ABSTRACT

This project gives a brief idea how various inductive loads used in all industries deals with the problem of power factor improvement. Capacitor bank connected in shunt helps in maintaining the power factor closer to unity. They improve the electrical supply quality and increase the efficiency of the system. Also the line losses are also reduced. Shunt capacitor banks are less costly and can be installed anywhere. This paper deals with shunt capacitor bank designing for power factor improvement and helped to reduce the electricity bill of an agro-based plant (Jagannath Cotton Mill) of a farmer located at Rayagada District, Odisha, India.

Keywords: capacitor bank, overvoltage consideration, power factor, reactive power

1. INTRODUCTION

1.1 Power Factor

We have done a case study on power factor improvement at jagannath cotton mill which comes under small scale industry located in Rayagada district, Odisha, India. Here we have given a comparison between the existing power factor and improved power factor and also we have shown here the benefit of power factor improvement. We have helped the entrepreneur to reduce his electricity with this case study.

Some of the machinery or equipment with low power factor are listed below:
1. Induction motors of all types.
2. Power Thyristors.
3. Welding machines.
4. Electric arc and induction furnaces.
5. Choke coils and induction furnaces.
1.2 Power Factor Improvement

The apparent power (KVA) in a.c. circuit can be resolved into two components, the in-phase component which supplies the useful power (KW), and the wattless component (kVAr) which does no useful work. The phasor sum of the two is the KVA drawn from the supply. The cosine of the phase angle between the KVA and the KW represents the power factor of the load. This is shown by the phasor diagram in Fig. 1(a). To improve the power factor, equipment drawing kVAr of approximately the same magnitude as the load kVAr, but in phase opposition (leading), is connected in parallel with the load. The resultant KVA is now smaller and the new power factor (cos $\phi_2$) is increased (Figs. 1(a) and (b)). Cos $\phi_2$ is controlled by the magnitude of the kVAr added. Thus any desired power factor can be obtained by varying the leading kVAr. A typical arrangement of shunt capacitor connected in parallel with a load.

![Fig. 1.2 phasor diagram of a plant operation at lagging power factor](image)

**Advantages of the grounded capacitor banks:**

Its low-impedance path to ground provides inherent self-protection for lightning surge currents and gives some protection from surge voltages. Banks can be operated without surge arresters taking advantage of the capability of the capacitors to absorb the surge. Offer a low impedance path for high frequency currents and so they can be used as filters in systems with high harmonic content. However, caution shall be taken to avoid resonance between the SCB and the system.

1.3 Designing of Capacitor Bank

The meaning of designing of capacitor bank is to calculate the requirement of reactive power in the power system to maintain the unity power factor. During the designing of capacitor bank the following points taken care for the better utilization of capacitor bank in the power system. Consideration of over-voltage as per IS 13925 (part I) 1998. Overvoltage consideration due to series reactor Consideration of fault level of the power system for which the capacitor banks are to be designed.

![Fig. 1.3 block diagram of capacitor bank connected in panel](image)

1.4 Advantages of Power Factor improvement:

The benefits that can be achieved by applying the correct power factor correction are: a) Reduction of power consumption due to improved energy efficiency. Reduced power consumption means less greenhouse gas emissions and fossil fuel depletion by power stations. Reduction of electricity bills. Extra kVA available from the existing supply. Reduction of I2R losses in transformers and distribution equipment. Reduction of voltage drops in long cables. Reduced electrical burden on cables and electrical components.

1.5 Maintenance of Capacitor Bank

Maintenance of a capacitor bank doesn’t require much time or energy. However it is important that regular inspections be carried out. This will help prevent early failure and pick up any fault. An inspection routine would include the following. Check and clean filters. Ensure tightness of all electrical connections. Ensure all fuses are not
damaged. Ensure all discharge resistors are operational. Ensure all contactors are operational. Remove all dust and deposit build-up. Tong test capacitor current

2. LOAD CALCULATION TABLE

<table>
<thead>
<tr>
<th>SL NO.</th>
<th>TYPE</th>
<th>RATING</th>
<th>MAKE</th>
<th>Nos.</th>
<th>RUNNING HOURS</th>
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<tr>
<td>1</td>
<td>AC</td>
<td>415V,1460 RPM</td>
<td>LCW225M</td>
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<td>6 Hr.</td>
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<td>2</td>
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<td>415V,1862 RPM</td>
<td>CROMPTON GREAVES Ltd.</td>
<td>1</td>
<td>24 Hr.</td>
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<td>3</td>
<td>AC</td>
<td>415V,1415 RPM</td>
<td>CROMPTON GREAVES Ltd.</td>
<td>1</td>
<td>24 Hr.</td>
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<td>4</td>
<td>AC</td>
<td>415V,1410 RPM</td>
<td>BONFIGLIOI Ltd.</td>
<td>1</td>
<td>24 Hr.</td>
</tr>
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<td>5</td>
<td>AC</td>
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<td>CROMPTON GREAVES Ltd.</td>
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<td>24 Hr.</td>
</tr>
<tr>
<td>6</td>
<td>AC</td>
<td>415V,4560 RPM</td>
<td>CROMPTON GREAVES Ltd.</td>
<td>1</td>
<td>24 Hr.</td>
</tr>
<tr>
<td>7</td>
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<td>415V,960 RPM</td>
<td>SUGUNA INDIA Ltd.</td>
<td>3</td>
<td>24 Hr.</td>
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<td>415V,1440 RPM</td>
<td>CROMPTON GREAVES Ltd.</td>
<td>1</td>
<td>24 Hr.</td>
</tr>
<tr>
<td>9</td>
<td>AC</td>
<td>415V,750 RPM(5.38KW)</td>
<td>CROMPTON GREAVES Ltd.</td>
<td>18</td>
<td>8 Hr./24 Hr.</td>
</tr>
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<td>415V,1430 RPM</td>
<td>CROMPTON GREAVES Ltd.</td>
<td>1</td>
<td>24 Hr.</td>
</tr>
<tr>
<td>11</td>
<td>AC</td>
<td>415V,1420 RPM</td>
<td>CROMPTON GREAVES Ltd.</td>
<td>6</td>
<td>24 Hr.</td>
</tr>
</tbody>
</table>

3. CALCULATION OF TARIFF

Before implementation of capacitor bank
By using the motor details here we are calculating the total power consumed in a mill in a month.
Unit cost = 5.50 Rupees
Total power consumed in a month = 34702.8 KwH
The total tariff of a customer = 34702.8X5.50 = 190865.40 Rupees

After implementation of capacitor bank
After adding of the capacitor bank the power factor will improve and it is approximately equals to 0.9.
Total power consumed in a month = 32680.68 KwH
Now, Total tariff of a customer = 32680.68X5.50 = 179743.74 Rupees
Savings per month 11121.66
Savings per year 133459.91 Rupees

4. CONCLUSION

Improvement of power factor makes the utility companies get rid from the power losses while the consumers are free from low power factor penalty charges. By installing suitably sized power capacitors into the circuit the Power Factor is improved and the value becomes nearer to 0.9 to 0.95, thus, capacitor banks used for power factor correction reduce losses and increases the efficiency of the power system and also increases stability.

References
[1] en.wikipedia.org/wiki/Power_factor_correction


