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Improvement of Availability and Maintainability through Actions Based on Root Cause Analysis of Failures: A Case Study of a Critical Machine

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Abstract - *Availability and maintainability of machines can be increased by reducing the downtime or breakdowns of the machines. Main objective is to improve the machine performance by finding out the major breakdowns causing production losses to the company and arriving & executing the counter measures by which these problems can be reduced. Availability and breakdown reduction methodology are adopted to improve the machine performance. Root cause analysis is conducted to find the root cause of breakdowns and some parallel improvement opportunities were also identified for implementation so as to reduce the downtime. The project thus aims to minimize downtime, maximize availability, minimize maintenance cost and maximize profit. The project work concludes that this will help the maintenance department to increase equipment availability. Data was collected from Steel Plant breakdown details of Housing less mill stand machine and Slitting machine i.e. the data is such as breakdown hours, breakdown occurrence, MTBF & MTTR 4 months before overhauling was done for corrective counter measures of machine. Then after corrective counter measures were done by Breakdown reduction methodology and operation parameter was collected from 4 months after implementation of corrective counter measures for each method. From this data performance parameters were calculated and compared with each other. After calculation it was found that Availability and MTBF of Housing less mill stand & Slitting machine is increased or MTTR is deceased. The Effectiveness of corrective counter measures of Housing less mill stand & Slitting Machine is improved.*

***Key* Words: Availability, Maintainability, root cause analysis downtime, MTTF, MTTR.**

1. INTRODUCTION

Equipment breakdown has always contributed towards machine downtime. Industrial Engineers have always tried to reduce downtime and increase the availability of machineries.

Availability- It is the probability that the system will perform available time at operating condition at only instant. Availability is the total time of utilization of a machine. Availability is the ratio of the difference between the total available hours and total breakdown hours to the total available hours.

$$\text{Availability} = \frac{\text{Total available hours- Total breakdown hours}}{\text{Total available hours}}$$

Maintainability- It is probability that a failure system will be restored at operating condition Maintainability is defined as the probability of performing a successful repair action within a given time.

MTBF (mean time between failures) - Mean time between failure is a concern the average time elapsed between a failure and the next time it occurred.

$$\text{MTBF} = \frac{\text{Total available time – total breakdown hours}}{\text{Total available time}}$$

MTTR (mean time to repairs)- Mean time to repair is the time to run after the occurrence of the failures.

$$\text{MTTR} = \frac{\text{Total breakdown hours}}{\text{No of breakdown}}$$

Root cause analysis through why- why analysis -It is method of problem solving used for identifying the root cause of faults or problem. A factor is considered a root cause analysis if removal there from the problem fault prevents the final undesirable event from recurring.

1.1 Advantages of availability & maintainability

- To reduce emergencies and optimize costs.
- To reduce life cycle costs.
- To improve customer service.
- Increase efficiency of equipment.
- To maintain plant and equipment.
- Reduce downtime and increase uptime of machine.
- To ensure safety of plant.
- High efficiency in plant.

- Improve the useful life of production equipment.
- Improve system reliability.
- Decrease cost of replacement.
- Decreases system downtime.
- Reduce injury.

2. Work of methodology

The initial data collection of the breakdown details of the machine i.e. the data's such as breakdown hours, breakdown occurrence, MTTR, MTBF are collected & studied.

- Selecting the critical machine **"Slitting machine"** for the analysis.
- Studying the type of failures occurred & frequently repeating failures.
- Following the breakdown reduction methodology.
- Performing root cause analysis to reduce the recurrence of failures.
- Performing "WHY-WHY" analysis.
- Replace the defective parts of the machine.
- Implementing the corrective steps.
- Monitoring and verifying the results.

2. Implementation and root cause analysis

2.1 Break down Description – "Slitting machine" is not working

Root cause – Some fire cracks present in the reel
Physical phenomenon – Slitter reel point break Root Cause from Why-Why Analysis.

Corrective counter measure

- Proper cooling must be provided on down side reel.
- Time to time greasing
- Connection of water regular of blade
- Provide water pressure should be high upside & downside.
- Check to stuck size of metal per hour by fitter.

