ENERGY MANAGEMENT AND AUDIT OF TEXTILE MILL
A CASE STUDY

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Abstract: Electricity consumption is increasing in textile mills, just because of the
continuous use of the modern equipments in inefficient operating parameters. The energy
cost is around 15\textsuperscript{o} to 20\textsuperscript{o} over the production cost and it stands next to raw material cost.
Hence now a day's area of focus is towards optimization of energy consumption at load end by improving the power factor. In this
paper, influence of motors and process of optimization in textile mill on energy conservation is
discussed with practical data.

Keywords: Energy, Textile mill, Energy audit, Power analyzer,Energy Saving

I. INTRODUCTION

In textile industry, electricity consumption and power cost is in increasing trend due to
modernized machines and continuous usage of the machines in inefficient operating parameters.
Apart from the cost of the power, there is shortage of man power in textile mills due to dusty
environment condition in the mill and large noise from the textile machines. Just because of this
reason workers are not working at textile mills. Hence, textile machinery manufacturers are
implementing automated machine, hence power requirement of the machine get increased.

To produce yarn (thread) from the raw cotton is the main objective of the textile mill which
requires six stages of process. The textile mill can be split into three systems namely, card sliver,
combed sliver and ring spinning system. The card sliver system consists of blow room and carding
machine. Its function is to remove the foreign particle from the raw cotton and convert the same into
thick yarn (sliver).The combed sliver system consists of draw frame and comber machines, the draw
frame machine ensures the uniformity in thickness of the sliver and comber machine removes the
unwanted short fiber in the sliver.

Speed frame and Ring frame machine are included in ring spinning system. It does the
conversion of sliver (thick thread) into yarn (thin thread). Spinning mill produce a Ring frame as its
final product.

- Industry Profile:
- Factory name: Deendayal Magasvargiya Sahakari Soot Girni Ltd. Islampur.
- Main products: They produce100\text{o} cotton carded and combed yarns in the range:
  - Ne 24s / 1 to Ne 60s / 1 Combed Weaving and Knitting yarns
  - Ne 20s / 1 to Ne 40s / 1 Carded weaving and Knitting yarns
  - Ne 30s / 1 to Ne40s / 1 Combed compact yarn
• Above yarn sare produced from best quality cotton from Maharashtra, Gujarat, Andhra Pradesh etc.
• We also produce embroidered cloth on sourer pent mat Embroidery machines.
• Registered max demand (KVA) =2,200
• Billed maximum demand (KVA) =1,750
• Avg. unit consumption (kwh) =11,02,605
• Tariff rate (Rs/unit) =7.07
• Max. demand charges(Rs) =4,41,000
• Daily energy consumption (kwh) =72,792
• Daily production (kg) =12500
• Units consumed for 1kg of yarn production (kwh/kg) = 6.14.
• Number of spindles=33000

II. LAYOUT OF COMPANY
Several strands of twisted material are included into yarn. Every separate strand is, made of fibres, all shorter the piece of yarn. To make the yarn these short fibres are spun into longer filaments. Long continuous strands may only require additional twisting to make them into yarns. Texturing means sometimes they are put through an additional process.

Figure below shows the layout of the industry. In which different departments are shown.

![Layout of Company](image)

**Fig 1: Layout of company**

III. ENERGY DISTRIBUTION IN DIFFERENT SECTORS

A. Energy Distribution In Textile Mill:
Power distribution in textile mills including productive and non productive machines:

<table>
<thead>
<tr>
<th>No</th>
<th>Department</th>
<th>Load in KW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blow room</td>
<td>133.18</td>
</tr>
<tr>
<td>2</td>
<td>Carding</td>
<td>237.9</td>
</tr>
<tr>
<td>3</td>
<td>Comber</td>
<td>115.1</td>
</tr>
<tr>
<td>4</td>
<td>Speed frame</td>
<td>310.42</td>
</tr>
<tr>
<td>5</td>
<td>Ring frame</td>
<td>1027.00</td>
</tr>
</tbody>
</table>
Table 1: Energy Distribution In Textile Mill

B. Energy Saving In Blowroom Department
1. Machine Name: Blow room (Aero fed)
   Machine Specification: Rated KW = 7.2 KW

<table>
<thead>
<tr>
<th>MC NO.</th>
<th>VOLTAGE (VOLTS)</th>
<th>CURRENT (AMPS)</th>
<th>PF</th>
<th>AVERAGE (KW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>Y</td>
<td>B</td>
<td>R</td>
</tr>
<tr>
<td>1</td>
<td>406.4</td>
<td>406.2</td>
<td>409.3</td>
<td>31.5</td>
</tr>
<tr>
<td>2</td>
<td>406.2</td>
<td>406.1</td>
<td>409.3</td>
<td>31.5</td>
</tr>
<tr>
<td>3</td>
<td>406.6</td>
<td>406.6</td>
<td>409.6</td>
<td>31.7</td>
</tr>
</tbody>
</table>

