Energy Management in Synthetic Fiber Industry "Case Study: Alexandria Fiber Co."

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Abstract: Energy conservation is an essential step towards overcoming the mounting problems of global energy crisis and related environmental issues. Energy Management is considered the key to effective energy conservation. Present study is dealing with developing an "Energy Management System", and implementing it in a real situation. A program was established as a continues improvement cycle. It started with formation of an energy management team, data collection, monitoring reports and audits. An action plan with specific goals was created based on recommendations of the energy management team. The implementation of the action plan included process modifications, old equipment replacement with more efficient ones, and power factor improvement. Cost savings and payback periods were also calculated. The implemented actions should have direct energy saving results. The established energy management system in this study can be implemented in different industries.

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1. Introduction

Acrylic fibers are textile material, a market survey in Egypt revealed a local demand of about 50,000 Tons per Year (TPY) of acrylic fiber. This requirement was met by importing acrylic fiber from European and South East Asian countries (El Raey, 2007).

Textile industry is one of the major energy consuming industries and retains a record of the lowest efficiency in energy utilization (Nagaraj, 2012). There are various energy-efficiency opportunities that exist in every textile plant. However, even cost-effective options often are not implemented in textile plants mostly because of limited information on how to implement energy-efficiency measures (Ali, 2010). Know-how on energy efficiency technologies and practices should be prepared and disseminated to textile plants.

Developing countries are interested in more efficient usage of energy. The know-how on modern energy saving and conservation technologies should, therefore, be disseminated and followed. It is particularly important that they acquire practical knowledge of the currently available energy conservation technologies and techniques. In the textile industry, appreciable amounts of energy could be saved or conserved (ECC, 1992).

Nagaraj, (2012) assumed paramount importance due to the rapid growth of process industries causing substantial energy consumptions in textile operations. This has made pathway to conservation of energy, which can be affected through process, machinery modifications and implementation of technological advancements relating to process optimization as well as development of newer methods to meet the challenge of substantial energy saving in textile wet processing. Hence, there is a need for replacing the conventional energy utilizing ways by the latest methods which will lead to considerable savings in terms of time, money and energy. Energy crisis globally, as well as high cost of fuels resulted in more activities to conserve energy to maximum extent.

The major elements in a strategic energy management program are management commitment, assessment and set of goals, creation and implementation of action plan; next evaluate progress and finally recognition of achievements, reassess of goals and set new ones. The concept for energy management system is based upon ISO quality management system of Plan-Do-Check-Act (Anonymous, 2004).

A successful energy management program begins with a strong organizational commitment. This involves assigning management duties to an energy director, establishing an energy policy, and creating a cross-functional energy team. Steps and procedures are then put in place to assess performance through regular reviews of energy data, and technical assessments. From this assessment, an organization is able to develop a baseline of energy use and set goals for improvement. Performance goals help to shape the development and implementation of an action plan (Anonymous, 2006).

An important aspect for ensuring the success of the action plan involves personnel throughout the organization. Staff should be trained in general approaches to energy efficiency in day-to-day practices. Evaluating performance involves the regular review of both energy use data and the activities carried out as part of the action plan. Information gathered during the formal review process helps in setting new performance goals, action plans and in revealing best practice (Anonymous, 2004; Worrell et al., 2010).

Moreover, using accumulated data shows how much energy was utilized and how it compared to the standard year(s) (Kennedy et al., 2003).

2. Materials and Methods

Study area

El Raey M. (2007) the plant is located at Amreya District, Alexandria. Its design capacity in ideal conditions should reach 100 Ton per Day. The main energy sources used in the plant are power and steam.

Energy Management strategy

The energy Management strategy was developed based on the elements shown in (Figure 1)

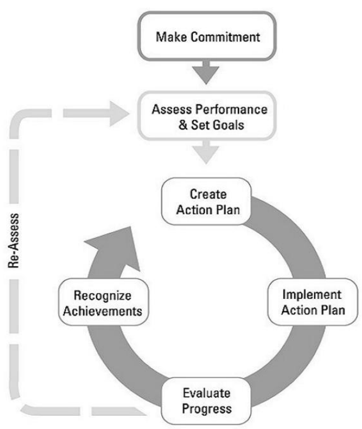


Figure 1. Main Elements of a Strategic Energy Management Program

Methods of Awareness Raising

Following the recommendations of Kennedy et al., (2003) an energy management program, to be successful, must have the backing of the people involved. An energy awareness campaign was launched in the company to introduce the importance of energy management to all levels of employees. The campaign consisted of: Training to shop floor employees about energy awareness. Editing articles about energy conservation in both the office and plant and publishing them in the monthly newspaper of the company. Energy saving posters were displayed in each office near the power switch key to remind the employees to switch off lights, PCs and printers when not being used.

