Optimizing Energy Utilization in the Cement Industry: An Energy Audit Approach

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Abstract: ***Cement Industry is one of the major energy consuming industries and optimum use of energy is at present important for our national economy. The energy cost is the highest component of cost structure of cement manufacture. Energy cost in Indian cement Industry account for over 40 - 50 % of the manufacturing cost of cement. Out of this the share of thermal energy alone in the form of fuel is about 30 – 35 % while the remaining 15-20% accounts for mainly electrical energy the other relatively smaller ones being explosive, diesel, etc.,. The major sources of energy to Indian Cement Industry are coal and electrical power. The specific energy consumption in Indian Cement Industry is about 33% higher as compared to relatively advanced countries in the world. Energy audit is the key to monitor energy consumption and energy flows at various locations for improving the energy efficiency. It determines the ways to reduce energy consumption per unit of product output. The present paper deals with the methods of energy audit in a cement industry to minimize energy losses and to maximize the energy utilization and efficiency.***

Keywords: Cement Industry, Energy audit, Types, Audit methods, Energy efficiency

1. Introduction

Energy Audit

A sound energy management programme in any organization would mean monitoring of energy consumption and energy flows at various locations, keeping a record of such measurements, and analysing the data for improving the energy efficiency. This is short known as Energy Audit. Energy Audit is the key to a systematic approach for decision making in the area of energy management, directs and controls the energy management programmes, it attempts to balance the total energy inputs with the use, and serves to identify all the energy streams in a facility. It qualifies energy usage according to its discrete functions. The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or lower operating costs.

With the advent of energy crisis and exponential hikes in the cost of different forms of energy. Energy audit is manifesting its due importance in various sectors. Energy Audit will help to understand more about the ways energy and fuel are used in an industry, and help in identifying the areas where waste can occur and where scope for improvement exists.

The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes, which are vital for production and utility activities. Such as audit programme will help to keep alive variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofits for energy conservation equipment and the like.

In general, Energy Audit is the translation of conservation ideas into realities by blending technically feasible solutions with economic and other organisational considerations within or specified time frame.

2. Types of Energy Audit

Basically there are two types of energy audit. They are
a) Preliminary scoping study
b) Detailed Energy audit

Preliminary scoping study is performed in a limited span of time. It focuses on energy supplies and demands accounting for at least 70% of total energy requirements. The detailed audit goes beyond quantitative estimate to costs and savings. It includes engineering recommendations and well defined projects with priorities. It accounts for approximately 95% of energy utilized in the plant.

Comparison of Preliminary and Detailed Audit

	Preliminary Audit	Detailed Audit
Objective	Set priorities for optimizing energy consumption	a) Quantity energy consumption / utilization. b) Evolve detailed engineering for options to reduce energy costs / consumption.
Scope	Highlight energy costs and wastages in major equipment process.	Formulate a detailed plan on the basis of quantitative and control evaluation.
Duration	2 to 10 days	1 week to 10 weeks
Audit frequency	Difficult to decide	May be 2 to 3 years in normal cases
Preparation	a) No pre-audit visit required. b) Detailed questionnaire to be compiled before the audit.	One / Two pre-audit required. In addition to points for preliminary audit, the following points have to be taken care of i. Advance notice to departmental heads. ii. Arranging for office and secretarial support. iii. Advance tentative schedule iv. Audit kit to be meticulously planned / arranged.
Due date	Within two weeks of completion of field work	Within 3 months of completion of field work

3. Resources for Energy Audit

Human Resources

Energy manager / or an energy engineer / co-ordinator would be the focal point during the conduct of an energy audit. The energy manager would be responsible for providing the major share of leadership in the workshop's energy conservation effort. The top management is responsible for the conducting of appropriate energy studies. The other people resources would include supervisors, plant operators, workers, maintenance mechanics, etc. Outside energy consultants, equipment vendors and engineering and design firms would also play a part in energy audit.

