Impact Factor (SJIF): 3.632
International Journal of Advance Research in Engineering, Science & Technology
e-ISSN: 2393-9877, p-ISSN: 2394-2444
(Special Issue for ITECE 2016)

A Review on Three Phase Power Factor Correction

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Abstract: This Work shows the theoretical analysis on three phase power factor correction and also shows the relation between Power factor and THD. This work also Contain the different methods for power factor correction and importance of its . The control algorithm or process of power factor correction.

Keywords- Power factor, THD, Capacitor

I. INTRODUCTION

Power factor is very important term in electrical power system. Power factor is the ratio between the real power and the apparent power drawn by electrical loads like motor, bulbs, crane etc. It is the efficiency of any electrical equipment or system, poor PF reduces the efficiency of the system because of those losses is increase in the system. PF is depends upon the nature of load (Inductive/Capacitive).it's should be nearer or about unity In industries due to discontinuous load or increases of inductive load power factor become poor. The equipment likes fluorescent lamp Mercury vapor lamps, Electrical motor, Industrial Heating and welding creates the poor power factor. Because of the poor PF

- Decreases the load handling capacity of equipment
- An increasing penalty for lower PF
- Efficiency of system is decreases.

II Types of power factor controller

Generally there are two types of technique are used to control the power factor these are:

Passive PFC:-This is a simple way of correcting the nonlinearity of a load by using capacitor banks. It is not as effective as active PFC, switching the capacitors into or out of the circuit causes harmonics, which is why active PFC or a synchronous motor is preferred [Wiki].

Active PFC:-An active power factor corrector (active PFC) is a power electronic system that controls the amount of power drawn by a load in order to obtain a Power factor as close as possible to unity. In most applications, the active PFC controls the input current of the load so that the current waveform is proportional to the mains voltage waveform (a Sine wave).Some types of active PFC are: Boost, Buck and Buck-boost. Active power factor correctors can be single-stage or multi-stage. Active PFC is the most effective and can produce a PFC of 0.99 (99%) [Wiki].

Synchronous:- Synchronous motors can also be used for PFC. Shaft less motors is used, so that no load can be connected and run freely on the line at capacitive (leading) power factor for the purposes of PFC.

III CAPACITOR

The static capacitor owing to its low losses, simplicity and high efficiency is now used almost universal y for power factor correction.

What is a Capacitor?-Simply put, a capacitor is an electric device that can store electric charge for later release. Generally, capacitors are used in one of the three ways: to store and release energy, to discriminate between DC (direct current) and AC (alternating current) frequencies, and to discriminate between higher and lower AC frequencies. A simple capacitor consists of two metal plates that are held parallel to each other with a small place between them. An insulating material called dielectric occupies the space. This insulating material can be made of many materials including oil, paper, glass, ceramics, and mica, plastic, or even air. Capacitance is a measure of the energy that a capacitor is capable of storing. The capacitance of a device is directly proportional to the surface areas of the plates and inversely proportional to the plates' separation.

How Capacitors Work:-Induction motors, transformers and many other electrical loads require magnetizing current (KVAR) as well as actual power (KW). By representing these components of apparent power (KVA) as the sides of a right triangle, we can determine the apparent power from the right triangle rule: $KVA^2 = KW^2 + KVAR^2$. To reduce the KVA required for any given load, you must shorten the line that represents the KVAR. This is precisely what capacitors do. The capacitor performs the function of an energy storage device. By supplying KVAR right at the load, the capacitors relieve the utility of the burden of carrying the extra KVAR. This makes the utility transmission/distribution system more efficient, reducing cost for the utility and their customers. The figure below shows an induction motor operating under partially loaded conditions without power factor correction. Here the feeder line must supply both magnetizing (reactive) and useful currents.

Determining Capacitor Requirements

The total KVAR rating of capacitors required to improve the power factor to any desired value can be calculated by using the tables published by leading power factor capacitor manufacturers. To properly select the amount of KVAR required to correct the lagging power factor of a 3-phase motor you must follow the steps as stated.

Step #1: Determine KW and Existing Power Factor.

Step # 2: Existing Power Factor on Table, move across table to Desired PowerFactor. The number represented is your multiplier number.

Step #3: Multiply KW by the multiplier of the Desired Power Factor

Typical Locations for Power Capacitors (Where/ What Type to Install)

The successful operation of a power factor correction depends largely on the correct positioning of the capacitors in the network; the importance of studying all relevant factors is emphasized. The relevant factors are: tariff in force; metering point; details of light, average, and full load KVA, KW and power factor; position of motors, welding equipment, transformers or other equipment causing bad power factor; and supply system problems such as harmonics. The siting of the capacitors, does to some extent, depends on whether each piece of equipment e.g. a motor, or a transformer, is being individual y corrected or the installation as a whole or part is being corrected as a block (generally known as bulk or group connection). In the first case the capacitor and the load (motor, transformer etc.) are as close together as possible; in the second case the capacitor is located at some convenient point in the system, such as a substation. Before power capacitors can be placed, the physical location of the utility meter should be determined since all power capacitors must be installed "downstream" of the meter.

IV Total Harmonic Distortion (THD) and Power Factor (PF)

The power factor PF for any non-sinusoidal quantities is defined by:

$$PF = \frac{V_s I_{s1} \cos\phi_1}{V_s I_s} = \frac{I_{s1}}{I_s} \cos\phi_1$$

I_{s1} is the rms value of the fundamental 60Hz component of the current. The displacement power factor (DPF, which is the same as the power factor in linear circuits with pure sinusoidal voltage and current) is defined as the cosine of the angle ϕ_1 (angle between the fundamental-frequency (60Hz) current and voltage waveforms) which could be written as: $DPF = \cos\phi_1$, therefore, the power factor PF with a non-sinusoidal current is:

$$PF = \frac{I_{s1}}{I_s} DPF$$

In terms of total harmonic current distortion $(THD)_i$, the PF and I_s (the rms value of the total current) could be written as:

$$PF = \frac{1}{\sqrt{1 + THD_i^2}} DPF \qquad (1)$$

$$I_s = I_{s1}\sqrt{\left(1 + THD_i^2\right)} \qquad (2)$$

where

From an examination of (1) and (2), we can conclude that the power factor value decreases with any high current harmonic content or distortion $(THD)_i$. These definitions assume that the source voltage is near sinusoidal of fundamental frequency (maximum allowable $(THD)_v$ =5%).

V Benefits of power factor correction

- Power factor correction reduces the reactive power in a system. Power consumption and thus power costs drop in proportion.
- Effective installation use an improved power factor means that an electrical installation works more economically (higher effective power for the same apparent power).
- Improved voltage quality
- Fewer voltage drops
- Optimum cable dimensioning Cable cross-section can be reduced with improvement of power factor (less current). In existing installations for instance, extra or higher power can be transmitted.

Smaller transmission losses the transmission and switching devices carry less current, ie only the effective power, meaning that the ohmic losses in the leads are reduced

V I CONCLIUSION

The power factor of a power system is the major of its economy. So, the design Engineers always attempts to make this power factor as close as to unity. Power factor decreases due to the increased usage of inductive loads**.** Therefore the power distribution companies always sets up a mandatory minimum power factor at the premises of consumers. In our state the mandatory power factor is 0.9 described by the **GujaratElectricity board.** The decrease in power factor below this reference is compensated bythe consumer based on their maximum demand and the no. of units consumed.

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