



AUTOMATIC POWER FACTOR CORRECTION

BHATT DHURUV N PARATE UMESH S BAVISKAR ANIKANT V

MAISURIYA DIVYAKANT G PROF.KRUNAL SHAH

ELECTRICAL ENGINEERING

SHROOF S.R.ROTARY INSTITUTE OF CHEMICAL TECHNOLOGY, VATARIA ANKLESHWAR

Abstract — Modern Power network cater to a wide variety of electrical loads and power electronic loads, which create a varying power demand on the supply system and pollute the system environment. It is therefore necessary to automatic switching operation of the suitable capacitor depending upon the load fluctuations without manual intervention. It can be achieved by using Automatic Power Factor Correction (APFC) System which can maintain consistently high power factor, nearer to unity. We will make a Contactor based APFC system that can sustain up to the rating of 20-25 KVA of the industrial load. The model will serve purpose of detecting the variation in power factor and automatically uses the matching KVAR to compensate.

Keywords-automatic, power factor, correction, capacitor, contactor, automatic power factor correction relay

I. INTRODUCTION

The inductor stores electrical energy in the form of magnetic energy and capacitor stores electrical energy in the form of electrostatic energy. Neither of them dissipates it. Further there is a phase shift of 90° between voltage and current. Hence when we consider the entire circuit consisting of resistor, inductor and capacitor, there exists some phase difference between the source voltage and current. The cosine of this phase difference is called **electrical power factor**.

$$\cos \phi = \frac{\text{Active power}}{\text{Apparent power}}$$

This factor ($0 < \cos \phi < 1$) represents the fraction of total power that is used to do the useful work.

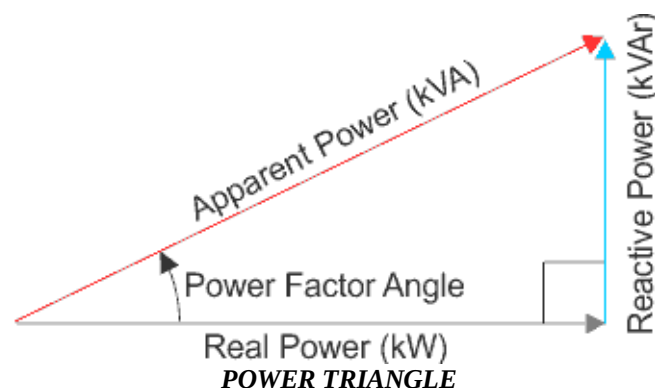
Apparent power: An electrical load that operates on alternating current requires apparent power, which consists of real power plus reactive power.

Total electrical power = Voltage across the element X current through the element.

This is called apparent power and its unit is VA (Volt Amp) and denoted by 'S'.

Active power: A fraction of this total electrical power which actually does our useful work is called as active power. It is denoted as 'P'.

$P = \text{Active power} = \text{Total electrical power} \cdot \cos \phi$ and its unit is watt.



Reactive power: The other fraction of power is called reactive power. This does no useful work, but it is required for the active work to be done. It is denoted by 'Q' and mathematically is given by,

$Q = \text{Reactive power} = \text{Total electrical power} \cdot \sin \phi$ and its unit is VAR (Volt Amp Reactive).

This reactive power oscillates between source and load.

To help understand this better all these power are represented in the form of triangle.

Mathematically, $S^2 = P^2 + Q^2$

Majority of the loads in the industries are highly inductive in nature such as induction motors, AC/DC drives, welding machines, arc furnaces, fluorescent lightings electronic controls and computers. There may be a few resistive loads for heaters and candescent bulbs. Very rarely industries may have capacitive loads such as synchronous motors. Net Industrial load is highly inductive causing a very poor lagging power factor. If this poor power factor is not been compensate, the industry will require a high maximum demand from Electricity Board and also will suffer a penalty for poor power factor. We connect APFC panel which include capacitors in the power system at appropriate places to compensate the inductive nature of the load.

II. AIM

Our aim is to make Contactor Based Automatic Power Factor control panel for the Industrial load so that the value of power factor would be nearer to unity for 20-25 KVAR load approximately. For the different KVAR, switching would be provided so that the losses of the panel are decreased.

