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Effect of TQM on the Maintenance of Pulverizer and Raw Coal Feeder in a Coal Based Thermal Power Plant

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ABSTRACT

Recognising quality to be a key focus for competitiveness, Total Quality Management (TQM) was established and used as a new philosophy for managing organisations. There is an increasing focus on quality throughout the world. Power Industry is the basic need for a sound economy. During past two decades large Thermal power Stations in different part of country have come up, to meet ever increasing demand of the electrical energy. India has fairly large low grade coal and it has been rightly accepted in principle that thermal generation should be so planned and designed to use this non-renewable resource properly. In pulverized fired furnaces, the finer the grind of the coal the greater will be the flame stability. Therefore working conditions of raw coal feeder and pulverizers should be maintained in perfect order. In achieving this purpose, maintenance department plays a crucial role. Regular maintenance is required to keep the RC Feeder and pulveriser working in order to reduce sudden breakdowns and outages and to reduce rejection rate of coal. In this paper a case study has been discussed carried out at a coal based thermal power plant focussing on the maintenance of the RC Feeder and pulveriser.

Keywords: quality, thermal power stations, pulverisers, raw coal feeder

I. INTRODUCTION

To survive and compete in the rapidly changing business environment many organisations around the world have been forced to employ new philosophies to improve their organisational performance. Many of these philosophies have total quality management (TQM) at their core. Definition of quality by Crosby [1] was given as “conformance to requirement”. Ishikawa[2] stated that “To practise quality control is to develop, design, produce and service a quality product that is always economical, most useful and always satisfactory to the customer.” Deming[3] pointed out that only 15 percent of quality problems are actually due to worker error. The remaining 85 percent are caused by processes and systems, including poor management. Ross[4] further elaborated, that Total quality management is based on a number of ideas. It means thinking about quality in terms of all functions of the enterprise and is a start-to-finish process that integrates interrelated functions at all levels. It is a systematic approach that considers every interaction between the various elements of the organization. Moreover, total quality management is integration of all functions and processes within organization in order to achieve continuous improvement.

Although there is much evidence in the literature of research being carried out in established economies, it is evident that there is a limited amount of research being undertaken concerning TQM in developing countries. Gosen et al. [5] stated that: “A number of gaps are identified in the literature on quality management in developing countries along with significant challenges including differing perceptions of quality”.

Reviewing the literature published by C. D. Goswami et. al. [6], it could be seen that presently India is facing serious challenges of energy security threat due to short fall of peak power supply by 16.6%. The coal based thermal power plant has been focused as major source of commercial energy. India has historically failed to meet its power sector targets by a significant margin and with tremendous opportunities ahead; the power sector continues to be affected by the shortfall both on generation as well as transmission side. Terziovski [7] examined the impact of Operations and Maintenance (O&M) practices, on power plant performance. His study showed that the relationship between O&M practices and plant performance is significant and positive in a cross-sectional sense. Both people-oriented “soft” as well technically-oriented as “hard” practices were found to be positive and significant predictors of plant performance. The findings also highlighted the impact of maintenance practices on plant performance compared to other practices such as long-term planning, customer focus, knowledge management, and employee involvement. Based on the study it was concluded that Total Quality Management (TQM) and maintenance philosophies are sources of sustainable competitive advantage in the power generation sector.

II. FACTORS CONSIDERED IN THE STUDY

It is acknowledged that there will always be debates about what factors to be included into any practices framework. In the context of power plant operations, information gathered from the literature review it has been found that practices relating to total quality and maintenance management are actively implemented in most plants.

The factors are: committed leadership, employee involvement, customer focus, strategic planning, knowledge management, and TPM-orientation. This work aims to validate these factors and determine the relationships between these factors and plant performance. Figure 1 shows the Maintenance Practice framework (Source: Terziovski).

