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Energy Management for Motor Driven Systems

The energy savings network—plug into it

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Table 8-1
Industries That Typically Exhibit Low Power Factor

Industry	Uncorrected Power Factor
Saw mills	45% - 60%
Plastics (extruders)	55% - 70%
Machine shops	40% - 65%
Plating, textiles, chemicals, breweries	65% - 75%
Foundries	50% - 80%
Chemicals	65% - 75%
Textiles	65% - 75%
Arc welding	35% - 60%
Cement Works	78% - 80%
Printing	55% - 70%

Sizing and Locating Power Factor Correction Capacitors

Once you decide that your facility can benefit from power factor correction, you need to choose the optimum type, size, number, and strategic locations for capacitors in your plant. The unit for rating power factor capacitors is the kVAR, equal to 1,000 volt-amperes of reactive power. The kVAR rating signifies how much reactive power a capacitor will provide.[8-1]

The value of individual motor reactive power is cumulative toward the overall plant reactive power. Therefore, when you improve the power factor of a single motor, you are reducing the plant's reactive power requirement.

The greatest power factor correction benefits are derived when you place capacitors at the source of reactive currents. It is thus common to distribute capacitors on motors throughout an industrial plant.[8-6,8-7] This is a good strategy when capacitors must be switched to follow a changing load. If your plant has many large motors, 25 hp and above, it is usually economical to install one capacitor per motor and switch the capacitor and motor together.[8-1]

Switched capacitors don't require separate switch control equipment when they are located on the load side of motor contactors. Thus, capacitors installed on the larger motors are nearly as economical as fixed banks installed at motor control centers. When some switching is required, the most economical method is to install a base amount of fixed capacitors that are always energized, with the remainder on the larger motors and switched when the motors are energized. Observe load patterns in order to determine good candidate motors to receive capacitors.

If your plant contains many small motors (in the 1/2 to 10 hp size range), it may be more economical to group the motors and place single capacitors or banks of capacitors at, or near, the motor

Example 8-2

Utility Rate Schedule: In this scenario, the utility charges according to kW demand ($4.50/kW) and includes a surcharge or adjustment for low power factor. The following formula shows a billing adjustment based upon a desired 95 percent power factor.

$$kW_{billed} = kW_{demand} \times \frac{0.95}{PF}$$

Where:

kW_{billed} = Adjusted or billable demand

kW_{demand} = Measured electric demand in kW

PF = Power factor as a decimal

The multiplier applies to power factors up to 0.95.

Plant Conditions: For our sample facility, the original demand is 4,600 kVA *x* 0.80 or 3,680 kW.

Billing Before Power Factor Correction	Billing After Power Factor Corrected to 95%
$\frac{3{,}680 \text{ kW} \times 0.95}{0.80}$ *= 4,370 × $4.50* *= $19,665/month or $235,980/year*	*= 3,680 × $4.50* *= $16,560/month or $198,720/year*

Savings are $37,260/year

Additional Benefits of Power Factor Correction

The "Industrial Electrical Distribution Systems Guidebook" contains worksheets for calculating the benefits of correcting individual motor and total plant power factor.[8-10]

Power factor correction capacitors increase system current-carrying capacity, reduce voltage drops, and decrease distribution system resistance (I^2R) losses.[8-1] Increasing the power factor from 75 percent to 95 percent results in a 21 percent lower current when serving the same kW load. Through adding power factor correction capacitors to your system, you can add additional kW load without increasing line currents, wire size, transformer size, or facility kVA charges. By including power factor correction capacitors in new construction or facility expansions, you can reduce project costs through decreasing the sizes of transformers, cables, busses, and switches.[8-1] In practice, however, ampacity ratings are a function of full-load equipment values; therefore, size reductions may be precluded by electrical codes.