Process optimisation - An effective tool for Cost Reduction

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ABSTRACT

In current scenario of limited demand, lower cost realisation and increasing competition in cement industry, lowering the product cost has become the need of the hour for survival. An effective measure to reduce the production cost is by optimisation of operational practices.

Process optimisation is an effective tool for improving the effectiveness of the system and hence, cost reduction in cement industries. The objectives for comprehensive study include:

- Optimisation of all unit operations.
- Lowering the specific energy consumption.
- Diagnostic studies of problems in raw materials, electrical, instrumentation, mechanical and process engineering sections and trouble shooting.
- Quality assurance with optimised utilisation of resources.
- Measures for improvement in environment.
- Lowering the production cost.

This paper covers the objectives, typical methodology and expected benefits of Process optimisation with the help of a case study.

1 INTRODUCTION

It is a well acknowledged fact that cement production is an energy intensive process. In view of the higher cost of energy, it is important for the cement production units to optimise the energy consumption. Moreover, due to high competition in the market it is equally important for cement production units to optimally utilise the available production capacity and hence, increase sales volume.

An effective tool to achieve these objectives is to by conducting 'Process optimisation' study and implementation of the identified improvement measures. It focuses on lowering the unit production cost as well as optimum capacity utilisation. An effective process optimisation study covers not only optimising the present operational practices, but also the possibilities to upgrade the available equipment and technologies with optimum capital expenditure (CAPEX).

Savings in production cost and increased sales volume lead to improved profitability of the production unit which is the ultimate objective of operating business.

Process optimisation may be done for one or more unit operations. However, it is generally more advantageous to conduct a comprehensive study covering entire cement production process. This is due to the fact that all the unit operations are inter related. The study may be done either by some members of the plant team or by by some external agency.

2 OBJECTIVES

The main objectives of the process optimisation study are as described below:

- **Optimisation of all unit operations.**

  Entire process of cement production is subdivided into several unit operations like Raw materials, Crushing, Raw materials grinding, Pyroprocessing, Cement grinding, Packing & dispatch etc. Further each unit operation is studied in details with an objective to identify the potential improvement areas for optimizing the operational practices. A special emphasis is laid on achieving the continuity of operations. Hence, the reasons of the plant stoppages are analysed.

- **Lowering the specific energy consumption.**

  Trends of the energy consumption in different unit operation are analysed by studying the energy reports, assessment of energy efficiency of the major equipment like clinker cooler, fans etc., conducting mass, gas & heat balance etc. Based on the analysis of these information, improvement measures are suggested to cut down the specific energy consumption. Improvement measures also include the exploration of possibility to utilise waste heat.

- **Diagnostic studies of problems in raw materials, electrical, instrumentation, mechanical and process engineering sections and trouble shooting.**

  Specific problems in these areas are identified and studied in details and improvements are suggested to minimise or prevent these problems.

- **Quality assurance with optimised utilisation of resources.**

  Quality assurance with optimised utilisation of resources cover apart from the product quality, the quality of operational and maintenance practices. Some times it is possible to utilise the low cost raw materials and fuels to produce a product of equivalent or superior quality. For example, it is well known that a clinker with higher tri calcium silicate (C3S) not only gives higher strength but also it is easier to grind. Hence, in that case apart from superior product quality, the cement grinding cost also reduces. It may also be possible to produce a product with different combination of available raw materials which shall require less heat of formation and hence, lower specific fuel consumption.

- **Measures for improvement in environment.**

  With the physical observations of operating practices and analysis of measurement reports & records, measures are suggested to improve the environment. These measures include minimising the spillages and leakages in the plant, reducing the dust emission and hazardous gas emission from stacks, material conveying equipment and their transfer points, storages etc.

- **Lowering the production cost**.

  Apart from the savings in the specific energy consumption, other possibilities to reduce the production cost are studied. A few examples of such measures include substitution of high cost raw materials by low cost raw materials, product optimisation including increased use of pozzolona in PPC, production of high value products etc.

3 METHODOLOGY

The process optimisation study is a systematic approach to study and analyse the effectiveness of facilities & efficiency of the operations and to suggest improvement measures'. Hence, a comprehensive methodology of the process optimisation involves several activities. A few important activities involved in the process optimisation study are as described below:

3.1 Data collection

This involves the collection of important details about the plant, major equipment/ machinery, available raw materials & fuels, sources of electrical power, operating parameters, product specifications, quality aspects including applicable standards, process flow sheet etc. In case the process optimisation is carried by an external agency, a detailed questionnaire is prepared and sent to plant in advance. It is important to confirm the authenticity of data collected for correct analysis.

3.2 Interaction with concerned team

Operational and maintenance practices of each unit operation are discussed with concerned team. Discussions also include the prevailing problems and bottlenecks in respective areas. Detailed information about the problems may be gathered from equipment history sheets, operational log sheets etc.

3.3 Field measurements

Important operational parameters like electrical energy consumption, temperature pressure, flow rates may be measured. It is important to ensure the accuracy of measurements by confirming the calibration status of the measurement instruments.

