Energy conservation audit and approaches for energy saving in textile process house - Part 2

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Abstract

While conducting the energy audit, a systematic approach is required. In this approach steps like preliminary survey, preparatory work, main audit/assessment, on-site and machine measurements, data collection, data validation, energy-saving calculations and report preparation are the requirements. To do this an auditor must have a knowledge of textile engineering as well as processing. The past data analysis, energy balance, in-depth equipment inspection and heat utilization factor estimations are the key areas to be seen during the energy audit.

Keywords

Energy balance, Textile processing, Steam consumption, Heat utilization efficiency factor, Thermal efficiency, and Fuel consumption.

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1.0 Introduction:

In this series of papers on energy conservation audit and approaches for energy saving in Textile process house part 1, we have discussed about identification and small description of major energy-consuming processes in a textile process house, various utility usage and potential saving possibilities in them.In this part 2, we will be discussing the audit framework i.e.general audit procedure or flowchart, the expected outcome from the energy audit, preliminary site inspection, data collection, identifying problems and focusing on audit plans accordingly, methodology of main survey, detailed inspection of equipment, work of measurement, data analysis and report preparation with expected content etc.

2.0 General audit procedure:

While conducting the energy audit the following aspects should be considered;

- Preparatory work
- Preliminary survey
- Main survey or actual audit
- Analysis of the collected data
- Report preparation with finding and saving opportunities

The importance and actual requirements of these activities are briefly described below.

2.1 Preparatory work:

Once it is decided that there is a need for an energy audit in the process house and it is to be conducted then to gather certain information a questionnaire is prepared and filled. Based on the data in the questionnaire, a temporary audit plan is elaborated. Generally, this questionnaire will be sent by the auditor or it can be self-prepared by the mill also. The input required in the questionnaire is factory details including address, number of employees, number of engineers, working hours, types of products manufactured, annual production, main processes involved in the manufacturing, current utilities or energy (water, fuel, power, gas) consumption, distribution system, types and numbers of machines required for wet processing, dry processing, batch or continuous processing, machine specification data, major used machines, width and quality wise quantity processed, the maximum temperature and pressure used in the process, details of fans, pumps, and blowers used with their rated capacity, details of air

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compressor, boiler, type of fuels and their calorific values, energy saving activities conducted in past, Technical measures taken in the past, key process parameters etc and finally the management expectations from this audit activity.

1.2 Preliminary Survey:

Before conducting the main survey, the audit team should identify the energy-saving opportunities. For that certain preliminary survey activities are required. These are; interviews of the workforce with certain questionnaires, looking at the data and related documents, site inspection in brief, and understanding the problems.

During the interview hearings on energy management status, implemented energy-saving activities in the past and their effect on the cost, current specific energy consumptions and the problems faced by them are done. The past data for certain periods for energy consumption for the whole factory and some of the major processes is taken and related documents are seen.

To prepare for the subsequent audit plant, an inspection of machines and processes is an important task so that significant energy-saving opportunities are found or noticed. For example, steam wastages or condition of insulation and environmental conditions in process houses etc hint the plenty of heat radiation and wastage. In brief site inspections, the measurement locations and tools used for measurement are recorded.

Based on the above observations and data gathered an auditor can build up a list of candidates for energy-saving opportunities and understand the problems. Accordingly, the auditor can elaborate on the main audit plan.

1.3 Main survey or Actual main audit:

After the preliminary survey and the temporary audit plan are ready, the work of the main survey starts. Depending upon the size of the mill/process house and the process routes/ cycles, this survey may take a time of one week to one month. The main two purposes of the main survey are

- To gather operational data with related inputs necessary for understanding the potential and feasibility of energy saving opportunities those were identified in a preliminary survey.
- To understand the obstacles or difficulties against these opportunities

In the main survey the following activities are to be conducted ;

2.3.1 Machinery and equipment in-depth inspection.

2.3.2 The measurement task

2.3.1 Machines and equipment in-depth inspection:

In the task of a preliminary survey we had filled out the questionnaire and based on the questionnaire inputs, the casewise detailing is done. While doing the detailing, the past data related to the a) process) process control parameters c) machine operations d) the machine maintenance/troubleshooting record e) the major stoppage and their reasons f) utility consumption data against the production are taken. Wherever required and possible, the energy balance diagram and process flow chart for the major machines and processes are drawn.

For example, in the case of a jet dyeing process, the above data is recorded for machine steam consumption, process time, temperature, machine surface temperature, insulation status, batch time including heating and cooling time), steam condensate recovery status, steam trap status, cooling water management, effluent drains and energy content in it, water quantity and steam consumption patterns etc. This step needs strong and in-depth observation and process knowledge so that the data gathered is used and analysed with the benchmarking for that process.