Instrumentation

For an energy audit to be done, measuring and recording instruments would be needed. Proper and adequate instrumentation is vital for an energy audit and it speeds the study and improves the accuracy of results.

Energy Records

Records of energy consumption, distribution and costs are very useful in the conduct of an energy audit. Records available for at least a full year of normal operation make it possible to evaluate seasonal variations and sustained trends.

4. Scope of Energy Audit

- Analyse present consumption and past trends in detail
- Review lighting requirements
- Consider submetering
- Compare standard consumption to actual
- Produce an energy balance diagram for the firm
- Review existing energy recording systems
- Compare consumption with other locations, other firms, previous period and budget
- Check records against invoices.
- Review records of maintenance engineer
- Check capacities and efficiencies of equipment
- Check working of controls
- Examine need for automatic controls
- Determine adequacy of maintenance
- Review fuel storage and handling
- Examine need for improved instrumentation
- Consider training energy management staff
- Review new projects with respect to energy use.
- Introduce life cycle costing.
- Consider changing the management information system to include energy parameters.
- Develop energy use indices to compare performance productivity
- Introduce energy use monitoring procedures
- Check frequency of energy reporting systems.
- Examine and monitor new energy saving techniques
- Examine need for energy saving incentives
- Consider publicity campaigns and incentives

5. Data Collection and Analysis

Basic data concerning the overall energy consumption, its cost and production figures for a period of the preceding five years have to be collected. The figures when compared give a trend of energy consumption and its cost per unit production over the years. As energy consumption is also related to production figures it should be expressed in a common term for example, Specific Energy Consumption - Kcal / Kwh / Unit of Production.

When sufficient data has been built up the existing records of consumption should be reviewed. The energy consumption and production figures available can be refined to an appropriate form. A graphical representation of energy input per unit of production (specific energy consumption) over the years, will give an immediate insight into the trend of energy consumption. A Sankey diagram can be drawn for accounting energy use and losses in the plant. By making a graph of specific energy consumption against product output from large number of readings, it may be possible to pick out the best set of figures which can be used as a target for future output or to optimise the process for energy use.

A process flow diagram, with energy consumption in each step / operation could be made which will indicate the order of energy consumption in different operations. Refining the data in various forms would thus help in locating the areas of high energy consumption, high costs and saving potential.

6. Energy Conservation Proposals

Energy Audit results in energy conservation proposals or projects. Initially, proposal with minimum investments are identified such as;

- Improvements in the standard maintenance of thermal insulation, instrumentation etc.
- Carrying out of plant efficiency trails
- Excess air control
- Stopping leakages
- Re-allocation of electric motors

The criteria used for ranking the proposals are the savings achievable from a project compared to the investments needed for effecting these savings. The savings to investment ratio (SIR) is calculated and the project with the highest SIR is selected first then the next highest and so on.

A discounted cash flow and / or life cycle cost analysis of the project should be carried out to get a complete **economic analysis of the proposal.**

Anticipated real project life	Payback
5 Years	2 Years
10 Years	3 Years
15 Years	4 Years

7. General Audit Programme

Records of consumption

- Produce detailed analysis of energy consumed over the most recent year. Show the amount, and cost per unit, of each fuel (This will be used for the purpose of the current audit and for providing a baseline for comparison with later years).

- Review existing records of consumption and determine if adequate information is available to management.
- Draw Sankey Diagram
- Compare consumption with other locations, previous periods and budgets
- Compare standard consumption to actual for each process, and identify losses.
- Test meter readings against records
- Test records against invoices.

