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Energy Conservation through Energy Audit of an Automobile Ancillary–A Case Study

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Abstract—*In automobile ancillaries involved in the manufacture of structural components of engines using powder metallurgy, power cost serves as a major cost to the company and should be controlled in an efficient manner. The aim of this paper is to discuss various techniques involved in the energy audit process and to present a study that was conducted in an automobile ancillary which uses the same manufacturing technique to achieve subsequent energy optimization by incorporating a standard "11 Step Problem Solving Methodology".*

1. INTRODUCTION

Powder metallurgy has come up to be one of the most efficient ways for the manufacture of engine equipment and parts that have to sustain a wide range of pressures and temperatures. This process involves blending fine powdered materials, pressing them into a desired shape or form (compacting), and then heating the compressed material in a controlled atmosphere to bond the material. Although this process is a very efficient method for manufacture of small sized components, it is highly energy intensive. The energy required for blending, compacting and sintering process alone can take up to 60% of the total cost of production of such components. Hence, energy optimization in manufacturing units producing engine components using powder metallurgy is of top priority.

To achieve such energy optimization, such manufacturing units organise energy audits on a regular basis. The term energy audit is commonly used to describe a broad spectrum of energy studies which ranges from a quick walk-through of a facility in order to identify major problematic areas to a comprehensive analysis of the suggestions of alternative energy efficiency measures useful to satisfy the financial criteria of investors.

This paper presents a case study of an energy audit of an automobile ancillary in Delhi-NCR region (named XYZ for anonymity) involved in the production of valve guides and valve seats for internal combustion engines using powder metallurgy. Company XYZ has been facing a continual increase in energy consumption with an inadvertent increase in electricity bills. Although this increase in the energy consumption is primarily due to the rise in the production volume, but the gradient in the increase in energy consumption is not as per the increase in production volume. The aim of this audit was to identify the major sources of energy consumption and suggest ways to control the rise in energy consumption.

2. LITERATURE REVIEW

For maximum profit, it is necessary to keep the production cost of a component to a minimum. Apart from the actual manufacturing cost, there are various other factors on which the cost of production of a product depends. Energy cost is one of the factors that directly influence the manufacturing cost of product.

Energy audits are conducted all over the world in various organization to optimize the energy consumption patterns. There are three types of energy audits, *viz.*

1. Preliminary energy audit
2. General energy audit
3. Detailed energy audit

The names of the types above suggest the level of scrutiny provided in each level [1].

Focussing on the areas where energy optimization can be achieved, Singh [2] compared the energy consumption patterns by industrial lighting by mathematically studying the consumption by halogen, LEDs and conventional lamps. The findings were later compared and the analysis of the results explains that even though the initial investments in replacing the existing halogen based lamps was high, the return of investment can be achieved in a relatively shorter period of time.

Khare [3] investigated various machines in an industrial unit. In his study by utility machines, service maintenance and production systems, were narrowed down to the compressed air, boiler and steam and the cooling tower system respectively. Followed by investigation, the applications of the suggestions achieved a total cost saving 79,000 INR within a payback period of 2 months only by optimizing mechanical components of various units like compressors, cooling tower, CT fans etc. in a boiler unit.

Kulkarni and Patil [4] achieved a total energy saving of 8, 98,700 INR. The above results were achieved by basic lighting survey which involved the replacement of copper ballast by electronic ballast coupled with the use of reflectors to improve illumination. Furthermore, an electrical motor survey brought up the fact that changing the metal fans with lighter plastic or fibreglass fans prevent material build-up and can help achieve a total reduction of approximately 2% since they can achieve the required revolutions per minute with a relatively lower consumption of electricity irrespective of the load on the motor. Also, by quantifying the amount of harmonic distortion due to the excessive use of non-linear electrical loads in automation and by installing suitable distortion filters, power wasted can be prevented.

A plethora of research papers are available in the field of energy audit. Many studies have been conducted to optimize the energy consumption in organizations of different scale. This study was focused on energy consumption optimization in an automotive component manufacturing plant.