III. CAUSES OF LOW POWER FACTOR

Since power factor is defined as the ratio of KW to KVA, we see that low power factor results when KW is small relation to KVA. Inductive loads. Inductive loads (which are sources of Reactive Power) include:

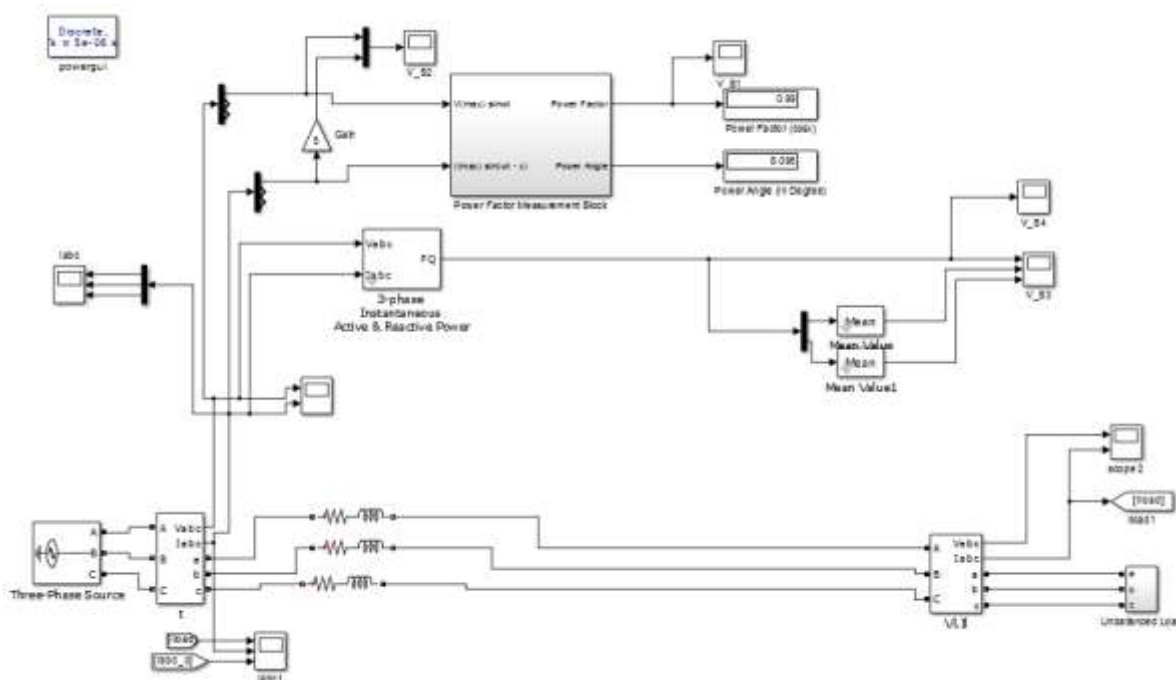
1. Transformer
2. Induction motor
3. Induction generator (wind mill generator)
4. High intensity discharge (HID) lighting

These inductive loads constitute a major portion of the power consumed in industrial complexes.

Reactive power (KVAR) required by inductive loads increases the amount of apparent power (KVA) in your distribution system. This increase in reactive and apparent power results in a larger angle (measured between KW and KVA). Recall that, as θ increases, cosine (or power factor) decreases.

