IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 3 Ver. III (May. - Jun. 2015), PP 33-39
www.iosrjournals.org

Implementation of Total Productive Maintenance on Boiler

Syed Md. Shahwaz (MTMP-13-17)[1,] Md. Ghazali (MTMP-13-11)[2]
M.Tech. in Mechanical Engineering (Manufacturing Technology & Automation)
Department of Mechanical Engineering
Al-Falah School of Engineering & Technology, Dhauj Faridabad, Haryana, (India) June, 2015

Abstract: *Boiler is an unit to generate the steam used for producing, furnishing and recovering heat together with the apparatus for transferring the heat, so made available to the fuel being heated and vaporized. Total productive maintenance (TPM) is a technique of maintaining and improving the integrity of manufacturing process and quality systems through the machines, equipment, processes and employees that add business value to the organization. TPM keeps focused on all equipment in top working condition to avoid breakdowns and delays in the manufacturing process. The present study aims to propose a methodology that can be used to compare the management methods and determine a method that can optimize maintenance to make the plants operate economically with the help of TPM.*

Keywords: *Boiler, Types of Boiler, TPM, Piller of TPM.*

I. Introduction

Boiler produces steam from water by heat of pulverized coal is air-blown into the furnace from fuel nozzles at the four corners and it rapidly burns, forming a large fireball at the centre. The water circulation rate in the boiler is three to four times the throughput and is typically driven by pumps As the water in the boiler circulates it absorbs heat and changes into steam at 700 °F (370 °C) and 22,000 kPa. It is separated from the water inside a drum at the top of the furnace. The saturated steam is introduced into superheat pendant tubes that hang in the hottest part of the combustion gases as they exit the furnace. Here the steam is superheated to 1,000 °F (540 °C) to prepare it for the turbine. [01,6,11]

Types of boilers:-Boilers are mainly classified into following classes:

1. Smoke tube boiler
2. Water tube boiler

Smoke tube boiler:-A smoke tube boiler is a type of boiler in which water circulates in tubes heated internally by the fire. The Smoke Tube Boiler is manufactured using the advanced technology which makes it a highly efficient Boiler. Boiler is Three Pass Fully Wet Back Type. Designed with proper grate area and furnace volume for efficient burning of solid fuels (Applicable for Solid Fuels). Good Combustion Efficiency as greater furnace diameters and furnace volumes are provided. Higher efficiencies as designed properly with required heating surface areas. Available for liquid fuels like LDO/HSD/FO/LSHS, gaseous fuels like Natural Gas/LPG/Biogas and Solid Fuels like Bagasse, Husk, Wood, Coal and other agro-wastes. Good Steam Purity up to 98% dry saturated as large disengaging surface and free board distance in boiler. Steam Quality as 98% dry saturated. Consistent and trouble free performance under 'Normal Operating Conditions'. Working Pressures of Boiler available at 7 kg/sq.cm/10.54 kg/sq.cm/15 kg/sq.cm and 17.5 kg/sq.cm for complete range of boilers for different fuels.[6,9,11]

Fig. 01. Smoke Tube Boiler

Water-tube boiler:-A water tube boiler is a type of boiler in which water circulates in tubes heated externally by the fire. Fuel is burned inside the furnace, creating hot gas which heats water in the steam-generating tubes. In smaller boilers, additional generating tubes are separate in the furnace, while larger utility boilers rely on the water-filled tubes that make up the walls of the furnace to generate steam. The heated water then rises into the steam drum. Here, saturated steam is drawn off the top of the drum. In some services, the steam will reenter the furnace through a superheater to become superheated. Superheated steam is defined as steam that is heated above the boiling point at a given pressure. Superheated steam is a dry gas and therefore used to drive turbines, since water droplets can severely damage turbine blades.Cool water at the bottom of the steam drum returns to the feed water drum via large-bore 'downcomer tubes', where it pre-heats the feedwater supply. (In 'large utility boilers', the feedwater is supplied to the steam drum and the downcomers supply water to the bottom of the waterwalls). To increase economy of the boiler, exhaust gases are also used to pre-heat the air blown into the furnace and warm the feedwater supply. Such water tube boilers in thermal power station are also called steam generating units.[6,9,11]

Fig. 02 **Water tube boiler**

Total Productive Maintenance:-TPM is a maintenance system developed for improving productivity by making processes more reliable and less wasteful.TPM is an extension of TQM(Total Quality Management). The objective of TPM is to maintain the plant or equipment in good condition without interfering with the daily process. To achieve this objective, preventive and predictive maintenance is required. By following the philosophy of TPM we can minimize the unexpected failure of the equipment. Original goal of total productive management: "Continuously improve all operational conditions, within a production system; by stimulating the daily awareness of all employees"[01,02]