Housekeeping

- Check that all control mechanics are effective and frequently tested
- Consider whether further instruments would be useful in measuring or controlling particular parameters (e g temperature, pressure, humidity, flow rate).
- Determine whether maintenance is adequate (e.g annual cleaning of boilers is unlikely to be sufficient to avoid fouling and corrosion of tubes).
- Consider how maintenance could be improved
  - more skilled manpower.
  - design change
- Review fuel storage and handling, consider whether temperatures are adequate or excessive consider whether vaporisation could be reduced (e.g. by reducing the vapour space above volatile liquids).
- Review lighting: consider if the most efficient form of lighting is used for each purpose. check lighting levels, maintain proper illumination.
- Review tariffs or contracts for supply of energy ensure the most appropriate tariffs are used, discuss with suppliers, if appropriate
- Check all reasonable steps are taken to minimize peak demands for electricity e.g. re-schedule tasks to off-peak periods, use an emergency type diesel generator as booster / alternative to electricity, preferably including waste heat recovery, monitor consumption precisely, use maximum demand meter.
- Consider the feasibility of using night rate electricity.
- Consider sub-meeting, so that consumption can be broken down to controllable unit, i.e. cost centers, thereby making some individual personally responsible

Personnel

Consider if specialist workers are adequately trained and motivated eg energy manager, maintenance engineer, instrument engineer, furnace operator. Review energy conservation propaganda or education eg. Posters, house magazines, circulars requests for suggestions from employees, talks and short courses, involvement of unions

Capital Investment

Review energy projects under consideration, check and calculation of return / pay-back review arguments for and against making the investment, check that tax implications are correctly taken into account. Review efficiency of furnaces, boilers and process equipment. consider whether they should be modified by pre-heating air, adding metering facilities, recovering waste heat, improved insulation, replacing burners (Modern burners have improved turndown capability which can be useful if there is a fluctuating load/ demand and can show a 30 per cent return on capital), adding economizers, returning condensate to boilers consider the size of equipment vis-a-vis demand.

8. Proforma for conducting Energy Auditing

Proforma 1

Furnaces

Furnace Details

Furnace : 1 2 3

Location :

Manufacturer :

Age (years) :

Type :

Stock material type :

Throughput rating (kg/hr)

Normal operating pressure (neg. in W.G.):

Type of heating system :

Burner(s)

Number :

Fuel(s) fired :

Manufacturer :

Age (years) :

Type :

Burner controls :

Furnace Evaluation Checklist:

Item	Equipment	Comments
Physical appearance	Furnace Burners Fuel System Atmosphere control system	
External Structure	Furnace walls Doors	
Safety equipment & instrumentation	Furnace Burner Fuel System Atmosphere control system	
Valves, fittings and insulation	Burners Fuel system Distribution	

Furnace Energy Audit Data Collection Form

Date :

Time :

Location :

Fuel Type :

Item	Units	Test 1	Test 2	Test 3
Flue gas analysis	%			
%CO2	%			
%CO2	%			
%CO2	%			
Flue gas temperature	ºC			
Ambient temperature	ºC			
Flue gas flow rate	ºC			
Flue gas flow rate	m^3/miin			

Item	Units	Test 1	Test 2	Test 3
Wall material emissivity				
Inside Wall temperature	ºC			
Outside wall temperature	ºC			

Feed material temperature	ºC			
- In				
- Out				
Stock throughput				
Stock emissivity				
Furnace Wall				
- Material - Thickness - Construction details				
Furnace and Door dimensions				

Proforma 2

Surface Heat Loss

Equipment Ambient temperature (ºC)

Equipment No.	Type of equipment	Inside temperature (ºC)	Identification of surface being examined

Characteristics of Surface			Surface Temperature (ºC)	Surrounding Air Velocity (m/sec)
Material	Condition	Colour		

Pipe/ Valve Flange Ambient temperature = (ºC)

Location	Size (mm)	Annual hours of operation	Bare or insulated	Type of insulation and its jacket

Condition of insulation	Surface Temperature (ºC)	Additional Information / Remarks

9. Conclusion

Energy Audit is an effective tool in defining and pursuing a comprehensive energy management programme. A careful audit of any type will give the unit a plan with which it can effectively manage the plant energy system at minimum energy costs. This approach would be useful for industries in combating escalating energy costs and also reap several other benefits like improved production, better quality, higher profits, lower emission, etc. The approach would broadly be the same in any type of industry and service.

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