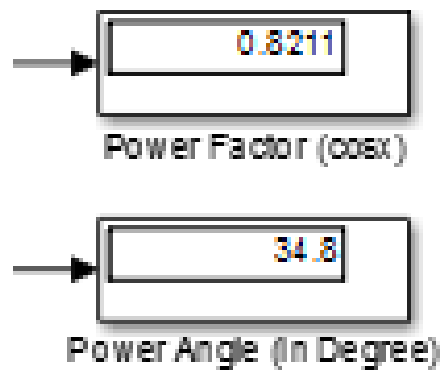
IV. MATLAB SIMULATION

1. MATLAB simulation without capacitor bank



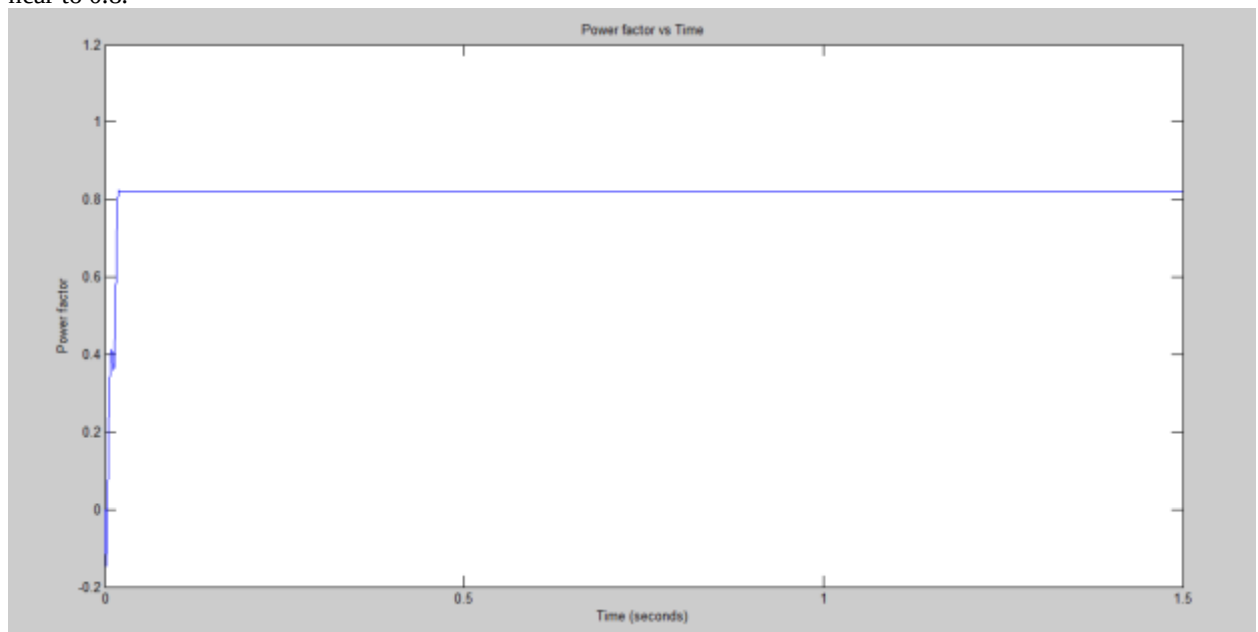
SIMULATION WITHOUT CAPACITOR BANK

In this simulation there is a three phase ac source is in it which is supply through the transmission line parameter. Then it is connected through the three phase star connected load. The V-I measurement block is there in sending end and the load side also to measure the value of voltage and current of each phase. For measurement of power factor there is also one block in this which measure and give the value of power factor and graph also. in this simulation the Capacitor bank is not connected through the load so the value of power is shown in figure.



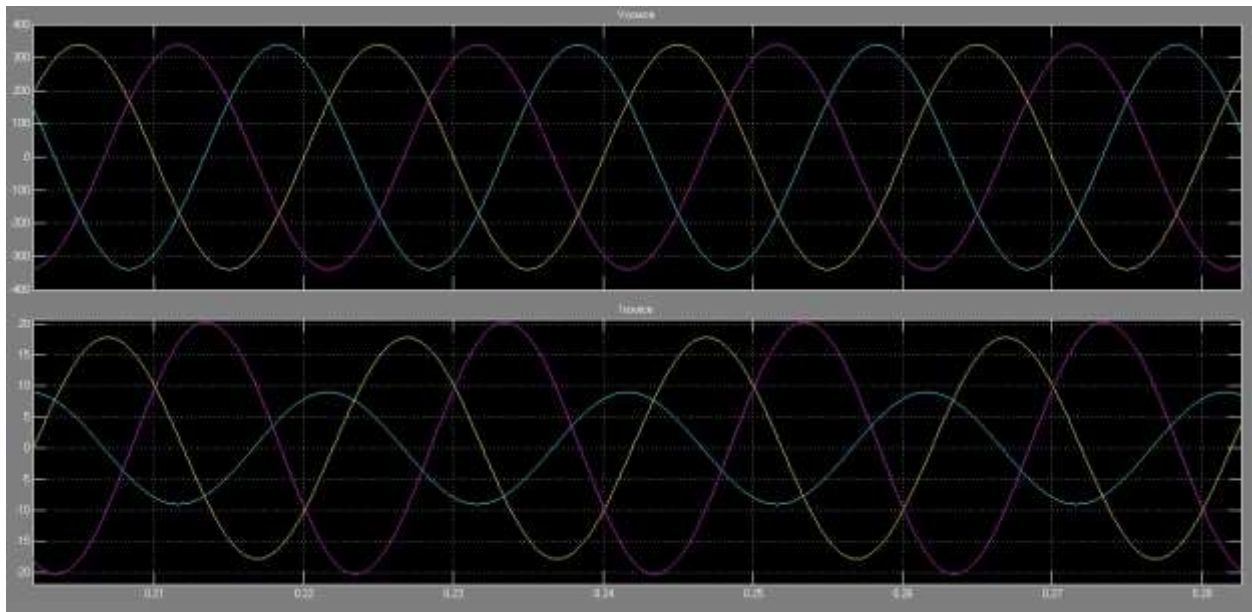
POWER FACTOR WITHOUT CAPACITOR BANK

There is graph of power factor without connected capacitor bank. Graph show that the value of power factor is near to 0.8.



