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Action Plans in Implementing Total Productive Energy Maintenance in Industry

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Abstract:
The aim of this paper is to describe and analyze energy management practices in a Health Care firm. The energy issue is becoming a determining factor in the living standards of individuals as well as societies. The increasing demand for increased productivity, improved quality of products/services, reduced environmental emissions, and reduced energy costs are all incentives for organizations to invest in and implement new energy efficiency technologies and management approaches. This necessitates a collective effort towards the efficient and wise utilization of all energy resources.
This paper introduces the concept of Total Productive Energy Management (TPEM). This approach would require the involvement of all members of a facility to take part in energy conservation activities in their facility by being responsible for the management of energy systems in the space(s) they occupy and/or the equipment they operate.

***Keywords**: Total Productive Maintenance [TPM]; Total Productive Energy Management; Monitoring and Targeting; CUSUM*

1. Introduction

(TPM) is a well-defined and time-tested concept for maintaining plants and equipment. TPM can be considered the science of machinery health.
TPM was introduced to achieve the following objectives:

- Avoid waste in a quickly changing economic environment.
- Produce goods without reducing product quality.
- Reduce costs.
- Produce a low batch quantity at the earliest possible time.
- Send only non-defective parts to the customers.
- Energy Optimization

Industrial energy efficiency is becoming increasingly important from the point of view of both public economy and business. Governments have instituted several incentives to increase energy efficiency in industry, since this is one of the most promising means to reduce CO2 emissions resulting from the use of fossil fuels [1]. From a business point of view, greater energy efficiency is of importance as it has direct economic benefits such as increased competitiveness and higher productivity [2-3]. Research, however, has shown that despite the existence of cost-effective energy efficiency measures in industry, these are not always implemented due to various barriers to energy efficiency such as split incentives, principal-agent relationships, and information imperfections and asymmetries [4-7]. The discrepancy between the optimal level of energy efficiency, assuming rational decision-makers, and the actual level of energy efficiency is called the energy efficiency gap [4].

2. Why Energy Management

Energy conservation means assessing the need for a certain task or using less energy to achieve the same task. The main objective is to effectively manage available energy sources to operate a facility in the most efficient way. There are two aspects of energy conservation:

2.1. Energy Efficiency

This aspect implies using less energy with no sacrifice on the part of the individual or the society. An example would be heating a room to the desired temperature with less energy through improving house insulation, the design of a more efficient heater, a combination of both or some other change that would improve the efficiency of the heating system within the building. This aspect primarily involves issues of economics and technology and requires the proper approach(s) for implementing the available technical aspects within given economic constraints.

2.2. Energy conservation involving user sacrifice

This aspect, on the other hand, implies using less energy if we are willing to make some sacrifices with respect to comfort and/or quality of living standards. An example would be cooling/heating the house with higher/lower room temperature (higher/lower thermostat setting) or hanging laundry in the sun rather than using a dryer. This aspect involves sacrifice, compromise and change in the standards of living.

Measures of energy conservation within acceptable limits of comfort and function could help in solving the energy problem. However, total building performance as an optimal operation of one component/system might not guarantee optimum overall performance, as component/system interaction could increase other costs and/or sacrifice quality function objectives of the organization or facility. Therefore, *"Energy efficiency and/or energy conservation efforts should not be equated with discomfort, nor should they interfere with the primary function of the organization or facility. Energy conservation activities that disrupt or impede the normal functions of workers and/or*

2.3. Processes and adversely affect productivity constitute false economies" [3]

It is important to recognize that energy conservation technical measures alone are not enough.

One might employ the best technology with the most efficient systems but, without proper energy management, these efforts might result in false economies.

