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EVALUATION OF TOTAL PRODUCTIVE MAINTENANCE SYSTEM IN A BEVERAGES BOTTLING PLANT

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ABSTRACT

Total productive maintenance (TPM) system is a practical approach aimed at maximizing the effectiveness of facilities that used in an organization. Therefore, it establishes a system of productive maintenance, covering the entire life cycle of equipment in all the departments of the plant and involves participation of employees from various levels and also which promotes small group autonomous activities. The strategy of maintaining the entire equipment in any manufacturing plant is crucial task for the effectiveness of production volume, but also to estimate its contribution towards improving and synchronizing manufacturing facilitates. The aim of this paper is to evaluate the contributions of TPM approach towards improving manufacturing performance in Hindustan Coca-Cola beverages (p) Ltd (HCCBPL) located at Srikalahasthi, Chittoor district, Andhra Pradesh. The correlation between various TPM implementation dimensions and manufacturing performance improvements have been evaluated for the estimation of overall Equipment Effectiveness (OEE) and Mechanical Efficiency (ME) values in CSD PET line.

Keywords: Lean tools, TPM, OEE, ME, CSD PET line

I. INTRODUCTION

Major businesses in India have been trying to adopt new manufacturing initiatives in order to reduce operating maintenance cost in the plants. Lean manufacturing is one of these initiatives that reduce waste and focus in cost reduction by eliminating non value added activities. The tools and techniques of lean manufacturing have been widely used in the discrete and process industries starting with the introduction of the Toyota production system which includes just in time, value stream mapping, total productive maintenance, single minute exchange of dies, 5s-good housekeeping principles and production smoothing have been widely used in discrete parts manufacturing sectors such as automotive, electronics and other process industries.

In order to achieve the world class manufacturing system every industry is trying to adopt lean tools. It is not only important to apply this lean tool but also to estimate its contribution while determining the never level to world class manufacturing system.

TPM is designed to maximize the Overall Equipment Effectiveness (OEE). It involves all departments that plan, use and maintain equipment, involves all employees from top management to front line workers. The concept of TPM was developed in Denso, A tier one automotive supplier in the Toyota group of suppliers, during 1960s and 70s in Japan. Therefore, the key concept behind effective improvements was autonomous maintenance system. The concept of OEE and focused improvement were found to be quite encouraging for success of TPM implementation. The objective of the TPM is to improve the labour productivity and to reduce the overall maintenance cost of the plant. The work of the Japanese consultant Koichi in Nissan Motors was acknowledged as 10% reduction in maintenance cost, 30% reduction in manpower and 14% increase in labor productivity were reported.

Recently, the rapid changing global market place calls for effectiveness improvement in a company's performance by focusing on cost reduction, increasing productivity levels, quality and guaranteeing deliveries in order to satisfy customers requirements. Any organization that want to survive in today's highly competitive business environment, it must address the need to diversify the product range with state-of-the-art product features, coupled with high quality, lower costs, and swift to R&D activities. In today's fast-changing market place, slow and steady improvements in manufacturing operations do not guarantee sustained profitability or survival of an organization. The Lean initiative is targeted to enhance competitiveness of organizations and it encompasses a powerful structured approach to change in the work culture of an organization to maximize the overall effectiveness of production and equipment by reading mistakes and accidents.



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II. LEAN TOOLS CONCEPT

TPM is the innovative Japanese concept [5]; the origin of TPM can be traced back to 1951 when preventive maintenance was introduced in Japan. However the concept of preventive maintenance was taken from USA. Nippondenso was the first company to introduce plant wide preventive maintenance in 1960. Nakajima (1988) proposed that to eliminate waste, Toyota became one of the first companies to implement TPM.

Bhadury. B [3] explained that TPM is a strategic management approach that has impact on the efficiency of the manufacturing organization's maintenance that optimizes equipment effectiveness, eliminates breakdowns and promotes autonomous maintenance by operators through day-to-day activities involving total workforce. Ahuja [2] overviewed that TPM is a unique Japanese philosophy, which has been developed based on the productive maintenance concepts and methodologies. This concept was introduced by M/S Toyota Motor Company, Japan in the year 1971.

Nakajima. S [4] is one main method to meet effective utilization of equipment in TPM.

TPM is aimed at maximizing equipment effectiveness through the optimization of equipment availability, performances, efficiency and product quality.

