Energy Audit - A Case study on Centrifugal Pump

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Abstract— Energy conservation is very important nowadays, considerable energy saving is possible by proper choice of equipments, and their effective and efficient use. Energy Audit is an important tool Energy Conservation and Energy Management. The Energy Audit is the index of the Energy Consumption which normalizes the situation of Energy Crisis by providing the conservation schemes. By energy audit the energy crisis can be handled through the efficient use of available energy. By using standard systems and procedures considerable amount of energy requirements per unit of output can be achieved. In this paper a case study of centrifugal pump in industry for energy audit is presented.

Key words: Energy Audit, Centrifugal Pump

I. INTRODUCTION

The Energy Audit is a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with their use, and serves to identify all the energy streams in a facility. Energy audit is an effective tool in defining and pursuing a comprehensive energy management program within a business. The energy accounting, better control of energy use, creating awareness and following standard rules and regulations are the major factors to be considered in Energy Audit. It includes survey of work place, energy usage analysis, energy usage procedures, finding energy improvement opportunities, recommendation with cost benefit analysis.[1]

There so many applications of pumps like commercial and public buildings, water and sewage systems, oil and gas exploration, pulp and paper mill, electricity generation, etc. In life cycle of pump the operation energy cost is 85% for large water utility pumps. The considerable reduction in energy consumption can be achieved by selecting higher efficiency pump, by improving pump system design. The reasons behind inefficient energy pumping are poor system design, over sizing of pump, pump and system mismatching, pipe work layouts. By selecting a best suitable pump for a given system 50% of energy saving is possible.[2]

II. ENERGY AUDIT

The energy audit identifies areas in the establishment of consuming unnecessarily too much energy. In factory, an energy audit increases awareness among plant personnel of energy issues. Itassesses energy saving opportunities so as to save money where it counts the most. An energy audit gauges the energy efficiency of the plant against best practices, when used as a baseline for tracking yearly programs against targets. Energy audit is the first step towards saving money in the production plant. An energy audit seeks to document things like energy being used on site per year which includes use of energy and opportunities for savings. The energy audit report establishes the need for plant metering and monitoring. The energy audit action plan lists the steps and sets the preliminary budget for the energy management program.

III. ANALYSIS OF ENERGY USE

It includes identification of areas where energy used is most useful. This enables to focus on areas where the audit should be focused and raises awareness of energy use and cost. The results could be used in the review of management structures and procedures for controlling energy use.

IV. TYPES OF ENERGY AUDIT

It includes the alternative energy efficient measures that would also satisfy the financial criteria of the investors.

A. Preliminary Audit

The preliminary audit also called as a simple audit, screening audit or walk through audit, is the simplest and quicker type of audits. It involves minimal interviews with the site operating personnel, a brief review of the facility utility bills and operating data, and a walk through of the facility to become familiar with the plant operation and identify areas of energy waste or inefficiency. Major problem areas will be uncovered during this type of audit. Corrective measures are briefly described and estimates of implementation costs, potential operating cost savings, and simple pay back periods are provided. This helps to prioritize energy efficient project and determine the need for a more detailed audit.

B. General Audit

General audit or a mini audit/site energy audit expands on the preliminary audit. More detailed information about facility operation is collected so as to perform a more detailed evaluation of energy conservation measures identified. Utility bills for a period of 12 to 36 months are collected to evaluate the facility's energy/demand rate structures and energy wage profiles. Additional metering of specific energy-consuming systems is often performed to supplement utility data. In depth interviews with facility operating personnel are conducted to understand major energy consuming systems as well as insight into variations in daily and annual energy consumption and demand.

C. Investment-Grade Audit

Facility's energy infrastructure must compete with non-energy related investment for capital funding. Both energy and non-energy investments are rated on a single set of financial criteria that generally stress the expected Return on Investment (ROI).

Return on Investment = Net Profit after taxes/Total Investment

The projected operating saving from the implementation of energy saving should provide confidence to the investors. The investment-grade audit also known as a comprehensive audit, detailed audit, maxi audit or technical analysis audit expands on general audit providing a dynamic model of energy use of existing facility and all energy conservation measures identified.

V. POINTS TO BE CONSIDER FOR DATA COLLECTION

The data should be accurate for estimation of energy saving. Note down the operating hours of all equipments. Machines works on large induction motors have variable load with different power requirements, so duty cycle is important. For electric power user the 3-phase current/voltage reading is required along with power factor.

