PLANT OPERATIONS AND PRODUCTIVITY ENHANCEMENT
A CASE STUDY

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ABSTRACT

The most advanced cement manufacturing technology does not, on its own, guarantee profitable operations. The cement manufacturing operation for maximum cost efficiency not only requires the advanced technological design but also sound operational practices.

Operational Audit is an effective way for enhancing the productivity and minimising energy consumption. The objectives of a comprehensive operational audit of a plant should include:

- Optimisation of the output
- Reduction in Specific Energy Consumption
- Trouble shooting in electrical, mechanical and process systems
- Dust abatement
- Quality assurance

This paper describes with the help of a case study, a typical methodology adopted for such an audit and the various measures suggested for optimising the operations and improving the productivity of a cement plant. The studies have identified the potentials for increasing production & reduction in energy consumption and in planning their investment priorities for their plants modernisation.

1. INTRODUCTION

In the present scenario, it has become imperative for Cement Manufacturers to look for cost reduction avenues to reduce cost and improve productivity effectively. Energy contributes almost 40% of cost of production and hence energy conservation assumes greater importance as one of the best way for improving productivity. Plant operational audit studies are an effective tool to identify the areas of energy conservation and plant optimisation.

The most important of these areas are process control and process optimisation. Other potential areas could include dust emission reduction, preventive maintenance etc. In this paper, authors have specifically dealt with process optimisation for enhancement of plant productivity and savings in energy consumption through Plant Operational Audit.

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2. OPERATIONAL AUDIT

In simple terminology ‘Operational Audit’ can be defined as “A systematic approach to examine the effectiveness of facilities and efficiency of the operations”. The approach can be broadly classified in following steps:

- Compilation of historical data
- Identification of bottlenecks and constraints
- Study and Analysis
- Recommendations
- Implementation of suggested measures

The methodology for Plant Operational Audit is shown in Figure 1.

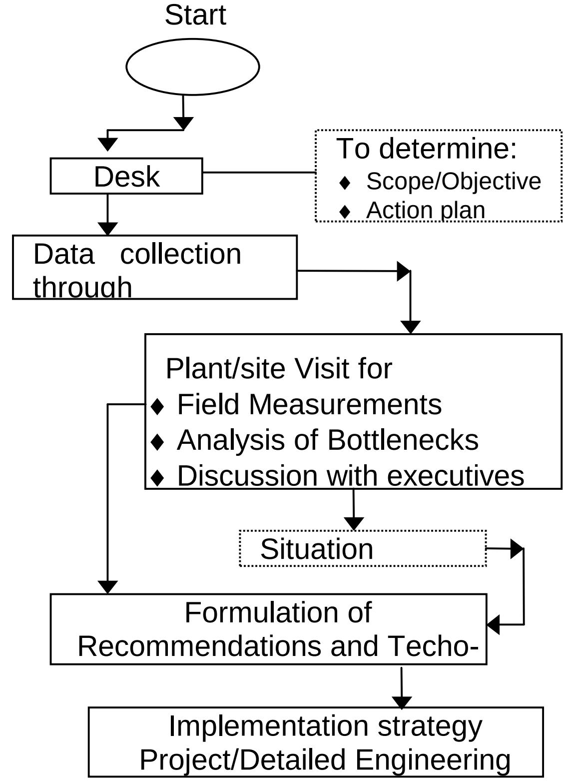

Figure 1

The purpose of Plant Operational Audit is manifold. It includes :

– To formulate strategies for increasing production and minimising the energy consumption which results in increased profitability.
– To create awareness towards the adoption of new technology.
– To develop a positive attitude towards energy conservation.
– To inculcate the habit of regular audit of operations to identify areas for improvements.

3. CASE STUDY

Holtec has recently carried out Operational Audit in a cement plant having a kiln of 2,000 t/d clinker capacity with Precalciner system, with a view to:

- Study the plant operations
- Assess the present systems energy utilisation effectiveness and identify the areas and causes for high energy consumption and
- Suggest measures for increasing the production and reducing the energy consumption.

<u>Plant Details :</u>

Plant capacity	:	0.66 mio t clinker per annum
Lime stone crusher	:	650 t/h, Hammer crusher, 1000 kW
Raw Mill	:	170 t/h, VRM, 1700 kW
Kiln	:	2000 t/d, Five stage Preheater, In line calciner, Conventional grate cooler

Coal Mill	:	25 t/h, Vertical roller mill, 355 kW
Cement Mill	:	120 t/h Ball mill, 2,800 kW + Roller Press, 500 kW

3.1 Diagnosis

The plant operation was studied in detail during the plant visit. Prior to the plant visit a comprehensive questionnaire was developed for collection of relevant data and information. Details of plant machinery and operational data to the extent possible were collected through this questionnaire prior to the visit to ensure proper desk study. The audit team comprising of Process, Mechanical, Electrical and Instrumentation specialists had extensive discussions with plant executives and collected additional relevant information on operational bottlenecks, parameters and energy consumption pattern. During the study various measurements of process parameters, energy and dust concentration, etc. were taken in raw mill, clinkerisation, coal mill and cement mill sections. Heat, Gas and Mass balance of pyro-processing sections were carried out with ultimate objectives of identifying the potential areas for production optimisation as well as energy savings.

