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POWER FACTOR IMPROVEMENT:A STEP AHEAD IN ENERGY EFFICIENCY

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ABSTRACT

Increased energy demand the world over and ever-increasing prices of energy have provided a justifiable reason for improving energy efficiencies of all energy intensive technologies. Improvement of energy utilization efficient is the practical solution only next to the alternative energy sources.

History has been witness to mankind continuous desire for improvement and up gradation of his standard of living. There are many examples that can be sighted to prove that up gradation of energy conservation technologies has been a never ending process.

History has also been witness to the haphazard utilization of the vital energy resources during the industrial revolution when energy sources were freely available and environment consideration were to least importance.

With the realization of rapid depletion of the world's energy reserves and the environmental impacts of energy use, efforts are underway to develop energy efficient machines and technologies to reduce the energy expenditure and to minimize environmental hazards. Development work has been evident in almost all the energy-consuming starting from the domestic to industrial sector. Development has been registered in cooking devices, vehicles, industrial technologies and agriculture engineering. The extent of development, in the field of energy efficiency improvement in different sector, that have taken place in the last two decades is quite relevant.

Investing in energy efficient products and services can help reduce operating costs, improve the work space environment and contribute to increased productivity. On the income statement this means lower expenses and increased profits. For the operations manager that investments can help balance a reduce budget, save jobs and possibly create new employment opportunities.

Keywords: Haphazard Utilization, Rapid Depletion, Alternative Energy Sources etc.

I. INTRODUCTION

Power factor is a measurement of how efficiently a facility uses electrical energy. A high power factor means that electrical capacity is being utilized effectively, while a low power factor indicates poor utilization of electric power. However, this is not to be confused with energy efficiency or conservation which applies only to energy. Improving the efficiency of electrical equipment reduces energy consumption, but does not necessarily improve the power factor.

Power factor involves the relationship between these two types of power. Active power is measured in kilowatts (kW) and reactive power is measured in kilovolt-amperes-reactive (kVAR). Active power and reactive power together make up apparent power, which is measured in kilovolt-amperes (kVA)

Power factor is the ratio between active power and apparent power. Active power does work and reactive power produces an electromagnetic field for inductive loads. Using the values in the power triangle example shown above, the facility is operating at 400 kW (active power) with an 80% power factor, resulting in a total load of 500 kVA.

Lightly-loaded or varying-load inductive equipment such as HVAC systems, arc furnaces, molding equipment, presses, etc. are all examples of equipment that can have a poor power factor. One of the worst offenders is a lightly loaded induction motor *(e.g.*, saws, conveyors, compressors, grinders, etc.)

End users should be concerned about low power factor because it means that they are using a facility's electrical system capacity inefficiently. It can cause equipment overloads, low voltage conditions, greater line losses and increased heating of equipment that can shorten service life. Most importantly, low power factor can increase an electric bill with higher total demand charges and cost per kWh.

II. CORRECTING POOR POWER FACTOR

Low power factor is generally solved by adding power factor correction capacitors to a facility's electrical distribution system. Power factor correction capacitors supply the necessary reactive portion of power (kVAR) for inductive devices.By supplying its own source of reactive power,as facility frees the utility from having to supply it. This generally results in a reduction in total customer demand and energy charges.

Power factor correction requirements determine the total amount of capacitors required at low voltage buses. These capacitors can be configured as harmonic filters if necessary. The power factor characteristics of plant loads typically are determined from billing information, however, in the case of a new installation,typical load power factors will determine the required compensation.

A properly designed capacitor application should not have an adverse affect on end user equipment or power quality. However, despite the significant benefits that can be realized using power factor correction capacitors, there are a number of power quality-related concerns that should be considered before capacitors are installed. Potential problems include increased harmonic distortion and transient over voltages.