- TPM establishes a maintenance strategy (level and type of PM, productive Maintenance) for the life of equipment.
- TPM covers all the departments such as planning, users and maintenance.
- TPM involves all staff members from top management down to shop floor workers.
- TPM promotes improved maintenance through small group autonomous activities.

Melesse Workneh Wakjira, et al., [1] had notified that if a company has an OEE of 85% or above, then it is considered to be a world class company. Abidianinc. [6] stated that there is an element to be integrated with the three elements of OEE stated above named planning factor. It is measure for the utilization of the installation in the theoretical production time or measure for the extent of not utilizing the installation.

III. TPM IMPLEMENTATION METHODOLOGY

TPM methodology implemented as follows:

- **Step 1:** Preparatory Stage:

Process-1: Announcement by Management to all about TPM introduction in the organization.

Process-2: Initial education and propaganda for TPM.

Process-3: Setting up TPM and departmental committees.

Process-4: Establishing the TPM working system and target.

Process-5: A master plan for institutionalizing

- **Step 2:** Introduction stage:
- **Step 3:** Implementation.
- **Step 4:** Institutionalizing stage

IV. CASE STUDY

Hindustan Coca-Cola Beverages (p) Ltd (HCCBPL) in Sri Kalahasthi is installed with three manufacturing lines such as Returnable Glass Bottles line (RGB), Carbonated Soft Drink Poly Ethylene Terephthalate Line (CSD PET), and Hot Fill (HF) juice line. The case study was carried out to check the OEE and ME in CSD PET line. This line is 200 Bottles per Minute (BPM) PET line and was started in the year 2004. Its products are 600ml, 1.25Ltr, 1.75Ltr, 2.0Ltr. Pack size machines in CSD PET line consists of Blower, Filler, Labeller, Caser and Palletizer.

Run time and paid time are given input in the CSD PET Line, where implementation of TPM pillars is the lean tool for maintenance of equipment and elimination of non-value activities is the process and production cases, OEE and ME are the outputs which are measurable.



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- Total Non-Production Time (NPT): the total time without production or when no use of man or machine.
- Total Paid Time (min): Total run time of the line which loses. It can be calculated as
= (24hrs×60) - total non - paid time = 1440- total non-paid time
- Actual Run Time: time taken to produces number of cases at rated speed.
- Total losses: Total Paid Time – Actual Run Time
- Overall Equipment Effectiveness (OEE) is defined as the ratio of actual production time to theoretic production time taken. $OEE = (\text{Total run time}/\text{total paid time}) \times 100$
- Mechanical Efficiency (ME): it measures of the effectiveness with which a mechanical system performers.

$$ME = [\text{Total run time}/ (\text{Total paid time} - \text{Planned loss})] \times 100$$

The data for OEE and ME are taken for 20 days. The data for first 10 days is shown in table-1.

V. RESULTS

From the Table-5, it is observed that planned losses occur in Filler section, Operational losses and Equipment losses in Filler and Blower are causing more downtime.

In the fig-1, OEE values for twenty days are shown, there is an increase in the OEE performance which shows the effective implementation of TPM, but still there is scope to improve further to attain a world class manufacturing.

Table-1: OEE and ME of CSD PET line

Production parameter	Days									
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Total paid time(min)	323	440	490	939	369	231	231	1264	745	1012
Total NPT time(min)	1117	1000	950	1070	501	1071	120	176	695	428
Production cases(units)	1704	2795	2195	2461	5055	1424	640	6033	1594	660
Run time(min)	204	335.5	263.3	295.4	606.2	170.9	76.8	723.9	191.3	791.7
Planned losses(min)	0	0	63	0	0	0	0	97	0	0
Operational losses(min)	39	57	63	57	107	110	24	149	463	72
Equipment losses(min)	74	41	42	15	223	82	120	240	30	148
Unrecorded losses(min)	5.57	6.46	58.63	0.56	2.73	6.01	10.15	59.07	60.63	0.22
Total losses(min)	118.5	104.4	226.6	74.56	332.7	498	154.1	540	553.6	220.2
OEE (%)	63	76	54	80	65	46	33	57	26	78
ME (%)	63	76	62	80	65	46	33	57	26	78

Table-2: Csd Pet Line Configuration Details

Quantity	Rated speed (BPM)	Production rate(cases/hour)	Bottles per case (units)
600 ml	200	500	24
1025 ml	150	750	12