To study the existing level of energy consumption and operational bottlenecks, process measurements were carried out when system was operating at stabilised production level. The process measurements and heat consumption details before and after optimisation are given at Figures 2 and 3 respectively.

After analysing the system bottlenecks, following recommendations were made to achieve higher output and energy savings. The recommendations are divided into two categories

- Without Investment i.e. Operational Improvements
- With Investment i.e. Technological Upgradations

3.2 Observations and recommendations (without investment)

Observations	Recommendations
♦ Variation in the dam ring height of VRM for raw material grinding.	♦ Maintain dam ring height about 85 mm uniformly across the table periphery.
♦ Raw mill feed sieving on 90 mm shows the residue upto 19.5%.	♦ Maintain the feed size to the mill maximum 90 mm by replacing the blow bars of the crusher.
♦ The leakage from raw mill outlet to ESP inlet is about 30%.	♦ Reduce the leakage to about 20% by arresting the false air points, resulting in power saving of ESP fan.
♦ Higher quantity of the coal transport air to kiln and PC firing.	♦ Quantity of the coal transport air was reduced in phases.
♦ Indication of the fuel rate from fuel firing system are not correct.	♦ Calibrate the fuel rate from fuel firing system to indicate the correct quantity of fuel consumption.
♦ Flap in the material discharge pipe of cyclone-5 was not present.	♦ A flap to be installed.

Observations	Recommendations
♦ Position of the damper for material diversion from cyclone-4 bottom to PC varies from 50-90%. Kiln operational upsets are observed due to the two fractions of material of different degree of calcination entering the kiln.	♦ Maintain the damper opening as 90-100% during normal kiln operation.
♦ Kiln inlet and PH outlet O_2 content are about 4.0% and 7.7% respectively, which is high.	♦ Reduce the O_2 content to 2-2.5% and 4-4.5% at kiln inlet and PH outlet respectively by sealing the false air infiltration points. Reduction in false air results in saving of PH fan power.
♦ High clinker temperature at cooler discharge i.e. 175-225°C and high cooler vent air temperature i.e.400-500 °C. ♦ Aeration openings of some grate plates were of diameter 5 mm as compared to the design value of 11 mm. ♦ Vertical gap between plates of two consecutive rows of 10-15 mm observed. ♦ Few clinker discharge hopper flaps are not operating.	♦ Water spray system to be installed at the middle of the second grate of the cooler. ♦ Aeration openings of all grate plates shall be according to the design value. ♦ Seal the vertical gaps by welding S.S strips and rods. ♦ Repair the damaged clinker discharge hopper flaps and make operative.

By implementing the above recommendations, the following improvements were envisaged:

Increase in output	=	20.00 %
Reduction in Thermal Energy	=	5.00 %
Reduction in Electrical Energy	=	14.00 %

3.3 Recommendations : With investment

- ♦ Replacement of the existing open dynamic separator in VRM with a new generation high efficiency separator.
- ♦ Incorporation of mechanical conveying for raw meal transport to silo to save electrical energy.
- ♦ Incorporation of mechanical conveying for kiln feed transport to Preheater to save electrical and thermal energy.
- ♦ Incorporation of dip tube in lower most cyclone to save thermal energy.
- ♦ Modification in cooler 1st grate with new generation static plates to increase production and save thermal energy.
- ♦ Cooler vent air duct needs to be repaired or replaced, as the same is extensive damaged and large holes were seen.

The details of heat balance carried out at the base temperature of ‘0’ °C before and after optimisation are given in Table 1:

Sn	Stream	Kcal/kg clinker	
		Before optmisation	After optimisation
1	Sensible heat of kiln feed	25.61	25.29
2	Sensible heat of kiln feed moisture	0.32	0.32
3	Sensible heat of fuel (coal)	3.39	3.22
4	Sensible heat of primary air to kiln	0.45	0.40
5	Sensible heat of cooler air	20.05	21.59
6	Sensible heat of false air in cooler	1.94	1.18
7	Sensible heat of false air in PH	1.63	1.55
8	Fuel transport air (Kiln + PC)	0.81	0.65
9	Kiln feed transport air	1.77	1.77
10	Sensible heat of water spray in cooler	-	0.56
11	Calorific value input from fuel firing	779.00	738.87
Total Heat Input		**834.96**	**795.39**
Heat Output			
1	Sensible heat of clinker	34.20	28.31
2	Sensible heat of PH exhaust gas	147.03	144.48
3	Sensible heat of dust	7.30	7.18
4	Cooler exhaust air fan	190.23	149.20
5	Heat of formation for clinker	398.99	396.35
6	Evaporation of moisture in kiln feed	3.04	3.03
7	Evaporation of water in cooler	0	14.21
8	Preheater and precalciner radiation	15.22	14.90
9	Kiln radiation loss	25.30	23.76
10	TAD, cooler and hood radiation losses	13.65	13.98
Total Heat Output		**834.96**	**795.39**