VI. CASE STUDY ON CENTRIFUGAL PUMP

A. Governing Equations for Efficiency Calculation

Hydraulic power can be calculated by,

$$P_h = \rho \times g \times Q \times H$$

Where,
P_h = Hydraulic power (kW)
ρ = Density of water (kg/m^3)
g = gravity (9.81m/s^2)
Q = Flow capacity (m^3/s)
H = Differential head (m)
Hydraulic horsepower can be calculated by,

$$P_{h(HP)} = P_h/0.746$$

Where, $P_{h(HP)}$ = Hydraulic horsepower (hp)
Pump efficiency can be calculated by,

$$\eta_{pump} = \frac{P_{h(HP)}}{BHP}$$

Where,
η_{pump} = Pump efficiency
BHP = Brake horsepower (hp)
Increase in efficiency can be calculated by,

$$= \frac{\eta_{pump(sugg.)} - \eta_{pump(exis.)}}{\eta_{pump(exis.)}}$$

Where,
$\eta_{pump(sugg.)}$ = Suggested pump efficiency
$\eta_{pump(exis.)}$ = Existing pump efficiency

B. Comparison of two pumps

Pump operates at full capacity with 6 hrs per day.
Existing pump details:
Model: Kirloskar Pump KDS-830++
Head: 28 meters
Discharge: 6 lps
BKW: 5.5 kW
BHP: 7.5 hp
Motor: 7.5 kW/10 hp, TEFC induction motor
Suggested pump details:
Model: Kirloskar Pump KDS-527++
Head: 28 meters
Discharge: 6 lps
BKW: 3.7 kW
BHP: 5.0 hp
Motor: 5.5 kW/7.5 hp, TEFC induction motor

	Our Requirements	Existing Pump Kirloskar KDS-830++	Suggested Pump Kirloskar KDS-527++
Head (m)	28	30	28
Discharge (lps)	6	11.1	6.4
BKW (kW)	-	5.5	3.7
BHP (hp)	-	7.5	5.0
P_h (kW)	1.6451	-	-
$P_{h(HP)}$ (hp)	2.2062	-	-
Pump efficiency (%)	-	29.42	44.12
Increase in efficiency (%)	-		49.97

Table 1: Comparison of Pumps

1) Cost Benefit Analysis

$$C = \frac{(\eta_{pump(sugg.)} - \eta_{pump(exis.)})}{\eta_{pump(sugg.)}} \times P \times Z \times S \times 0.746$$

Where,
P = Cost of energy per kWh
Z = Nos. of operating hours per year
S = Energy supplied to Motor

$$C = \frac{(44.12 - 29.42)}{44.12} \times 10 \times 6 \times 365 \times 7.5 \times 0.746$$

$$C = Rs\ 40{,}824\ per\ year$$

Cost of new pump type KDS-527++ = Rs 23,000

$$Pay\ back\ period = \frac{Cost\ of\ new\ pump}{Cost\ benefit}$$

$$= \frac{23000}{40824}$$

$$= 7\ months$$

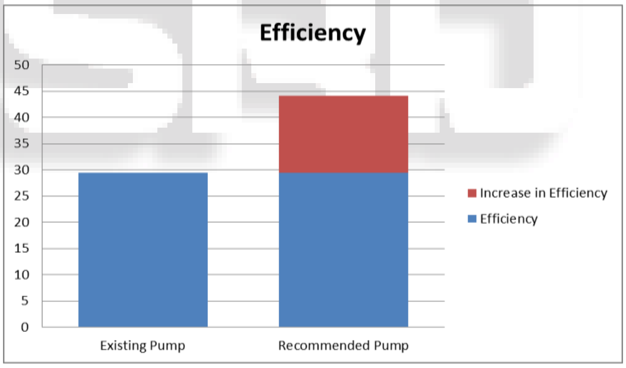

Fig. 1: Efficiency Graph

VII. CONCLUSION

In this paper the energy audit is shown for centrifugal pump. From the comparison table it is clear that the existing pump is driven at partial load so that a considerable amount of energy is lost and so that the efficiency of pump is law. By choosing the right pump for the given application, which will run at full load or near to full load will give greater efficiency compared to existing one and so that considerable amount of energy saving can be achieved. And considerable saving in form of money can be achieved.

REFERENCES

[1] Energy Audit and Energy Management by V. K. Gaudani, IECC press.
[2] Energy Conservation, Vol-II, Energy Efficiency in Electrical Systems by V. K. Gaudani, IECC press.
[3] Manuals of Pumps and Motors of Kirloskar Brothers Limited.

