Specific Energy Consumption Reduction in a Carbide Cutting Tool Industry

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Abstract

Energy is consumed in a broad variety of ways across all sectors of life, from the provision of vital resources such as water, oil and gas, to the lighting and heating in homes and the power required by industry and commerce. Much of that energy is consumed usefully, but huge amounts are wasted every day. It is the waste or inefficient use of energy that must be addressed. The importance of energy conservation or reduction in consumption is not only a technique for cost reduction but also a mandatory responsibility of individual to protect the environment from Pollution and to avoid the depletion of natural resources.

This study presents an approach to reduce the energy consumption using SQC Technique. As a measure to compare and analysis the energy consumption trends, the Specific energy consumption was taken as basis. The main objective of this study is to reduce the specific energy consumption by 15% by using DMAIC approach. For Data collection, energy meters are connected at individual consumption end and then interface all meters to a computer through modbus communication. All the meters are configured to the computer to display the real trend of the selected Parameters like voltage, current, Power and Power factor etc. Through data collection, the major consumption area's has been identified and analysis has been done to identify the studies to reduce the consumption. After implementing the studies, the results are validated

The specific energy consumption has reduced from 0.64 Units/Piece to 0.57 Units/Piece after implementing the studies. As a result, the reduction in specific energy consumption was 10.9% against the target of 15%.This unveils the scope for further improvement and which may need further detailed study and analysis of the present condition.

Key Words: Energy Conservation, Specific Energy Consumption, DMAIC Approach.

Abbreviations

CVD	Chemical Vapor Deposition.
ENCON	Energy Conservation
EMS	Energy Management System
KVA	Kilo Volt Ampere
LF	Load Factor
PF	Power Factor
SEC	Specific Energy Consumption

1. INTRODUCTION

Energy efficiency is a fundamental element in the progression towards a more sustainable energy for future and has been on the business agenda for years with significant strides already achieved. As global energy demand continues to grow, actions to increase energy efficiency will be essential. There are many environmental benefits to energy efficiency including reduced emissions and reduced use of resources. The intention of energy conservation for a company begins with change in economic environment, direction of top management, regulatory compulsions from Government and stakeholders. The process of energy audit kicks off with good intention but many a times the findings are sealed in the bounded copy of audit reports. The factors that affects are organizational, technical, environmental, cultural and the people. There are initiatives taken over a period of time to conserve or to save the energy used for various purposes during the journey of human Life. But the results were not satisfactory as there were no systematic approach to address the issues. However, at present, a systematic methodology was evolved to conserve energy in a sustainable basis and also adopt renewable energy sources. The figure 1 explains the lifecycle solution for energy efficiency. Energy efficiency refers to the ratio between the inputs of energy consumed and the output of an energy service. Active Energy Efficiency is defined as effecting permanent change through measurement, monitoring and control of energy usage. Passive energy efficiency is regarded as the installation of countermeasures against thermal losses, the use of low consumption equipment and so forth. The figure 1 below depicts a PDCA cycle which ensures that the effort to achieve the energy efficiency should be continuous in a systematic manner.

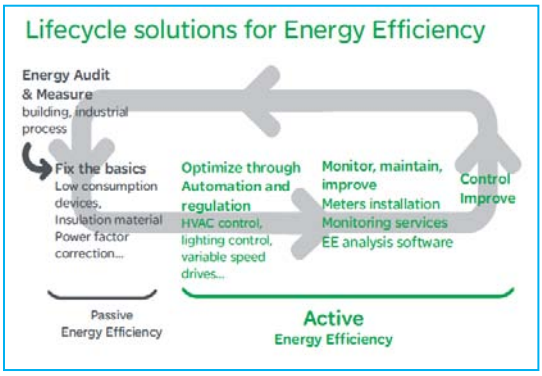

Fig. 3 Energy efficiency

Ravindra M Datar [1] mentioned that the energy audit is the first step towards systematic effort for conservation of energy. An energy audit identifies where energy is consumed and how much energy is consumed in an

