Facts About
Power Factor Correction

"Power Factor & Power Quality Specialists"

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Principle of Power Factor Correction

The total Electrical Power (Kilo Volt Amperes or kVA) used by the industrial or commercial facility has two components:

Productive Power (Kilowatts or kW) which produces work

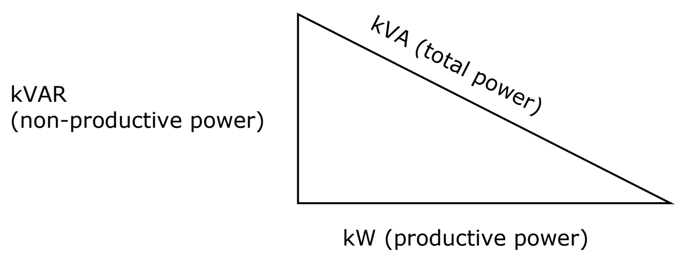
Reactive Power (Kilovar or kVAR) which generates the magnetic fields required in inductive electrical equipment (AC motors, transformers, inductive furnaces, ovens, etc.).

Reactive Power produces no productive work.

Because the inductive electrical equipment employing magnetic fields requires this Reactive Power, which produces no productive work, the Total Power (kVA) provided by the generating source must be greater than the Productive Power (kW).

Power Factor is a measure of system electrical efficiency.

The ratio of Productive Power (kW) to Total Power (kVA) is Power Factor. It is a measure of system electrical efficiency in an alternating current circuit, and is represented as a % or decimal.



$$\text{Power Factor} = \frac{\text{kW (productive power)}}{\text{kVA (total power)}}$$

The relationship between kVA, kW and kVAR is non-linear and is expressed $kVA^2 = kW^2 + kVAR^2$

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Why Improve Power Factor

Reduce Utility power bill

Removing system kVAR improves the Power Factor and reduces the Utility Power Bill. Most utility power bills are influenced by kVAR usage.

Increase system capacity

Improving the Power Factor releases system capacity and permits additional loads (motors, lighting, etc.) to be added without overloading the system. In a typical system with a .80 P.F., only 800 kW of productive power is available out of 1000 kVA installed. By correcting the system to unity (1.0 P.F.), the kW=kVA. Now the corrected system will support 1000 kW, versus the 800 kW at the .80 P.F. uncorrected condition; an increase of 200 kW of productive power.

Improved system operating characteristics

A good power factor (.95) provides a "stiffer" voltage, typically a 1-2% voltage rise can be expected when power factor is brought to +/- .95.

Improving power factor will lower losses in the distribution system of the facility since losses are proportional to the square of the current.

Methods

Static or fixed Power Factor correction

Compensation o the load side of the AC motor starter (motor switched or "at the load"). A good application for essential or constant loads over 40 HP.

Central Power Factor correction

Compensation for electrical systems with fluctuating loads. Usually installed at the main power distribution.

The capacitors are controlled by a microprocessor based relay which continuously monitors the reactive power requirements. The relay then connects or disconnects capacitors to supply capacitance as needed.

When harmonic distortion is a concern systems are built based on the principles explained under Harmonic Distortion and Power Factor Correction.

Harmonic distortion & Power Factor correction

In recent years the way electricity is used has changed significantly. Developments in semi-conductor technology have created a major increase in thyristor and converter-fed loads. Electronic equipment, particularly that using solid state devices, can have a detrimental effect on the electrical power system in a facility to the point where operation of electrical and electronic equipment is disrupted. Solid state devices generate Harmonics into the electrical system, i.e. they generate frequencies that are integer multiples of the fundamental line frequency of 60 Hz. The harmonics lead to a higher capacitor current, because of the higher frequencies are attracted to the capacitor. The impedance of the capacitor decreases as the frequency increases.

Harmonic distortion can result in any or all of the following:

- Premature failure of capacitors
- Nuisance tripping of circuit breakers and other protective devices
- Failure or malfunctioning of computers, motor drives, lighting circuits and other sensitive loads.

The rising capacitor current can be accommodated by design improvements of the capacitor. However, resonating circuits may occur between the power factor correction capacitors and the inductance of the feeding transformer as well as the main feeders. If the frequency of such a resonating circuit is close enough to a harmonic frequency, the resulting circuit amplifies the oscillation and leads to immense over-currents and over-voltages.

De-tuned Capacitor Banks

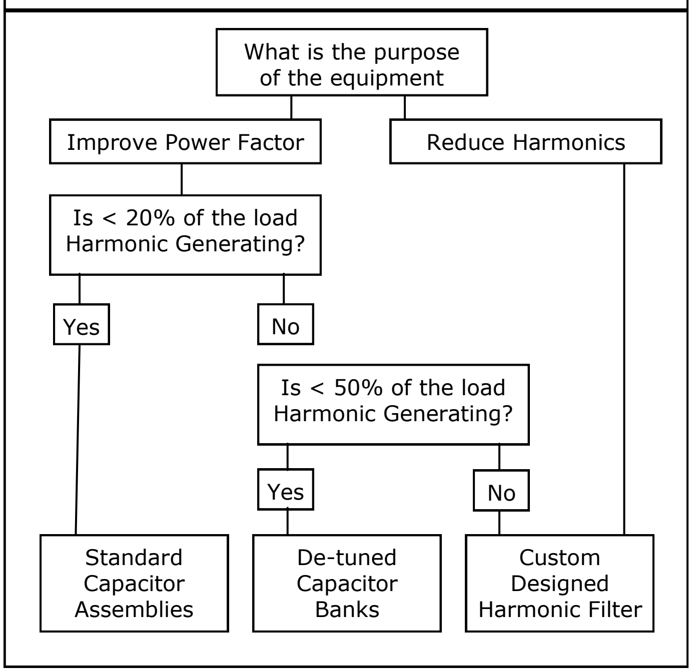
The installation of de-tuned (reactor-connected) capacitors is designed to force the resonant frequency of the network below the frequency of the lowest harmonic present. This ensures that no resonant circuit and no amplification of harmonic currents exists. Such an installation also has a partial filtering effect, reducing the level of voltage distortion on the supply, and is recommended for all cases where the share of harmonic-generating loads is more than 20% of overall load to be compensated.

Tuned Filtered Capacitor Banks or Harmonic Filter

A filter circuit presents a very low impedance to the individual harmonic current diverting the majority of the current into the filter bank rather than the supply. The resonance frequency of a de-tuned capacitor is always below the frequency of the fifth harmonic.

Reactive Power Compensation can be properly planned with the aid of the diagram shown at the right.

Planning Reactive Power Compensation



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