Modern Power Factor Systems

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The Introduction of Active Power Factor Systems

As power electronics have become progressively cheaper to design and manufacture, enterprising manufacturers have diversified their power electronic offerings into the Power Quality market. Sometimes, these companies have a reasonable understanding of the intricacies of the Power Quality market sector, but often it is seen as purely an extension of their existing power electronics capability. This has led to claims of poor reliability against traditional systems and over-hyped benefits of active systems. As Power Factor specialists, kVArCorrect is attempting to provide a balanced overview of the technologies available for power factor correction.

Traditional Capacitor-Based Power Factor Systems

A traditional approach to correcting poor power factor involves the use of Power Capacitors to produce leading VAr's to offset the lagging VAr's produced by inductive loads. This is not rocket science, and the concept has been in use for almost 75 years. As supply systems have become more polluted with spikes, surges, harmonics, and other disturbances, various additional components have been added to capacitor-based systems to ensure reliability. Two examples of this additional componentry are series harmonic blocking reactors and zero voltage crossing contactors. Mostly, these additions have been in response to a need or a reliability issue. Over time, the heat generated in these types of systems has been steadily increasing. A simple power factor system of 20 years ago produced very significantly less heat than a modern capacitor-based system produces in 2016. Unfortunately, many capacitor-based systems are designed and built using traditional switchboard design and building techniques and the effects of the extra heat are seldom catered for, with the result that reliability suffers.

Because of these issues, the first piece of advice to give a potential user of power factor equipment is to ensure that it is designed and built by Power Factor Specialists, not just put together from a shopping list of components in much the same way as traditional switchgear cabinetry is built. Ask the potential supplier for the thermal calculations to accompany the system – this is often overlooked, but is critical to the reliability of the system.

Active versus Capacitor-Based Power Factor Systems

An often talked about 'new' technique for correcting poor power factor is "Active Compensation". This is where power electronics are used to generate the leading VAr's that are required to compensate for the lagging VAr's in the facility. Many claims are made for Active Systems, and there are some clear benefits. However, there are a serious number of disadvantages as well, as shown in the following table. The third column in the table relates to kVArCorrect's Hybrid system, which was developed specifically to overcome the limitations of both capacitor-based systems and active systems. It uses a traditional capacitor-based approach for bulk power factor correction, with a smaller active system to handle high speed as well as leading power factor requirements. The Hybrid system is designed to have the best of both technologies whilst offering superior reliability.

	Capacitor system	Full active system	Hybrid Systems
Cost	Low	High	Medium
Can handle leading power factor	No	Yes	Yes
Can provide exact kvar requirements	No	Yes	Yes
Operates at near real time compensation	No	Yes	Yes
Type of capacitors used	Oil or dry type	Electrolytic	Electrolytic and dry
Capacitors switched at zero crossing point	No	n/a	Yes
Easily maintained	Yes	No	Yes
Heat generated	Moderate	Higher than capacitor systems	Moderate
Easily expanded	Easy	Difficult	Easy
Cost of expansion	Low	High	Low
If electronics fail, still deliver kvars	Yes	No	Yes
Can be maintained and repaired on site	Yes	No	Yes

To expand on this table: Fully active systems are only price competitive for smaller systems, as they come in fixed minimum sizes. When choosing an active system, it is important that the end user looks at the cost of expanding the system if required. For example, if you start with a 100kVAr active system, and would like to expand by 20kVAr, a complete 100kVAr module will need to be purchased, as opposed to increasing the size of the existing system or even purchasing a smaller module. In general, fully active systems are expensive to expand in this way, compared to capacitor-based and Hybrid systems.

Fully active systems are completely electronic and if the electronics fail in any way, the whole unit shuts down and most often will require repair and/or replacement at the supplier's factory. Whilst the system is off-site being repaired, the customer is exposed to full power factor penalty tariffs and peak demand charges from the electricity supplier. In comparison, capacitor-based and Hybrid systems can be repaired on-site by electricians using readily available components. More importantly, these units will still function as a capacitor-only system if the power electronics fail, meaning the customer is still protected against power factor penalty tariffs and peak demand charges from the electricity supplier.

Fully active system suppliers often criticise as well as exaggerate the heat load of capacitor-based systems, and the frequency of capacitors overheating. In reality, a fully active system will generate more heat per kVAr than a capacitor-based system, and effective cooling is even more critical – with many fully active systems requiring placement in an air-conditioned room. Further, active system vendors often criticise capacitor-based systems for having a large number of capacitors. While this does mean the traditional units take up more space, the power factor capacitors used are safer and more reliable. This is because in a fully active system, electrolytic capacitors are hidden from sight to smooth the DC bus within the unit. These capacitors are filled with very corrosive acids to increase the microfarads of capacitance (allowing them to be much smaller physically).

Summary

While fully active systems can provide exact kVAr requirements for both leading and lagging power factor in near-to real time, they can be extremely expensive, and are totally return-to-base in the event of electronics failure (leaving the site completely unprotected against power factor penalties and peak demand charges). Clients are often shocked to discover the cost of expanding a fully active system is at least as high as the original installation. Capacitor-based systems are designed to be field-repairable by registered electricians, allowing for continuous power factor correction – as opposed to the fully active system being completely off-line and off-site for repairs.

Hybrid systems only rely on the active electronics for less than 25% of the overall available corrective kVAr's, meaning 75% or more of the power factor correction is still available on-line to mitigate the potential penalties, should the electronics require repair or servicing. Hybrid systems combine the speed and control benefits of a fully active system, with the maintainability and reliability of a capacitor-based system.

Thermal design plays an important role in all of these power factor control systems, and it is imperative that it is considered by the manufacturers – an example of the significance of choosing a manufacturer specialises in Power Factor.