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Reduction in Breakdown Time of Milling Machine by Root Cause Analysis

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Abstract: The industries have become more competitive in nature due to the technical research and development which made the industries to improve their productivity to meet their market demand. The industries started to invests more on machines for high productivity, but when the machine is not working properly then these machines has to be get repaired and it leads to breakdown hours and the manufacturers has loss in their productivity. So in this paper a solution has been suggested for reducing the break down hours of milling machine. This can be achieved by reducing the breakdown hours of the milling machines. Milling machine performs various machining processes like milling, grinding and boring etc. on the work piece. So to avoid this, Root-Cause Analysis of these defects is carried out and the modifications are to be done as per the results of analysis. Root cause analysis for milling machine is conducted to find the root cause of machine for breakdown time and some parallel improvement opportunities were also identified for implementation so as to reduce the breakdown time of machine. The project thus aims to minimize breakdown time and maintenance cost with maximum availability and profit, increase MTBF & decrease in MTTR. Finally to prevent the failure of equipment before it actually occurs.

Keywords: Root Cause Analysis, Preventive maintenance, Breakdown Reduction Methodology, Mean Time between Failures (MTBF), Mean Time to Repair (MTTR)

I. INTRODUCTION

Breakdown generally refers to sudden physical damage to machine, from any cause not omitted which requires repair or replacement to enable normal working to continue.Machine maintenance is important in industry because of the need to increase availability and to decrease the machine breakdown time. Scheduled preventive maintenance reduces the regular breakdown hours. To minimize sudden problems occurred in machine, root cause analysis is done regularly. Root cause analysis is a method of analyzing a particular problem in the machine for reducing a breakdown hours, considering the basic factors which are responsible for that breakdown problem to occur. Some of the methods used in RCA includes Why – Why analysis, Barrier analysis, Change analysis, Causal Factor Tree analysis, Failure mode & effect analysis, Fish – bone diagram, Pareto analysis and Fault Tree analysis etc. Out of these methods, Why – Why analysis method [1] is used for current project. This method is considered to be the most reliable method of analysis in the industry.

II. PROBLEM STATEMENT

In this paper, FN 2 type of vertical milling machine is utilized for study purpose. On this machine, milling, grinding and boring operations are carried out on connecting rod as a work piece. During operations, movement of worktable is quite inefficient and due to which breakdown of machine occurs. So there is a need of root cause analysis of machine to avoid frequent maintenance & to reduce number of breakdown hours.

Break down Description

Break down Description– work table is not moving properly
Root cause – drive clutch is not working rapidly
Physical phenomenon –slide was jammed

Root Cause from Why – Why Analysis

1	Why?	not working at Rapid Speed
2	Why?	Slide jerk problem
3	Why?	abnormal noise in gear box
4	Why?	Drive motor overload / trip

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Corrective counter measure –

1. Replace the brush
2. Adjustment of wedge
3. Replace the gear key
4. Proper lubrication required

II. CONSTRUCTION AND IMPLEMENTATION

i) Study of existing component with modifications

The movement of work table is carried out by lead screw & lead screw is driven by gear box. When there is failure in gear box, it affects the movement of work table. So to have efficient movement of work table, total gear box assembly is replaced by hydraulic power unit. Fig. 1 shows the actual gear box of milling machine. There is abnormal noise in gear box due to wear & tear of gear. Fig. 2 shows the hydraulic power unit which replaces the mechanical gear box of milling machine.

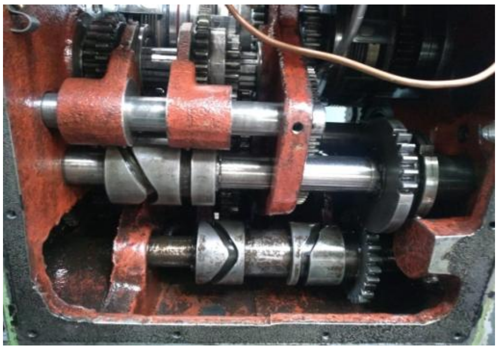
Fig. 1 - Gear Box of milling machine (Before)


Fig. 2 – Hydraulic Power unit (After)

Fig. 3 shows the lead screw of milling machine. There is a necessity of replacement of lead screw; because of slide jerk problem occurs due to overhauling of lead screw and also whole gear box assembly was replaced by hydraulic power unit. So, lead screw is replaced by hydraulic actuator. Fig. 4 shows the hydraulic actuator which replaces the lead screw.

Benefits after implementations: Now, work table is moving efficiently during the machining process, so the problem of component being rejected is solved. The problems related breakdown hours is eliminated because of newly designed hydraulic power pack.


Fig. 2 – Lead screw of work table (Before)


Fig. 4 –Hydraulic cylinder of work table (After)

III. CALCULATIONS

i) Before Implementations

Readings are obtained during period of DEC 2018 month

Availability = $\frac{\text{TotalAvailablehours} \quad -\text{Totalbreakdownhours}}{\text{TotalAvailablehours}}$

Availability = $\frac{416-90}{416}$ = 0.7836

Availability = 78.36%

Loss of availability = 1 – 0.7836**= 0.2164**

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Loss of availability = 21.64%

MTBF = $\frac{\text{TotalAvailablehours} \quad -\text{Totalbreakdownhours}}{\text{Numberofbreakdown}}$

MTBF = $\frac{416-90}{3}$

MTBF = 108.66 hrs.

