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Ronk Power Factor Capacitors Can Reduce kva and Save You Money

Correcting power factor problems is an increasingly cost-effective practice as more power suppliers turn to charging for low power factor.

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Power factor, they say, is a bit like the weather – everybody talks about it, but nobody *does anything* about it. That is no longer a fair comparison; now you can do something to control bad power factor.

This article will review technical considerations and discuss the benefits of power factor correction.

Terminology & Trigonometry

Three important terms relate to power factor: real power (kW), apparent power (kva), and reactive power (kvar). The first term, real power or kW, is perhaps the best understood. It represents the actual amount of work being done by the electrical system. In simplified terms, the work being done (kW) times the number of hours you do this work (h) becomes the portion of the bill we are most familiar with – kWh or energy charge.

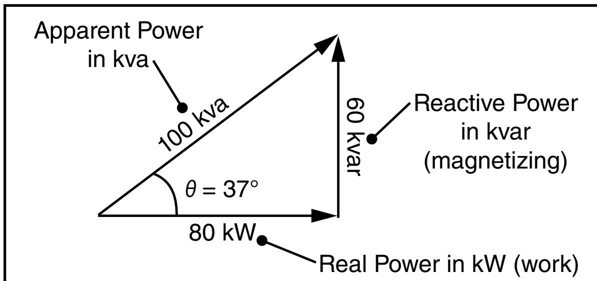
The next term, apparent power or kva, is simply the volts multiplied by the amps. It is probably the most misunderstood term in the electrical field. The key to understanding this concept is to remember that it is called *apparent* power.

While it may seem that the "real power" should be the volts times amps, it is not (except in the very rare case where the power factor is exactly 1.0). In a typical plant or operation, some of the apparent power is used simply to magnetize the electrical devices. You may be already familiar with the term "magnetizing currents." This magnetizing, or reactive (kvar), power does not do any work and, as a result, does not register as kWh on the power meter.

Therefore, it is possible to see a high apparent power (kva) alongside a low real power (kW) level, if the magnetizing power is significant. This is where "power factor" (PF) enters the picture. The power factor percentage is simply the real power (kW) divided by the apparent power (kva).

In a system where no magnetizing or reactive current is present, real and apparent power are equal, and the power factor is 100% (sometimes called unity power factor). Most systems in the real world have a power factor much lower than 100%. This is where confusion arises, since the magnetizing (reactive, kvar) power is not simply the difference between apparent power and real power. The reason is that the real and magnetizing currents are not "together" in a linear progression, but fall out at right angles to each other.

Figure 1 Typical plant power at 80% power factor



$$\text{Power Factor (PF)} = \frac{kW}{kva} \quad \frac{80}{100} = 0.80 \text{ or } 80\%$$

Mathematically:

θ = Power Factor Angle $\theta = 37°$

Power Factor = $\cos\theta$ $\cos 37° = 0.80$ or 80%

Note large reactive power compared to real and apparent powers.

In the example above, note that the magnetizing power is actually 60 kvar, which is considerably more than the difference between the apparent (100 kva) and the real (80 kW) power. (Also note that the figure is a familiar 3-4-5 right triangle.) Other articles and textbooks explain the theory and calculations in depth, so we will proceed to practical implications.

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To keep it simple, remember the basic terms: real power (kW) represents the actual work done, apparent power (kva) represents volts times amps, power factor (PF) is real power as a percentage of apparent power, and magnetizing or reactive power (kvar) makes up the difference between the real and apparent powers (because the real and magnetizing currents are at right angles, the reactive power can be much greater than it might appear, as shown in Fig.1).

If you have followed up to this point, something will probably bother you. Recall that we said earlier that the energy charge is measured on the kilowatt-hour meter, and we also said that the magnetizing current represented a non-work current. It follows that since the magnetizing (reactive) power will not register on the kilowatt-hour meter, we do not pay for it. Then, why would we waste our time trying to understand power factor, magnetizing power, or reactive power?

Low Power Factor Costs

The main reason for addressing apparent power is that many power suppliers are exploring direct (and indirect) methods for charging for low power factor outside of the kilowatt-hour rate. Rightfully so, since the power factor is more costly to serve than a high power factor load with the same kilowatt-hour consumption.

Costs increase because the power company must be capable of generating the apparent power (kva). Low power factor means more expensive generating capacity is needed for the given amount of work. Line losses in the transmission and distribution system that are absorbed by the power company as part of doing business are proportional to the line currents squared; extra reactive power means wasteful loss of increasingly costly energy.

Low power factor requires larger transformers to service a given load. That not only boosts the initial cost of service, it also generally makes future maintenance more expensive. While this simplifies the situation somewhat, it remains true that low power factor loads are, in effect, less energy efficient. As a result, many industrial and agricultural sites are now paying a premium for energy based on their degree of inefficiency. Fortunately, the use of relatively inexpensive power factor correction capacitors can improve power factor of the load and reduce these potential power premiums.

Capacitors Can Save

Capacitors use reactive current, which is 180° out of phase with the magnetizing current required by most electrical devices. By properly matching the capacitors with the magnetizing current required by the load, you can reduce or cancel the cause of low power factor in most applications.

In practice, the question arises as to where to locate the power factor correction capacitors in the electrical system. The most efficient location is, of course, at the source of the problem.

Since a large portion of the problem is generated by electric motors, the major portion of the correction can frequently be accomplished right at each motor or its magnetic starter. Section 460 of the 2014 National Electric Code offers guidance on the proper installation of capacitors on motors. Three big advantages are realized when wiring on the motor side of the starter in accordance with NEC 460-8:

1. No additional protection or disconnect is required.
2. You get automatic switching, since the capacitors are disconnected when the motor is off.
3. Current in the wiring to the motor is reduced.

Since an individual motor connection may not solve the entire problem, additional capacitors can be located at the service entrance or at the branch circuit. These capacitors must have a means of protection and disconnect to comply with NEC.

The bottom line of any successful installation is a favorable cost/benefit ration. By equating the capacitor cost to the reduction in power premiums, the benefits of using power factor correction capacitors can be analyzed in dollars and cents.

Contact our Sales team for more information on these products and other Ronk quality products:

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