Problem	Slitter reel point break
Why?	Some fire cracks present in reel initially.
Why?	Not proper adjustment of slitter box on rest bar stand.
Why?	Due to oversize material.
Why?	Cooling provided on Time Based Maintenance

- Inspection of hardness of metal by operator (50 HRC- 53HRC)

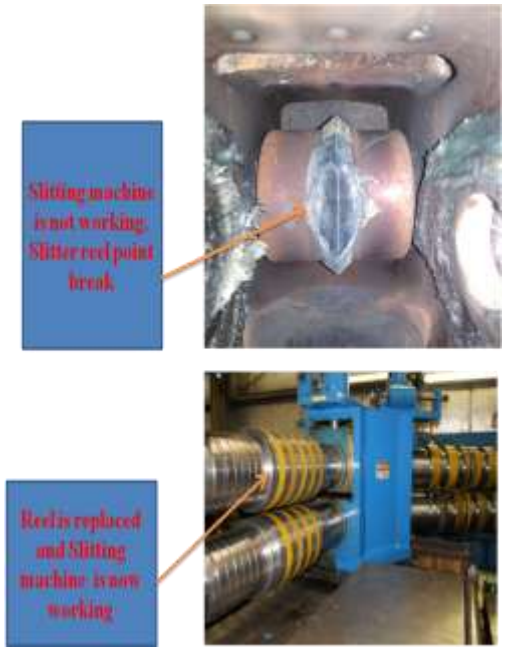


Fig -1 Slitter Guide box

Benefits– After provided cooling and proper adjustment of slitter box on rest bar now working hence the slitter machine problem is eliminated & Slitter machine operation is further preceded.

- **RESULTS AND DISCUSSION**
- **Process Parameters of Slitting Machine before the Implementation of Counter Measures.**
- Total downtime of Slitting machine in the period **Oct-2015** to **feb-2016** = **146** hours.
- Total available time for Slitting machine in the period **Oct-2015** to **feb-2016** = **2860** hours.
- (22hours×26 Days, 26Days×5Months = 572×5=2860) Excluding Sundays, holidays, & lunch time.
- 3. Total number of breakdowns in the period **Oct-2015**to **Jan-2016**= **46**

$$\textbf{Availability} = \frac{\textbf{Total available hours- Total breakdown hours}}{\textbf{Total available hours}}$$

$$\textbf{Availability} = \frac{2860-146}{2860} = 0.9489$$

Availability = 94.89%

Loss of availability = 1- 0.9489 = 0.0511

= 5.11%

$$\textbf{MTBF} = \frac{\text{total available hours – breakdown hours}}{\text{no. of breakdown}}$$

$$= \frac{2860-146}{46} = 59 \text{ hours}$$

= 59.00 hours.

- $$\text{MTTR} = \frac{\text{total breakdown hours}}{\text{no. of breakdowns}}$$
- $= \frac{146}{46} = 3.17$
- **= 3.17 hours**
- **Process Parameters of Slitting Machine after the Implementation of Counter Measures**

- Total downtime of Slitting machine in the period **march-2016** to **june-2016** = **52 hours**
- Total available time for Slitting machine in the period **march-2016** to **june-2016 = 2288 hours**
- (22hours×26Days,26Days×3Months=572×4=Excluding Sundays, holidays, & lunch time.
- Total number of breakdowns in the period **march-2016** to **june-2016= 27**

- **Availability** = $\frac{\text{Total available hours- Total breakdown hours}}{\text{Total available hours}}$
- **Availability** = $\frac{2288-52}{2288} = 0.9772$

= 97.72 %

- **Loss of availability** = 1- 0.9772 = 0.0227

= 2.27%

- **MTBF** = $\frac{\text{total available hours – breakdown hours}}{\text{no. of breakdown}}$

$= \frac{2288-52}{27} = 82.81$ hours

= 82.81 hours.

