Electrical panel design for power factor improvement in commercial and industrial application

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***Abstract* - In the present technological revolution power is very important, as the power demand in industrial and commercial load is increases. So we have to discover out the causes of control misfortune and progress the framework . Due to a variety of electrical and power electronics loads, the power system losses it's efficiency, hence causing lagging power factor which gives heavy penalties to consumer by electricity board and also pollute the system environment. So we need to improve the power factor of the electrical system. It can be improved by using APFC system which can maintain constantly high power factor nearer to unity. Most of the load used in industries are inductive in nature due to this they consume reactive power which will affect the generation of plant. The motive of this project is to build an Automatic Power Factor Correction (APFC) panel, which is able to control the energy consumptions of a system and automatically improve its power factor.**

***keywords* - Power factor, APFC system, Power factor correction, System efficiency, Reactive power.**

I. INTRODUCTION

In the present situation, power factor is one of the most precious and major issue. Any electrical load that operate on AC system that need apparent power, but apparent power is addition of active power and reactive power, but load consumed active power. Also, reactive power is important for load, because reactive power is the power required by the load and it get return to the power source.

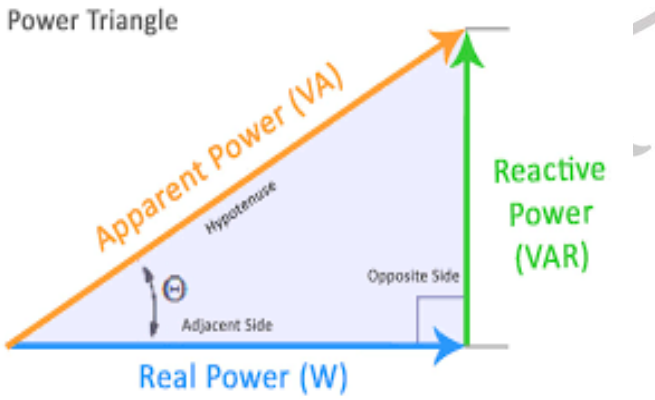

Fig. (A) Power Triangle

Power factor is ratio of the active power(KW) to the apparent power (KVA) drawn by an electric load. It has been a limited effect on how current is being converted into useful work output and due to the good indicator the load current has effect on the efficiency of the supply system. In industry most of the load i.e. motor, welding machine, furnace, compressor, etc. causing lagging power factor that's why there is loss and wastage of energy which result in high power billing and heavy penalty from electricity department. If the load is unbalanced it is complicated to maintain nearer to unity power factor. To solve this difficulty APFC panel is being used which keeps unity power factor. So many commercial and industrial loads need automatic power factor correction system. In present time the cost of the electricity is higher, therefore it is important to compensate the electric power for reducing cost.

At present no comprehensive Indian standard accessible for testing APFC boards. In Bureau of India standards (BIS), the national standards body of India has expansive money related back to CPRI to attempt R&D venture for enhancement of unused standard for LV APFC boards. CPRI in connection with APFC board makers and buyers has defined an Indian Standard for "APFC boards for voltage rating up to 1000 volts". The standard will help both producers and utilities to set up variety in testing and also to install suitable APFC panels for achieving the target power factor, closer to unity. Therefore, to improve the efficiency of LV system by minimizing the losses in distribution system.

II. PROBLEM IDENTIFICATION

1. Poor Power Factor:

Nowadays, many industries using inductive load hence power factor gets reduced. Therefore, following problems are identified:

- Increase heat loss and reduced plant life
- Unstabilise voltage levels
- Upgrade costly equipment's
- Decrease energy efficiency
- Increase electricity cost by paying poor power factor penalty

2. Power factor without using APFC Panel:

When power factor gets reduced, we use capacitor bank to improve the power factor. But at the time of manually operating of capacitor bank we can't maintain exact power factor. When we are operating capacitor bank manually sometimes we connect low KVAR capacitor bank instead of exact required capacitor bank so that we cannot get nearly about unity power factor. And sometime for high KVAR capacitor bank we gets leading power factor.

3. Power factor correction for non- linear loads:

An unsteady stack on an electric framework is commonly a rectifier or a few kind of bend detachable gadget such as a fluorescent light, electric welding machine, or arc furnace. Since current is aggravating by a exchanging activity, the current contains recurrence components that are products of the control framework recurrence. Unstable loads disturb the current waveform from a regular sine wave to some other form. Unstable loads produce harmonic currents in addition to the pure sinusoidal AC current.