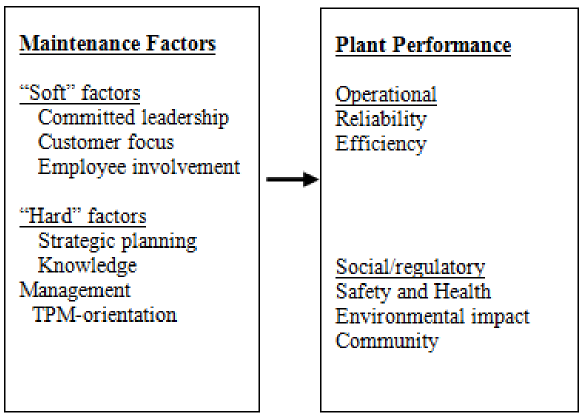

Figure. 1 Maintenance Practice Framework (Source: Terziovski)

III. COAL BASED THERMAL POWER PLANT: A CASE STUDY

3.1 Introduction

ABC TPP has a total installed generation capacity of 1360 MW comprising of four Units of 110 MW each, two Units of 210 MW each and two Units of 250 MW each. The coal pulverizing plant of a unit of 110 MW plant was selected for the case study.

3.2 Coal Pulverizing Plant

3.2.1 Introduction

Of the commercial fuels – coal, heavy furnace oil and light diesel oil, coal is the basic fuel used in the boiler, where the study has been conducted, for power generation due to its distribution and availability.

Indian bituminous coal specifications:
Moisture – 5 - 30%
Ash – 1 - 60%
Volatile – 12 - 40%
Abrasion Index – 60 - 125Mg/Kg
HGI – 45 - 110

Most efficient way of utilizing coal for steam generation is to burn it in pulverized form. Pulverized coal fire firing is a method whereby the crushed coal generally reduced to fineness such that 70 – 80% passes through a 200 Mesh sieve is carried forward by air through pipes directly to burners or storage bins from where it is passed to burners and discharged into combustion chamber. The mixture of coal and air ignites and burns in suspension condition. For pulverizing the coal equipments and systems would be required with high availability.

The main equipments in a pulverizing plant are:

1. Pulverizers (Coal Mills)
2. Raw Coal Feeders

3.2.2 Pulverizer

XRP623 (18 TPH) Bowl Mill type pulverizers have been installed in the units of the plant where the study has been conducted. Bowl mill is a medium speed mill having 30 – 120 rpm, with no metal to metal contact between grinding elements.

Factors affecting the Milling Plant Performance

1. Grindabilty of Coal

It is the measure of the ease with which coal can be pulverized. The coal available at plant has HGI varying between 45 HGI – 60 HGI (Hard Grove Grindability Index). Higher the HGI easier is the coal pulverization.

2. Moisture Content

The total moisture content of the raw coal is made of inherent and free or surface moisture. The drying of moisture is carried out by PA fans. The mill capacity decreases with the increase in moisture. The hot air temperature should lie between 75 ^{0}C – 85 ^{0}C

3. Fineness of Milled Product

The mills are designed for bituminous coals and normally for this type of coal to give optimum efficiency a fineness of 70% through 200 mesh is desired. This mill and classifier is designed to produce this fineness. The mill fineness and output both are interdependent.

4. Size of Coal Input

Larger the size of coal input to the mill more is the amount of work per unit is increased to get the same fineness. The desired size of coal lies between 25 mm – 50 mm.

5. Mill Wear

Mill wear is caused due to grinding action and abrasive nature of coal. It depends mainly on the gap between bowl surface and grinding rollers and quality of coal. The gap between bowl surface and grinding rollers is maintained 3mm.

6. Calorific Value and Rejectable Material Content of the Coal

The plant is designed for coal having calorific value of 4800 KCal/Kg. But in India coals have calorific value range between 3200 – 3600 Kcal/Kg. So this is the major factor which affects the performance of the coal mill. The rejectable materials consist of stones, iron bars, broken hammers etc. these materials causes damage of mill parts, vibrations, coal spillage and mill outages.

