Electrical Energy Audit in Textile Plant: A Study

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Abstract: Textile plant being one of the most energy intensive processes holds a good promise of saving electrical energy. This report through one of its preliminary study of a major textile plant identifies the key areas where electrical energy can possibly be saved. The report opens up new vista of saving energy in a textile industry.

Keywords: Textile plant, electrical energy saving opportunity, energy audit.

1. INTRODUCTION
The three basic needs for human beings are food, clothing and housing. Textile plants therefore fulfil the second basic need of human beings. The process of making cloth is energy intensive and therefore offers much scope in conservation of energy since electrical energy is the major form of input that goes in the process and energy audit of electrical energy holds a promise.

2. PROBLEM DEFINITION
Most of the textile plants have several common features and therefore if the key features for conserving electrical energy are identified then it is quite possible that these can be replicated to the other plants as well. The key objective of this work is to make a preliminary study of a major textile plant to identify and quantify these saving opportunities.

3. METHOD
A major textile plant producing yarn fiber from caprolactam as raw material is identified in the region. After several visits, the process of yarn making is understood. Major energy consuming devices are identified and after doing the related literature survey the energy saving opportunities are identified and even quantified in some cases.

4. RESULTS AND DISCUSSIONS
As a result of the study conducted in the textile plant, a layout of this plant so formed is shown in Figure 1.

![Plant Layout](image1)

Figure 1: Textile Industry Layout

The electrical energy saving opportunities in various sections of this plant are identified and listed below:

4.1. Identifying Oversized Motors
When a motor is made to drive a load which is low as compared to the horsepower rating of the motor, efficiency of the motor reduces. A large number of motors are working in this manner in the textile plant. There are many reasons that lead to over-sizing of the motor in the plant. Few of them are listed below: (a) Absence of actual loading parameters; (b) lack of knowledge about the actual load; (c) Incorrect future planning to handle the increase in load while selecting motors; (d) To handle any motor failure in critical process.

Equation that is used to estimate the proper load for a motor is shown below:

\[
\text{Load} (\%) = \left( \frac{\text{input KW} \times \text{full load efficiency}}{\text{rated HP} \times 0.746} \right) \times 100
\]

It is observed that efficiency of a motor decreases rapidly when operated at less than 50% load [1]. It is recommended that downsizing of the motor is economical where original motor is working at less than 50% load. Seven oversized motors in the range of 15-50 HP are identified.

4.2. Identifying Power Factor Improvement
Losses in the electrical system also depend on how close is the power factor to the unity. As the power factor keeps on going far from unity the efficiency goes on decreasing. Many electrical systems in the plant works at very low power factor which lead to lower efficiency. To achieve good power factor nearing unity to gain the better power factor benefits in the electricity bills, to reduce the Maximum Demand and applicable charges in the electricity bills, and to improve
power quality, the plant needs to employ dynamic reactive power compensation equipment.

\[
\text{KVAR rating} = \text{KW} \left( \tan \phi_1 - \tan \phi_2 \right)
\]

Figure 2: Power Factor Improvement

Figure 2 shows that by connecting capacitors we can improve the power factor of the equipment thus reducing the losses resulting in increase in energy saving [2, 3]. A total of 187 KVAR power factor improvement capacitors are recommended in the plant.

4.3. Identifying the Proper Loading of the Transformers

Transformers in the plant are operated in parallel mode. This mode of operation is frequently required. While using transformers, many things are there which need a lot of attention. Such as voltage-ratio, impedance matching, polarity matching, phase matching and proper loading. The break-even point for switching over from single operation to dual operation is given by the expression in fig. Simulating this equation, we get the graph of this break-even point as a function of ratio of full load loss to no load loss. This is also shown in Figure 3. The transformers under study are recommended to be operated in parallel as the load goes higher than 84%.

\[
\text{Loading} = \left( \frac{2 \times \text{no-load losses}}{\text{full - load losses}} \right) \times 100
\]

Figure 3: Percentage Loading vs. Break-even Point

4.4. Identifying Energy Loss in the Compressed Air system

More than 85% of the electrical energy supplied to the compressor in the plant is lost as waste heat. This system leads the systems in wasting electrical energy. So this property of compressed air system gives more energy saving opportunities [4].

\[
\text{Energy lost due to leakage} = \text{specificpower for compressed air generation} \times \text{leakage quantity}
\]

Measures that can be implemented to save energy are:
(a) Reducing the inlet air temperature; (b) Minimising the leakages; (c) Proper maintenance; (d) Optimising the compressor to match its load; (e) Proper piping size.

Implementing these measures in the plant, large energy can be saved.

4.5. Identifying Energy Loss in the Pumping System

Pump systems consist of pumps, driver, pipe installation and controls and are a part of the overall motor system. Pump applications in the plant include pumps for circulating cooling fluids to various sections in the plant [5]. Measures that can be implemented to save energy are:
(a) Maintenance; (b) Proper pumping size; (c) More efficient pumps; (d) Proper pipe sizing.

\[
\text{hydraulic power} = \text{pump capacity} \left( \frac{m^3}{s} \right) \times \text{head} (\text{m}) \times \text{fluid density} (\text{kg/m}^3) \times \text{acceleration} (\text{m/s}^2)
\]

\[
\text{pump efficiency} = \frac{\text{hydraulic power}}{\text{electrically} \times \text{motor efficiency}}
\]

5. CONCLUSION AND FUTURE SCOPE

Electrical energy is the most flexible type of energy since it can be converted to any form and can be transferred with equal ease. With every passing year the demand of electrical energy rises much higher than its supply. And therefore the only way to plug this gap is to identify the places where it can be conserved.

The preliminary study of textile plant has explored the possible energy saving areas such as in induction motors, p.f. improvement and optimised parallel loading of transformer. And analysis of some has been done as a way of warm up exercise. It has been seen in this study that a huge chunk of energy can be saved in replacing in-house rewound induction motors by new motors. It is therefore suggested that detailed study and analysis of these rewound motors be done in the future.

REFERENCES


Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management programme. As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, mon-. Bureau of Energy Efficiency.