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Effective Ways To Implement The Energy Audit

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Abstract- *It is mandatory for energy consuming industries to go through energy audit for reducing excessive consumption of energy. In India, as it is developing country the rate of generation of energy decides the economic growth of country. Auditing of energy is precisely the best solution for any kind of industry for the conservation of energy where the whole system is analyzed and a report stating the possible changes in the system for optimum consumption of energy. The paper focuses on importance of energy audit and methodology to find out various flaws in the system and remedies on that flaws.*

Index terms- *Audit methodology, Energy audit, Energy conservation, Energy efficiency.*

Introduction- Industrial sector makes up for a very large part of the industrial structure in any country. In India, this sector is often characterized by the use of outdated technologies. Industries in India are generally considered as less efficient in material and energy use compared to Industries in developed countries. In India energy losses are very high compare to developed countries. Various studies indifferent countries have shown that significant energy-efficiency improvement opportunities exist in the industrial sector, many of which are cost effective. These energy-efficiency options include both cross-cutting as well as sector-specific measures. Even so, many plants do not have the capacity to conduct an effective energy audit. In some countries, government policies and programs aim to assist industry to improve competitiveness through increased energy efficiency. Manufacturing companies lack the knowledge about the possibilities of energy savings and increased productivity.

An audit encourages a detailed study of how facility uses energy, what the facility pays for that and finally recommending various Energy Efficiency Measures (EEM) that will save huge amount of money in bills. Purpose of energy auditing is to recommend steps to be taken by Management for improving the energy efficiency, reduce energy cost and saving the money on the energy bills.

An energy audit is an inspection, survey and analysis of energy flow for energy conservation in an industry, process to reduce the amount of energy input into the system without negatively affecting the output. Energy audit is a testing and analysis of how the enterprises and other organizations use energy. According to national energy conservation laws and regulations for energy consumption, investigation and energy audit management

Audit activities in general order include:

1. Identification of all energy systems
2. Evaluation of conditions of the systems
3. Analysis of impact of improvement to those systems.
4. Preparation of energy audit report

Types of energy audit-

The energy audit orientation would provide positive results in reduction energy billing for which suitable preventive and cost effective maintenance and quality control programs are essential leading to enhanced production and economic utility activities. The type of energy audit to be performed depends upon the function or type of industry. There can be three types of energy audit.

1. Preliminary Energy Audit
2. General Energy Audit
3. Detailed Energy Audit

a. Preliminary energy audit-

A preliminary audit is simply a screening audit or walk through audit and the quickest type of audit. It is focuses on the major energy supplies and demands. It leads to taking step which are important for the implementation of energy conservation program in an industry. It involves collection of necessary data and a brief review of whole industrial systems and identifies areas of inefficiency. In this audit only areas of major problems remains uncovered. This level of data and information is not sufficient for making of final decision on implementing proposed remedies so it is necessary to do an energy efficiency projects and determined the need of more detailed audit.

b. General energy audit-

A general energy audit is basically a complete energy audit of an industry or an organization. It is the next step after preliminary audit which involves a detailed study of whole industrial systems. It takes considerable amount of time and it focuses on detailed evaluation of energy conservation measures.

It expands on the preliminary audit described above by collecting more detailed information about industry operation and by performing a more detailed evaluation of energy conservation measures.12 to 36 month of utility bills collection is carried out to allow the auditor to evaluate the industry's energy demand rate structures and energy usage, energy consumption profiles. Metering of specific energy-consuming systems is performed to supplement utility data. Interviews with industry operating personnel are conducted to provide a better understanding of energy consuming systems and to understand short- and longer-term energy consumption patterns. General audit identifies all energy-conservation measures appropriate for the industry, given its operating parameters. A detailed financial analysis is performed for each measure based on detailed implementation cost estimates. Sufficient detail is provided to justify project implementation.

c. Detailed Energy Audit

For detailed energy audits, more detailed data and information are required. Measurements and a data inventory are usually conducted and different energy systems (pump, fan, compressed air, steam, process heating, etc.) are assessed in detail. Hence, the time required for this type of audit is longer than that of preliminary audits. The results of these audits are more comprehensive and useful since they give a more accurate picture of the energy performance of the plant and more specific recommendation for improvements.

Major attention is given to understanding operating characteristics of all energy consuming profiles and conditions causing variations in load profiles on both an annual and daily basis. Monitoring of system operating characteristics is done.

