

**Automatic Power Factor Correction in EHV System**Bhavin Seta¹, Prof. Deepa Karvat²¹Student Electrical, P.I.E.T²Asst. Prof. Electrical, P.I.E.T

Abstract — This paper investigates the power factor correction of electrical loads is a problem common to all industrial companies. Earlier the power factor correction adjusting by capacitor manually. The power factor correction equipment are different type. Such as, Synchronous Alternator, Synchronous Compensator, Static var Compensator, Banks of Static Capacitors. The Static capacitors are give up the reactive power in the system. Whereas the variation in load to the different Static capacitor are used. The power factor is a ratio of the actual power to the apparent power. And the Reactive Power is very useful in the power system. Because the inductive load is used in power system and the system is absorbed the reactive power. The designing auto-adjustable power factor correction is to ensure the power factor unity.

Keywords- Capacitor, Power factor, Phase Angle, Power System Load, Equipment of Power Factor Angle

I. INTRODUCTION

Power factor is a ratio of active or usable power measure in kilowatts (KW) to the total power measured in kilovolt amperes (KVA). the cosine of angle between Voltage and Current in A.C Circuit is Known As power factor. the power factor value is very from 1% to 100%, here 100% is called the unity power factor. and the 1% means all the power supplied as a reactive power.

The improvement in power factor, first the process of the energy stored in capacitors and inductive devices. As the voltage in the A.C circuits are very from zero to maximum voltage. during starting time the inductive devices are gives up energy from its electro magnetic field, and capacitors are stored energy in the electrostatic field. as the maximum point the voltage is in decreasing condition. at the time capacitors gives up energy and inductive devices stored energy. the capacitors may be considered as a kilovolt amp- reactive (KVAR) generator. the concept of the capacitors as a kilovolt amp-reactive (KVAR) generator is helpful in power factor improvement.

Apparent Power(KW):

$$S = V \times I \quad (1\phi) \quad \text{Eq. 1}$$

$$S = \sqrt{3} V \times I \quad (3\phi) \quad \text{Eq. 2}$$

Where V= phase to phase Voltage

I= line current.

Active Power(KVA):

$$P = V \times I \times \cos \phi \quad (1\phi) \quad \text{Eq. 3}$$

$$P = \sqrt{3} V \times I \times \cos \phi \quad (3\phi) \quad \text{Eq. 4}$$

So, The Power Factor($\cos \phi$):

$$\cos \phi = \frac{S}{P} \quad \text{OR} \quad \cos \phi = \frac{KW}{KVA} \quad \text{Eq. 5}$$

Where, S = Apparent Power

P = Active Power.

The power factor angle is Shown in the Fig 1.

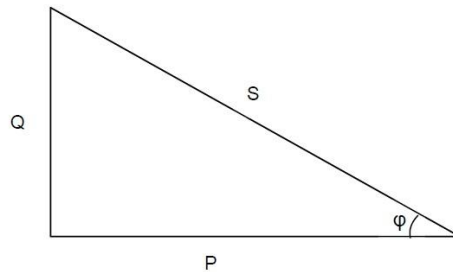


Fig. 1 Power Triangle

POWER FACTOR:

In alternating current circuits, the current absorbed by a load can be represented by a two components:

1. Active Component(IR):
2. Reactive Component(IQ):

In the most common case, the ohmic-inductive load is present. so, the total current I lags with respect to the active component. the power factor $\cos \phi$ is a ratio between the active component IR and total current I, ϕ is the phase angle between the voltage and current.

$$\cos \phi = \frac{I_R}{I} = P/S \quad \text{Eq. 6}$$

Where, P= Active Power

Q= Reactive Power

Phase angle(ϕ):-

$$\phi = \cos^{-1} (P/S) \quad \text{Eq. 7}$$

$$\text{Here, } P = S \cos \phi \quad \text{Eq. 8}$$

$$Q = S \sin \phi \quad \text{Eq. 9}$$

$$Q/P = \tan \phi \quad \text{Eq. 10}$$

$$X_L = 2 \pi fL \quad \text{Eq. 11}$$

$$Z = R + jX_L \quad \text{Eq. 12}$$

$$\tan \phi = (X_L/R) \quad \text{Eq. 13}$$

$$\phi = \tan^{-1} (X_L/R) \quad \text{Eq. 14}$$

ACTIVE POWER:

$$P = V \times I \times \cos \phi \quad \text{Eq. 15}$$

$$P = \sqrt{3} V \times I \times \cos \phi \quad \text{Eq. 16}$$

REACTIVE POWER:

$$Q = V \times I (\sqrt{1 - \cos^2 \phi}) \quad \text{Eq. 17}$$

$$Q = \sqrt{3} V \times I (\sqrt{1 - \cos^2 \phi}) \quad \text{Eq. 18}$$

Most apparatus connected to the power supply network required not only active power but also certain amount of reactive power. reactive current are maintain the magnetic field of motor and transformer. series inductance in transmission lines also consumes reactive power. inductive circuit also required a reactive power. reactive power generated by a rotating compensator or capacitors.