Table 2: Blow room Machine Rating

<table>
<thead>
<tr>
<th>MC NO.</th>
<th>POWER DRAWN</th>
<th>PRESENT PF</th>
<th>TARGET PF</th>
<th>CALCULATED CAPACITOR SIZE</th>
<th>REDUCTION IN LOSSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.84</td>
<td>0.46</td>
<td>0.98</td>
<td>10.22</td>
<td>78.1</td>
</tr>
<tr>
<td>2</td>
<td>5.8</td>
<td>0.45</td>
<td>0.98</td>
<td>10.40</td>
<td>79</td>
</tr>
<tr>
<td>3</td>
<td>5.9</td>
<td>0.46</td>
<td>0.98</td>
<td>10.18</td>
<td>78.1</td>
</tr>
</tbody>
</table>

Table 3: Reactive Power Compensation

C. Calculation:

For machine 1
Phase angle of the present power factor (PF1)
\[ \Phi_1 = \cos^{-1} (PF_1) = \cos^{-1} (0.46) = 62.61 \]
Phase angle of the required power factor (PF2)
\[ \Phi_2 = \cos^{-1} (PF_2) = \cos^{-1} (0.98) = 11.48 \]
KVAR rating of the required capacitor
\[ = P \times (\tan \Phi_1 - \tan \Phi_2) \]
\[ = 5.84 \times [\tan (62.81) - \tan (11.48)] = 10.22 \text{ KVAR} \]

For machine 2
Phase angle of the present power factor (PF1)
\[ \Phi_1 = \cos^{-1} (PF_1) = \cos^{-1} (0.45) = 63.26 \]
Phase angle of the required power factor (PF2)
\[ \Phi_2 = \cos^{-1} (PF_2) = \cos^{-1} (0.98) = 11.48 \]
KVAR rating of the required capacitor
\[ = P \times (\tan \Phi_1 - \tan \Phi_2) \]
\[ = 5.84 \times [\tan (63.26) - \tan (11.48)] = 10.41 \text{ KVAR} \]
For machine 3
Phase angle of the present power factor (PF1)
\[ \Phi_1 = \cos^{-1}(PF\ 1) = \cos^{-1}(0.46) = 62.61 \]
Phase angle of the required power factor (PF2)
\[ \Phi_2 = \cos^{-1}(PF\ 2) = \cos^{-1}(0.98) = 11.48 \]
KVAR rating of the required capacitor
\[ = P \times (\tan \Phi_1 - \tan \Phi_2) \]
\[ = 5.84 \times [\tan (62.61) - \tan (11.48)] = 10.18 \text{ KVAR} \]
Total KVAR = Machine 1 (KVAR) + Machine 2 (KVAR) + Machine 3 (KVAR)
\[ = 10.22 + 10.40 + 10.18 \]
Total KVAR = 30.8

Annual saving and payback period

Before Power Factor Corrections:
Total Load KVA (old) of machine 1, 2, 3
\[ = \frac{KW}{\text{Old Power Factor}} \]
\[ = 17.54 / 0.46 \]
\[ = 38.13 \text{ KVA} \]
Total electrical Load KW = kW1 + kW2 + kW3
\[ = 5.84 + 5.8 + 5.9 \]
\[ = 17.54 \text{ kW} \]
KVA Demand Charge = KVA X Charge
\[ = 38.13 \times 250 \text{ ...From electricity bill} \]
\[ = 9,532 \text{ monthly} \]
\[ = 9532 \times 12 = 1,14,384 \text{ annually} \]
Annual Unit Consumption = kW x Daily uses x 365
\[ = 17.54 \times 24 \times 300 \]
\[ = 1, 26,288 \]
Annual charges = 126288 \times 6.97
\[ = 8,80,227 \]
Total annual cost = 8, 80,227 + 1, 14,384
\[ = 9, 94,611 \]
Total Annual Cost before Power Factor Correction = 9, 94,611 Rs

After Power Factor Correction:
Total Load KVA (old) of machine 1, 2, 3
\[ = \frac{KW}{\text{Old Power Factor}} \]
\[ = 17.54 / 0.98 \]
\[ = 17.89 \text{ KVA} \]
Total electrical Load KW = kW1 + kW2 + kW3
\[ = 5.84 + 5.8 + 5.9 \]
\[ = 17.54 \text{ kW} \]
KVA Demand Charge = KVA X Charge
\[ = 17.89 \times 250 \text{ ...From electricity bill} \]
\[ = 4,472 \text{ monthly} \]
\[ = 53,664 \text{ annually} \]
Annual Unit Consumption = kW x Daily uses x 365
\[ = 17.54 \times 24 \times 300 \]
\[ = 1, 26,288 \]
Annual charges = 1,26,288 × 6.97 = 8,80,227
Total annual cost = 8,80,227 + 53,664
= 9,33,891
Total Annual Cost before Power Factor Correction
= 9,33,891 Rs.