MTTR = $\frac{\text{Totalbreakdownhours}}{\text{Numberofbreakdown}}$

MTTR = $\frac{90}{3}$

MTTR = 30 hrs.

ii) After Implementations

Readings are obtained during period of March2019 month

Availability = $\frac{\text{TotalAvailablehours} \quad -\text{Totalbreakdownhours}}{\text{TotalAvailablehours}}$

Availability = $\frac{416-15}{416}$ = 0.9639

Availability = 96.39%

Loss of availability = 1 – 0.9639 = **0.0360**

Loss of availability = 3.60%

MTBF = $\frac{\text{TotalAvailablehours} \quad -\text{Totalbreakdownhours}}{\text{Numberofbreakdown}}$

MTBF = $\frac{416-15}{1}$

MTBF = 401 hrs.

MTTR = $\frac{\text{Totalbreakdownhours}}{\text{Numberofbreakdown}}$

MTTR = $\frac{15}{1}$

MTTR = 15 hrs.

IV. RESULTS

Following table shows Comparison of results before and after implementation of counter measures.

Table 1:- Comparison of results before and after implementation of counter measures

Sr. No.	Parameters	Readings	
		Before	After
1	Availability implementation %	78.36	96.39
2	MTBF implementation (Hours)	108.66	401
3	MTTR implementation (Hours)	30	15

Following graphs shows Comparison of results before and after implementation of counter measures.

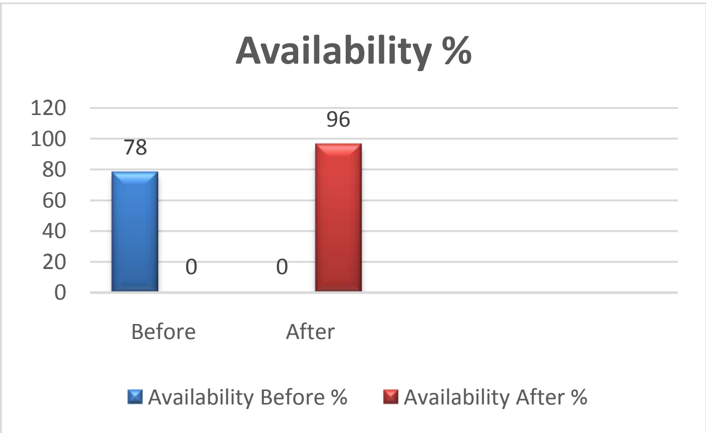

Fig.4.1Comparison of Availability before and after implementation of counter measures.

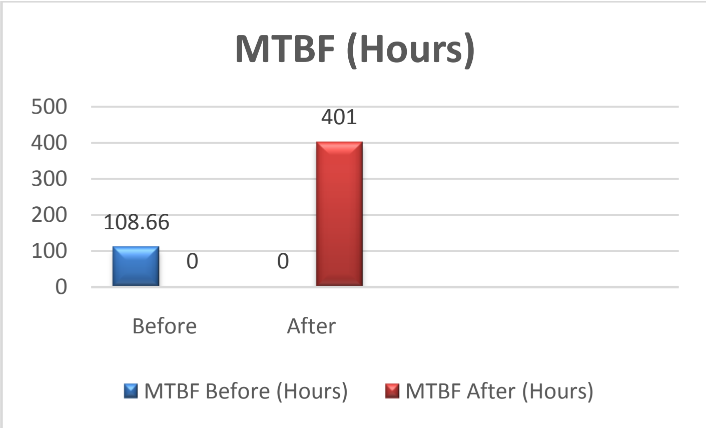

Fig.4.2Comparison of MTBF before and after implementation of counter measures.

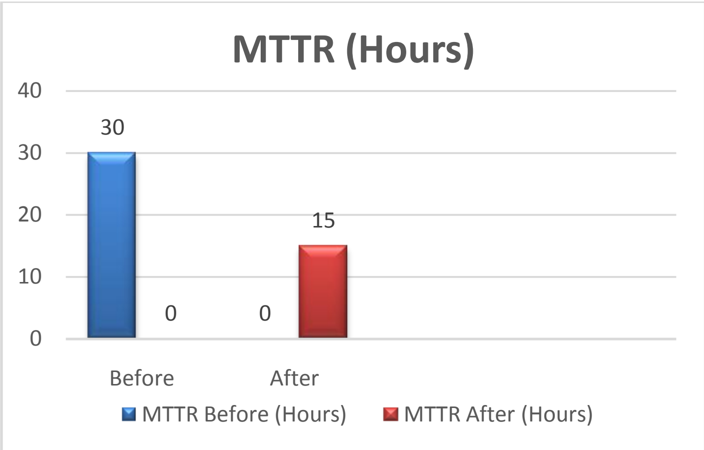

Fig.4.3Comparison of MTTR before and after implementation of counter measures.

V. CONCLUSION

The use of root cause analysis helped to identify the correct causes of failures by which the suitable counter measures are developed and implemented. The process parameters such as Availability, MTBF, and MTTR are calculated before and after the implementation of counter measures. Continuous monitoring of processes is done after the implementation of counter measures and following conclusions are drawn:

The Availability of the milling machine is increased from 78.36 to **96.39%.**
The MTBF of the milling machine is increased from 108.66 to **401hours.**
The MTTR of the milling machine is decreased from 30 to **15 hours.**

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