existing facility, building or system. Information gathered from the energy audit can be used to introduce energy conservation measures. Energy auditing evaluates the efficiency of all building components and systems that impact energy use. The audit process begins at the utility meters where the sources of energy coming into a building or facility or a system. The efficiency of each of the functions is assessed, and energy and cost-savings opportunities are identified. At the end of the process, an energy audit study is prepared. George Reyes & Martin Rosen [2] narrated that the activity of a systematic energy audit comprises of identifying the energy system, evaluate the condition, the scope for improvement and reporting. There are three types of audits namely Walk through Audit, Standard Audit and Computer simulation. M/S. Schneider Electric [3] explored the two approaches to energy efficiencies namely, Active energy efficiency and Passive energy efficiency. The Active Energy Efficiency is defined as effecting permanent change through measurement, monitoring and control of energy usage. Passive energy efficiency is regarded as the installation of countermeasures against thermal losses and the use of low consumption equipments. An article by International Chamber of commerce [7], summoned the barriers exist between the deployment and adoption of enhanced energy efficiency measures.

P M Sayeed [4] explained that the Industry is the major energy consumer utilising about 50% of the total commercial energy use in India. The six key industries – namely aluminium, cement, fertilizers, pulp& paper, petrochemicals and steel - consumes about 65% of the total energy use in India. The energy intensity in some of these industries is reported to be higher than the industries in developed countries. One of the main reasons for higher energy use is the presence of obsolete and energy inefficient processes in some of these sectors. Karl & Roger [5] described about the requirement of an effective energy management system. They have mentioned that the reduction in energy consumption can be achieved through a lot of strategies in EMS depending up on the industry and system. Each strategy consists of set points, parameters and sequences that will ultimately determine how successful the strategy is for saving energy or improving the system. N.M.Majhi [9] highlighted the barriers like environmental, organizational, cultural, financial and People related towards the energy management services and how its affect the industries to sustain the profitability. The author suggested the adoption of DMAIC method of energy management and SWOT analysis to overcome the barriers but provided an efficient energy manager or Leader to co ordinate the activities.

In this Study, a systematic approach was taken to reduce the energy consumption in a Carbide Cutting tool Industry. The Specific energy consumption per product has measured and through DMAIC approach various studies were identified aim to reduce the same by 15%.

2. PROBLEM DEFENITION

The consumption from the generation and transport of electricity are generally three times the primary energy actually consumed. Or in other words, saving one unit of electricity in a home or business obviates the consumption of three times that amount of primary energy at a power plant. The carbide industry is an energy intensive industry because the energy cost is more than 20% of total cost. The aim of this study was to reduce the specific energy consumption by 15%. This has been achieved by implementation of an effective energy management system through DMAIC approach.

3. METHODOLOGY

This study addressed how the six sigma technique with DMAIC approach can apply to reduce the energy consumption. DMAIC is a Six Sigma acronym for the five interconnected phases of a process improvement study: Define Measure, Analyse, Improve, and Control. At the study level, the DMAIC structure enables study teams to identify the root causes of process variation, design and implement solutions to resolve these problems and to then measure and control the improvements. However, the following methodology had adopted to successfully complete the study.

- Literature review done by referring manuals, articles, journals to understand the energy conservation measures in various industries and different methods adopted to reduce the same.
- Studied and analyzed the present energy consumption at different function/area by real time monitoring of energy meters.
- Identified the area/function which is major contributors of energy consumption through statistical analysis.
- Studied the losses/scope for Improvement by measuring/comparing the efficiency and effectiveness of energy consumption in equipments.
- Identified and implemented different studies/methods to reduce the energy consumption.
- Implemented an effective Energy Management System to monitor and control the energy consumption through establishing standards & procedures/instruction and audits.

