Application of TPM to Enhance Overall Equipment Effectiveness in Yarn Manufacturing

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Abstract*: In an emergent and highly populated country like India, the Cotton Textile Industry is exceptionally important, to meet the demand for clothes and exports to other countries for the improvement of GDP. The Cotton Textile Industry accounts nearly 30% of the total value of exports and employs more than 55 million labors. In order to withstand the global competition, it is necessary to improve the productivity. Productivity can be ensured by availability of machines without any break downs. In the case, higher down time and break down due to lack of maintenance policies in the Carding process is observed in the Textile Industry where the work is carried out. Total Productive Maintenance is a tool which has been used here to improve the maintenance activities and to reduce the downtime. The main goal of the Total Productive Maintenance (TPM) is to improve the Overall Equipment Effectiveness (OEE). Prior to the implementation of TPM the company's present status has been checked. By using the Root cause analysis (cause and effect diagram) various major causes for low OEE has been identified, analyzed and solutions to overcome those drawbacks have been discussed. Solutions are implemented and OEE has been calculated, improvements are recorded and discussed.

Keywords* : Overall Equipment Effectiveness, Total Productive Maintenance, Yarn Manufacturing.

I. INTRODUCTION

The textile industry is one of the largest industries in the world. Spinning is the first stage in textile manufacturing process. Spinning is the process of making yarn from the cotton. In spinning there will be several sections from blow room to winding. The section consists of blow room, carding, drawing, combing, ring frame and winding. The cotton bales are converted into yarn by the set of above operations.

[1] In recent years the competition among the industries is greater. The industries increase new tactics to live on the sector magnificence opposition. The fabric enterprise faced the main six large losses. The implementation of total productive maintenance can enhance the maintenance coverage by the involvement of all employees in the company. TPM is implemented in 3 ranges and that will assist to enhance the performance of the organization [2]. Now a day's customer wishes right satisfactory product with much less rate. The study [3] shows the proper maintenance system can enhance the availability of the machines. It improves the Overall Equipment Effectiveness of the company. [4] By the use of the kaizen concept six big losses may be decreased. Kaizen is one of the pillar of TPM that improves the productivity of the organization. [5]TPM goals to maximizing the overall equipment performance. Using the numerous maintenance standards breakdowns and stoppages are reduced. According to this have a look at [6] the general system effectiveness is advanced from 68.9% to 71.4%. TPM is the most effective tool to enhance the OEE. The success and failure of the business enterprise depend on TPM. In this paper [7] shows the important problem faced by the industry is maintenance. It accounts for 30% of the total cost of the product. TPM has been evolved to improve the maintenance system there by means of improve the machine efficiency. [8] Success of the company may be measured in terms of productivity. Productivity can be improved by way of decreasing the losses in the organization. The losses may be removed by means of implementing TPM and that enhance the maintenance.

II. METHODOLOGY

For the selected textile industry, the data is collected and recorded from the carding process, with the data which has been collected OEE is calculated. The calculated OEE is much lower when compared with the world class OEE. Further numerous opportunities cause for low OEE has been analyzed using Root cause analysis tool (cause and effect diagram). From Root cause analysis, major cause for low OEE is prioritized and selected. Total Productive Maintenance has been used to identify the solution for enhancing OEE. Autonomous maintenance is implemented in the industry which is also the pillar of total productive maintenance. Hence maintenance is improved, and down time is reduced such that machine availability is ensured for continuous production without any interruptions. The observation has been taken after Total Productive Maintenance implementation. Then the improvement has been proven by comparison of results before implementation of TPM and after implementation of TPM.

A. Overall Equipment Effectiveness

Overall Equipment Effectiveness is the gold standard for measuring manufacturing productivity. It identifies the percentage of manufacturing time that is truly productive.

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By measuring OEE and the underlying losses you will gain important insights on how to systematically improve your manufacturing process.OEE is the single best metric for identifying losses benchmarking progress and improving the productivity of manufacturing equipment.OEE can be expressed as follows.

Overall Equipment Effectiveness = Availability x

Performance Efficiency x Rate of Quality

Where,

Availability = (Running Time – Downtime)/Running Time x 100

Performance Efficiency = Operating Speed Rate x Net Operating Rate x 100

Rate of Quality = Good Count/Total Count X 100

III. RESULTS AND ANALYSIS

A. Collection of Data in the carding section

(Before TPM Implementation)

Table-1: Collection Of Data In The Carding Section (Before TPM Implementation)

Day	Machine No	Downtime per Shift (min)
1	1	87
2	2	121
3	3	106
4	4	104
5	5	207
6	6	102
7	7	219
8	8	112
9	9	160
10	10	105
11	11	136

Table 1 shows the down time per shift before implementing TPM in the carding section.