2.3.2 The Measurement task:

This is a very important task of the audit as all the calculations and potential saving opportunities are derived from these calculations. Even if past data is available from the plant record, certain data needs to be verified so that the related heat balance and calculations reach to the realistic point and solution or saving will be practical and realistic. In the energy audit, it is important to understand and know the actual conditions of the process and machine. For example, The energy efficiency in partial load operations is lower than in full load operations. In some equipment, energy efficiency fluctuates with the change in ambient conditions [1].

Also, to perform the measurement task, you need certain portable instruments. Generally, the advanced process equipment and machines are fitted with measurement tools and inbuilt software to display the same on the computer screen. The process parameters data measured and recorded from these tools is the basic data input to you. However, certain data needs to be verified during the audit process and also to measure the data where there is no provision available on the machine, you need portable instruments like a power analyser, IR-based temperature gun, portable steam flow meters, portable water flow meters etc.
Thus collected data is recorded on the data record sheet with predefined formats.

2.4 Analysis of the data:

Here the validation and scrutinisation of the above-mentioned practical efficiency levels, and collected and measured past data /information are the important activities. To perform these activities, the auditor should have in-depth knowledge, skill and experience of the various processes in the textile mills. Many times the measured data is found invalid and it shows inconsistency in the calculation of energy balance for the specific process. Hence, auditor skills, knowledge and experience are important.

After the collected data validation, the areas of energy consumption and wastage are identified with the help of energy or heat balance and computation of heat utilization

factor for the equipment or process or machine under the scope of the study. Here the knowledge regarding the textile material type being processed, and its benchmarking for energy consumption in a particular process becomes the decision maker to find out the potential of the energy saving.

2.4.1 Heat utilization efficiency (HUE) factor:

The thermal efficiency of an individual machine or process can be measured. However, it is a complex task to measure the same for the total process plant as there are different sorts processed with different routes and machines and thus casting a heat balance for the mill as a whole becomes a difficult task. Also, it would be misleading to compare the daily fuel consumption per fabric kg. Hence, the HUE factor estimation approach is considered for a better understanding of energy (heat) usage and wastage.

Heat utilization efficiency factor= Target fuel or energy consumption /Actual fuel or energy consumption.

In this approach, target fuel consumption for a mill is estimated based on actual fabrics processed with adopted process routes and compared with actual consumption and the HUE factor is calculated.

While estimating Target fuel or energy consumption the following aspects are to be considered

- Practical efficiency levels in all stages of steam generation, distribution and consumption
- The steam consumption benchmark for the processes and machines involved (was already given in part 1 of this paper)
- Various heat losses for machine warming up, distribution, unaccounted line leakages, steam quality, and fuel consumption for boilers on holiday (called banking of boiler). Generally, it is taken as 15-16%
- Coal losses on storage etc

2.4.2 HUE factor calculation:

While calculating the HUE factor for the whole plant the following steps are followed

- Daily steam consumption at each machine is calculated by multiplying the daily production of that machine by its benchmark steam consumption.
- The total daily steam requirement of the whole plant is the simple addition of the steam requirement of all the machines (refer to STEP 1 below)
- To arrive at target steam demand the steam losses factors are also considered. (refer to STEP 2 below)
- By considering the steam-to-fuel ratio the target fuel requirement per day can be estimated
- Actual fuel consumption per day data is as per the boiler log book.
- Based on this data HUE factor can be calculated refer to STEP 2 below)

STEP 1 Calculation of Target steam requirement per day

Sr. no.	Steam consumption process or machine	Fabric production Kg/per day	Steam consumption norms:- kg of steam / fabric kg	The daily steam requirement in Tons
1	Desize washing and CBR	12000	2.5	30.00
2	Mercerizing	4000	1.5	06.00
3	Stenter	12000	1.8	21.60
	Etcetc	Etcetc	etc	Etc…

Total target steam requirement = 1+2+3+ etc....= 120 Tons /day

STEP 2 Calculation of HUE factor

Sr. no.	Particulars	unit	Calculation result
1	Total Steam requirement	Tons/day	120
2	Steam loses allowances @16%	Tons/day	19.2
3	Total target steam requirement	Tons/day	139.2
4	Steam to fuel ratio for boiler		6
5	Overall fuel requirement	Tons/day	23.2
6	Actual fuel consumption (as per mill record)	Tons/day	32
7	HUE factor		23.2/32 = **0.725**

Depending upon the work practices, process efficiencies, maintenance level, leakages, wastages and machine thermal efficiency, the HUE factor was found to be in the range of 0.45 to 0.85

The HUE factor level of 0.85 reveals that energy usage is optimum or there is very little scope for saving in short the 0.85 hue factor can be taken as a benchmark.

Now, here as per the illustrated calculations example, the energy saving and hence monetary saving potential is there.

The auditor has to find these opportunity areas by observing wastages, losses, and work practices and making individual process heat balance tables for significant and major processes.

The expected annual savings can be calculated by using the following formula

Annual saving in Rs = Fuel cost in Rsx[1 – (estimated hue factor / 0.85)]

For the above illustrative example and fuel rate of Rs. 10000 per ton and considering 300days /year working,

Potential saving in Rs. = 32*1000 [1-(0.725/0.85)]
= Rs. 47040 per day = Rs. 12,23040 per month

In detail, the savings are calculated for major /significant processes showing the potential. For every energy saving there may be capital investment the same also should be considered while estimating the saving along with the pay-back period to make it more feasible and commercially viable.