Methodology-

1. **Data collection-**

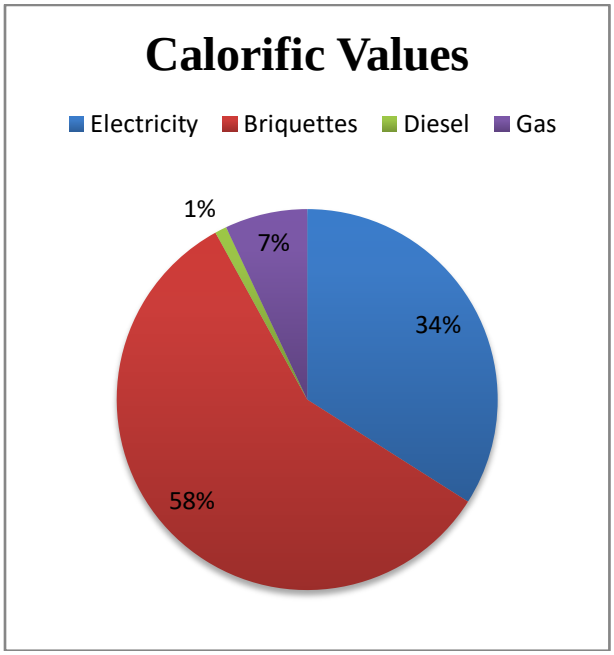
Determining the current position of the industry is the starting point of energy audit. The use most recent 12 months' historical data will help to calculate the annual energy consumption of an industry. This may include the collection of data regarding consumption of energy, which in the form of Electricity, Liquid Petroleum Gas (LPG), Heavy fuel oils, briquettes etc. it is useful to gather such type of data on consumption and expenditure over the last year. The quantification of current energy consumption and cost is good starting point, it helps to inform where to concentrate efforts to achieve the best result.

sample tables and pie charts with the data required is shown below:

Table No.1 Fuel consumption

Months	Electricity (Kwh)	Briquettes (Kg)	Diesel (Ltr.)	LPG (Kg)
April 15	637875	179181	883	9541
May 15	657000	216860	3609	9917
June 15	313650	254134	1011	10246
July 15	605325	266395	2357	9541
Aug 15	575325	256340	499	10152
Sept 15	591600	257748	569	9165
Oct 15	602475	233664	75	9729
Nov 15	369150	109597	4497	4515
Dec 15	186675	193641	62	7144
Jan 16	557625	130338	5196	6580
Feb 16	575625	250714	30	6982
Mar 16	645450	243714	3933	7932
Total	**6614775**	**2602326**	**18044**	**101441**

Pie charts obtained from above table no.1



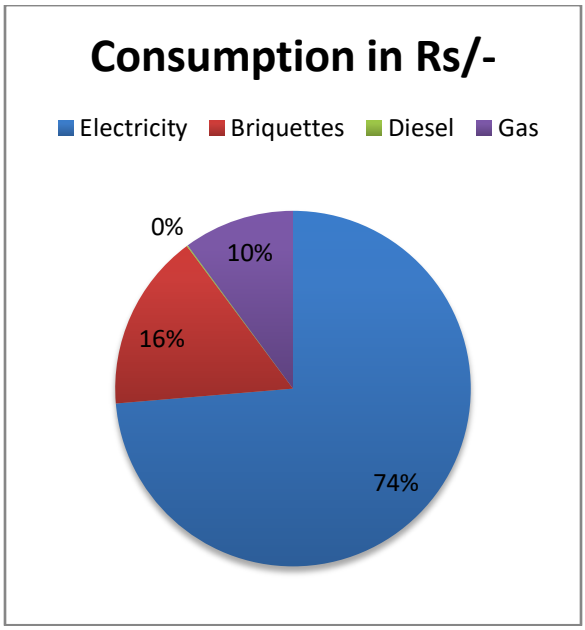


Fig. consumption is Rs.

Data analysis:

2. Compressor leak test:

This test is performed to ensure that the compressor is good in running condition and that proper clearances were maintained. The type of compressor used to provide the compressed air is screw compressor i.e., is rotating type. The leak test is conducted only when the whole production work is stop or only on maintenance period of company as for leakage test all the air connections are required off in order to calculate the accurate loading and unloading time of compressor.

2.1 Performance assessment and energy conservation measures in compressed air system:
Type of compressor = screw compressor
Compressor capacity = 525 CFM
Initial pressure = 5.6 kg/cm^2
Final pressure = 6.2 kg/cm^2
The compressor is in continuous operation

Percentage leakage in the compressed air system:

Table no. 2 measurements taken during compressor leakage test

Sr. No.	Loading time (sec)	Unloading time (sec)
1	25	51.75
2	27.59	54.7
3	27.85	55.21
4	28.82	55.91
5	27.31	54.39
Average time (minutes)	0.455	0.906

2.2 Calculation:

Percentage leakage =

$$\frac{\text{loading time}}{\text{loading time+ unloading time}} \times 100$$

$$= \frac{0.455}{0.906+0.455} \times 100$$

Percentage leakage = 33.43%
Leakage in CMM = 4.97
Leakage per day = 7158.57 CMM
Specific power for compressed air generation
= 75kW/(14.87X 60) CMH
= 0.084

Power loss due to leakage per Day
= 601.76 kWh

Financial Loss
= 15044 kWh / Month
= 1, 35,396Rs / Month
= 14, 62,276Rs/ Annum
Annual financial loss = Rs. 14, 62,276/-
2.3 Remedies–
As per above analysis to reduce such huge amount of financial loss, some investment is required in the compressors. Investment in compressor consists of:

i. Timely maintenance or replacement of gauges.

ii. Proper and regular maintenance of FRL unit.
iii. Addition of foot switches.
iv. Installation of solenoid valves for ring mains etc.