II. POWER FACTOR CORRECTION

The low power factor is mainly due to the effect of the power loads are inductive load, it takes lagging currents. the improvement in power factor some loads are connected in parallel with the load. one of such device is capacitors. It takes leading current.

POWER FACTOR CORRECTION EQUIPMENT:

- 1) Synchronous Alternator:
- 2) Synchronous Compensator (SC):
- 3) Static Var Compensators (SVC):
- 4) Banks Of Static Capacitors:

1) Synchronous alternator:

Synchronous alternators are used for the generation of electrical energy. they are supplied electrical power to the final loads through transmission and distribution systems. It is also very the generated voltage and consequently the regulate reactive power without the change in a technical data.

2) Synchronous Compensators:

This Devices are Used in Nodes of the Power Transmission and Sub-Transmission network for the Regulation of Voltage and Reactive Power Flows. Synchronous Compensator are not Used in the Power Distribution Network. Because, their higher installation and Maintenance cost also high.

3) Static Var Compensator:

Development Of Power Electronics in replacement of Synchronous Compensator With Static System for the Control of Reactive Power Such as,

1. TSC- Thyristor Switch Capacitors
2. TCR- Thyristor Controlled Reactors

The Upper Compensators are Reactive Power Compensator Based on The Electromechanical Components. In Which Compensators, The Switching of the capacitors are not used to Opening and Closing of the Contactors, But Control by The Anti-parallel Thyristors.

TSC is a Step by Step Control of reactive Power Delivered by the Groups of Capacitors. And TCR is a Continuous Control of reactive Power Drawn By the Inductor is Possible. These Devices are Used in the High and Very High Voltage networks.

4) Banks Of Static Capacitors:

The Capacitor is a Passive Dipole Consisting of Two conducting Surface Called Plates, Isolated From One to Another Through A Dielectric Materials.

The Last generation of capacitors are dry types and improve their electrical characteristics using specific treatment. No risk of pollution in a dry type capacitors.

when the alternating voltage is applied across the plates of capacitors, the capacitor is subjected to charge and discharge cycles. when the capacitor is in charging mode than the reactive energy stored. the capacitor is in discharging mode than the inject such energy in the circuit to which is connected.

Capacitor energy equation such as,

$$E_c = \frac{1}{2} C V^2 \quad \text{Eq. 35}$$

Where, E_c = Capacitor energy

C = Capacitance

V = Applied Voltage

Because of their Capability of storing and delivering energy, Capacitors are used as a power factor correction banks. and reactive power in the static device as a capacitors banks are used.

