Study of total productive maintenance & its implementation approach in steel manufacturing industry: A case study of equipment wise breakdown analysis

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Abstract - The purpose of this paper is implementation of total productive maintenance by performing machine wise breakdown analysis. A total productive maintenance (TPM) is a medical science of machine which improves the performance of maintenance activity, product and process quality, employee morale and job satisfaction. The study establishes that focused on section wise breakdown analysis, breakdown types wise and equipment wise breakdown analysis to avoid delay in manufacturing process.

Key Words: Total Productive Maintenance, TPM Pillar, Implementation, Overall Equipment Effectiveness, Autonomous preventive maintenance.

1. INTRODUCTION

Total Productive maintenance is an expansion of lean manufacturing system. The goal of TPM is to optimize zero breakdown zero accident, and zero loss. If machine uptime is not predictable and then industry unable to produce velocity of sales. Therefore, a critical adjunct to assuring supply is a proactive system. With the help of proper training and autonomous preventive maintenance (PM), companies have been able to increase the Overall equipment effectiveness and to reduce the machine breakdowns. TPM is based on the permanent search for the improvement of the efficiency of the processes and the means of production, for a concrete and daily involvement of all the people who participate in the productive process. Zero defects, zero accidents, zero stops.

1.1 Need for breakdown analysis

In the steel manufacturing industry breakdown is a major issue which will indirectly affect the manufacturing process and the production delay occur. Machine breakdown has always contributed towards machine down time. Hence breakdown analysis methodology is suggested for improvement in manufacturing process. Through this analysis availability of machine increases maintenance cost decreases.

2. LITERATURE REVIEW


3. TPM Implementation road map:

In order to initiate the application of TPM concepts in plant maintenance activities, it is necessary for workers to find out that the management of the highest level has a serious commitment to the program.

Implementation Step:

STEP1: Declaration of TPM
The first step in this effort is to declaration of TPM. The entire edifice of TPM is built and stand, on eight pillars (Sangameshwran & Jagannathan, 2002).

STEP2: Education of employees

It is aimed to skilled employee through proper training whose morale is high and who has eager to work and perform the required function effectively and independently.

STEP3: 1S and 2S implementation

Eliminating unnecessary item from the work place and Keeping parts / accessories in the allocated place.

STEP4: Selection of manager model machine

After implementation of 1S and 2S. On the basis of their cost and their efficiency. A manager model machine is selected for the implementation of of TPM. If the machine efficiently perform and target achieved then we implement to all machine in the entire plant if target not achieve then Implementation continued by CLIT (cleaning, lubrication, inspection & tightening).

4. PILLARS OF TOTAL PRODUCTIVE MAINTENANCE

The Japan Institute of plant maintenance propose the introduction of TPM program. The TPMinitiatives classified in to eight TPM pillars to optimize plant and equipment efficiency such as Jishu Hozen; Kobetsu Kaizen; Planned Maintenance; Quality Maintenance; Education & Training; Initial Flow Control; Office TPM; Safety health & environment (Ireland & Dale, 2001; Shamsuddin et al., 2005; Rodrigues & Hatakeyama, 2006).

PILLAR1-JISHU HOZEN (JH)

This is a unique seven-step methodology which converts the operator (in small manageable steps) into a maintenance man who can take care of his machines basic required maintenance. The touch and feel of the machine and its parts helps in creating the bond between the operator and the machine. This converts him from operator to a care taker of the machine. Because operator knows maximum about the machine or equipment without any doubt these are not qualified engineer, experienced fitter but the operator who operates the machine knows maximum about the machine.

AIM:-

1. To avoid uninterrupted operation of equipment or machine by maintaining four basic condition ie; cleaning, lubrication, inspection & tightening.
2. Qualified operators to operate the machine or equipment.
3. Eliminating the defects at source through active employee participation.
4. Stepwise implementation of JH activites.

There are following seven basic steps for jishu hozen:

STEP1: Initial cleaning

It helps in identifying the abnormalities on the machines. Through Initial cleaning of the machine reduces potential future breakdowns. Tags are put on the wherever abnormalities observed, then analysis and on the based upon analysis action is taken to prevent the abnormalities. Identifying the fuguai for maintaining the machine neat and clean so that the abnormalities can be checked for its recurrence again. Hence, operators are responsible to clean up the machines to prevent it from force deterioration.