Many definitions exist for energy management, all of which agree on the same objective of achieving the same task for less energy use without sacrificing the quality of the environment and/or products through the employment of capital, technology and management skills. Any activity that improves the use of energy falls under the overall definition of energy management which has a wider scope than just conservation [4]. Examples of this include:

- Conserving energy in a facility
- Raising awareness for energy conservation
- Developing strategies for wise energy usage
- Keeping track of energy use in a facility
- Researching and employing technology to conserve energy
- Managing energy supplies and reducing interruptions
- Utilizing new technologies and/or equipment for energy conservation [8]

3. Energy Management and Maintenance Prevention

The purpose of this goal is to reduce the amount of Energy usage and maintenance required by the equipment. The analogy that can be used here is the difference in the maintenance requirements for a car built in 1970 compared to a car built in 2000. The 1970 car was tuned up every 3040,000 miles. The 2000 car is guaranteed for the first 100,000 miles. This change was not brought about by accident. The design engineers carefully studied the maintenance and engineering data, allowing changes to be made in the automobile that reduce the amount of maintenance. The same can be true of equipment in a plant or facility.

3.1. The 9-Pillar Activities

TPM deployment covers implementation of the following eight (8) activities in small and synchronized steps along with these pillars one more pillar can be introduced to the TPM. These steps are designed to steadily graduate people and activities from one level of achievement to the next and gradually modifying traditional ways of working into TPM way. TPM, in this way aims to bring in a cultural change in the organization.

The 9-Pillar activities under TPM are:

Autonomous maintenance (Jishu-Hozen)

- Maintaining basic conditions on shop floor and in machines
- All over participation through over lapping committees
- Selection of Model Machines for autonomous maintenance

Individual (Focused) improvement (Kobetsu Kaizen)

- Loss identification and focused improvement
- Department. Cost-loss Kaizen matrix
- Kaizens: registration and monitoring
- Targets: three year basis; reviewed

Planned maintenance

- Focus on prevention
- Why-why analyses
- Improvement in reliability, maintainability and cost

Quality maintenance

- Eliminating in process defects
- Developing perfect machine for zero defect in products.

Office

- Improving office man-hour efficiency by eliminating non-value added (NVA) activities
- Office oriented for excellent support for manufacturing
- Education and Training
- Skill development for uniformity of work practices
- Skill for zero defects, zero breakdowns, zero accident

Safety, Health and Environment

- To achieve zero accidents, zero health hazard at work
- To maintain clean environment
- Initial Flow Control
- Minimal start up loss for machinery and new product development
- Appropriate design changes

And the 9th Pillar is

Energy Optimization

- Energy Monitoring
- Targeting
- Error Reporting

4. Implementation and Monitoring

All the pillar activities are conducted as per a well-designed plan, through the over lapping committees. While the Pillar Heads execute and monitor the respective pillar functions on a mill wide basis; the HODs are responsible for implementation in the departments. Committees have representation from various areas which facilitates communication and working as a team. Weekly meetings are held by the Pillars and HODs to monitor progress and review the action plans. The steering committee chaired by the President holds the meeting on a monthly basis.

Under the autonomous maintenance (Jishu-Hozen), various machines are selected as 'models' to implement and demonstrate the concepts. A group comprising persons from both production and maintenance departments perform the Jishu-Hozen activities in the following steps:

- Knowledge of machine and safety aspects
- Initial cleaning and inspection
- Identify sources of contamination and eliminate/identify Fuguai (Abnormalities)
- Developing cleaning, inspection and lubrication standards
- General inspection skills training
- Implement improvements to make operation easier
- Collect and analyse various data for improvements Units