Preventive Maintenance:-Preventive maintenance (PM) is a time based maintenance method in which the maintenance activities are planned and scheduled based on predetermined counter intervals in order to prevent breakdowns and failures from occurring. The primary goal of PM is to preserve and enhance equipment performance and reliability by preventing failure of equipment before it failure occurs by such actions as replacing worn components. PM is commonly used where equipment failure is age related or where the equipment failure rates follow what is called bath-tub curve (Figure 3). It is recommended that for new maintenance organizations, PM should be started in small steps and move to next step when the previous is successful. When building a PM system, equipment with high downtime, high number of repairs or repetitive breakdowns should be targeted. The PM should find root cause of common failures, review work order history, brainstorm with operation and maintenance (O&M) employees in order to develop PM procedures to address the root causes of failures. [01,02,3]

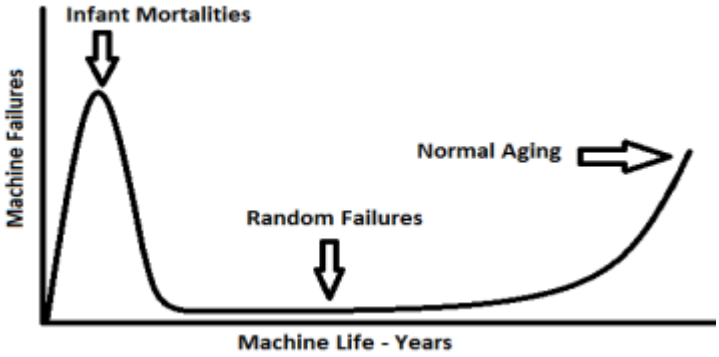

Fig. 03 The bathtub curve for preventive maintenance.

Condition Based Maintenance:-Condition Based Maintenance (CBM) is a set of maintenance actions based on the evidence of need for maintenance obtained from real time assessment of equipment condition obtained from embedded sensors and external tests and measurement taken by portable equipment.[01,02]

The productive/Lean Maintenance Method:-Proactive maintenance means that lean maintenance uses PM and CBM strategies to prevent and predict failure instead of reacting to it. Planned and scheduled means that the maintenance activities are documented in such a way that the required activities, labour needs, spare parts and time needed to complete the tasks are known in advance.[01,02]

TPM Implementation: The following is the brief description of each of the TPM implementation activities:[1,2,4]

i. Master plan: The TPM team, along with manufacturing and maintenance management, and union representatives determines the scope/focus of the TPM program. The selected equipments and their implementation sequence are determined at this point. Baseline performance data is collected and the program‟s goals are established.
ii. Autonomous maintenance: The TPM team is trained in the methods and tools of TPM and visual controls. The equipment operators assume responsibility for cleaning and inspecting their equipment and performing basic maintenance tasks. The maintenance staff trains the operators on how to perform the routine maintenance, and all are involved in developing safety procedures. The equipment operators start collecting data to determine equipment performance.
iii. Planned maintenance: the maintenance staffs collects and analyzes data to determine usage/need based maintenance requirements. A system for tracking equipment performance metrics and maintenance activities is created (if one is not currently available). Also, the maintenance schedules are integrated into the production schedule to avoid schedule conflicts.
iv. Maintenance reduction: The data that has collected and the lessons learned from TPM implementation are shared with equipment suppliers. This „design for maintenance‟ knowledge is incorporated into the next generation of equipment designs. The maintenance staff also develops plans and schedules for performing periodic equipment analysis (burner pump, fuel filter, rotary cup atomizer, furnace tube and valve, etc.). This data from analysis is also fed into the maintenance database to develop accurate estimates of equipment performance and repair requirements. These estimates are used to develop spare parts inventory policies and proactive replacement schedules.
v. Holding the gains: The new TPM practices are incorporated into the organization‟s standard operating procedures. These new methods and data collection activities should be integrated with the other elements of the production system to avoid redundant or conflicting requirements. The new equipment management methods should also be continuously improved to simplify the tasks and minimize the effort required to sustain the TPM program.