Major Problem Areas of Mills Observed During Study:

1. Abnormal noise/ vibrations in mill
2. High mill coal spillage
3. Low pulverized fuel fineness
4. Mill fire
5. Low capacity of mill

3.2.3 Raw Coal Feeders

The purpose of a RC feeder in the coal pulverizing circuit is to feed the raw coal from the bunker into the pulverizer in controlled and varied quantities corresponding to the boiler load demand. Volumetric Coal Feeder is used in this plant.

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Major problem areas of R C Feeders observed during study:

1. **Over Feeding**
2. **Poor Rangeability**
3. **Feeder Fire**
4. **Contamination of Variator Oil**

3.3 Fault Message Conveying Procedure

In this procedure the information of failure or improper working of equipments and machineries is conveyed to the authorities and technical personnel so that the problem is fixed as soon as possible. This is the procedure in which C & I department, operation department and maintenance department work together to convey the fault message efficiently. In this procedure the communication among all the departments and their personnel plays crucial role. Here the soft issues of TQM i.e. communication, decision making, leadership etc. are the core factors which affect the working immensely.

The process of conveying message is carried out as below:

- If any fault occurs in any machine or equipment the operator in control room informs to the AE (Control room) and shut down the machine temporarily. AE (Control room) sends the complaint either in written form or via phone call to Site Incharge (Maint. Deptt.).
- The Site Incharge/ Technician (Maint. Deptt.) goes to the site and check the problem physically. According to the condition of fault he takes Permit to Work. If the fault is minor he takes Live Permit to Work (PTW) and if the fault is complicated then he has to take Dead Permit to Work (PTW).
- In Live PTW the technician fixes the problem along with workers and helpers under the supervision of JE (Maint. Deptt.) and in Dead PTW the AE (Maint. Deptt.) is informed and the machine is kept shutdown until the fault has been removed.

- In Dead PTW the AE (Maint. Deptt.) informs the XEN (Maint. Deptt.) and SE (Maint. Deptt.) is informed about the fault only if there is major breakdown and further actions are taken to fix the problem efficiently as soon as possible.

3.4 Total Preventive Maintenance

Total preventive maintenance has been implemented in the plant to minimize the chances of sudden breakdowns and outages. Some of the schedules of TPM have been given below:

Daily Checks Carried Out on RC Feeder and Seal Air Fan:

a) Physical condition of the feeders and seal air fan is checked for any abnormality.
b) Lubricating oil level of variators & gear box is checked and oil is topped up to normal, if level is low
c) Oil/coal/air leakage is checked daily
d) RC Feeder flap movement is changed daily according to the quantity of coal to be fed
e) Seal air is checked daily and maintained at proper pressure

Daily Checks Carried Out on Coal Mills:

a) Physical condition of the feeders and seal air fan is checked for any abnormality
b) Oil level in main oil bath chamber & journal assembly is checked out & topped up if required
c) Oil bath temperature is checked daily on hourly basis
d) Oil & coal leakage is checked on daily basis
e) Proper flow of cooling water & lube oil is checked daily

Table1 shows schedule of TPM of Coal Mills and RC Feeders

Sr. No.	**Description of the equipment / sub - equipment**	**Schedule of Preventive Maintenance**	**Period of Preventive maintenance**	**Estimated time required**
1	Coal Mills	Roller & spring setting and oil level checking of roller assembly	After 8-10 days	One hour
2	Coal Mills	Servicing of mechanical face seal assembly	After 8 months	50 hrs
3	Coal Mills	Checking of wearing of worm gear and worm shaft teeth	During O/H of unit	One day
4	Coal Mills	Replacement of grinding rolls	After 1300-1500 running hrs	18 – 20 hrs
5	Coal Mills	Replacement of Bull ring segments	After 2600-running 2800 hrs	20 – 24 hrs
6	Coal Mills	Replacement of worn out separator body spares such as inner core, MDV etc.	During O/H of units	4 – 5 days
7	RC Feeder	RC Feeder O/H	During O/H of units	2 – 3 days
8	RC Feeder	Servicing of RC Feeder	During changing grinding rolls and bull ring segments	5 – 6 hrs