3. Air conditioners:

Air conditioning audit is for detecting the source of degradation of the performance and to find the profitable improvement in money and energy saving. Including split AC and centralized AC unit of industry, air conditioners are major energy consuming part.

3.1 Steps to determine the total possible financial savings in the split AC and in the central AC system the:

i. Measuring areas and volume of the rooms where air conditioning is provided.
ii. Look for tonnage capacity of AC in particular rooms and their average temperatures, as over sizing of AC with respect to area will reduce the efficiency of AC by 3%.
iii. Looking for ACs whose temperatures purposefully maintained on some specific temperatures, humidity also taken into consideration in such cases.
iv. Locating the leakages from the doors and windows openings.
v. Looking at loads for cooling which includes lighting, office equipment, solar gains and specific processes.
vi. In case of split AC direct sunlight on condenser also taken into consideration. It will reduces the efficiency of air conditioner and consume more electricity.

Sr.No.	Installed AC tonnage capacity	Room volume (Cubic ft.)	Required rating	Excess tonnage
1.	5	250	2	3
2.	5.5	496	4.1	1.4
3.	4	260	2.2	1.8
4.	8	750	6.2	1.8
5.	8	640	5.3	2.7
6.	2	200	1.5	0.5
7.	4	170	1.5	2.5
8.	1.5	120	1	0.5
9.	4.5	370	3.1	1.4
10.	1.5	42	0.75	0.75
11.	2	44	0.75	1.25
12.	2	44	0.75	1.25
13.	1.5	44	0.75	0.75
14.	3	44	0.75	2.25
15.	3	44	0.75	2.25
16.	4	135	1.5	2.5
17.	1.5	59	0.75	0.75
18.	2	35	0.75	1.25
19.	2	84	0.75	1.25
20.	2	58	0.75	1.25

Table No. 3 AC consumption

3.2 Calculations:

In air conditioning mostly loss of excessive energy occurs due to over sizing of AC. The following calculations show the energy consumption due to over sizing of AC and respective financial loss.

Recommended tonnage of AC = 2 ton
Installed AC = 5tones
Computer room excess tonnage
= 3tonn
=10.56 kW

Excess loss considering excess wattage
= 10.56 × 0.15
= 1.584
Annual loss in kW:
As ACs are inworking conditions 4hrs in a day.
Therefore,
= 1.584× 4 × 26 × 12
= 1977 kW / annum
Annual loss in rupees:
1 kw = 9.5/- Rs
= 1977× 9.5
= Rs. 19907/-
Annual financial loss = Rs. 19907/-
Note:-Above calculation is for 1 AC the total financial loss due to over sizing of ACs considering all split ACs and central AC system is about **Rs. 8,38,097.7/-**

3.3 Remedies-

i. Use 3 - star rating ACs.
ii. Avoid leakages from the door, windows as much as possible
iii. In Assembly rooms or in test rooms where low temperature is required constantly, if possible install curtains to avoid leakages,
iv. Replace the oversize ACs with the recommended one.

4. Capacitors:

Capacitors are used duringthe motor startup phase and are disconnected from the circuit once a rotor reaches a predetermined speed, which is generally about 75% of the maximum speed of motor.

It is necessary to observe all the capacitors and based on their current rating and average current ratio between KVAR and KVR was calculated. If the percent deviations is in the range of 0-10% then the capacitor is in good working conditions. If it is in between range of 10-15% then those capacitors are required to monitor properly. The capacitors with negative percentage deviation are recommended to be replaced immediately.

4.1 Calculations:

Store PBD KVAR = 25 KVAR

$$\text{Average current} = \frac{(R \times Y \times B)}{3}$$

$$= \frac{27.4 \times 27.12 \times 27.6}{3}$$

= 27.37 A

$$KVR = \frac{\sqrt{3}\, V \times I \times \cos\emptyset}{1000}$$

Here, Cos ϕ = 1

$$= \frac{1.725 \times 27.37 \times 430}{1000}$$

= 20.30 KVR

$$\text{Annual loss in kW} = \frac{KVAR - KVR}{25 \times 75 \times 24 \times 0.3}$$

$$= \frac{25 - 20.30}{25 \times 75 \times 24 \times 0.3}$$

= 101.48 kW/ anuum

Annual financial loss = Rs. 964/-

Note:-
Above calculation is for 1 capacitor the total financial loss due to faulty capacitors is about **Rs. 21,000/-**

4.2 Remedies:-

i. Timely monitoring of capacitors
ii. The capacitors with negative deviation are replaced immediately.

5. Conclusion:-

Comprehensive energy management program can be implemented by the energy audit of the total system and which is very effective tool for identification of energy saving measures. Industrial energy system can be effectively managed at minimum energy cost with the help of precise energy audit of that industry.Improvement in production, and quality improvement as well as increase in profit are the advantages of energy audit.

Also it leads us towards contribution in global energy saving Manufacturing industry is the major sector which consumes energy on large scale so energy audit is carried out in manufacturing industry and some energy saving measures are presented in this paper based on real time field data. Energy saving opportunities are presented in this paper in the form of tests, findings and remedies. Effective financial savings can be achieved by the implementation of such type of energy audit so this work is of significant importance.

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