- **MTTR** = $\frac{\text{total breakdown hours}}{\text{no. of breakdowns}}$

$= \frac{52}{27} = 1.925$

- **Comparison of results before and after implementation of counter measures of Slitting machine.**

Availability before implementation (%)	Availability after implementation (%)	MTBF before implementation (hours)	MTBF after implementation (hours)	MTTR before implementation (hours)	MTTR after implementation (hours)
94.89	97.72	59.00	82.81	3.17	1.93

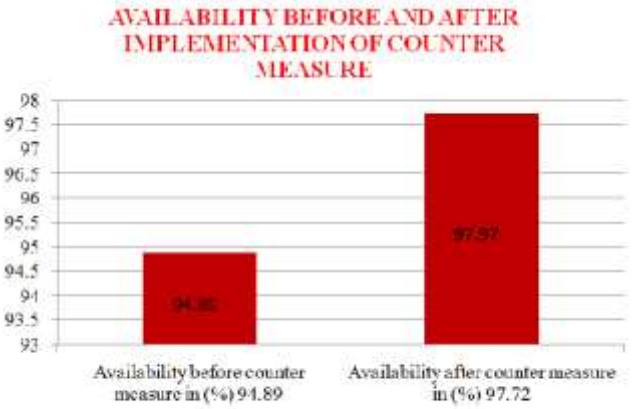


Fig .1 Graph Showing Comparison of Availability before and after implementation of counter measures

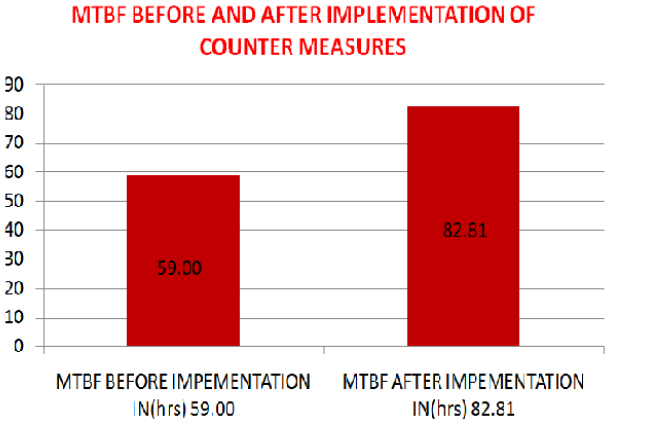


Fig .2 Graph Showing Comparison of MTBF before and after implementation of counter measures

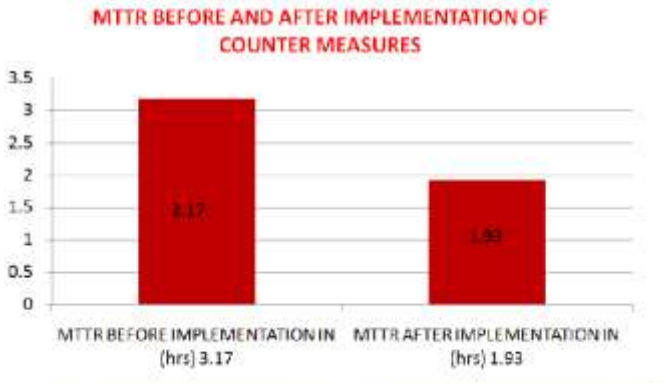
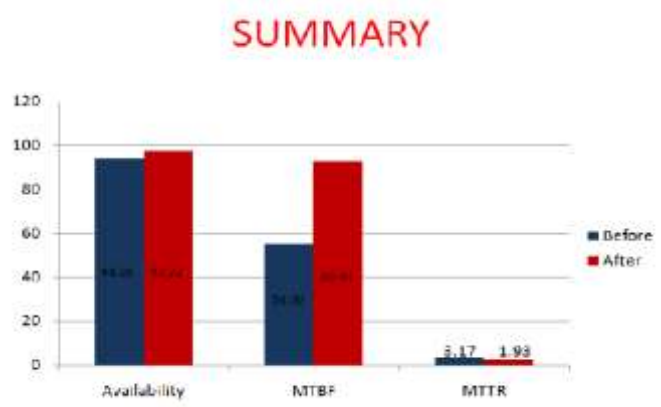


Fig .3 Graph Showing Comparison of MTTR before and after implementation of counter measures



CONCLUSIONS

The process measurable such as Availability, MTBF, and MTTR are calculated before and after the implementation of counter measures.

- The Breakdowns such as slitter reel point and due to some fire cracks damage on bearing and bearing pin is completely eliminated.
- The availability of Slitting Machine is increased from 94.89% to **97.72%.**
- The MTBF of Slitting Machine is increased from 59.00 hours to **82.81** hours.
- The MTTR of Slitting Machine is decreased from 3.17 hours to **1.93** hours.
- The Effectiveness of corrective counter measures of Slitting Machine is improved.

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