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Paper On To Study Power Factor Control Methods And Devices

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Abstract: *In this paper, the need of power factor improvement and the impacts of power factor improvement in electrical systems is discussed. The paper also covers the basic concepts of power factor, Cause and effect of low power factor values, method to improve the power factor values, study of different power factor control devices and the advantages of power factor improvement simple manner. The low power factor problem is one of the important issues in electrical industry. This problem reduces the economy index value of our country. This paper would be helpful for the Diploma students and Electrical Engineers to study the basics of power factor and the advantages of power factor improvement.*

I. Inroduction

A power factor can be described in various terms such, it can be called as the ratio between active power and apparent power, it can be defined as the cosine of angle between voltage and current. The cosine of the angle between voltage and current is considered (not sine or tangent or cotangent angle), because the phasor diagram of voltage or current from power triangle is considered.

OBJECTIVE

To study the various power factor correction method.

POWER FACTOR THEORY

In any AC system the current, and therefore the power, is made up of a number of components based on the nature of the load consuming the power. Theseare resistive, inductive and capacitive components. Inthe case of a purely resistive load, for example, electrical resistance heating, incandescent lighting,etc., the current and the voltage are in phase that isthe current follows the voltage. Whereas, in the case of inductive loads, the current is out of phase with thevoltage and it lags behind the voltage. Except for afew purely resistive loads and synchronous motors , most of the equipment and appliances in the present day consumer installation are inductive in nature, for example, inductive motors of all types, welding machines, electric arc and induction furnaces, chokecoils and magnetic systems , transformers and regulators, etc. In the case of a capacitive load the current and voltage are again out of phase but now the current leads the voltage. The most common capacitive loads are the capacitors installed for the correction of power factor of the load.

The inductive or the capacitive loads are generally termed as the reactive loads. The significance of these different types of loads is that the **active (ortrue or useful) power** can only be consumed in the resistive portion of the load, where the current andthe voltage are in phase.

(**Watt less or) reactive power** which is necessary forenergizing the magnetic circuit of the equipment (and is thus not available for any useful work). Inductive loads require two forms of power - **Working/Activepower** (measured in **kW**) to perform the actual work of creating heat, light, motion, machine output, etc., and **Reactive power** (measured in **kVAr**) to sustain the electromagnetic field. The current known as wattles current is required to produce the magnetic field around an electric motor. If there was no watt-less current then an electric motor would not turn. The problems arise due to the fact that we can sometimes have too much watt-less current, in those cases we need to remove some of it.

The vector combination of these two power components (active and reactive) is termed as**Apparent Power** (measured in **kVA**), the value of which varies considerably for the same active power depending upon the reactive power drawn by the equipment. The ratio of the active power (kW) of the load to the apparent power (kVA) of the load is known as the **power factor** of the load. It is a measure of how effectively the current is being converted into useful work output and more particularly is a good indicator of the effect of the load current on the efficiency of the supply system. A load with a power factor of 1.0 result in the most efficient loading of the supply and a Load with a power factor of 0.5 will result in much higher losses in the supply system.

Methods of Power Factor correction

Conventional methods

1)Static capacitors:

Provides leading current which neutralize (totally or approximately) the lagging inductive component of load current (i.e. leading component neutralize or eliminate the lagging component of load current) thus power factor of the load circuit is improved.

Installed in Vicinity of large inductive load e.g Induction motors and transformers etc, and improve the load circuit power factor to improve the system or devises efficiency

2) Synchronous condensers:

When a Synchronous motor operates at No-Load and over-exited then it's called a synchronous Condenser. Whenever a Synchronous motor is over-exited then it provides leading current and works like a capacitor.

When a synchronous condenser is connected across supply voltage (in parallel) then it draws leading current and partially eliminates the re-active component and this way, power factor is improved. Generally, synchronous condenser is used to improve the power factor in large industries.

3) Phase advancers:

It is a simple AC exciter which is connected on the main shaft of the motor and operates with the motor's rotor circuit for power factor improvement. Phase advancer is used to improve the power factor of induction motor in industries. As the stator windings of induction motor takes lagging current 90° out of phase with Voltage, therefore the power factor of induction motor is low. If the exciting ampere-turns are excited by external AC source, then there would be no effect of exciting current on stator windings.Therefore the power factor of induction motor will be improved. This process is done by Phase advancer

Recent Methods

1)Distributed Generation: is the latest method for reactive power control. Though the main purpose of D.G is not reactive power support it, it can be used to maintain power factor.

2)Static Synchronous Compensator:STATCOM or Static Synchronous Compensator is a shunt device, which uses force commutated power electronics(i.e. GTO, IGBT) to control power flow and improve transient stability on electrical power networks. It is also a member of the so-called Flexible AC Transmission System (FACTS) devices. The STSTCOM basically performs the same function as the static var compensators but with some advantages.

In the case of two AC sources, which have the same frequency and are connected through a series reactance, the power flows will be:

- Active or Real Power flows from the leading source to the lagging source.
- Reactive Power flows from the higher to the lower voltage magnitude source.

Consequently, the phase angle difference between the sources decides the active power flow, while the voltage magnitude difference between the sources determines the reactive power flow. Based on this principle, a STATCOM can be used to regulate the reactive power flow by changing the output voltage of the voltage-source converter with respect to the system voltage.

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