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European Journal of Applied Engineering and Scientiic Research, 2018, 6(2):18-23

ISSN: 2278-0041

Energy Audit and Management Case Studies of Diesel Engine Manufacturing Industry

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ABSTRACT

All the Governments in world-wide increasingly see energy efficiency as an important aspect of sustainability. It is difficult to imagine spending an entire day without using energy. Because of the limited amount of non-renewable energy sources on earth, it is important to conserve our current supply or to use renewable sources so that our natural resources will be available for future generations. Energy Audit attempts to balance the total energy inputs with its use. Energy audit is an effective tool in defining and pursuing comprehensive energy management program. The Strategy of adjusting and optimizing energy, using systems and procedures so as to reduce energy use, In any facility, the three top operating expenses are often found to be energy (both electrical and thermal), labour and materials. Energy management function constitutes a strategic area for cost reduction.

The Diesel Engine Manufacturing industry is energy intensive. This study aimed to investigate and apply a proper Energy Management System (EMS) for the industry and identify potential savings by applying novel approaches. A number of improvement actions were identified, related cost savings were calculated and an action plan was developed for the implementation of those improvements. This paper describes energy management in Kirloskar Oil Engines, Pune with "energy-efficiency improvements" case studies. The implemented projects like, Use of Solar Water Heating System instead of electric heaters, Waste Heat Recovery from Compressors and waste heat recovery from exhaust of furnace which had highest cost savings.

Keywords: Heat recovery, Diesel engine, Fossil fuel

INTRODUCTION

The manner in which oil prices affect emerging and developing economies has received attention. Dependence on energy resources procured from outside the country has today created a precarious situation in terms of managing energy security of a country [1-3]. For a country such as India, which needs huge capital for improving its social and economic conditions, be it alleviating poverty or providing education for all of its 1.324 billion population, importing of energy supplies at a very high price does not augur well for future continuous energy supply [4-7]. Demand for energy to power the basic needs of life like Light, Heat & Mobility will continue to expand in future [8-12].

It becomes therefore imperative for Indian Industries to do their bit in reducing the overall energy consumption that is essential for producing goods and services. There is growing appreciation of the role that improvements in energy efficiency can play in bridging the gap between energy supply and demand [9,10,13,14].

At the same time, there is increasing realization that these improvements are not penetrating society as rapidly as their potential would suggest [15]. Attention is therefore being turned to the factors determining the implementation, acceptance and spread of these improvements. The term "energy-efficiency improvements" is used here in this extended sense to include any measure that results in the delivery of an energy service with a reduction of energy consumption [1,3,5,6].

Further, the term "energy-efficiency improvements" is not restricted to "retrofitting", i.e., improving the efficiency of devices and processes already in place and in operation, to conventional technologies. It includes an emphasis on energy efficiency in new plant and equipment, new technology and to the energy-intensive sub-sectors of industry.

Objective of the project

Nature sets some basic limits on how efficiently energy can be used, but in most cases our products and manufacturing processes are still a long way from operating at this theoretical limit. Very simply, energy efficiency means using less energy to perform the same function. The objective of this project was to undertake extensive work on Energy audit and management in order to bring energy cost reductions [16,17].

The idea behind undertaking this project was to work on practical cases of energy audit and Management, in order to understand the following:

- Identifying energy cost saving from the complex system.
- Prioritization of equipment for energy cost maximization.
- Equipment replacement, retrofitting or maintenance decisions for maximizing energy efficiency and minimizing operating costs.
- Identifying the energy efficient equipment's if replacement is planned.
- Various features involved in engineering, procurement and construction of energy conservation projects.
- The potential problems that could occur and ways and means to overcome them.
- Energy performance evaluation, monitoring energy efficiency and cost control.

With these objectives in mind energy Efficiency improvement projects were implemented in 'Kirloskar Oil Engines Ltd. Khadki, Pune 411003'.

Following approach was adopted for the energy audit

- Establish energy consumption at the facility.
- Collect existing or easily obtained data from sources such as log books, etc.
- Estimate the scope for saving.
- Identify the most likely and the easiest areas for attention.
- Conceive, develop, and refine ideas.
- Set a baseline.
- Identify areas for more detailed study/measurement.
- Contact consultants and vendors for new/efficient technology.
- Assess technical feasibility, economic viability and prioritization of Energy Conservation options for implementation.
- Select the most promising projects.

Following baseline data was collected

- Technology, processes used and equipment details.
- Capacity utilization.
- Amount and type of input materials used.
- Fuel Consumption.
- Electrical energy consumption.
- Other inputs such as compressed air, cooling water, etc.
- Quantity and type of wastes generated.
- Percentage rejection/reprocessing.

- Efficiencies/yield.