3.4 Calculations & analysis

Based on the measured parameters, calculations are made and the values are analysed to identify the improvement potential.

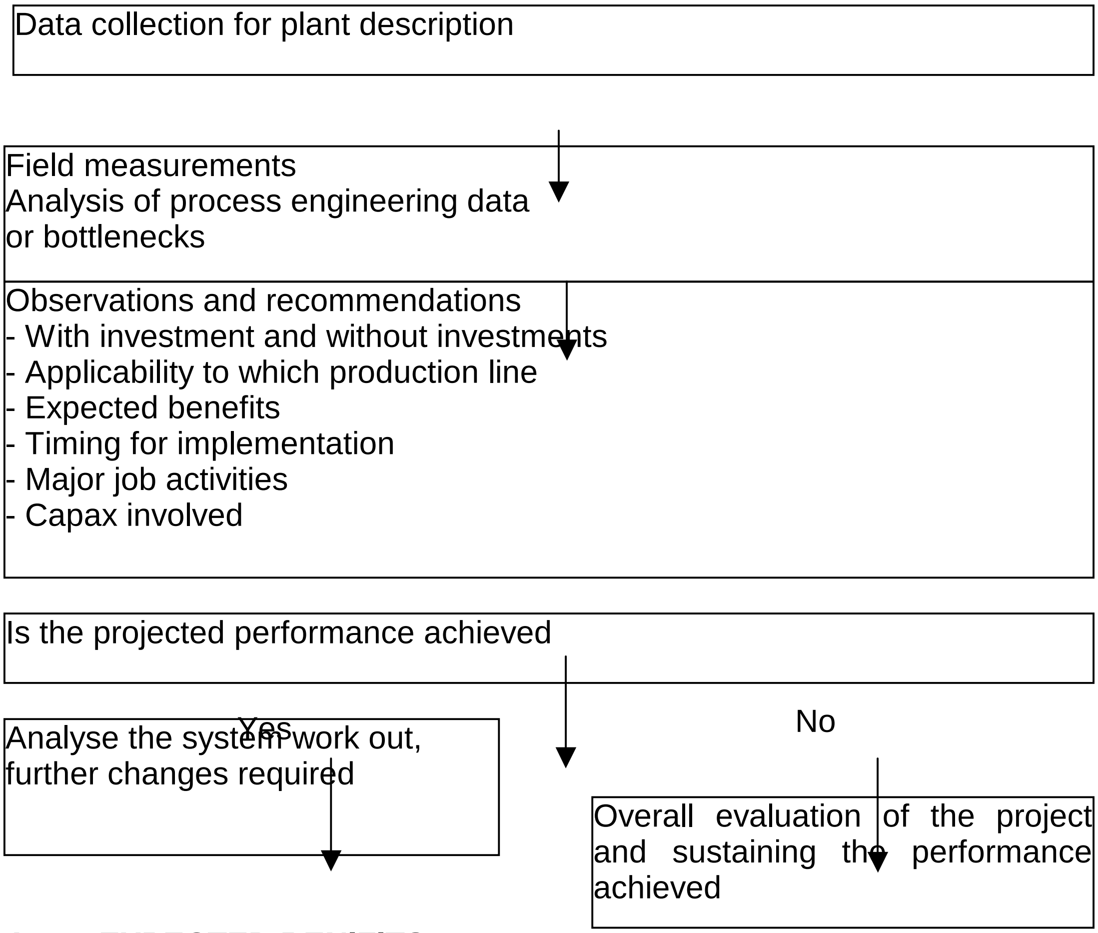
3.5 Recommendations

On the basis of data collected, interaction with the plant team, observations,measurement of important parameters and their analysis etc., recommendations are made for improvements. Recommendations include upgradation of equipment and technology, if any. Further, the recommendations are categorised as 'with no investment', 'with nominal investment' and 'with major investment'.

3.6 Presentation and report

Important findings of the process optimisation study are presented to the top management and the plant team. During presentation, the recommendations are discussed in details with expected benefits. Further a report is also submitted covering the a brief plant description, important observations, recommendations for improvement, time for implementation, , expected duration of implementation, estimated capex, expected benefits in financial terms and expected payback period.

A schematic representation of a typical methodology is as given below:



4 EXPECTED BENIFITS

Process optimisation study shall identify the potential improvement areas and suggest improvement measures to be implemented. Implementation of improvement measures may be done at once or in phases as decided by the plant management.

Some of the expected benefits of the process optimisation are as listed below:

- Optimum capacity utilisation of available facilities in all unit operations.
- Saving in specific fuel consumption.
- Saving in specific electrical energy consumption.
- Consistency in plant operation and hence improved run factor.
- Improved product quality.
- Reduction in maintenance cost.
- Assessment of potential capacity of plant and suggestions for achieving the

same.

5 CASE STUDY

Holtec Consulting Private Limited (Holtec) had carried out a process optimisation study in a cement plant in Pakistan. At the time of study, the plant was operating at a production level of about 1800 tpd clinker. The average values of specific fuel consumption and specific power consumption at the time of study were about 977 kCal/kg clinker and about 131.55 kWh/t cement respectively. The major equipment in the plant were a two chambers central discharge ball mill for raw material grinding, a dry process kiln with twin string preheater (PH) and a precalciner (PC) in calciner string, grate cooler and a two chamber, closed circuit ball mill for cement grinding.