Sample Calculation On OEE Of the carding machine 1

- Running time per shift=480min
- Downtime per shift=87min
- Operating time per shift=480-87=393min

Availability=

Operating time/running time*100=393/480*100=81.87%

- Defect amount=12kg
- Time taken to fill one cane=48min
- Actual cycle time=0.88
- Ideal cycle time=0.83
- Output per shift=432kg
- Rate of quality=Total output-defect amount/total output*100

  =432-12/432*100=97.22%

- Actual processing time=Actual cycle time*output=380.16min
- Operating speed rate=Ideal cycle time/actual cycle time*100

  =0.83/0.88*100=94.31%

- Net operating rate=Actual processing time/Operating time*100

  =380.16/393*100=96.73%

- Performance efficiency=Operating speed rate*net operating rate*100

  =94.31*96.73*100=91.22%

- OEE=Availability*Performance efficiency*Rate of quality

  =81.87*91.22*97.22%

  =72.61%

The Calculated OEE for the entire carding section is shown in Table 2.

U-shaped production line is a special type of cellular manufacturing used in just-in-time (JIT), production systems and Lean Manufacturing. The U-line arranges machines around a U-shaped line in the order in which production operations are performed. Operators work inside the U-line. The proposed layout plan will help to overcome the problem by,

- Minimize the machine idle time.
- Maximize production.

Table-2: Calculation of OEE in the carding section (Before TPM implementation)

	Machine number	1	2	3	4	5	6	7	8	9	10	11
A	Running time per shift(min)	480	480	480	480	480	480	480	480	480	480	480
B	Planned stoppage per shift(min)	0	0	0	0	0	0	0	0	0	0	0
C	Loading time per shift(A-B) (min)	480	480	480	480	480	480	480	480	480	480	480
D	Downtime per shift(min)	87	121	106	104	207	102	219	112	160	105	136
E	Operating time per shift(C-D) (min)	393	359	374	376	273	378	261	368	320	375	344
F	Defect amount(kg)	12	10	10	11	7	11	6	9	9	10	11
G	Output per shift(kg)	432	378	320	398	284	416	256	374	332	368	357
H	Ideal cycle time(min)	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
I	Actual cycle time(min)	0.88	0.94	0.98	0.94	0.96	0.91	1.01	0.98	0.96	1.01	0.96
J	Actual processing time(I*G)(min)	380.2	355.3	372	374.2	272.6	374.6	258.6	366.5	318.7	371.7	342.7
K	Operating speed rate(H/I*100)%	94.31	88.29	84.69	88.29	86.45	91.21	82.17	84.69	86.46	82.18	86.45
L	Net operating rate(J/E*100)%	96.73	98.97	98.46	98.5	99.5	98.9	98.85	99.45	99.9	99.8	99.41
M	Availability (E/C*100)%	81.87	74.79	77.91	78.33	56.87	78.75	54.37	76.66	66.66	78.12	71.66
N	Performance efficiency (K*L*100)%	91.22	87.36	83.38	86.96	86.01	90.2	81	84.4	86.39	82.34	85.93
O	Rate of quality products %	97.22	97.35	97.36	97.23	97.53	97.36	97.65	97.59	97.8	97.28	
OEE	M*N*O*100%	72.65	63.65	64.86	68.22	47.71	69.16	44.14	63.18	56.32	62.57	60.12
AVERAGE OEE		61.14 %										

B. Cause and Effect Analysis

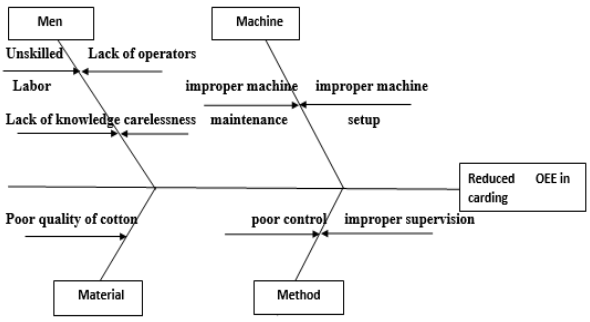

Fig. 1. Cause and effect analysis

From the cause and effect analysis (Fig.1) it is found that the reason for low OEE is due to the operators. The workers have the lack of knowledge. Due to the lack of knowledge of handing the machines more breakdowns were occurring. The other reason is the company having improper maintenance policy. The implementation of Autonomous Maintenance is the suitable solution to improve OEE. The steps for implementing Autonomous Maintenance is shown in Fig. 2.

C. Steps in Autonomous Maintenance Implementation

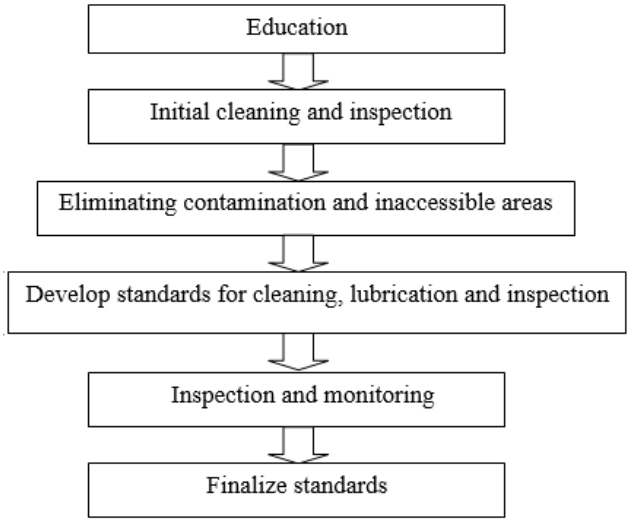

Fig. 2. Autonomous Maintenance Steps

D. Collection of Data in the carding section

(after TPM implementation)