Since Preventive maintenance is carried out in the plant then also the plant has to face sudden breakdowns of coal mills. Some major reasons of breakdown observed during study are:

a) Ingress/ Foreign Materials such as Railway hooks, roller pins, broken hammers, iron bars, stones etc. These ingress materials damage roller assembly, roller spring, shaft assembly, main vertical shaft, worm shaft, mechanical seal failure and major cause of outage of mills.

b) Jamming of Roller Assembly

Due to failure of mechanical seal the coal powder mixes with the lube oil and form a greasy mud type substance called sludge. After approx. 15 – 20 running hrs the sludge starts damaging the bearings of roller assembly and ultimately leads to the jamming of roller assembly.

c) Choking of Mills

This problem is caused either due to jamming of roller assembly or due to free movement of RC feeder flapper.

3.5.Coal Rejection from Coal mill

Huge coal rejection is the major problem occurred in the coal mill. It directly affects the cost of production. Rejection of coal from coal mills mainly depends on:

1. Quality of coal (Mills are designed to grind coal having GCV = 4800 Kcal/Kg)
2. Primary air header pressure (Should be 25 – 28 T/hr)
3. Mill outlet temperature (Should not exceed 95^{0}C in any case)
4. Mill and RC Feeder maintenance

3.6 System Improvement

System improvement is required to increase the performance of the plant, increase the life of equipments and to reduce the maintenance cost. Some of the improvements have been presented in this study.

3.6.1 Minor Improvements

1. Mechanical face seal provided on all the mills with conventional gear box.
2. Stand by pump & motor, cooler & filter provided in lube oil system.
3. Ceramic lined inner cones (lining on both sides) and venturi outlets provided for longer life.

	Conventional Grinding Rolls	**HPMS**
Material	Ni Hard Grinding Rolls	Centrifugally Cast Inserted Carbide Grinding Rolls
Running hours	1300 hrs	5000 hrs
Roller and Spring setting	After 8 – 10 days	After 18 – 20 days
Maintenance Breakdown Time	More	Less
Mill Current	More (21 – 24 Amp.)	Less (15 – 18 Amp.)
Wear Rate (Grinding Rolls)	40 mm (In 1300 running hrs.)	70 mm (In 5000 running hrs.)
Wear Rate (Bull Ring Segments)	25 mm (In 2600 running hrs.)	45 mm (In 5000 running hrs.)

4. Tall top classifier provided for better classification.
5. Ni-Hard lines are provided on wear prone parts.

6. Mills are located between boiler and ESP instead of boiler and turbine bay for better maintenance.
7. Pneumatic reject handling system provided in place of belt conveyor.

The above all improvements were to improve the working, performance and reducing maintenance cost of conventional bowl mills. But then also high maintenance cost, huge coal rejection, inefficient performance of coal mill and boiler are often observed. So to reduce these problems some major improvements have been carried out in this plant. Two of them have been discussed in this study.

3.6.2 High Performance Milling System (HPMS)

Conventional Bowl mills have Ni-Hard grinding rolls and matching Bull ring segments which get worn out in very short time and require regular maintenance. So to increase the life of Coal mills and to reduce the maintenance cost the conventional grinding rolls were replaced by High Performance Milling System.

HPMS system consists of Hi-Chromium Insert type Grinding Roll Mills with matching Bull Ring Segments. This system has improved the grinding elements life. Introduction of HPMS has led to uniform mill output, lesser maintenance cost, less coal rejection and has increased life of coal mill significantly.

The HPMS system was installed and commissioned in coal mills in 2009 in this unit. There are six coal mills present in this unit. Significant improvement in outage of mills and guaranteed life of grinding equipment, achieved during six month period.

Table.2 shows comparison between Conventional Grinding Rolls and HPMS:

Table.3 shows Coal Mill Outage Hours before and after installation of HPMS.