3. METHODOLOGY

To perform an energy audit in facility XYZ, the following steps were followed as per existing audit methodologies developed in IEA EBC Annex 11, by ASHRAE and by Krarti [Fig. 1].

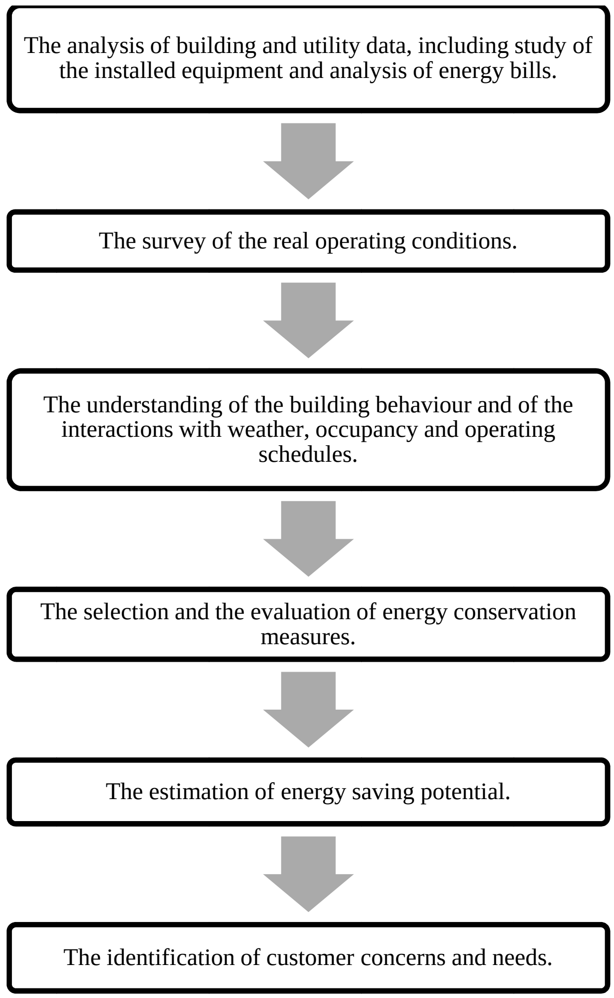

Fig. 1: Energy Audit Steps

The main source of electricity is primarily arranged from the state electricity board (RSEB) and secondary DG supply in case of power outages. The company spends an average of Rs. 30, 00,000 per month on electricity bills [Fig. 2]. The amount prescribes the combined cost from both sources.

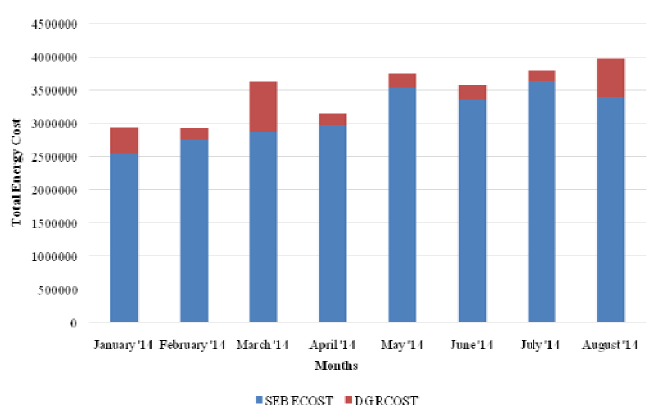

Fig. 2: Monthly Energy Cost

As seen from the above data representation in [Fig. 2] the average energy consumption trend sees a 21% increase from April 2014 to May 2014. This increase in energy consumption can be accounted to the use of chillers, air-conditioners and over-head fans.

Out of the total machining and other equipment, it was found out that 55-60% of the total energy is consumed by the 150T press, sintering furnaces, air compressor and (Category A). 30% of the total energy was consumed by the sintering furnaces (Category B). The remaining 10% energy is Out of

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30% of the total energy was consumed by the sintering furnaces (Category B). The remaining 10% energy is consumed by the CNC machines in the machining area, air conditioning, lighting and other utility machinery (Category C) [Fig. 3].