Table 1: Types of Fuguai

<table>
<thead>
<tr>
<th>Types of Fuguai or defects</th>
<th>Classification</th>
<th>Category Name</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>Near Miss situation(safety related)</td>
<td>Safety guard missing</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>Item not kept at their designated place</td>
<td>Unwanted items</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>Force deterioration</td>
<td>Nut, bolt missing</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>Component not able to full fill it's specific function</td>
<td>Pressure regulator not working</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>Not user friendly</td>
<td>Cable not properly dressed</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>Hard to access area</td>
<td>Hard to clean, Hard to lubricate</td>
</tr>
</tbody>
</table>

STEP 2: Counter measures against the sources of contamination and hard to access areas

The contaminating sources from where dust, oils comes and mixed with the other lubricant or dust creates the abnormalities in the machine which leads to future breakdown. The identification of these sources (coolants, lubricants etc, are necessary and cannot be eliminated; but needs to be contained), by analyzing them and taking action such as implementation of localized guards, Open-close window not only helps in maintaining the machine neat and clean but also makes many of the accessible parts accessible for cleaning.
inspection, lubrication and tightening of loosened parts (this is implementation of basic maintenance required which is often missed out leading to numerous breakdowns).

STEP 3: Implementation of tentative standards

Tentative standards are created with the help of maintenance personal, operates, qualified engineers, experienced fitters. Monitored by operators to ensures that these abnormalities do not creep up again.

STEP 4: General inspection

Only the trained operator performs inspection on the sub systems of the machines such as pneumatic, lubrication system, fasteners, etc so that abnormalities specific to the operation are easily identified, analysed and addressed.

STEP 5: Autonomous inspection

A check list is prepared so that inexperienced personal can also perform the same job independently as per check list. The purpose of autonomous inspection is to implement visual control and take measure to prevent careless error.

STEP 6: Standardization

The purpose of this step is to review the operator’s role, improve all activities being carried out, also improve maintenance and control of autonomous inspection and established a system. Implement standards and visual control check point of the equipment at workplace.

STEP 7: Autonomous Management

A machine on which these activities are carried out, will never ever perform breakdown due to force deterioration. Autonomous management activity not only prevent breakdown but also strive for zero failure, zero defects.

PILLAR 2- Kobetsu Kaizen(KK)

Kai” means change, and "Zen" means good (for the better) means Continuous Improvement. In which a small group of employee work together for improvement of the machine in terms of productivity, Quality, Cost, Safety, Delivery and morale.

The aims of this pillar to avoid 16 chronic loss.

Kobetsu Kaizen activities try to eliminate 16 chronic loss. The basis of these activities is to enhance and demonstrate the technological, analytical and KAIZEN.

AIM:- To reduce all 16 losses of a plant to zero level.

### Table 2: 16 Chronic Loss

<table>
<thead>
<tr>
<th>S.No</th>
<th>Losses</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Failure losses – Breakdown loss</td>
<td>Losses that impede equipment efficiency</td>
</tr>
<tr>
<td>2</td>
<td>Setup/adjustment losses</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cutting blade loss</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Startup loss</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Minor stoppage/Idling loss</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Speed loss – operating at low speeds</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Defect/rework loss</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Scheduled downtime loss</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Management loss</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Operating loss</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Line organization loss</td>
<td>Losses that impede Human work efficiency</td>
</tr>
<tr>
<td>12</td>
<td>Logistic loss</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Measurement and adjustment loss</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Energy loss</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Die, Jig and tool breakage loss</td>
<td>Losses that impede Production resources</td>
</tr>
<tr>
<td>16</td>
<td>Yield loss</td>
<td></td>
</tr>
</tbody>
</table>

PILLAR 3- Planned Maintenance (PM)

This pillar significantly reduces instances of unplanned down time when the equipment is in shut down we enable most of activities during this period . This is schedule based maintenance to measure failure rate.

Six big losses identified in TPM field are

- Breakdown losses
- Set-up and adjustment losses
- Minor Idling stoppage losses
- Reduced speed losses
- Defect Rework losses
- Start-up losses
PILLAR 4- Quality Maintenance(QM)

In order to construct this pillar, the Industry inculcates the culture of zero defect/Non conformity philosophy and specifically quality issues with improvement projects focused on removing root sources of defects.

PILLAR 5- Initial Flow Control(IFC)

In this pillar we construct a MP sheet or maintenance prevention sheet as well as life cycle casting(LCC) sheet. On the basis LCC sheet Industry purchase the equipment.

PILLAR 6- Office TPM (OTPM)

This pillar started after achieving four other pillars (JH, KK, QM, PM). This pillars extends benefit in administrative function (eg:Order processing, procurement, scheduling). This technique is applied to reduced waste.

PILLAR 7- Education &Training( E&T)

An education is not how much to memorize or how much to know It is being able to differentiate between knowing-how and knowing-why. It is not sufficient to knowing –how they should also learn knowing why. Hence training provided for employee to work in multi direction. And easily perform their job.

PILLAR 8- Safety, Health & Environment (SHE)

Safety is the maintenance of peace of mind, The basic purpose of SHE is zero accident, zero health damage zero pollution so that human being work in the industry with peace of mind, They should have hygienic environment.