5. Reducing Energy Costs through Application of TPM

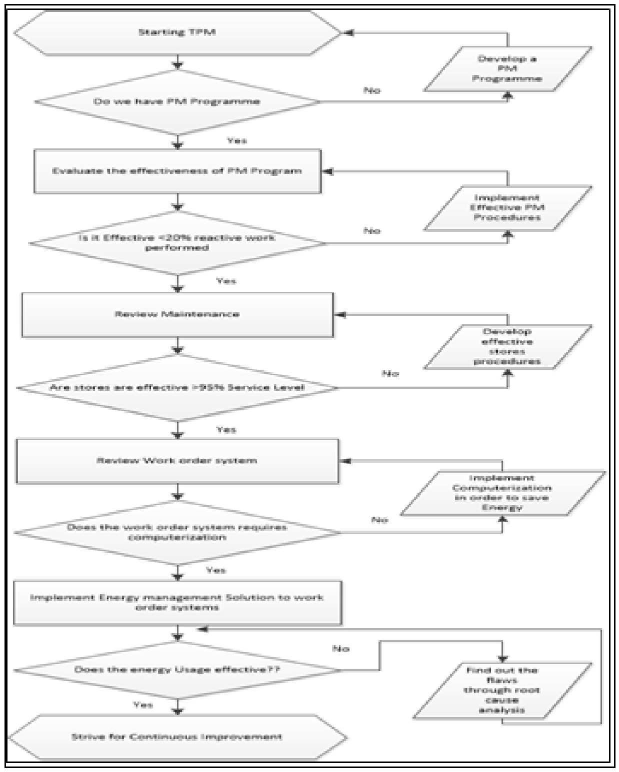

Figure 1: Flow Chart Showing Strives For Continuous Improvement

An activity board at the site displays the status and records of energy consumed by the machine. Step-wise audits are conducted on the model machines to ascertain proper implementation and continual improvement.
One Such Example Display Board Is Shown In Table 1.

ENERGY CONSUMPTION KAIZEN MATRIX	
Sl. No.	
Particulars Machine Name Machine No Power Consumed Per Day Products Produced In KG	
Unit Power Cost	
Production Cost	
Benchmark [2014-2015]	
Loss Compared To Benchmark	
Gains Compared To Benchmark Quality/Amount	
Remarks	

Table 1: Energy Gain-Loss Matrix

5.1. One Point Lesson

A one point lesson is a 5 to 10 minutes learning tool, which normally take less than 15 minutes to write. It is a lesson on a single topic/point, on one sheet of paper. It normally consists of 80% diagram and 20% may be produced by hands or graphics. It is generally prepared by Supervisors or group leaders and sometimes by operators.

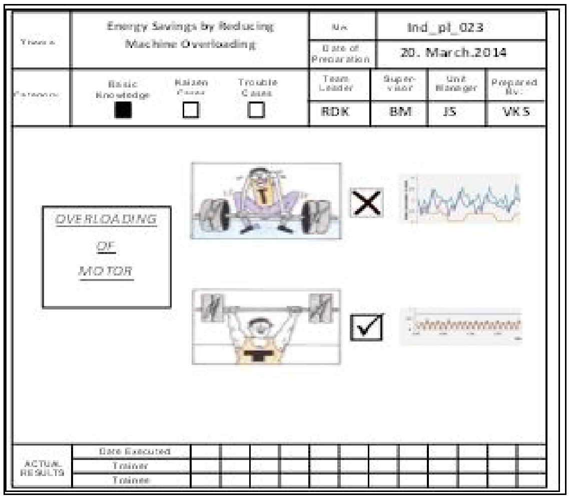

Figure 2: One point lesson example

5.2. Improvement Strategies and Productive Systems

The improvement strategies of TQM and TPEM can be considered as catalysis to a productive system that is producing a product or service. A Productive system can be considered to have a process that converts a set of inputs into a set of outputs. The performance of the productive system can be characterized with productivity, quality, cost, delivery etc. [8]. This is explained in the figure 3.

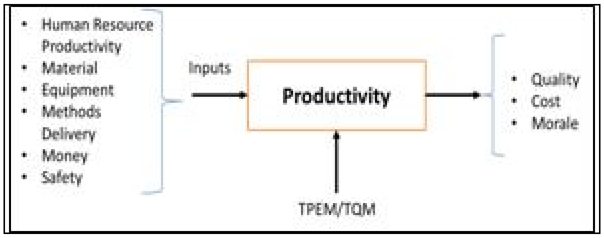

Figure 3: Productive systems Input and Output Factors

In any productive system the level of Output is measured by the following factors
Productivity (P), Cost(C), Quality (Q), Delivery (D), Safety(S), Employee Morale (M)

6. Data Collection and Analysis

Compared to the potential volume of data that many energy information systems can generate, the volume required to support defined TPeMs can easily be an order of magnitude less. This is not to say that energy information systems should never collect detailed data at all; it is more accurate to say that such an information system should be designed to capture just the right amount of detailed data required to accomplish the primary goals of the system.