Power factor improvement devices such as capacitor banks should be installed near the load centers or loads which are responsible for poor power factors. In industrial set up, automatic power factor correction devices such as capacitor banks are installed and they are controlled by automatic switching circuit using a controller. There controller switches ON or OFF the series or blocks of capacitors depending upon the amount of correction required. The working of these automatic power factor controllers is as follows:

III.AUTOMATIC POWER FACTOR CONTROLLERS

Various types of automatic power factor controls are available with relay/ microprocessor logic. Two of the most common controls are:

1) Voltage control
2) kVAR control.

3.1 Voltage control

Voltage alone can be used as a source of intelligence when the switched capacitors are applied at point where the circuit voltage decreases as circuit load increases. Generally, where they are applied the voltage should decrease as circuit load increases and the drop in voltage should be around 4-5% with increasing load. Voltage is the most common type of intelligence used in substation applications, when maintaining a particular voltage is of prime importance. This type of control is independent of load cycle. During light load time and low source voltage, this may give leading PF at the substation, which is to be taken note of j.

3.2 KiloVARControl

KiloVAR sensitive controls (Fig.1) are used at locations where the voltage level is closely regulated and not available as a control variable. The capacitors can be switched to respond to a decreasing power factor as a result of change in system loading. This type of control can also be used to avoid penalty on low power factor by adding capacitors in steps as the system power factor begins to lag behind the desired value. KiloVAR control requires two inputs - current and voltage from the incoming feeder, which are fed to the PF correction mechanism, either the microprocessor or the relay.

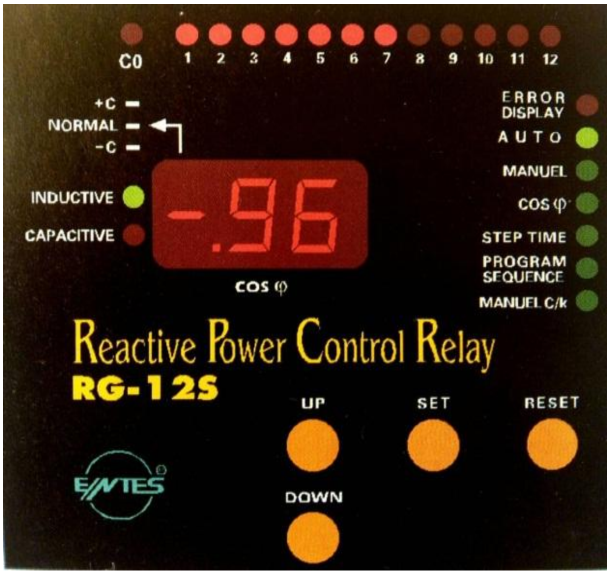

Fig.1: KiloVAR Sensitive Control

IV.AUTOMATIC POWERFACTOR CONTROL RELAY

It controls the power factor of the installation by giving signals to switch on or off power factor correction capacitors. Relay is the brain of control circuit and needs contractors of appropriate rating for switching on/off the capacitors.

There is a built-in power factor transducer, which measures the power factor of the installation and converts it to a DC voltage of appropriate polarity. This is compared with a reference voltage, which can be set by means of a Knob calibrated in terms of power factor.

When the power factor falls below setting.The capacitors are switched in sequence. The relays are provided with First in First out (FIFO) and First in Last out (FILO) sequence. The capacitors controlled by the relay must be of the same rating and they are switched on/off in linear sequence. To prevent over correction hunting, a dead band is provided. This setting determines the range of phase angle over which the relay does not respond; only when the PF goes beyond this range, the relay acts. When the load is low, the effect of the capacitors is more pronounced and may lead to hunting. Under current blocking (low current cut out) shuts off the relay, switching off all capacitors one by one in sequence, when load current is below setting. Special timing sequences ensure that capacitors are fully discharged before they are switched in. This avoids dangerous over voltage transient. The solid state indicating lamps (LEDS) display various functions that the operator should know and also and indicate each capacitor switching stage.]

V.INTELLIGENT POWER FACTOR CONTROLLER (IPFC)

This controller determines the rating of capacitance connected in each step during the first hour of its operation and stores them in memory. Based on this measurement, the IPFC switches on the most appropriate steps, thus eliminating the hunting problems normally associated with capacitor switching.

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