Committee Formation

A committee was formed for monitoring and reporting energy consumption in the plant. In addition, identify potential savings and improvements projects for energy conservation. The committee consisted of an energy manager, energy coordinator and a cross functional technical team from the following departments Electrical, Instrumentation, Material Preparation, Production, Utility, and Mechanical. Roles and responsibilities were assigned to each member.

Monitoring Procedure

A monitoring and reporting system for power and steam collection data was introduced. The following data were collected: Power Consumption in Material Preparation area (kWh/Day), Power consumption by Production area (kWh/Day), Power consumption by Utilities (kWh/Day), Total Power consumption (kWh/Day), Total steam consumption (Ton Steam /Day) and Total Production (Ton Fiber /Day). Power consumption ratio is directly related to production. Power consumption ratio is calculated by dividing total power consumed on that month by total production.

A monthly review meeting was held by the energy management committee to identify the abnormalities, suggest improvement areas, set targets and review actions taken. Moments of meetings were being documented and circulated to all concerned in addition to top management. The recommendations of these meeting were discussed with the top management and the agreed goals aspects were included in the action plan.

Auditing

Based on Kennedy et al., (2003) the energy audit process starts with an examination of the historical and descriptive energy data for the facility. Specific data that should be gathered in this preliminary phase includes descriptive information about the facility such as a plant layout, and a list of each piece of equipment that significantly affects the energy consumption. Before the audit begins, the auditor must know what special measurement tools will be needed. A briefing on safety procedures is also a wise precaution. During the implementation of the management program, two types of audits were conducted in the plant: internal and external audits.

Internal Audit

The internal audit was conducted by in-house technical personnel. The audit was conducted on weekly basis. The purpose of the audit was to identify any steam, air, water or raw material leakages, abnormalities or losses in a specific area.

External Audit

As per Kennedy et al., (2003) an external agency for technical services support was consulted for identifying energy savings opportunities in the facility. The external audit team was accompanied by in-house members of the energy management team. The role of the energy management members was to facilitate the audit, provide technical support and exchange experience with the auditors. In agreement with the energy audit was conducted in three phases: preparing for the audit visit; performing the facility survey and implementing the audit recommendations.

Equipment and Tools

During the external energy audit conducted in the facility more specialized and complicated instrument were used such as: Portable Ultrasonic Flow meter (portalok7sz_04), Stroboscope (Testo 476), Ultrasonic leakages detector (Ultraprobe® 10,000), Thermal Image Camera (Fluke Ti32), Temperature-Humid meter (Vaisala Humicap® Hand-Held) & Thermometer (Raynger ST80) and Power Quality analyzer (Fluke 43).

Action Plan

The action plan was established based on the results of performance assessment analysis, suggestions indicated by the energy management team in their review meetings and recommendations of both the internal and external audits. The action plan contains: Status of action, Goals description, Actions required to be taken to achieve each goal, responsible of implementing the action, Dates of completion, revised completion and actual completion, Comments, Expected Savings, Estimated Investment, Expected Payback.

Next, a tracking system was developed to review the action plan. Status of actions were being updated on the system by the assigned responsible in coordination with the energy management coordinator and energy manager. The updated track of action plan was reviewed by top management on monthly basis. Consequently, performance assessment was done and new goals were set.

3. Results

Power Consumption

In order to assess the current performance of power consumption in the plant, four years data from 2009 to 2012 was collected for the power consumption ratio and plotted as shown in (Figure 2). Moreover, (Figure 3) shows total power consumption in 2012 in different areas in the plant.

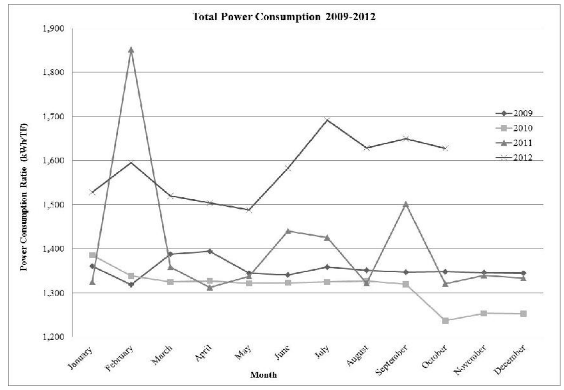


Figure 2. Power Consumption Ratio from 2009 to 2012

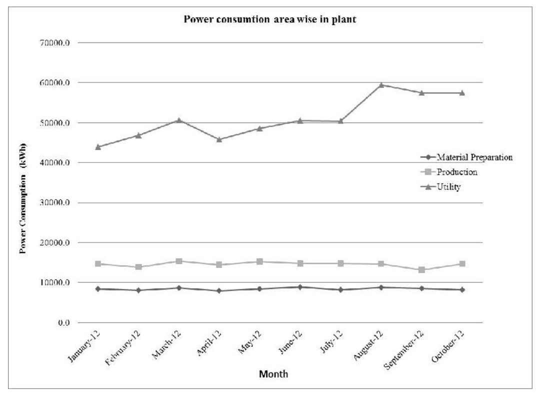


Figure 3. Total power consumption in 2012 in different areas.

