Bajog electronic GmbH
the EMC specialist

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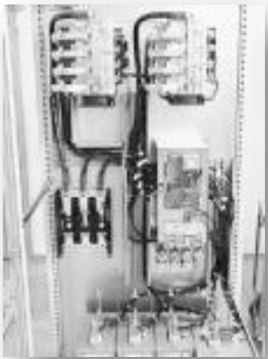
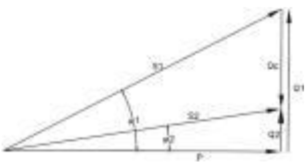
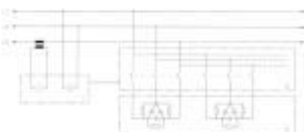
Effective management of energy consumption and network quality
Effective reactive power compensation



Compensation unit integrated into power rack



Determining the required reactive power capacitor of the difference between the phase angle



Principle of compensation of inductive reactive power

A company is not only considered in terms of annual sales, its profitability and its quality management, but increasingly about the environmental impact and its environmental management.
Energy saving and network optimization are among the most important tasks of management.

Although all energy supplier are anxious to ensure quality power supply, but power quality is compromised by several factors:
In case that the proportion of non-linear loads users such as power converters or frequency converters close to 15%, resulting harmonics, whose frequency corresponds, are a multiple of the sine fundamental mode. Furthermore inductive or capacitive loads increase the apparent power, so that the real power is limited. Currently, the standard EN 61 003 part 2 (Harmonics) and Part 3 (Flicker) is valid and in it concerns and defined the necessary network quality.

Companies want through environmental programs targeted energy consumption and strive for economical exposure with the net power.

Demand high power costs for energy savings a conscious energy budget should be part of the company philosophy.

Most of the power supplier companies require by crossing the limits from consumers adequate compensation.

Useless reactive power?

Reactive power is a kind of electrical energy that cannot be converted directly into other usable forms of energy.
However, it is necessary to realize clearing procedure of nonlinear components such as inductors and capacitors.

In an inductance the so-called reactive power is used to build up the magnetic field, in capacitors, the electric field is built up with it.
This power is not consumed in the components, but stored. As long as the instantaneous values of voltage and current in an ideal coil is positive, energy is stored in the magnetic field. During the next 90 ° of the period, this energy is returned into the grid.

The reactive power oscillates between the generator and the load with a double line frequency, while the active energy load will be converted into usable energy forms.

As a measure of reactive power in a network portion the power factor is specified. He is the cosine of the angle between current and voltage profile. As smaller the angle, as closer the cosine is 1 and more active power can be transmitted; in terms of total power exchange.

The growing energy needs require an optimization of the energy transfer by the Suppliers.

It is important to consider the composition of the supplier to the user transmitted apparent power, which is composed of vector of the active and reactive power.

The reactive current causes additional voltage drop and thus current temperature losses and generate burden to generators, transformers and wires.

The power suppliers accept and fix a minimum on power factor difference and compute substantial additional fees if it falls below these limits.

Reactive power demand

components which using reactive power, are asynchronous motors, transformers, controlled power converter and induction furnaces. In transformers, the reactive power is determined by the power that is needed for magnetization. The high-quality characteristics of today's power transformer plates keep the magnetization relatively low. Because of the stray reactance of the transformers, the reactive power factor at full load compared to idle can increase to the two-to four-fold value.

Controlled converters extract reactive power from the power grid, resulting from the magnetizing reactive power of the converter transformer and of the load-dependent commutation reactive power.

Because of the oscillating reactive power between generator and users, all current generator and transmitting facilities under additional load beside to the active current.

Is transmitted for example in a three-phase network, an active power of 400 kW, then the current is at a voltage of 380 V and a power factor of 1 ca. 600 A.

With the same active power and power factor of 0.5 ca.1200 A must be transferred, and loaded the live components significantly stronger.

The energy producers have to produce by same active power more apparent power. This is done either by starting additional generators to the grid, which will be operated with out load, or by power generators. Both options increase the cost situation and reduce efficiency and effectiveness.

In transformers and transmission cables current heat loss are increasing because of the square section in the power loss.

Higher currents also cause higher voltage drops.