Nine Essentials of TPM

1) Self maintained work place
2) Elimination of the 6 big losses
3) Zero Breakdowns
4) Zero Defects
5) Optimal life and availability of tools
6) Self-improvement
7) Short production-development time and low machine life cost

8) Productivity in indirect departments
9) Zero Accidents

TPM Implementations Stages:-
a) Stage A-Preparatory Stage
b) Stage B-Introduction Stage
c) Stage C-TPM Implementation
d) Stage D-Institutionalizing Stage

a) Stage A-Preparatory Stage Step 1-Announcement by management to all about TPM introduction in the organization: Proper understanding, commitment and active involvement of the top management in needed for this step. Senior management should have awareness programmes, after which announcement is made. Decision the implement TPM is published in the in house magazine, displayed on the notice boards and a letter informing the same is send to suppliers and customers. Step 2-Initial education and propaganda for TPM: Training is to be done based on the need. Some need intensive training and some just awareness training based on the knowledge of employees in maintenance. Step 3-Setting up TPM and departmental committees: TPM includes improvement, autonomous maintenance, quality maintenance etc., as part of it. When committees are set up it should take care of all those needs. Step 4-Establishing the TPM working system and target: Each area/work station is benchmarked and target is fixed up for achievement. Step 5-A master plan for institutionalizing: Next step is implementation leading to institutionalizing wherein TPM becomes an organizational culture. Achieving PM award is the proof of reaching a satisfactory level.[01]

b) Stage B-Introduction Stage A small get-together, which includes our suppliers and customer"s participation, is conducted. Suppliers as they should know that we want quality supply from them. People from related companies and affiliated companies who can be our customers, sisters concerns etc. are also invited. Some may learn from us and some can help us and customers will get the message from us that we care for quality output, cost and keeping to delivery schedules.[01]

c) Stage C-TPM Implementation stage In this stage eight activities are carried which are called eight pillars in the development of TPM activity. Of these four activities are for establishing the system for production efficiency, one for initial control system of new products and equipment, one for improving the efficiency of administration and are for control of safety, sanitation as working environment.[01]

d) Stage D-Institutionalizing Stage By now the TPM implementation activities would have reached maturity stage. Now is the time to apply for preventive maintenance award.[01]
Six sigma: Six sigma is a comprehensive and flexible management system for achieving, sustaining and maximizing business success, a process driven by closely understanding customer needs, disciplined use of facts, data and statistical analysis and build on diligent attention to managing, improving and reinventing business processes. [01]
Core elements of the six sigma method: Close understanding of customer needs Diligent use of statistical analysis for analysis and support decisions Systematic, structured approach to issues affecting processes Continuous and sustained improvement. The term sigma (σ) refers to statistical standard deviation which is a measure of the degree of variation from the mean in a population. A deviation from the population mean represents a defect or nonconformity. A six sigma standard is equivalent to six standard deviations corresponding to 3.4 Defects per Million Opportunities (DPMO). It is seen that the level of variation from the mean represent the level of defects or the sigma level. It is seen that defect level reflects the spread of the variable (X) about the mean value. A narrow spread of population about the mean value is most desirable as it corresponds to fewer defects.[01]

Six Big Losses:-One of the major goals of TPM and OEE is to reduce or eliminate what are called the six big losses which they are the most common causes of efficiency loss in manufacturing. the frequent adjustment to maintain the production within tolerance, the loss in a six big losses as following:

1. Downtime Losses: Breakdown losses this loss is due to parts failure where they cannot work anymore and they need either repair or replace. These losses are measured by how long it takes from labour or parts for fixing the problem. Setup and adjustment time, These losses are due to the changes in the operating conditions, like the start of the production or the start of the different shifts, changes in products and condition of the operation. The main examples of this kind of losses are equipments changeovers, exchange of dies, jigs and tools. These losses consist of setup, start-up and adjustment down times.

2. Speed Losses: When the output is smaller than the output at references speed these are called speed losses. When considering speed losses, one dose not check if the output conforms to quality specifications. This can be found in two forms: Minor stoppage losses these losses are due to the reason of machine halting, jamming, and idling. Many companies are considering these minor stoppages as the breakdowns in order to give importance to this problem. Other is Speed losses; these losses are due to the reduction in speed of the equipment. In other words the machine is not working at the original or theoretical speed. If the quality defect and minor stoppages occurs regularly then the machine is run at low speed to cover the problems. It is measure by comparing the theoretical to actual working load.
3. Defect or quality losses: Rework and quality defects; these losses are due to the defective products during the routine production. These products are not according to the specifications. So that rework is done to remove the defects or make a scrap of these products. Labour is required to make a rework which is the cost for the company and material become a scrap is also another loss for the company. The amount of these losses is calculated by the ratio of the quality products to the total production.
4. Yield losses: these losses are due to wasted raw materials .The yield losses are split into two groups. The first one is the raw materials losses which are due to the product design, manufacturing method etc. The other group is the adjustment losses due to the quality defects of the products which are produced at the start of the production process, changeovers etc.[01]

Steps involved in Total Productive Maintenance: Identifying the job to be taken & appropriate case register, Preparation of schedule of maintenance, Preparation of history card of all the repair work carried on such a machine. Preparation of job specification, Preparation of maintenance schedule and detail program of work with time frame for completion , Preparation of inspection chart, Preparation of maintenance report on the work done, Feed back on the corrective action/ repair work done and its results.