III. SYSTEM DESCRIPTION AND METHODOLOGY

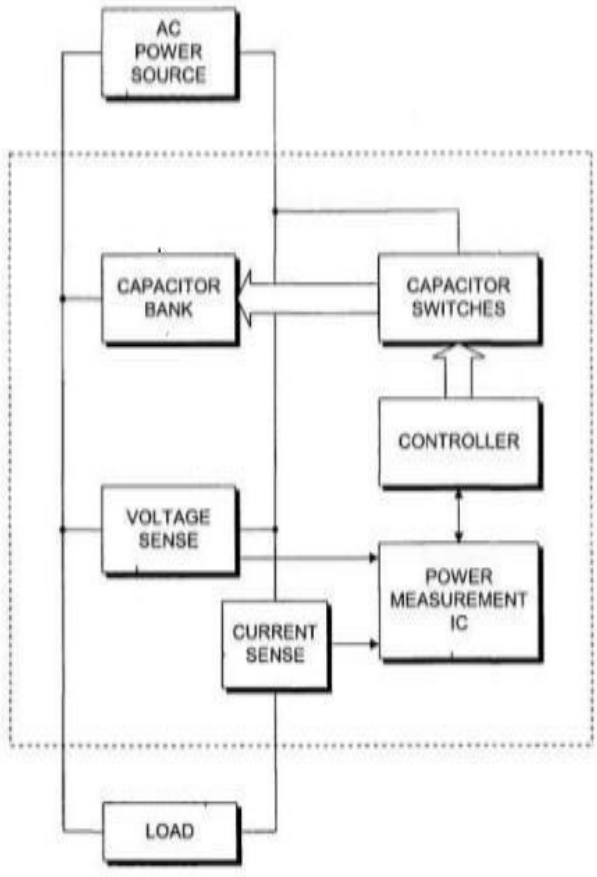

Fig (B) Block diagram of APFC panel

As per the block diagram of APFC panel. The main supply is connected to input of APFC Panel. When power factor is sensed by the CT & PT placed in the line side then the level of line voltage and current the capacitor banks are operated to archive calculated power factor by APFC relay. The right capacitor bank will work with respect to KVAr required to realize target PF by APFC board. After CT & PT will check the feedback from the switching capacitors. Finally stored or targeted PF given to load.

APFC RELAY:

A device is used to sense, calculate, display and store all electrical network parameters. Voltage & current feedback is gain through CT's & PT's. Multi Method Switching (MMS) calculation permit client to set distinctive target control figure for commercial and mechanical electrical stack. A create in self-test office given for checking calibration and operation of the hand-off without any outside stack. Control capacities indeed at moo working load with higher precision of APFC controller discover utilisation and application in all section of industry viz. Automobile factories, production plants, chemical & fertilizer plants, metal industries etc. Over voltage protection, under voltage protection, under load protection, over load protection, high temperature etc. act as a breaking operation of APFC System.

Capacitor bank:
Capacitor bank is an assembly of number of capacitors which are used to contribute KVAr in the electric system and finally improved the desired power factor. Shunt capacitor bank are arrangement of series or parallel connected units.

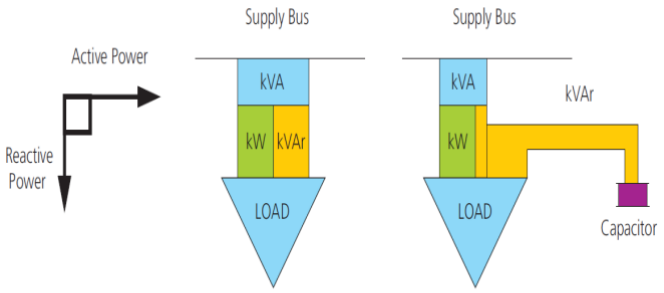

Figure 1: Phase relationship between Active and Reactive Power

Figure 2: Network without Capacitor

Figure 3: Network with Capacitor

Fig. (C) Power Flow dia. With and Without Capacitor

In electrical establishments, the working stack KW and its normal control calculate can be demonstrated from the power charge. Alternatively, it can also be easily evaluated by the formula:

$$Average\ P.F. = \frac{KW}{KVA}$$

$$Operating\ Load\ KW = KVA\ demand\ \times Average\ P.F.$$

The average P.F. is consider is an initial P.F. and the final P.F. can be suitably assumed as target P.F. In such a cases require capacitor KVAr can be calculated as:

$$KVAr = KW(tan\emptyset_1 - tan\emptyset_2)$$

Where,
$\emptyset_1 = \cos^{-1}(PF_1)$

$\emptyset_2 = \cos^{-1}(PF_2)$

Capacitor value in microfarad can be calculated as:
$$C = \frac{KVAR}{2\pi f V^2}$$

Where,
f = supply frequency

V = supply voltage

Case study of inductive load
Given: 400V,50Hz,3ph,100KW,0.8P.F. lag

Solution:
Original pf: $cos\emptyset_1 = 0.8$
Desired pf: $cos\emptyset_2 = 0.95$
Input: P=100KW

$$KVAr = KW(tan\emptyset_1 - tan\emptyset_2)$$

KVAr= 42.11KVAr

$$C = \frac{KVAR}{2\pi f V^2}$$

C= 837.75 uF

Causes of Low Power Factor;
When the inductive load lags the current behind the voltage it causes low power factor. Therefore, power factor of the system is lagging. The inductive load is responsible for low power factor are as follows:

- Inductive loads such as induction motors, generators, transformers and certain lighting loads causes low factor
- A transformer produces magnetizing current from the supply. At light loads, this current does not influence the power factor much but at light load the primary current power factor is low.
- Electric release light, bend lights, mechanical warming heaters, welding gear work at moo slacking control figure.

ADVANTAGES:

- Reduction in apparent power demand.
- Reduction in Line Current.
- Avoid Power Factor penalty.
- If power factor improves above 0.95 then there will be incentives in electricity bill.
- Constantly high power factor under fluctuating loads.
- Prevention of leading power factor.

APPLICATION:

- Automobile Industries, Cement Industries, Metal Industries.
- Chemical & Fertilizer Plant, Pharmaceutical Industries.
- Hospitals, Malls, Banks, IT Parks, Commercial Complexes.
- Windmill, Power Stations, DG Stations, Crushers.
- Railway / MES / Ordinance Workshops

IV. CONCLUSION

From the think about of APFC board able to conclude that the effect of contactor exchanged programmed control figure boards has been considered at quickly changing and scattered loads. The target power factor was also improved much better from 0.8 to approximately 0.99 almost unity when compared to its absence, thus there is reduce in the effect of high power bills and heavy penalties from electricity department.

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