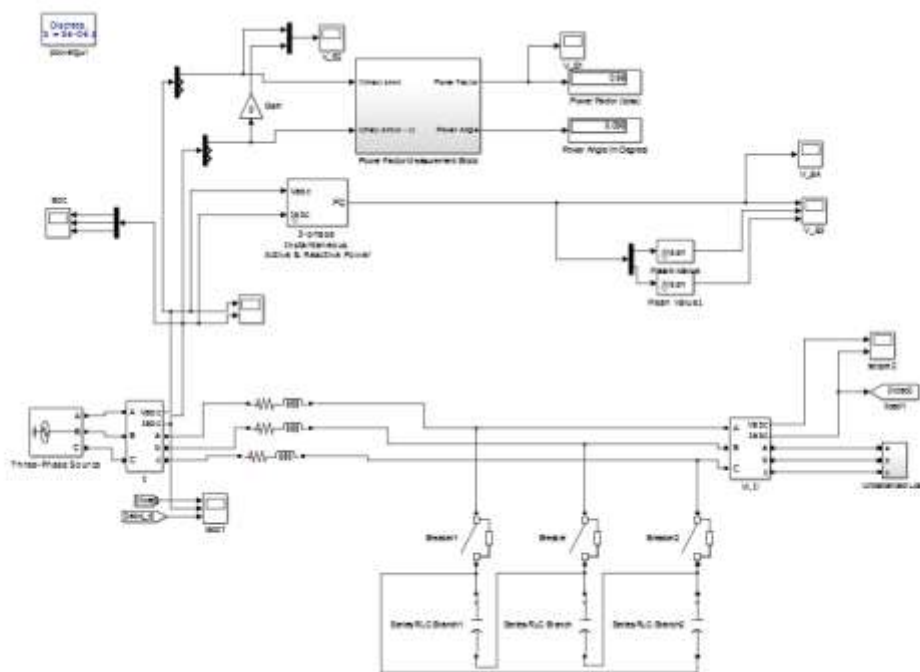
POWER FACTOR VS TIME WITHOUT CAPACITOR BANK

The system voltage and current are not in phase in this simulation so to get the voltage and current in phase we need to connect capacitor bank. Here is the graph of voltage and current which is not in phase.