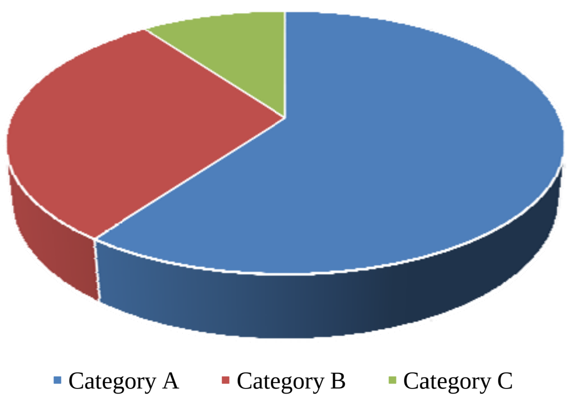

Fig. 3: Energy Consumption Distribution

Table 1 shows the number of machines belonging to the above mentioned categories based on their energy consumption.

Table 1: Number of machines as per assigned categories

CATEGORY	EQUIPMENT	NUMBER
A CATEGORY (Total Load>90 kW)	15T PRESS 50T PRESS 70T PRESS 150T PRESS 200T PRESS 300T PRESS AIR COMPRESSER SINTERING FURNACE	04 04 01 02 02 01 01 04
B CATEGORY (15 kW<Total Load<90 kW)	AMMONIA CRACKER	02
C CATEGORY (Total Load<15 kW)	CNC MACHINES AUTO LATHE MACHINES GRINDING MACHINES GROOVING MACHINE LIGHT DIPPING MACHINE COLD CUTTER FLEX GUARD CUTTER FLEX TAPE CUTTER CRACK TEST MACHINE PROFILE PROJECTOR LIGHTS (250W) FANS AIR CONDITIONERS	14 04 06 01 01 01 01 02 02 01 112 48 21

All the above categories were individually monitored and investigated.

4. RESULTS AND DISCUSSIONS

After careful investigation of the machines, the following observations were made,

- There is a seasonal variation in the electricity consumption. . Due to this seasonal shift, the percentage increase in electricity consumption between April, 2014 and May, 2014 was around 21%. This increase in the electricity consumption was due to the increase in the use of chillers, air conditioners and fans.
- 150T press had the largest production volume as compared to the other presses. The press encountered major energy losses due to consistent breakdowns and took a considerably larger time in set-up and maintenance. The above factors coupled with the unavailability of workers resulted in a total of 80% contribution to the total machine down-time.
- The factory uses domestic geysers to shower hot water on the liquefied ammonia cylinders to prevent its freezing in winter season. The showered water goes wasted due to the unavailability of appropriate storage system involving channels to direct water to the storage tank. Moreover, efficient heat transfer cannot be achieved by using running hot water as the source. This ultimately adds to the energy losses.
- After rigorous investigation of the compressed-air system, it was found that there were multiple points of leakage within the system, primarily along the distributor channels at the inlet to the CNC and Auto-lathe machines. Furthermore, it was found out that the air guns employed for the cleaning of job piece after machining were misused by the workers. These leaks and misuse do not let the compressor go off-load and hence runs continuously, resulting in the increase in the energy consumption.
- The facility uses Halogen lamps for illumination. These lamps have an individual power rating of 250 Watts. Given the number of lamps in the factory, the power cost pertaining to these lamps can be greatly reduced by using more efficient lamps with similar luminous intensity.

5. CONCLUSIONS AND FUTURE SCOPE

A culminated report of the above observations was presented to the facility. After analysis of the operating conditions and various machines, it was found that there is a great scope of optimization in the compressed air system, hydraulic presses, lighting system and nitrogen plant's inlet system. By carefully monitoring and working over the existing flaws in the operation of the above stated areas, maximum energy savings can be achieved.

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