Table-3: Analysis of losses in day-1

losses	Equipment						% of losses
	Blower	Filler	Labeller	Caser	Palletizer	Total	
Planned loss (min)	0	0	0	0	0	0	0
Operational loss (min)	1	10	10	2	0	39	32
Equipment loss (min)	0	0	0	38	6	74	62



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Total Analysis Of Losses For 10 Days In Each Unit

Table-4: Analysis of losses (min)

losses	Equipment						Total	% of losses
	Blower	Filler	Labeller	Caser	Palletizer			
Planned losses (min)	0	160	0	0	0	160	7	
Operational losses (min)	278	494	106	53	157	1088	48	
Equipment losses (min)	420	364	24	55	152	1015	44.8	

Table-5: Analysis of Total Losses in each unit

Losses	Equipment					
	Blower	Filler	Labeller	Caser	Palletizer	Total
Total Losses(min)	698	1018	130	108	309	2263
% of Losses	30.8	45	5.8	4.8	13.7	

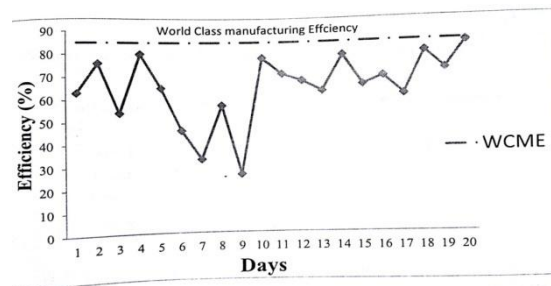


Fig-1: Overall Equipment Effectiveness Trend

In the fig-2, Mechanical Efficiency values are shown for twenty days, it shows the improvement in the equipment efficiency. To increase further, TPM pillars implementation should be in effective manner.

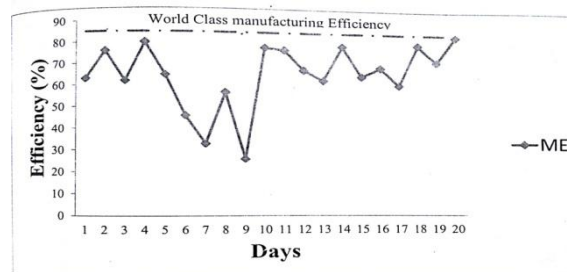


Fig-2: Mechanical Efficiency Trend

Fig-3 shows the total losses in blower, filler, labeller, caser and palletizer for 10 days continuously.

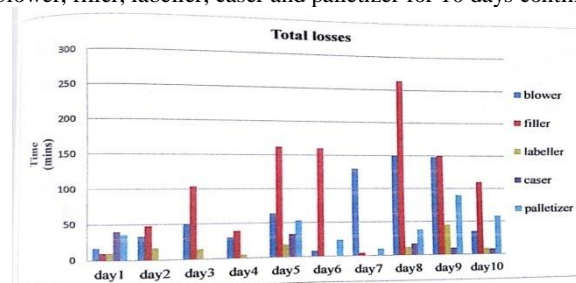


Fig-3: Total losses



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Table-6: comparison of OEE values before and after TPM Implementation

Before TPM Implementation 2004		After TPM implementation 2015	
Month	OEE (%)	Month	OEE (%)
January	55	September	76
February	46	October	80
March	54	November	83

From the Table-6, the comparison between OEE is shown before and after TPM implementation. From this Table there is an increase in the OEE values after TPM implementation but still there is a scope to improve further to attain world class manufacturing which is possible by effective implementation.

VI. CONCLUSIONS

- ❖ It is observed that total losses in filler, blower and palletizer are 45%, 30.8% and 13.7% respectively. Which causing downtimes of the entire line.
- ❖ OEE values are in the process of achieving nearer to world class manufacturing efficiency (83%), but there is scope to improvement in filler and blower sections with effective implementations of TPM pillars result will be quite satisfactory and may reach a world class OEE value in between 85%-90%.
- ❖ The study clearly reveals that the successful TPM system implementation can facilitate the manufacturing organization quite for achieving enhanced manufacturing performance leading to competitive advantage.
- ❖ The reasons for downtime in each machine and its frequency are stated clearly, that which can be addressed through the effective implementation of TPM pillars.
- ❖ Finally, with concludes that the maintenance activities of each machine should be implemented effectively to mitigate the equipment losses.

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