7. M&T Tasks and Elements

The energy used by any business varies with production processes, volumes and input. In the M&T system the level of energy use is compared to key performance indicators, which enables the company to evaluate the energy efficiency of their own processes, compared to standard values. The M&T Typical tasks are:

- Measuring energy consumption over time
- Relating energy consumption to drivers
- Setting targets for reduced consumption
- Frequent comparison of consumption with Targets
- Reporting variances
- Taking action to correct Variances

To sum up, monitoring and targeting system allows a company to control the following criteria: Checking the accuracy of energy invoices, allocating energy cost to specific departments, determining energy performance, recording energy use in order to improve the energy efficiency and finally detect performance problems in equipment or systems by using less popular but very effective technique called CUSUM analysis [10].

8. Gains through TPEM

Within three years, the company could affect the following reductions through various energy conservation efforts under TPM.

- Electrical Energy 13.3 %
- Water 17.64 %
- Co2 Reduction 5%

The approach for energy conservation included:

- Improvement in capacity utilization
- Optimization of voltage
- Optimization of frequency
- Optimization of operating procedures
- Installation of Variable Frequency Drives (VFDS)
- Adoption of energy efficient lighting[LMS]
- Technology upgrading
- Assessment and monitoring

The energy consumption trends in Figure 4 show that power consumption has decreased due to various conservation schemes implemented.

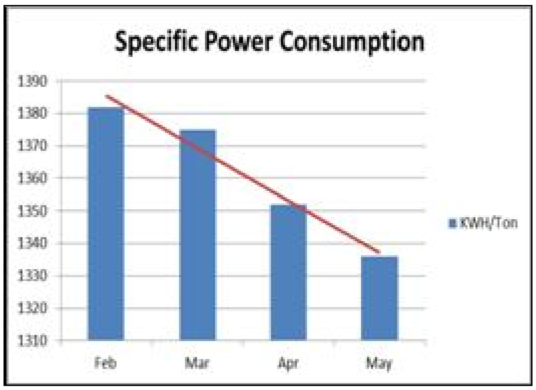

Figure 4: Power Consumption from Feb'14 to May'14

Besides the installation of Variable Frequency Drives (VFDS) and optimization of voltage, the following areas were identified for corrective measures:

- Provision of load transfer from grid to turbine without interruption to utilize sources
- Prevent idle running of equipment by Interlocking of pumps and agitators Switch off equipment through timers
- Delta star for lightly loaded motors
- Neutral compensation for unbalance loads
- Light emitting diodes (LEDS) for indicating lights
- Use of energy savers for lighting circuits
- Use of photo cells for street lights
- Splitting of circuits for better control

9. Advantages and Barriers of TPEM

The major advantages of implementing Total Productive Energy Maintenance in an Organization are:

- Productivity Improvement - Productivity is improved through fewer losses in the company
- Quality Improvement - Quality is improved as a result , that the failures and malfunctions is reduced
- Cost Reduction - The cost is reduced because the losses and other not value added work is reduced
- Employee Ownership - Ownership of equipment by operators through Autonomous Maintenance
- Employee Confidence - "Zero failure", "zero defect" and "zero accident" conditions builds employee self-confidence
- Improved working environment - Clean working conditions provides a good working environment
- Increased Plant Reliability

As there are more advantages in this technique there are few barriers too. They are:

- Breakdown losses
- Setup and adjustment losses
- Idling and minor stoppage losses
- Speed losses
- Quality defects and rework losses

10. Conclusion

TPeM offers a systematic approach to enhance plant efficiency, involving persons from all disciplines. Significant gains have been reported by organizations that have adopted TPM. The system encompasses the concepts ISO-9001,

ISOI4001, and OHSAS etc.; with a greater degree of involvement and ownership, and is easily adaptable. The company where we implemented this concept has greatly benefited in terms of overall plant efficiency, housekeeping and employee morale.

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