Table 1 : Details of heat balance

Performance indicators before and after implementation of the recommended improvement measures in plant operational audit, are given in Table 2:

Performance Indicators		Before optimisation	After optimisation
Thermal energy, Kcal/ kg clinker	:	834.96	795.39
Electrical energy, kWh/ t OPC	:	108.54	94.98

Table 2: Performance indicators before and after optimisation

4. CONCLUSIONS

In the product like cement which is primarily a low value product, with high incidence of taxes and duties, high energy costs, the avenues available to a plant for reducing its costs are limited. In the present environment due to energy crisis and steep increase in the cost of energy and other input materials, it has become imperative to give serious thought on how to make operations and equipment efficient towards use of energy and adoption of latest technology equipment to retain the requisite competitive edge in the market.

Based on the several studies in the field of operational audit, it has been observed and proven that production level can be improved and energy consumption can be reduced by:

- Doing continuous process diagnostics investigations / monitoring,
- Process optimisation,
- Maintaining the preheater and precalciner strings, dedusting system, ducting and
- Providing quality utility services in terms of compressed air quality, water quality, etc.

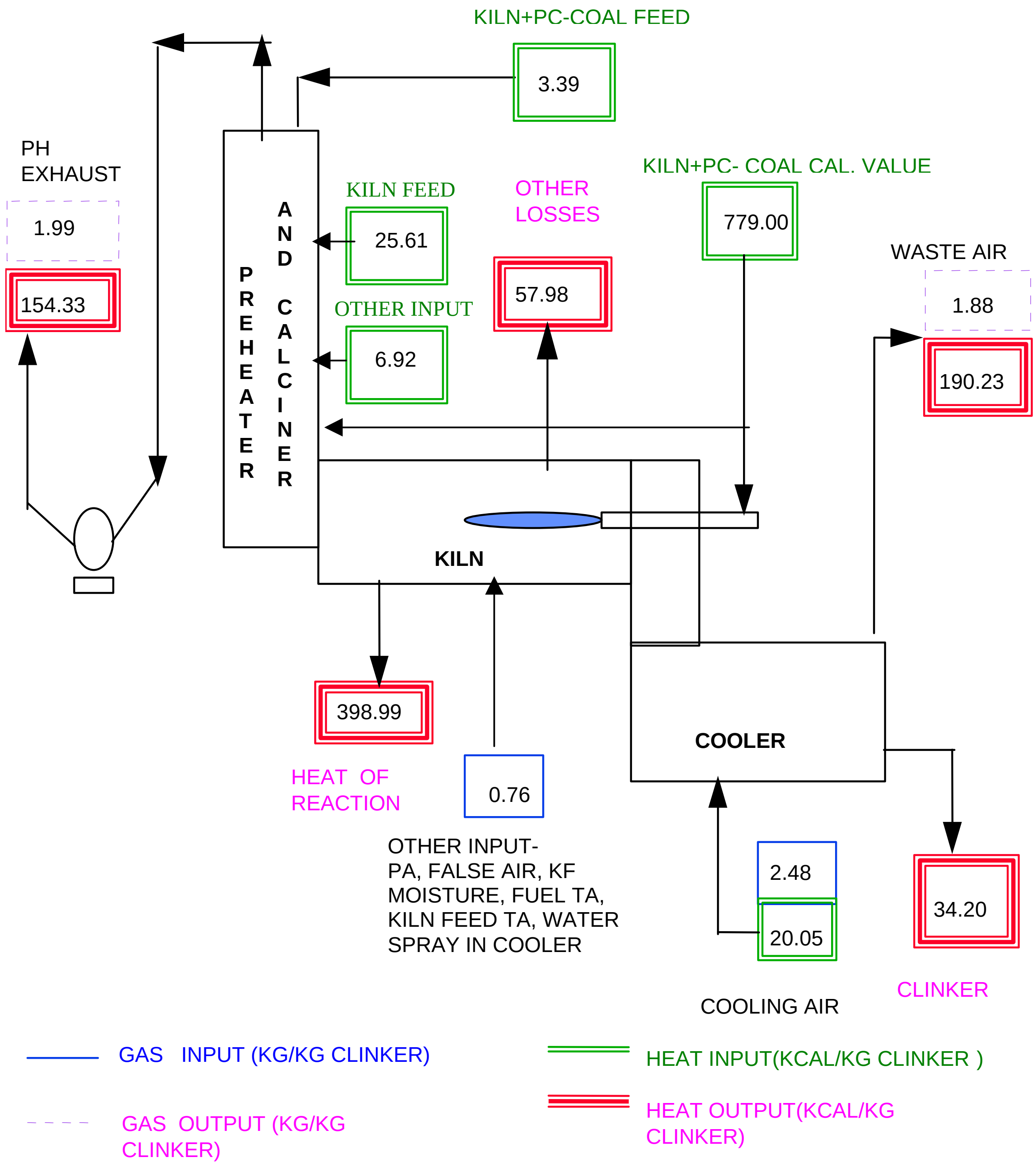

Figure 2: Process Measurements and Mass, Gas & Heat Balance- Before optimisation

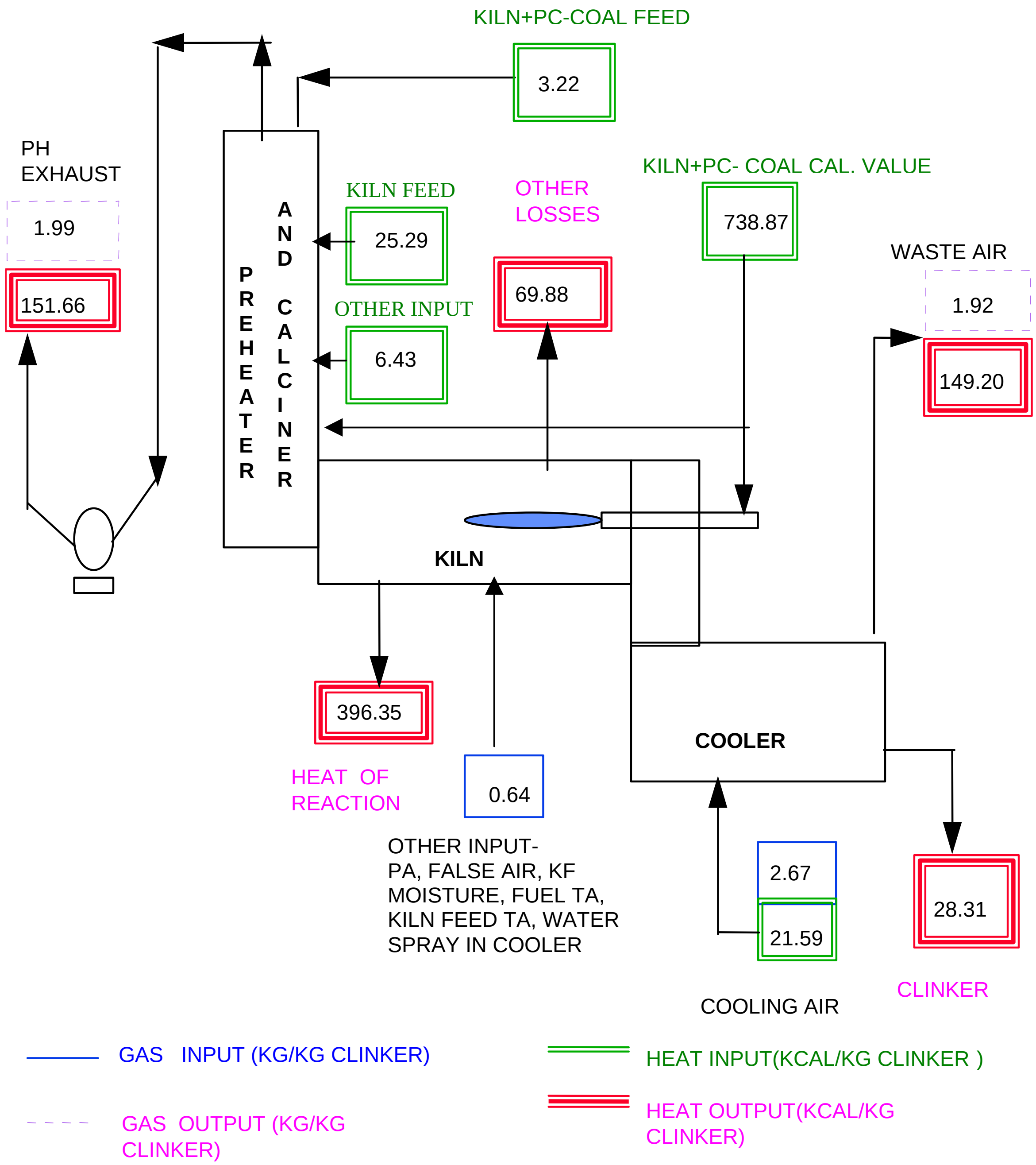

Figure 3: Process Measurements and Mass, Gas & Heat Balance- After optimisation