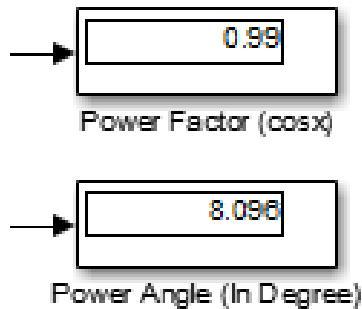


VOLTAGE VS CURRENT WITHOUT CAPACITOR BANK

2. MATLAB SIMULATION WITH CAPACITOR BANK

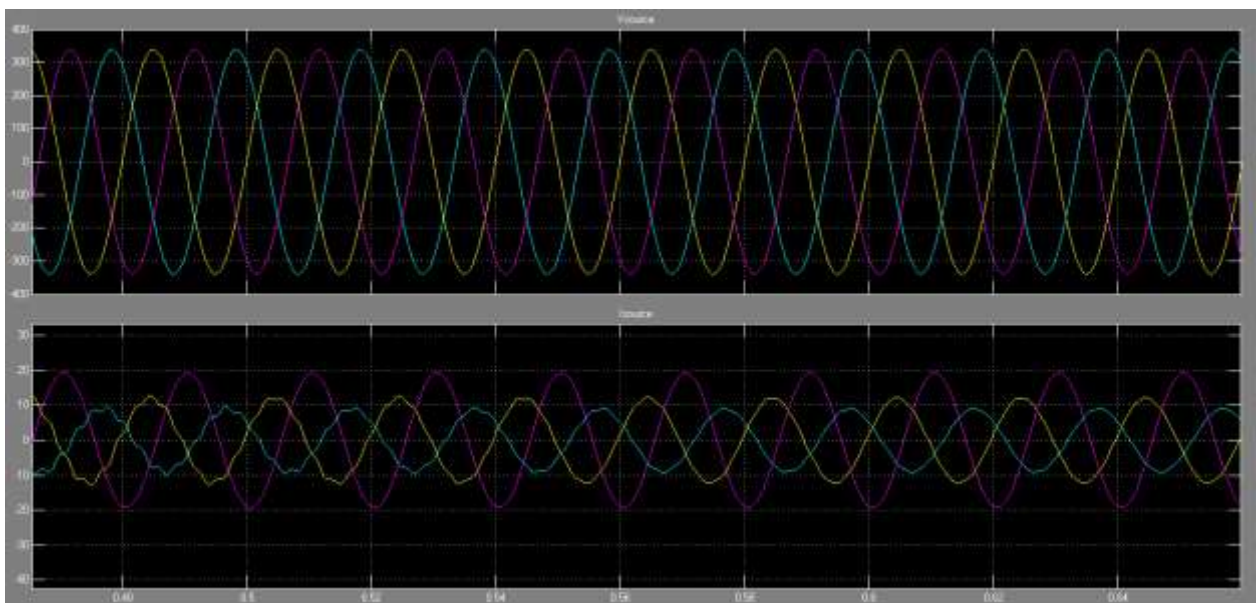


In this simulation the capacitor bank is connected to the load side to compensation of reactive power. if we connect capacitor bank in this according to the load variation the breaker is connect or disconnect the capacitor bank. In this we get the power factor near to unity which is required to get the voltage and current in phase. Which reduce the losses as well as power consumption is also reduce. Here is the value of power factor which is 0.99 near to unity.



POWER FACTOR WITH CAPACITOR BANK

This is the wave form of voltage and current which are in phase. So that power factor become near to unity as 0.99.



VOLTAGE VS CURRENT WITH CAPACITOR BANK

Conclusion:-from this we can conclude that if the value of power factor is near to unity the voltage and current are in phase with it so that line losses and power consumption are less. Also it will be benefit to industry that industries not give any penalty for low power factor and power consumption of industries will reduce so cost is less.

References

1. Morden power system protection by, D.P.KOTHARI, I J NAGRATH
2. Article of automatic power system protection by Mr. A Kumar Tiwari
3. Automatic power factor correction Prof. S. Ghosh
4. WWW.ELECTRICAL4U.COM
5. WWW..ELECTRICALNOTES.COM
6. Voltage Profile Improvement of Transmission Lines Using Static VAR Compensator by PG Student [ED&PS], Dept. of EEE, Disha Institute of Management & Technology, Raipur, Chhattisgarh, India
7. Capacitor application issues by Thomas M. Blooming, P.E.Senior Member, IEEE Minimizing the penalty in industrial sector by engaging the automatic power factor correction panel using microcontroller by Prasad phad sagar jundare from k.j collage of engineering, pune, India
8. V.K Mehta and Rohit Mehta, "Principles of power system", S. Chand & Company Ltd, Ramnagar, Newdelhi-110055, 4th Edition, Chapter, 6.
9. Sharkawi E I, Chen M A, Vandari S V, Fisser G W, Butter N G, Vinger R J, "An Adaptive Power Factor Controller for Three Phase Induction Generator", IEEE Transaction on Power Apparatus and Systems

10. Nalbant M K, "Power Factor Calculations and Measurement", IEEE Conferences on Applied Power Electronics
11. Rakendu Mandal, Sanjoy Kumar Basu, Asim Kar, Syama Pada, "A Microcomputer Based Power Factor Controller", IEEE Transaction on Industrial Electronics Sharaf AM and Huang H, "Nonlinear Load Reactive Compensation and Power Factor Correction Using Modulated Power Filter".
12. Rao U M, Vijaya M A, Venakata S S, Williams T J, Butter N G, "An Adaptive Power Factor Controller For 3 Phase Induction Generators", IEEE Transaction on Power Apparatus and Systems
13. Mr. Musthafa.P, Mr. M.Sivasubramanian, Mr.K.Sakthidhasan, "Analysis of Dynamic Power Factor Correction Using Flexible Ac Transmission Systems
14. Prakash V, Baskar S, and Sivakumar S, "A Novel Efficiency Improvement Measure In Three-Phase Induction Motors, Its Conservation Potential and Economic Analysis"
15. Jones, L. D.; Blackwell, D. (1983) "Energy Saver Power Factor Controller for synchronous Motors", IEEE Transactions on Power Apparatus and Systems
16. Rakendu Mandal; Sanjoy Kumar Basu; Asim Kar; Shyama Pada Chowdhury (1994) "A Microcomputer – Based Power Factor Controller", IEEE Transactions on Industrial Electronics
17. Ramasamy Natarajan (2005). "Power System Capacitors." Boca Raton, FL: Taylor & Francis.