More detailed analysis was done for the different areas (Figures 4, 5 and 6) present monthly power consumption in Material Preparation, Production and Utility areas respectively.

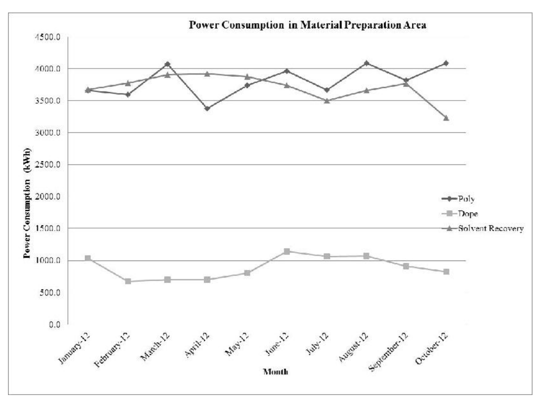


Figure 4. Monthly power consumption in Material Preparation.

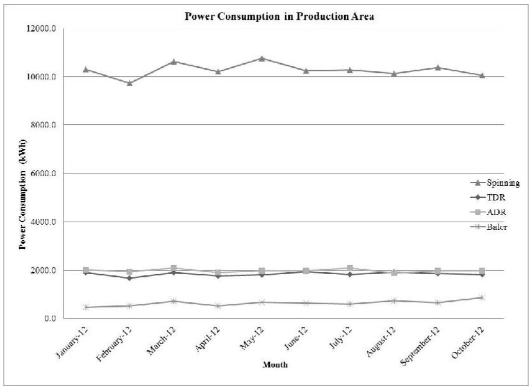
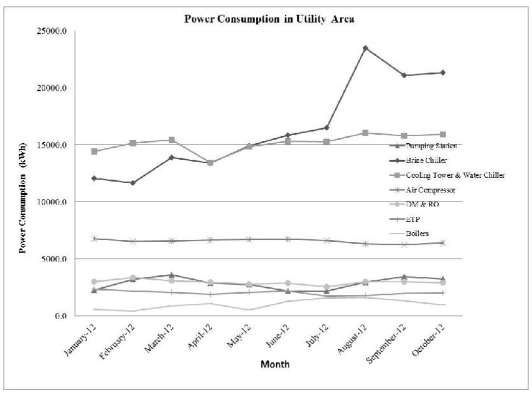


Figure 5. Monthly power consumption in Production area



Figures 6. Monthly power consumption in Utility area

Steam Consumption

Figure (7) shows steam consumption ratio in 2011 and 2012. Daily steam consumption ratio was calculated and plotted against norm.

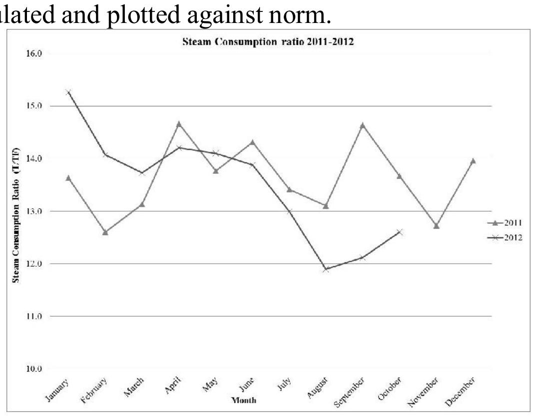


Figure 7. Steam consumption ratio in 2011 and 2012

The energy audit and action plan

An energy audit was conducted and an action plan for the energy management system was established. The most important goal were as following

a) Power Factor improvement

Power factor describes how much of the current contributes to real power in the load. It was found out that the Present power factor (P.F.) is 0.94. There is incentive of 0.5% of electricity bill for every increase of 0.01 P.F. from 0.92 P.F. onwards.

b) Steam Insulation & leak Survey

Steam trap and insulation survey was conducted by using infrared thermal imager. Thermal insulation provides safety, energy savings, and performance benefits. Few lines were found without insulation and most of valves are without insulation.

All steam traps were checked and five traps were found passing. Their location were identified for attending.

c) Utility Cooling Tower Pumps

There are three pumps in Utility cooling tower. Two pumps normally operates and one as standby. Design and Measured Data for Utility cooling tower Pumps were collected.