Coal Mill Outage Hours		
Coal Mill	Before HPMS	After HPMS
Coal Mill A	82.26	20.10
Coal Mill B	71.58	11.11
Coal Mill C	64.28	20.34
Coal Mill D	59.37	21.24
Coal Mill E	61.54	19.36

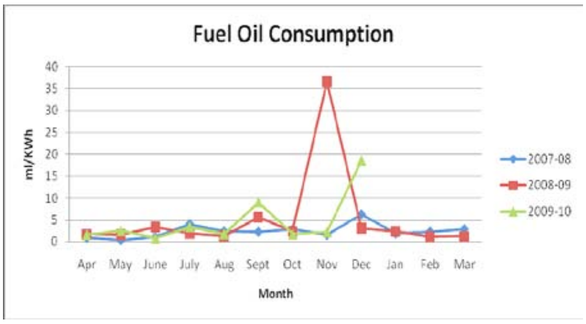
Table.4 shows comparison between parameters such as Auxiliary Consumption, Specific Oil Consumption and Specific Coal Consumption before and after installation of HPMS.

Parameters	Six Months before installation of HPMS system	Six Months after installation of HPMS system
Aux. Consumption (%)	11.60	11.46
Sp. Oil Consumption (ml/kWh)	2.73	1.93
Sp. Coal Consumption (gm/kWh)	878	870

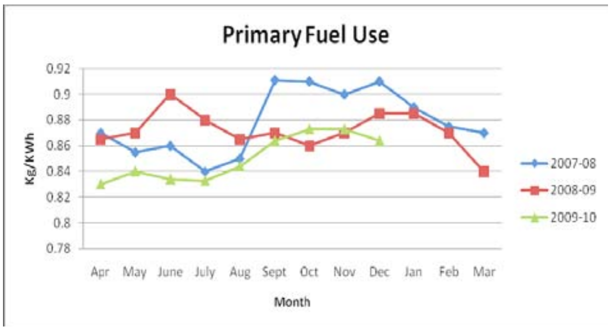
3.7 Performance of the Plant

The performance of the plant is greatly affected by both hard and soft factors directly or indirectly. Role of staff, working condition of machines and equipment, maintenance of machines, quality of fuel, system improvement etc. all these factors have major effect on the performance of the plant. By following the TQM the plant has shown huge growth. Historical operation data was taken and graphs have been plotted so as to have a better look and understanding of the performance of the plant shown in previous years.