5. CASE STUDY

A case study has been conducted in one of the leading manufacturing of Structural steel mill. The study conducted 6months to identify section wise, type wise and the particular equipment in which maximum breakdown occur.

i) Section wise breakdown analysis

<table>
<thead>
<tr>
<th>Section</th>
<th>No. of Breakdowns</th>
<th>Percentage(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical</td>
<td>96</td>
<td>65.75</td>
</tr>
<tr>
<td>Electrical</td>
<td>9</td>
<td>6.16</td>
</tr>
<tr>
<td>E&amp;I</td>
<td>36</td>
<td>24.66</td>
</tr>
<tr>
<td>Mechanical+EI</td>
<td>5</td>
<td>3.42</td>
</tr>
<tr>
<td>Total</td>
<td>146</td>
<td></td>
</tr>
</tbody>
</table>

ii) Type wise breakdown analysis

<table>
<thead>
<tr>
<th>Types</th>
<th>No. of Breakdown</th>
<th>Total Hours (Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>40</td>
<td>384</td>
</tr>
<tr>
<td>Major</td>
<td>19</td>
<td>1808</td>
</tr>
<tr>
<td>Medium</td>
<td>87</td>
<td>1817</td>
</tr>
<tr>
<td>Total</td>
<td>146</td>
<td>4009</td>
</tr>
</tbody>
</table>

iii) Equipment wise breakdown analysis

<table>
<thead>
<tr>
<th>Name of Machine</th>
<th>No. of Breakdown</th>
<th>Breakdown Hours(Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stacker</td>
<td>13</td>
<td>299</td>
</tr>
<tr>
<td>Cooling Bed</td>
<td>12</td>
<td>247</td>
</tr>
<tr>
<td>Cold saw-2</td>
<td>12</td>
<td>398</td>
</tr>
<tr>
<td>Extraction trolley</td>
<td>8</td>
<td>184</td>
</tr>
<tr>
<td>Cold saw-1</td>
<td>7</td>
<td>211</td>
</tr>
<tr>
<td>Layer Chain transfer</td>
<td>6</td>
<td>107</td>
</tr>
<tr>
<td>Cold Saw 1</td>
<td>5</td>
<td>136</td>
</tr>
<tr>
<td>Cold saw</td>
<td>5</td>
<td>104</td>
</tr>
<tr>
<td>Straightener</td>
<td>4</td>
<td>139</td>
</tr>
<tr>
<td>Mill Descaler</td>
<td>4</td>
<td>96</td>
</tr>
<tr>
<td>Cold Saw-2</td>
<td>4</td>
<td>62</td>
</tr>
<tr>
<td>STD #9</td>
<td>4</td>
<td>85</td>
</tr>
<tr>
<td>Stopper</td>
<td>3</td>
<td>52</td>
</tr>
<tr>
<td>SAW 2 Exit roller table</td>
<td>3</td>
<td>123</td>
</tr>
<tr>
<td>Furnace</td>
<td>3</td>
<td>65</td>
</tr>
</tbody>
</table>
Stacker area 3 57
Cold Saw 2 2 27
Wheel stopper 2 20
Secondary Descaler 2 10
Photo cell 2 16
Bend metal 2 16

RHF
Hydraulics 2 30

Std #5 2 48

Finishing area 2 36

Std #14 2 31

STD #6 2 60

RHF 2 30

STD #8 2 35

STD #7 2 708

Billet Centring system in Furnace 1 32

Cold Saw 2 1 8

Manipulator 1 15

Lifting aprons 1 5

Communicaton Fault in Mill 1 85

Stand NO # 2 1 25

Stand NO #13 1 25

Stand NO # 1 1 8

Roller table 1 5

Main Descaler 1 11

Camera 1 15

Strapping m/c 1 22

Stand #15 1 24

Cold saw Descaler 1 25

Technogamma 1 23

RHF Exit RT 1 11

Stand #2 1 10

Stand #9 1 25

Wheel Stopper 1 15

Stand #4 1 21

Stand #5 1 26

Cold Saw #1 1 100

Std #9 1 15

Std #15 1 12

Std #4 1 20

Mill Area LCS 1 10

6. RESULT & CONCLUSION

In this case study 6 months breakdown analysis has been performed and observed during 6 months total 146 Nos of breakdown occur maximum 66% breakdown occur in Mechanical section ie;96 breakdown out of 146. Also observed that in medium type maximum 87 Nos breakdown occur whose total hours(min) 1817 min and in equipment stacker maximum 13Nos breakdown occur whose total breakdown hours(min) 299. Hence we finally conclude that equipment wise ie; Stacker, Cooling bed, Cold saw-2 having maximum breakdown occur So, Corrective Action & Preventive action (CAPA) must require in this particular equipment to accomplishing TPM goal.

REFERENCES


BIOGRAPHIES

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