4. DATA COLLECTION

SI NO	Area	Function	Energy Consumption
1	Chiller	Utility for air conditioning and Process	23%
2	Compressor	Utility	18.95%
3	Sintering Process	Heat treatment	12.77%
4	Milling & grinding machines	Milling and Profile grinding	7.5%
5	Coating	Chemical Vapor deposition	6.4%
6	Lighting	Plant and area Lighting	8.5%
TOTAL			**77.12%**

Table 1. Vital area's for improvement

Data Collection is an important activity in any study because data articulates the current status clearly. The data collection is done to obtain useful information and

also to establish facts for making decisions. To study and to focus on the areas of improvement, data's were collected and through Pareto analysis the vital causes were identified. The figure 2 below tabulates the vital areas where the 77.12% of energy is being consumed.

5. ANALYSIS

This phase of the study was intended for identifying major root causes by data and process analysis. It facilitated to identify gaps between existing performance and goal performance. Cause & effect and why – why analysis have done to identify the root causes of the problems. The table 1 below shows the summary of the analysis. There were 12 improvement points identified through analysis.

SI No	Area	Problem	Root Cause
1	Chiller	Variable Load demand	Common chiller for different process
2	Chiller	Low set Point	Too much variation on demand
3	Chiller	More Idle Run	No small or medium capacity chiller
4	Furnace &Machines	High Thermal Loss	Unable to detect the loss
5	Furnace &Machines	Machine is ON while not in use	Machine design
6	Furnace &Machines	Accessories running continuously	Machine design
7	Furnace &Machines	More Batches on furnace	The batch Quantity is less
8	Compressor	More loss in distribution	Unable to detect the loss
9	Compressor	More consumption	Use of air for clean the part
10	Compressor	More consumption	Use of air GUN
11	Lighting	More consumption	No control over utility lighting
12	Lighting	More consumption	Use of metal halide lamp

Table 2. Analysis summary

6. PROBLEM SOLVING

There were 12 root causes identified through analysis and studys were also mapped to achieve the results. The table 2 below shows the action plan summary of the identified studys. By considering the ideal situation, an effort has made to tabulate the benefit out of the completion of the each study.

SI No	Problem	Solution	Benefits
1	Variable Load demand in chillers	To provide separate chiller for both process	Savings of 1,84,800 units/Annum
2	Low set Point for chiller	To provide a small chiller to a process to stabilize the load	Savings of 1.32 Lakh units/Annum
3	More Idle Run for chillers	To provide a small or medium capacity chiller	Savings of 42360 Units/Annum
4	High Thermal Loss on furnaces	To conduct a thermography study	Savings of 22,217 Units/Annum
5	Machine is ON while not in use	To establish Poke – Yoke or Kaizen	Savings of 1,22,888 units/Annum
6	Machine Accessories running continuously	To provide interlock between machine and accessories	Savings of 55,860 units/annum
7	More Batches on furnaces	To improve the loading method	Savings of 28,600 Units/Annum
8	More loss while air distribution	To conduct the air audit	Savings of 24,000 Units/Annum
9	More air consumption	To provide regulated air for gun	Savings of 24,000 Units/Annum
10	More air consumption	To reduce the air consumption for part cleaning	Savings of 7000 units/Annum
11	High energy consumption on lighting	To control the lighting through opto sensor	Savings of 2,513 Units/Annum
12	High energy consumption on lighting	To replace the metal halide Lamp with CFL	Savings of 54,900 units/Annum

Table 3. action plan summary

7. RESULT AND DISCUSSION

After implementation of improvements, measurements were performed to analyse gap between expected and achieved results. The specific energy consumption was measured along with the specific cost to verify the benefit. The graph 1 below shows the summary of the result.