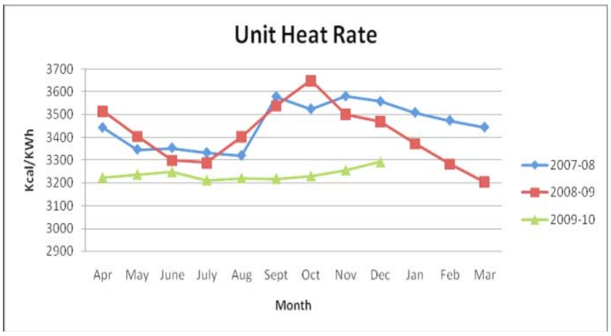
1. Fuel Oil Consumption



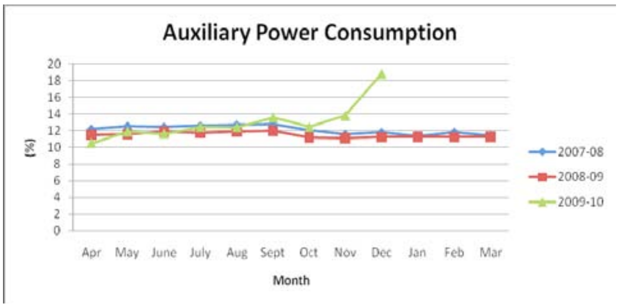
2. Primary Fuel Used



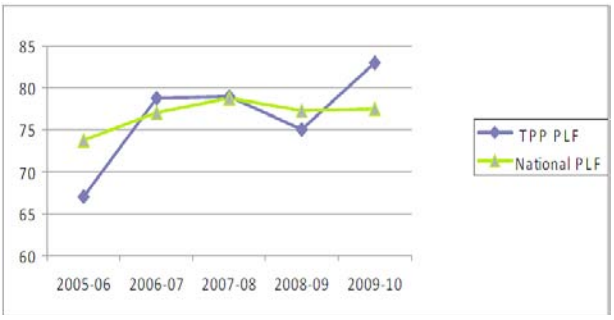
3. **Unit Heat Rate**



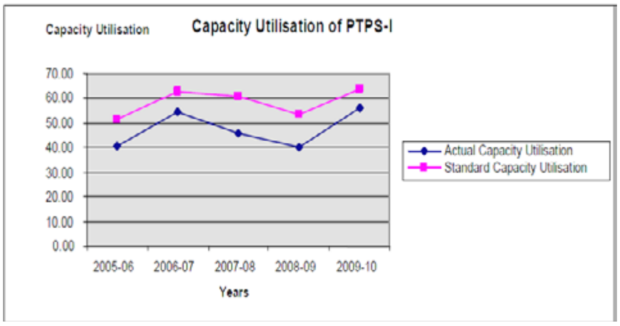
4. **Auxiliary Power Consumption**



5. **Plant Load Factor**



6. **Capacity Utilisation**



IV. CONCLUSION

A case study was conducted in a Thermal Power Plant to know how maintenance practices are carried out along with management methods. The main findings of this study is that effective maintenance of power plants needs to comprise of both 'soft' and 'hard' practices in order to achieve competitive advantage in deregulated power generation sector.

Committed leadership and maintenance oriented towards TPM are the major factors affecting the performance of plants. Continuous improvement should be carried out so as to keep upgrading the TPP. It can also be concluded that in addition to quality practices, which tend towards developing the people aspect of the organisation, the technical aspect of plant equipment and physical assets should be given equal emphasis.

V. DELIMITATIONS

In this paper whole plant couldn't be considered so management & maintenance practices of only Coal mills were studied. Moreover a single plant was visited so the information from these visits will only be used as inspirational source to collect ideas and inputs regarding maintenance practices carried out in TPP. An important issue to consider in maintenance work is the handling and coordination of spare parts. Due to an ongoing project, aiming to centralizing the spare part inventory, this management issue was not covered in this thesis.

VI. FUTURE SCOPE OF THE STUDY

The study carried out in this paper presents the macro view on TQM and maintenance methods. So it is recommended that micro case studies should be carried out on different issues of TQM and maintenance methods. TQM along with maintenance practices and techniques such as TPM helps a lot in improving the performance of power plants but other approaches such as six sigma, benchmarking, lean manufacturing etc can be implemented in TPPs

REFERENCES

[1] Gosen, J., Babbar, S., and Prasad, S. (2005), "Quality and developing countries: the role of international and organizational factors", International Journal of Quality & Reliability Management, Vol. 22, No. 5, P. 452-464.

[2] Goswami C. D., Sarkar K., Chakravarty R.S, Saxena A. K. (2006), "Role of power plant performance optimization in particularly in achieving energy security for India". Technical papers, Mecon Limited.

[3] Crosby, P. (1979) "Quality is Free", McGraw-Hill, New York.

[4] Ishikawa, Kaoru (1985), "What is Total Quality Control? The Japanese Way" New Jersey: Prentice Hall. ISBN 0-13-952433-9.

[5] Deming, W. Edwards (1986), "Out of Crisis" Published by MIT, Center for Advanced Engineering Study, Cambridge, MA 02139.

[6] Ross, J.E. (2000), "Total Quality Management", Allama Iqbal Open University. Islamabad. P.3.
[7] Terziovski M. (2008), "Operation and Maintenance Practices and their Impact on Power Plant Performance", Journal of Academy of Management, Submission no. 11129.
[8] Chaudhary R., "Pulverisers and Feeders", NTPC