CASE STUDY I

Use of solar water heating system instead of electric heaters

When you convert electrical energy into heat, the process is known as electrical heating. The best example of an electric heating device is to take a look at an electric heater which has a number of different heating applications whether it is with regards to heating oil or water or an interior space. The core working of the electrical heater is based on the joule heating principle. Here, an electrical current that is passed through a conductor is converted into heat which is then used for industrial heating [7,8,11].

In the industrial plant operations while assembling of various parts of diesel engines crankcase are washed before painting and assembling with (water+cleaning solvent). The solution (water+Solvent) used to wash the crankcase become hot having maintained maximum temperature of 60°C. The liquid tank contains 8 nos. of heaters of 5 kW rating are used to heat the solution. The heaters are ON for 24 h, which consumes large amount of electricity.

Power consumption was reduced by supplying heat generated from solar water heating system to heat the water instead of using conventional heaters in the liquid tank.

Summary of case study

Table 1: Summary of case study

Reduction in Annual energy consumption	**95152 kWh per annum**
Total yearly electricity bill saving (Rs. 9.61 per unit)	Rs. 9,14,410
Investment made in project	Rs. 16,30,000
Payback period	21 months
ROI	56.09%
Solar radiation intensity	300 kCal/m^2 h
Total collector used	55 nos.

As shown in Table 1, by implementing an Energy Management System project, Kirloskar oil Engines has saved 95152 units of power per annum, against a minimal capital investment of Rs. 16,30,000. The company will able to offset this investment in 21 months. This profitability analysis shows that improvements in industrial energy efficiency through the implementation of an energy audit and management project, it also provide an enabling and sustainable business model to increase and enhance the enterprise's competitiveness.

CASE STUDY II

Waste heat recovery from compressors

Many businesses gain significant financial benefits from installing waste heat recovery equipment, especially if their site has long operating hours. The cost of recovering hot water systems can have pay back investment in less than two years [18].

During the process of compressing the air heat is generated which is 'dumped' into the environment even though it could still be reused for some useful and economic purpose. The essential quality of heat is not the amount but rather it's 'Value'. The strategy of how to recover this heat depends in part on the temperature of hot air generated during compressing. If some part of this waste heat is utilized it can be possible to improve the efficiency of compressors. As much as 80-93% of the electrical energy used by an industrial air compressor is converted into heat. In many cases, a properly designed heat recovery unit can recover up to 50-90% of this available thermal energy and put it into for doing useful work like heating water/air used in other industrial processing units [12,14].

In a Compressed air system, compressed air is leaving the compressor at 120°C to 150°C. The total heat recoverable at 60°C,

Waste Heat Recover:

$Q=V \times ñ \times C_p \times T$

Where,

- Q is the heat content in kCal
- V is the flow rate of the substance in m^3/h
- ñ is density of the air in kg/m^3
- C_p is the specific heat of the substance in kCal/kg°C
- T is the temperature difference in °C
- C_p (Specific heat of air)=0.24 kCal/kg/°C

This amount of heat is supplied to the 4 number of diesel engine washing machines having heaters of capacity 15 kW, 45 kW, 28 kW, 15 Kw, respectively. All these heaters are ON for 24 h in the tanks for heating (water+solvent) having maintained maximum temperature 60°C of liquid tank. The basic principle lies in the transferral of heat into a medium and then transporting it to where it can be utilised. If water was to be heated, this will reduce approximately 72% of the overall power consumption for water heating using conventional electric heaters.

Summary of case study

Table 2: Summary of case study

Annual electricity saving	**70,121 kWh per annum**
Investment required in this project	Rs. 9,56,687
Annual electricity cost saving (Rs. 9.61 unit)	Rs. 6,73,862
Payback period	17 months
Return on Investment	70.43%

After implementing an Energy Management System project, has saved 70121 units of power per annum, against a minimal capital investment of Rs. 9,56,687. The company will able to offset this investment in 17 months as shown in Table 2. This profitability analysis shows that improvements in industrial energy efficiency through the implementation of an energy audit and management project, it also provide an enabling and sustainable business model to increase and enhance the enterprise's competitiveness [16-18].

CASE STUDY III

Waste heat recovery from the exhaust of furnace

Thermal efficiency of process heating equipment, such as furnaces, ovens, melters, heaters and kilns is the ratio of heat delivered to a material and heat supplied to the heating equipment. For most heating equipment, a large amount of the heat supplied is wasted in the form of exhaust or flue gases. These losses depend on various factors associated with the design and operation of the heating equipment. This technical brief is a guide to help plant operators reduce waste heat losses associated with the heating equipment. In any industrial furnace the products of combustion leave the furnace at a temperature higher than the stock temperature. A sensible heat loss in the flue gases takes place, while leaving the chimney. It carries 35-55% of the heat input to the furnace. The higher the quantum of excess air and flue gas temperature, the higher would have been the waste heat availability. A recuperator is a device that recovers heat from the exhaust gas coming out from a furnace. A metallic recuperator has heat transfer surface made up of ceramics. When the exhaust gas temperature is lower than 1000°C and air for combustion is preheated, a metallic recuperator is used in general [5,10,13,14].