Reactive power from the capacitor

As an alternative to removal from the network can be taken from the reactive power of capacitors, so that it is not provided by the generators and transmitted over the lines of the RU. A reduction of the phase angle will improve the power factor. The capacitors are conveniently situated near the largest reactive power consumer in the system.

Increases in energy networks, the share of non-linear loads than 15% are harmonics, whose frequency is a multiple of the fundamental sine vibration. The network impedance and the compensation capacitors form a parallel resonant circuit whose resonant frequency for the harmonic currents increased resistance shown so that a higher harmonic voltage drop and thus to balance flows between network and capacitors, leading, in turn, has an overload of plant failure.

Remedy here, the series connection of a choke coil for compensation capacitor-tion. Such a detuned capacitor bank has a series resonance frequency, which is tuned to the harmonic frequency and shifts the parallel resonance in non-critical areas. The series resonant circuits can, for example with the information that provides a network analysis, are tuned to the critical harmonic frequencies.
Compensation systems

Plants to compensate for reactive power are available in various designs and capacities. In these systems, microprocessor control unit detects a phase angle of the current and voltage and compares it with an adjustable target power factor. Depending on the deviation from target and actual is a circuit diagram to determine the result of the necessary capacity to compensate. This switching matrix is transmitted to the control unit. In principle, only a current and a voltage can be measured. This variant is sufficient for three-phase systems with enough symmetrical conditions or slight asymmetries, provided that the phase with the lowest performance is measured power factor. With varying asymmetries a variation of this diagram is RECOMMENDED, and the phase angle is determined in each phase individually and compensated.

The switching unit receives the standard version or as custom solutions offered systems which commands the unit and realized the connection of the capacitor battery to the power grid. Standard solutions used here contactor circuits. At high switching frequencies, such as occur with changing load requirements, or more precisely power factor adjustment using multiple steps of the capacitor values, the switch contacts wear out relatively quickly and must be replaced constantly. A modern solution is the use of thyristors and triacs. Avoids any wear due to arcing and high maintenance costs are avoided.

The capacitor bank is measured by the compensated reactive power. Several capacitor delta connections are the values of her staggered so that the connection of different capacitor arrangements, a gradation is achieved with the same step size. The capacitors, which are made in the self-healing MKP technology were fitted with internal discharge resistors. If the discharge take place very quickly, such as more match per minute, then discharge reactors are used. These components ensure that the voltage is dropped across the capacitors when re-connection of a compatible value for the switching elements.

These three main elements of a reactive power compensation system are depending on the model to 500 kVAr integrated as a single device in the form of cabinet or customized in a cabinet available. For high demands on accuracy and speed of adjustment of the capacitor power to the respective devices is also required reactive power with 32stufig switchable capacitor bank in the lower performance range at 50 kVAr as Central Compensation available.
Glitch-free switching network

Bajog built compensation systems that cause the thyristor due to no power instabilities by inrush current and avoid the current overload of capacitors. With contactor circuits, the maximum current peak power is limited only by the line impedance, with peak voltages exceeding 1600 V. The technique gently and connection of the compensation units enables the zero crossing, so that there are no arcs, and the wear is minimal. The use of thyristors to prevent over-compensation and over-voltages. Lack of contact resistance at the contact points to prevent arcing. The use of the equipment is possible in hazardous areas. The control process is variable (eg total control range 0 to 200 kVAR in 5 to 60 seconds) can be selected.

By inductors and capacitors result is a complex oscillating circuit, which is in the resonance case for a rise in voltage on the capacitors of the installations and responsible consumer. The result is a surge of more than 1300 V. Experiments have shown that using a simulated pulse (lightning) of 2 kV and a duration of 20 microseconds (lightning phase against N / PE), a stress concentration of ± 5 kV. Undefined states of stress due to lightning strikes, intentional or unintentional power-off and general fault conditions can cause any electrical, electronic system, to electronically controlled filters and compensation units damage by voltage feedback. By a suitable protection, this is impossible. It guarantees to an undefined state of stress the proper "boot" of the compensation system and a proper control operation.

Check also :
http://www.bajog.de/en/technical-report/reason-for-x2-and-y2-demolition.html
http://www.bajog.de/en/technical-report/new-test-parameter-necessary.html

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