2.5 Report Preparation

In the final report, information like the audit scope, process routes, machine list, current level of utility or energy consumption, measurement data tabulation, major processes energy balance, heat utilization efficiency, machine-wise power and steam benchmarking, energy wastage areas and list of priority and actionable along with the investment and payback period etc should be mentioned.

The energy audit should necessarily contain

- Title page
- Index of contents
- List of tables and figures
- Executive summary i.e. in the short extract of the whole report
- Introduction
- Audit methodology, activities and results
- Recommendation for energy saving and priorities matrix
- Appendices for support documents

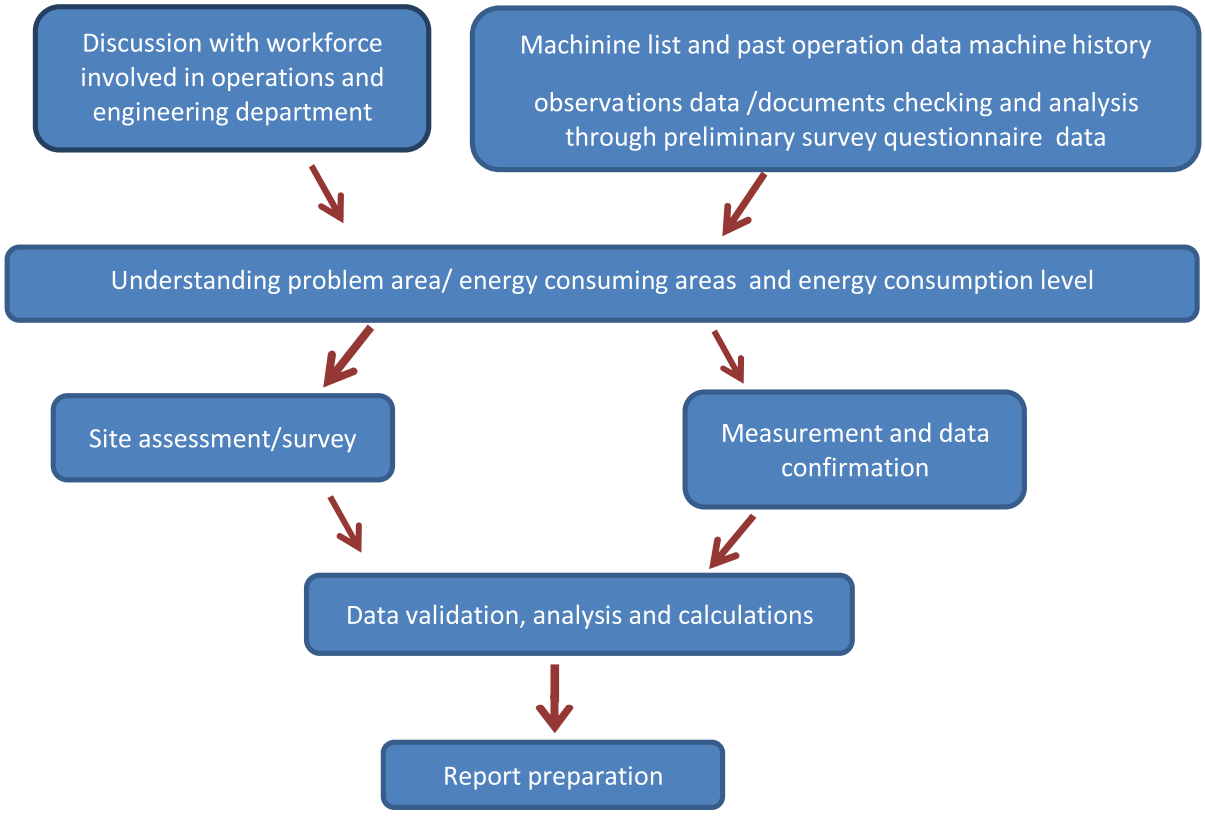
3. Energy audit general Flow chart

All the above-mentioned activities are described can be shown in the form of a flow chart below

4. Conclusion

Conducting an energy audit requires the skill and in-depth knowledge of engineering along with textile processes. Preliminary survey, main audit /site assessment, in-depth equipment observation and inspection, Estimation of heat utilization efficiency factors, energy or heat balance for major and significant energy consuming processes, Loss estimation, capturing the correct data and its validation, past data analysis and commercial feasibility of the saving options are the key factors in the energy audit. The auditor should report the energy-saving opportunity areas both with and without capital investment. When there is a need for a capital investment then the payback period of less than 2 years will be recommendable. The payback period from 2-3 years will be conditionally accepted by the management depending upon the durability of the equipment/system incorporated for the savings.

Energy audit general Flow chart



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