing to the annual business plan of the company, That prevents the failure of an organization. It is a maintenance program that works with TQM and lean management. However the employees must be appropriately trained, empowered and convinced that TPM is a sustainable and management should be totally committed to the program

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