Table (1) shows the comparison in performance between the current utility cooling tower pump and the suggested new pump. Saving and payback period calculation are as following (Table 2)

Table 1. Comparison in performance between the current utility cooling tower pump-C and the suggested new pump

	Design	Present	New pump-
Flow (m^3/hr)	295	282	295
Head (m)	50	49.5	35
Motor Efficiency (%)	90	90	90
Power Input (kW)	Not Available	89.2	42.2
Pump Efficiency (%)	Not Available	47.4	74.0

Table 2. Saving and payback period calculation for replacement of utility cooling tower pump-C.

Energy saving (kW)	47.0
Operating hours per day (hrs)	24
Number of operating days (nos)	360
Power tariff (EGP/kWh)	0.44
Annual Savings (Million EGP)	0.179
Investment (Million EGP)	0.047
Payback Period (Months)	3

d) Motor loads

Motor load survey was carried out. It was found out that the operating motors are 35 years old motors almost near to their life span.

e) Change type of lighting

The lighting system provides many opportunities for cost-effective energy savings. Lighting energy use represents only 5-25% of the total energy in industrial facilities (Kennedy et al., 2003). The light system was checked during the energy audit. It was found that 400 and 250 watt HPMV lamps were used in different locations.

4. Discussions

Power Consumption

It can be noticed from (Figure 2) that highest power consumption ratio was on February 2011 due to temporary shutdown in production line whereas the utilities were still operating. At the same time, trend of power consumption ratio in 2012 increased more than other trends due to addition of new motors in utility area. More detailed data collection started in 2012, so more data was available for analysis.

From (Figure 3) it can be noticed that utility area is the major power consumer in the plant. Consequently, more detailed analysis was done for this area.

Figure (4) shows that lowest consumption was in Dope preparation and highest is in Polymerization and Solvent recovery. Figure (5) presents highest consumption is in spinning machine and lowest in baler. Figure (6) presents detailed analysis of monthly power consumption for all major units in the area. Highest power consumption is by Brine chillers, Cooling Towers and Water Chillers. The next major consumers are air compressors and finally, the lowest power consumption is by pumping station, RO & DW plant, ETP and boilers. According to this analysis utility area was considered the first priority area. It had a high potential for power optimization and conservation.

Steam Consumption

Steam consumption data was limited due to non-availability of steam flow meters. Only total steam consumption data for all the plant was available. One of the main recommendations by the energy management committee was to provide proper stream flow meters to monitor steam consumption in different areas.

The energy audit

In agreement with Kennedy et al., (2003) energy audit examines the ways energy is currently used in that facility and identifies some alternatives for reducing energy costs. The goals of the audit are to understand how that energy is being used and possibly wasted, to identify and analyze alternatives such as improved operational techniques and/or new equipment that could substantially reduce energy costs, to perform an economic analysis on those alternatives and determine which ones are cost-effective for the business or industry involved.

Implementation of action plan

Applied recommendations by the energy management team and the external auditors mentioned in the energy audit report were taken into consideration in the action plan. Goals were set, responsibilities were assigned and related time frame was created. In addition, required human and financial resources were provided for the accomplishment of the set goals.

a) Power Factor improvement

It is important to have a power factor close to unity. Reflected power is undesirable because the transmission lines or power cord will generate heat which causes problems for the electric utilities. (ASEA, 2004).

Capacitor banks are used to improve the quality of the electrical supply and the efficient operation of the power system (Gustavo et al., 2003). It was recommended to add Capacitor banks on 6.3 kV to achieve a Power Factor of 0.99. This will have a potential saving of 0.2 million EGP/Year and a payback period of one year.

b) Steam Insulation & leak Survey

It has been estimated that a 3 mm diameter hole on a pipeline carrying 7 Kg/cm^2 steam would waste 33000 liters of fuel oil per year (Vikram et al., 2012). Correcting steam traps will give steam saving of 0.1 MT/hr, annual saving will be about 807 MT/Year with monetary saving of 11,310 EGP/ Year.

c) Utility Cooling Tower Pumps

As shown in (Table 1) it was found out that the three operating pumps at the utility cooling tower were operating at low efficiencies. Suggestions were proposed to isolate the header as it is not required and causes head increase.

In addition, it was recommended to replace one pump with a new more efficient pump. Table (2) a potential saving of approximately 0.18 Million EGP/Year and payback period of 3 months only.

d) Motor loads

According to the results of the motor survey It was suggested to change the old motors in phased manner starting with lower rating motor. For 15 kW motor loaded at 70%, payback period is 2 years.

e) Change type of lighting

It was recommended to replace the used 400 watt HPMV lamp with a 200 watt "Pulse start Metal Halide" lamp. The Saving potential is 960 kWh/year/lamp and the payback will be less than one year. In the same way, the replacement of 250 watt HPMV lamp with 150 watt "Pulse start Metal Halide" lamp will save approximately 744 kWh/year/lamp and has a payback less than one year.

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