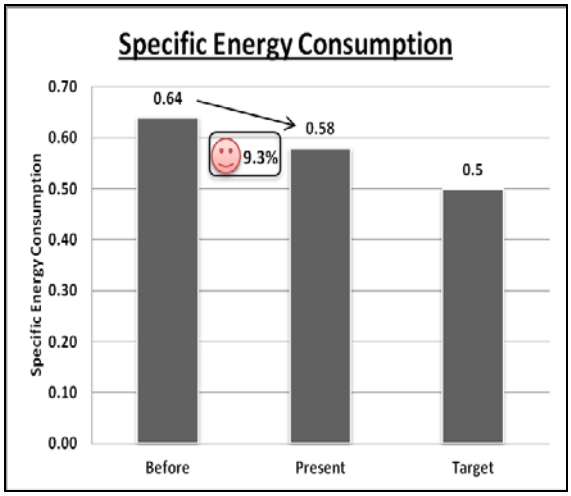

Fig. 3 Graph showing summary of results

The specific energy consumption has reduced from 0.64 kWh/piece to 0.58 kWh/piece. The target was to

achieve 0.5 kWh Units/Piece. Even though the target was to achieve 15% reduction in specific energy consumption; the actual achieved was 10.3%.

To quantify the benefit, the specific energy cost was measured for a period of 3 months. The specific energy cost is the cost of energy to produce a unit product. The figure 4 below shows the reduction in specific energy cost. There is a reduction of 6.55% after the completion of the studies.

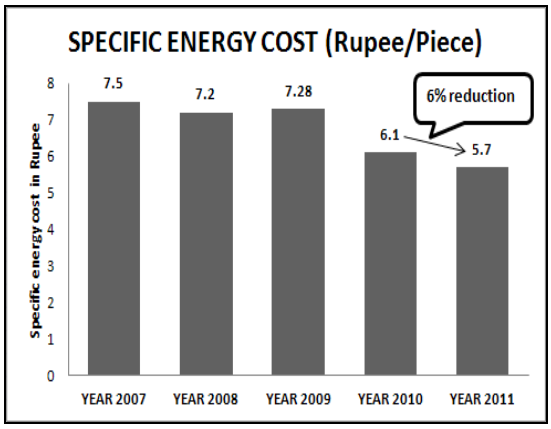

Fig. 4 Study benefit

The studies benefitted a saving of **Rs-28, 97,870** per annum.

8. CONCLUSIONS

The result shows that there is a lot of scope for further improvement. Even though the total energy savings were above 15%, the specific energy consumption was reduced by 10%. From the study we conclude that the energy cost was more than 20 % of the manufacturing cost. The specific energy consumption was taken as a measure to reduce the energy conservation activities. The study follows DMAIC approach. The specific energy consumption was reduced from 0.64 to 0.57 Units /Piece. The specific energy consumption shows a decreasing trend after implementing the study.

9. REFERENCES

1. Ravindra M Datar (2006), Energy audit, retrieved on 3/05/2011 from, *http://www.senergy/india.com/downloads /senergy-energy- audit.pdf*
2. Author Unknown, Energy Audit, retrieved on 5/07/2011 from *http://www.energyusernews.com*
3. Schneider electric (2008), Active energy, retrieved on 6/07/2011 from *http://www2.schneider-electric.com/medias /solutions/downloads/161active_ee_white-paper02_control.pdf*
4. P M Syeed (2004), Energy conservation in India, retrieved on 5/6/2011 from *http://www.powermin.nic.in /whats_new/pdf/Ministers_artical.pdf*
5. Karl & Roger, Energy Management system, retrieved on 6/14/2011 from *http://www.peci.org/documents/PECI_PracticalGuide1_0302.pdf.*
6. N M Majhi, "Managing Barriers to Energy Management Services", Issue of Technical Paper EE – 2009.
7. B H Bhatia, "Energy Efficiency with case studies" – Journal Published by International Chamber of Commerce, Document No.213/75 on 19th November 2009.
8. M/S Bosch, "Energy Efficiency at Bosch" – Case study from M/S Bosch: December 2009.
9. M/S Hindustan Zinc Ltd, "Details of ENCON Projects Implemented" – study report from M/S Hindustan Zinc Ltd, Vishakhapatnam (2008)