Measurement and data collection

Table 3: Data collected and there measurements

Furnace	Melting bath temp (°C)	Molten bath capacity (kg)
SRK	760	500 kg
OF1	755	250 kg
OF2	759	250 kg

Table 4: Parameters and the quality

Sr. No	ParameterS	Quantity
1	Production rate	220 kg/h
2	HSD consumption	18 L/h
3	Time for one batch	90 min
a	Melting time	70 min
b	Pouring and charging	30 min
4	Melting point of aluminium	660°C
5	Monthly consumption	10,000 L

Summary of case study

Table 5: Summary of case study

Reduction in oil consumption	10,704 kg/year
Diesel oil cost saving (Rs. 63/L)	Rs. 6,74,352 per annum
Investment required	Rs. 6,00,000
Payback period	1 year
Efficiency of furnace before implementation of project	15%
Efficiency of furnace after implementation of project	33%

The recovery and utilization of waste heat not only conserves fuel (fossil fuel) but also reduces the amount of waste heat and greenhouse gases damped to environment. After implementing an Energy Management System project, has saved 10,704 kg of diesel oil per annum, against a minimal capital investment of Rs. 6,00,000. The company was able to offset this investment in 1 year as shown in Tables 3-5.

Cost-benefit analysis after implementation of all projects

Table 6: Cost-benefit analysis

Sr. No.	Projects	Investment Rs.	Anticipated yearly energy saving
1	Solar water heating system for paint booth system in R shop	14,30,000	95,152 kWh
2	Waste heat recovery from compressors for hot water generation required for diesel engine washing	8,56,687	70,121 kWh
3	Waste heat recovery from exhaust of furnace	6, 00,000	10,704 kg/year

CONCLUSION

Although industrial energy efficiency can be improved by operational measures without capital expenditure (good housekeeping), ultimately capital investment is required. Increasing the rate of investment into energy efficiency should be a prime objective and a result of policy. Measuring that rate to the extent that it is possible can provide an overall measure of success of industrial energy efficiency programmes. Mandatory audits can increase the rate of project development but ultimately all projects have to be financed [17].

This study evaluated different technologies and current waste heat recovery practices in a variety of applications in industry: Systems analyzed varied significantly in terms of typical recovery practices. It was concluded that alternate sources like use of solar energy and use of waste heat from compressors and furnaces can be significant and require further investigation. Large quantities of low-temperature waste heat are available in industry for heating water required in the processes as shown in Table 6.

REFERENCES

[1] Venugopal, V.J., Mangalore Refineries and Petrochemicals Ltd., BEE ISSUE # EE28, **2016**.

[2] Rasmussen, N.T. and Roitman, A., International Monetary Fund (IMF) Working Paper- WP/11/194, Middle East and Central Asia Department, **2011**. p. 1-30.

[3] Loper, J., Devranoglu, S. and Capanna S., Working Document of the NPC (National Petroleum Council) Global Oil & Gas Study, **2010.**

[4] Reddy, A.K.N., *Energy Policy*, **1992**. 19(10): p. 953-961.

[5] Leroux, M., Energy Management - ABB Inc.

[6] Olivier, J.B. and Jordi, G., NBER (National Bureau of Economics Research) Working Paper No. 13368, **2007**.

[7] Maithel, S., et al., Energy Conservation and Pollution Control in Brick Kilns, **1999**.

[8] Mills, E., Martin, N. and Harris, J., ECEEE Summer Study Proceedings, Panel 4 - ID 150 - p1, **1998**.

[9] McKane, A. et al., Proceedings of EEMODS 07. - Report Number: LBNL-63417, **2008**.

[10] Moezzi, M., California Institute for Energy and Environment (CIEE), University of California, **2009**.

[11] Jue, E., Centre for Clean Air Policy (CCAP), **2008**.

[12] Roubini, N., The effects of the recent oil price shock on the U.S. and global economy, **2004**.

[13] Banerjee, N., Rollins, S. and Moran, K., ACM New York, NY, USA, **2012**.

[14] Perry, R. and Wacks, K., CableLabs®, **2010**.

[15] Gillingham, K., Richard, G. and Newell, and Palmer, K., NBER Working Paper No. 15031, **2009**.

[16] Jaffe, A.B. and Stavins, R.N., *Energy Policy,* **1994**, 22(10): p. 804-810.

[17] Hanleya, N., *Ecol Econ*, **2008**, 68(3): p. 692-709.

[18] Priolkar, J., *Innov Res Sci Technol*, **2016**, 2(10).