Capital Cost of 31 KVAR APFC Panel
= 34,875 Rs
Total Annual Cost after Power Factor Corrections
= 9,33,891 + 34875
= 9,68,766

Payback period:
Total Annual Cost after Power Factor Correction
= 9,68,766 Rs.
Total Annual Cost before Power Factor Correction
= 9,94,611 Rs
Annual Saving = 9,94,611 – 9,68,766
Annual Saving = 25,845 Rs.
Payback Period = Capital Cost of Capacitor APFC panel / Annual Saving
= 34875 / 25845
= 1.3 years.

D. Energy Saving In Humidification Plant

In the manufacturing process of textile yarns and fabric the atmospheric condition with respect to temperature and humidity plays very important part. The property likes dimensions, weight, tensile strength, elastic recovery, electrical resistance etc. of all textile fibers whether natural or synthetic are influenced by moisture region. The recent FRP blades have improved aerodynamics characteristics and are much more energy efficient as compared to aluminum blades, there is a good potential to replace aluminum blade with FRP blades. This would reduce the power consumption of the fan by 15-20%.

<table>
<thead>
<tr>
<th>Sr No.</th>
<th>Motor Name</th>
<th>Voltage</th>
<th>Kw</th>
<th>Amp</th>
<th>Rpm</th>
<th>Hp</th>
<th>Current (Amp)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>1</td>
<td>Cyclon Fan</td>
<td>400</td>
<td>15</td>
<td>32</td>
<td>-</td>
<td>20</td>
<td>12.1</td>
</tr>
<tr>
<td>2</td>
<td>Return Air Filter 1</td>
<td>400</td>
<td>0.37</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.3</td>
</tr>
<tr>
<td>3</td>
<td>Return Air Filter 2</td>
<td>400</td>
<td>0.37</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.9</td>
</tr>
<tr>
<td>4</td>
<td>Return Fan 1</td>
<td>415±10%</td>
<td>22</td>
<td>42</td>
<td>985</td>
<td>30</td>
<td>39.3</td>
</tr>
<tr>
<td>5</td>
<td>Return Fan 2</td>
<td>415±10%</td>
<td>22</td>
<td>42</td>
<td>985</td>
<td>30</td>
<td>34.5</td>
</tr>
<tr>
<td>6</td>
<td>Return Fan 3</td>
<td>415±10%</td>
<td>22</td>
<td>42</td>
<td>985</td>
<td>30</td>
<td>39.2</td>
</tr>
<tr>
<td>7</td>
<td>Supply Fan 1</td>
<td>415±10%</td>
<td>18.5</td>
<td>34</td>
<td>-</td>
<td>25</td>
<td>29.8</td>
</tr>
<tr>
<td>8</td>
<td>Supply Fan 2</td>
<td>415±10%</td>
<td>18.5</td>
<td>34</td>
<td>-</td>
<td>25</td>
<td>29.7</td>
</tr>
<tr>
<td>9</td>
<td>Supply Fan 3</td>
<td>415±10%</td>
<td>18.5</td>
<td>34</td>
<td>-</td>
<td>25</td>
<td>31.6</td>
</tr>
<tr>
<td>10</td>
<td>Water Pump</td>
<td>415±10%</td>
<td>30</td>
<td>60</td>
<td>-</td>
<td>40</td>
<td>35.2</td>
</tr>
</tbody>
</table>

Table 3: Energy Saving In Humidification Plant

In Textile mill for humidification plant above motors are used to maintain the temperature of the plant. That mill was established in 1999 at that time fan of the return and supply motor was aluminum material, still they uses aluminum fans for air circulations. If we replace the
existing aluminum blades of the supply and return fan by the modern technology fiber reinforced plastic (FRP) blades then the effectiveness of humidification plant is improved to 71 to 80% and the efficiency of motor is improved to 40 to 60% approximately. In this way the specific energy consumption of fan has reduced.

IV. CONCLUSION

In India, there are many textile industries. Hence, ample energy can be saved by incorporating the above technique in all the textile mills. In general, most of the mills have not included renewable energy techniques in productive and non-productive machines. By means of adopting these techniques, significant energy saving can be realized.

REFERENCES