Table 3: Collection of data in the carding section (After TPM implementation)

DAY	1	2	3	4	5	6	7	8	9	10	11
MACHINE NO	1	2	3	4	5	6	7	8	9	10	11
DOWNTIME PER SHIFT	80	75	95	112	102	146	106	91	133	114	82

Table 3 shows the down time per shift after implementing TPM in the carding section. When comparing the result with Table 1 it is well agreed that down time has been drastically reduced.

E. Calculation of OEE in the carding section

(after TPM implementation)

	Machine number	1	2	3	4	5	6	7	8	9	10	11
A	Running time per shift(min)	480	480	480	480	480	480	480	480	480	480	480
B	Planned stoppage per shift(min)	0	0	0	0	0	0	0	0	0	0	0
C	Loading time per shift(A-B) (min)	480	480	480	480	480	480	480	480	480	480	480
D	Downtime per shift(min)	80	71	95	112	102	146	106	91	133	114	82
E	Operating time per shift(C-D) (min)	400	409	385	368	378	334	374	389	347	366	398
F	Defect amount(kg)	11	8	9	7	8	9	6	8	10	12	11
G	Output per shift(kg)	438	445	396	380	388	345	385	393	350	361	412
H	Ideal cycle time(min)	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
I	Actual cycle time(min)	0.87	0.88	0.93	0.94	0.94	0.99	0.94	0.92	0.98	0.96	0.92
J	Actual processing time(I*G)(min)	381	391	368	357	364	341	361	362	343	346	379
K	Operating speed rate(H/I*100)%	95.4	94.3	89.2	88.2	88.2	83.8	88.3	90.2	84.6	86.4	90.2
L	Net operating rate(J/E*100)%	95.2	95.6	95.6	97	96.3	99.4	96.5	93.1	98.8	94.5	95.3
M	Availability (E/C*100) %	83.3	85.2	80.2	76.7	78.8	70.6	77.9	81.1	72.2	76.2	82.9
N	Performance efficiency (K*L*100) %	90.8	90.34	85.3	85.6	84.9	83.3	87.8	83.9	83.6	81.6	85.9
O	Rate of quality products %	97.25	98.1	97.7	98.1	97.9	97.3	98.4	97.9	97.1	96.7	97.2
OEE	M*N*O*100%	72.4	74.9	65.6	66.3	63.5	57.3	65.6	68.2	57.96	63.2	67.6
AVERAGE OEE		65.68 %										

The Overall Equipment Effectiveness has been raised to 65.68% (Table 4) which will have a good impact on the productivity and leads to improvement in turnover of the firm.

IV. CONCLUSION

The various processes in the yarn manufacturing are studied and carding process is analyzed. From that analysis it is found that overall equipment effectiveness is low. Due to the breakdowns and stoppages more, working hours would be wasted. The reason for low OEE is found and suitable solution is implemented. After the implementation of Total Productive Maintenance, the OEE is improved from 61.14% to 65.68%. TPM implementation is the only solution to sustain the world class competition to improve the productivity.

REFERENCES

1. Shatrughan Tomar and Arun Kumar Bhuneriya, "Analysis of OEE for TPM Implementation", International Journal of Business Quantitative Economics and Applied Management Research., **2**(8), , 2016.
2. R..Senthil Kumar, "Application of Total Productive Maintenance (TPM) in the spinning mill".
3. Jitendra Kumar, "OEE improvement by TPM implementation - case study", International Journal of Advanced Technology in Engineering and Science., **2**(4), 2016.
4. Nafis Ahmed, Jamal Hossen and Syed Mithun Ali, " Improvement of Overall Equipment Efficiency (OEE) of Ring Frame Section of a Spinning Mill – A Case Study", 2017.
5. Kaleshnath Chatterjee and Suman Bhattacharyya, "Total productive maintenance in spinning industry", The Indian Textile Journal, 2014.
6. Ravikant.V and Rajeshkumar U, "The Implementation and Evaluation of Total Productive Maintenance –A Case Study", International Journal of Application or Innovation in Engineering and Management, **2**(10), 2013.
7. Chetan S Sethia, Prof. P. N. Shende and Swapnil S Dange,"A Case Study on Total Productive Maintenance in Rolling Mill, "Journal of Emerging Technologies and Innovative Research, **1** (5), 283-289, 2014
8. Akhmad Fauzi and Gimbal Doloksaribu, "Efforts in Improving Overall Equipment Effectiveness (OEE) of Weaving Machine in Tire Cord Division at Tire Manufacturing Company in Indonesia", International Journal of Science and Research. **5** (7), 2016.

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