Motives of TPM:-
1. Adoption of life cycle approach for improving the overall performance of production equipment.
2. Improving productivity by highly motivated workers which is achieved by job enlargement.
3. The use of voluntary small group activities for identifying the cause of failure, possible plant and equipment modifications.

Uniqueness of TPM:-

The major difference between TPM and other concepts is that the operators are also made to involve in the maintenance process. The concept of "I (Production operators) Operate, You (Maintenance department) fix" is not followed.

TPM Objectives:-
1. Achieve Zero Defects, Zero Breakdown and Zero accidents in all functional areas of the organization.
2. Involve people in all levels of organization.
3. Form different teams to reduce defects and Self Maintenance.

Direct benefits of TPM:-
1. Increase productivity and OPE (Overall Plant Efficiency) by 1.5 or 2 times.
2. Rectify customer complaints.
3. Reducethe manufacturing cost by 30%.
4. Satisfy the customers needs by 100 % (Delivering the right quantity at the right time, in the required quality.)
5. Reduce accidents.
6. Follow pollution control measures.

Indirect benefits of TPM:-
1. Higher confidence level among the employees.
2. Keep the work place clean, neat and attractive.
3. Favorablechange in the attitude of the operators.
4. Achieve goals by working as team.
5. Horizontaldeployment of a new concept in all areas of the organization.
6. Share knowledge and experience.
7. The workers get a feeling of owning the machine.

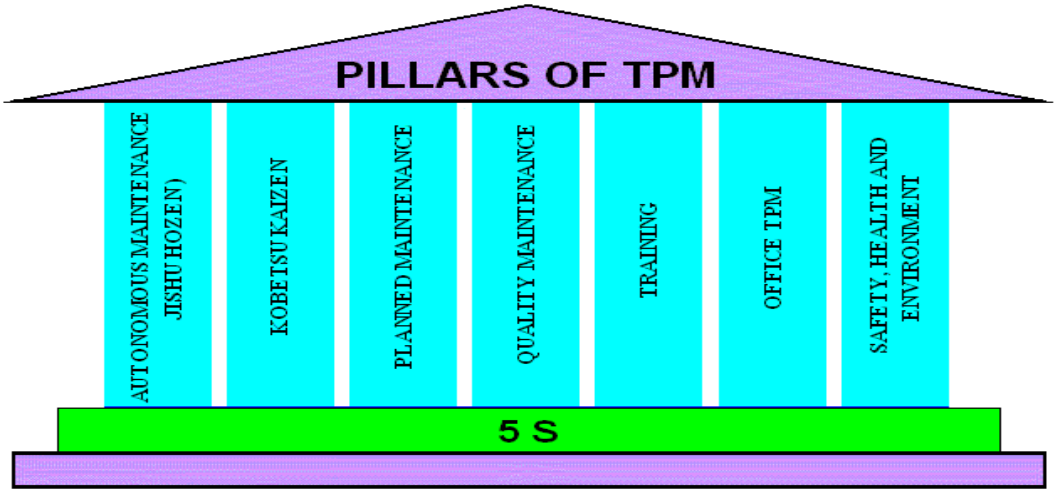

Fig. 04 Pillars of TPM[02]

Pillar 1 - 5S:-TPM is started with 5S. Problems cannot be clearly seen when the work place is unorganized. Cleaning and organizing the workplace helps the team to uncover problems. Making problems visible is the first step of improvement. Application of 5S: Sort (remove unwanted items). Straighten (organize). Scrub (clean). Standardize (make routine). Spread (expand to other areas).

Pillar 2 - Jishu Hozen (Autonomous maintenance) :-This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs. The operators are responsible for upkeep of their equipment to prevent it from deteriorating.

Pillar 3 - Kaizen:- Kaizen means that lean focuses on continuous evaluation and improvement of the maintenance processes in terms of time, resources use and quality of work. "Kai" means change, and "Zen" means good (for the better). Basically kaizen is for small improvements, but carried out on a continual basis and involve all people in the organization. Kaizen is opposite to big spectacular innovations. Kaizen requires no or little investment. The principle behind is that "a very large number of small improvements are move effective in an organizational environment than a few improvements of large value. This pillar is aimed at reducing losses in the workplace that affect our efficiencies. By using a detailed and thorough procedure we eliminate losses in a systematic method using various Kaizen tools. These activities are not limited to production areas and can be implemented in administrative areas as well.