5.1 After preliminary study of plant operation during plant visit, Holtec suggested the following improvement measures.

- Optimisation of grinding media distribution in raw mill.
- Plugging the false air infiltration in the system.
- Calibration of some instruments.
- Provision and functioning of the mechanical flaps at the bottom of dust settling chamber in the tertiary air duct (TAD).
- Adjusting the feed distribution in kiln and calciner string PH.
- Reducing the primary air quantity in PC and kiln.
- Adjusting the flame momentum of kiln firing burner.
- Optimisation of grate cooler operation.
- Optimisation of gas cooling in the gas conditioning tower (GCT).

Based on the process measurements and control room indiactions, the gas and heat balance was carried out for pyroprocessing section as given at Annexure 1.

With implementation of above improvement measures and under Holtec's operational supervision, the following were achieved:

- Raw mill capacity increased from about 150 tph to about 165 tph.
- Increase in kiln capacity to about 2400 tpd clinker.
- Lowering of the specific fuel consumption to about 885 kCal/kg clinker.

- Reduction in specific power consumption to about 103 kWh/t cement.

5.2 After detailed study, Holtec had recommended several improvement measures for plant optimisation. Recommendations were classified as 'Without investment', 'With nominal investment' and 'With major investment'. Holtec assessed the potential capacity of plant as 3000 tpd clinker. For achieving this capacity, some important recommendations made are as given below:

- Installation of dust suppression system on crusher hopper and its conveyors.
- Installation of line -2 raw mill for raw materials grinding.
- Installation of one additional belt conveyor for feeding the raw mill hoppers.
- Replacing the fuel oil by coal as fuel and installation of a coal mill of capacity 30 tph.
- Removal of venturies in down comer ducts of kiln and PC string PH.
- Installation of compressed air assisted water spray in PC string down comer duct.
- Installation of 3rd cyclone in parallel to the existing top stage twin cyclones in PC string for saving in pressure drop.
- Extension of PC height by 5 meters.
- Installation of grid resistance regulators for HV fans.
- Re – locating the PC string ID fan after GCT for saving in electrical energy consumption of ID fan.
- Replacement of PC string ID fan by a new suitably designed, high efficiency fan.
- Installation of kiln shell temperature scanner.
- Installation of variable speed drive for cooler fans and one of the cooler exhaust fans.
- Extension of clinker cooler area by provision of 3rd grate and increasing the capacity of cooling air fans.
- Installation of line -2 cement mill for cement grinding.

- Control of raw mill and cement mill operation using PID loops.
- Installation of heavy duty relays for blowers and fans.
- Connecting LV capacitor banks on LV Bus and individual PF improvement.

With Holtec's assistance, plant implemented some of the above measures. Implementation of these improvement measures were done in a planned manner in consultation and supervision of Holtec, in a planned shutdown of about 5 weeks. Plant is presently operating at an average production level of about 2850 tpd clinker. With complete implementation of the above recommendations the expected kiln production will be 3000 - 3100 tpd clinker. At this production level, the expected specific fuel consumption and specific power consumption shall be about 750 kCal/kg clinker and 90 kWh/t cement. Estimated pay back period for the capacity upgradation worked out to about 5 months. Moreover, the plant operational consistency has improved a lot as a result the annual production has increased significantly.

A comparison of the heat balance prepared for the conditions before and after implementation of the improvement measures is given below in the Table 1:

Table 1: Saving in Thermal Energy

Sn	Stream	Thermal energy, kCal/kg clinker	
		Before modification	After modification
Heat Input			

		Thermal energy, kCal/kg clinker	
1	Sensible heat of raw meal	22.78	22.78
2	Sensible heat of raw meal moisture	0.49	0.49
3	Sensible heat of fuel	4.76	3.65
4	Sensible heat of primary air to kiln	0.60	0.4
5	Sensible heat of primary air to precalciner	2.00	-
6	Sensible heat of cooler air	23.25	20.83
7	Sensible heat of nose ring fan air and false air	15.40	9.42
8	Calorific heat from fuel	976.94	749.35
Total Heat Input		1046.22	806.92
Heat Output			
1	Sensible heat of clinker	47.50	24.70
2	Sensible heat of exhaust gas (Kiln & calciner strings)	399.49	218.59
3	Sensible heat of PH exhaust dust	24.12	19.01
4	Sensible heat of cooler exhaust air	81.17	81.17
5	Heat of formation	408.45	408.45
6	Evaporation heat for moisture in raw meal	6.49	6.49
7	Radiation and other losses	79.00	48.51
Total Heat Output		1046.22	806.92

6 CONCLUSION

The process optimisation is an initiative to improve the plant performance in terms of optimum capacity utilisation, savings in energy consumption, reduction in maintenance cost, improved product quality and improved consistency in plant operation. Process optimisation study also covers the potential capacity of the plant and measures to achieve the same.