Pillar 4 - Planned Maintenance : It is aimed to have trouble free machines and equipments producing defect free products for total customer satisfaction. This breaks maintenance down into 4 families.

1. Preventive Maintenance
2. Breakdown Maintenance
3. Corrective Maintenance
4. Maintenance Prevention

Pillar 5 - Quality Maintenance:- It is aimed towards customer delight through highest quality through defect free manufacturing. Focus is on eliminating non-conformances in a systematic manner, much like Focused Improvement. We gain understanding of what parts of the equipment affect product quality and begin to eliminate current quality concerns, then move to potential quality concerns. Transition is from reactive to proactive (Quality Control to Quality Assurance). QM activities is to set equipment conditions that preclude quality defects, based on the basic concept of maintaining perfect equipment to maintain perfect quality of products. The condition are checked and measure in time series to very that measure values are within standard values to prevent defects. The transition of measured values is watched to predict possibilities of defects occurring and to take counter measures before hand. [02,05]

Pillar 6 - Training :-It is aimed to have multi-skilled revitalized employees whose morale is high and who has eager to come to work and perform all required functions effectively and independently. Education is given to operators to upgrade their skill. It is not sufficient know only "Know-How" by they should also learn "Know-why". By experience they gain, "Know-How" to overcome a problem what to be done. This they do without

knowing the root cause of the problem and why they are doing so. Hence it become necessary to train them on knowing "Know-why". The employees should be trained to achieve the four phases of skill. The goal is to create a factory full of experts. The different phase of skills are
Phase1 : Do not know.
Phase2 : Know the theory but cannot do.
Phase 3 : Can do but cannot teach
Phase 4 : Can do and also teach.

Pillar 7 - Office TPM :-Office TPM should be started after activating four other pillars of TPM (JH, KK, QM, PM). Office TPM must be followed to improve productivity, efficiency in the administrative functions and identify and eliminate losses. This includes analyzing processes and procedures towards increased office automation.

Pillar 8 - Safety, Health And Environment:- In this area focus is on to create a safe workplace and a surrounding area that is not damaged by our process or procedures. This pillar will play an active role in each of the other pillars on a regular basis.

II. Result And Discussion

The efficiency of the thermal power plant is increased by implementing TPM. In above cases, we conclude that the efficiency of a boiler increases by implementing TPM on it. TPM is a technique which when implemented carefully with full help of top management will result in increasing plant operations and ensure high plant efficiency and capacity usefulness.

References

[1]. Implementation of Total Productive Maintenance on Boiler Amit Borikar1, Ankit P. Shingare1, Jay R. Sarnaik1, Avinash G. Bhusari1 1Mechanical, J.D.I.E.T. YAVATMAL/S.G.B.A.U., INDIA
[2]. ROLE OF TOTAL PRODUCTIVITY MAINTENANCE IN POWER PLANT PERFORMANCE BY PROF. J.A. KAGAL IIPE
[3]. Ahuja, I.P.S. & Khamba, J.S. (2008a). An evaluation of TPM initiatives in Indian industry for enhanced manufacturing performance.International Journal of Quality & Reliability Management, 25(2), 147-72.
[4]. Ahuja, I.P.S. & Khamba, J.S. (2008b). Justification of total productive maintenance initiatives in Indian manufacturing industry for achieving core competitiveness.Journal of Manufacturing Technology Management, 19(5), 645–669.
[5]. Bhadury, B. (2000). Management of productivity through TPM. Productivity, 41(2), 240-51.
[6]. Dunn, R. (1988). Maintenance update–88. Plant Engineering, 42(8), 60-62.
[7]. Eti, M.C., Ogaji,S.O.T. &Probert, S.D. (2006). Reducing the cost of preventive maintenance (PM) through adopting a proactive reliability-focused culture. Applied Energy, 83, 1235-1248.
[8]. "A case study-Ukai Thermal Power Station", M.E. dissertation, by N.S.Mehta,S.V.N.I.T,surat
[9]. A methodology for in-situ calibration of steam boiler instrumentation,
[10]. A Thesis by GUANGHUA WEI Submitted to the Office of Graduate Studies of Texas A&M University.
[11]. Training Report by Barauni Rifinery, IOCL submitted by Syed Md Shahwaz

Web Reference
[1]. www.wikipedia.com
[2]. www.google.com
[3]. www.yahoo.com
[4]. www.tpmquality.com