III. SIMULATION AND RESULT

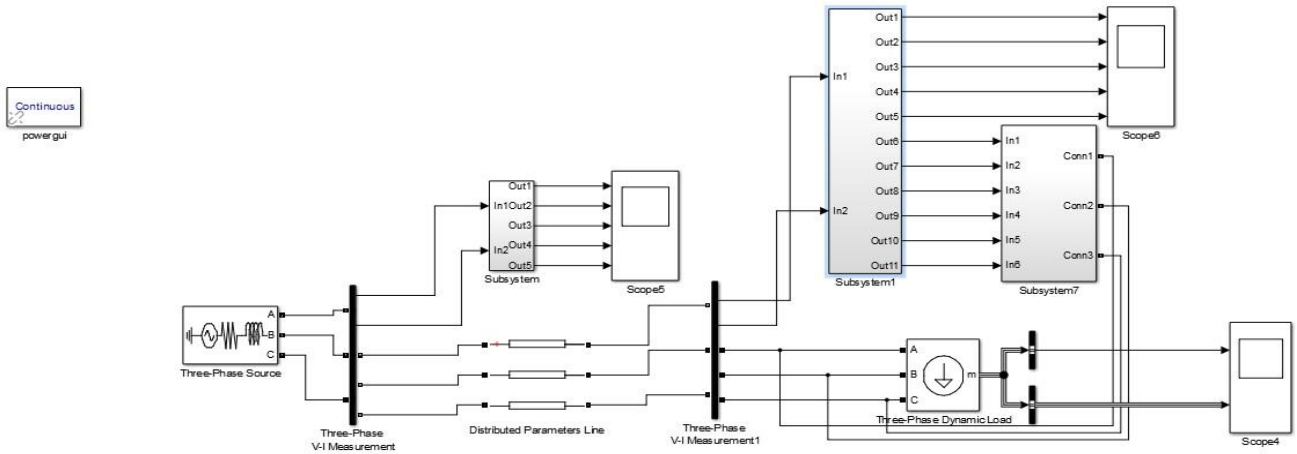


Fig. 1 Three Phase Bus System

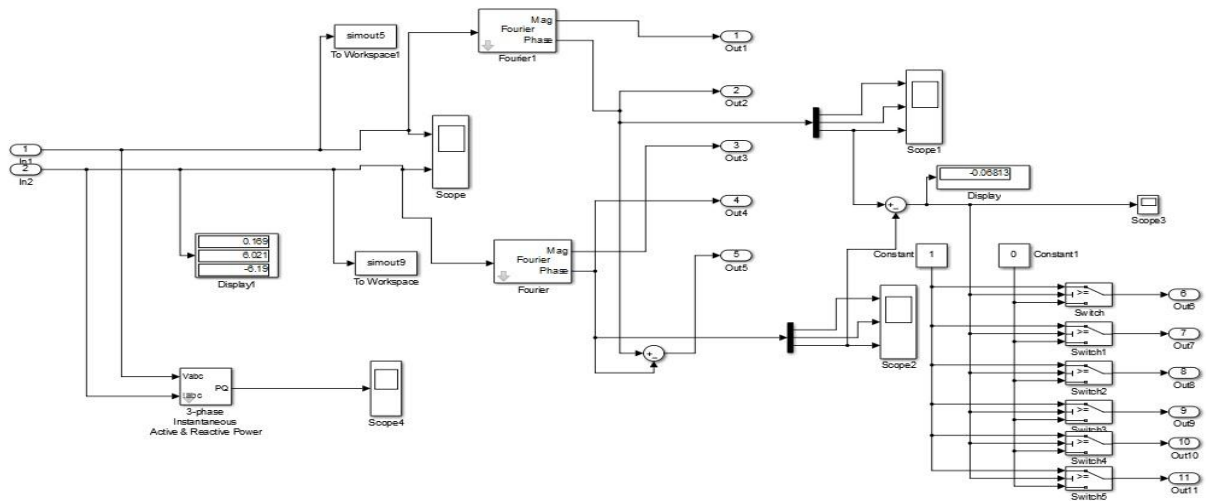


Fig. 2 Secondary Side Phase Angle

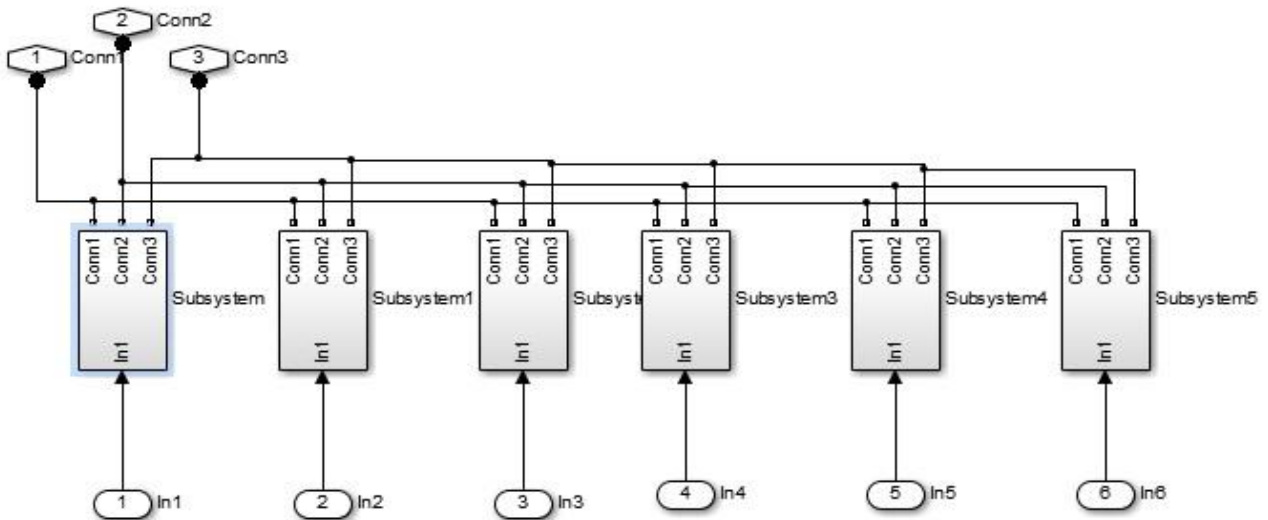


Fig. 3 Capacitor Banks

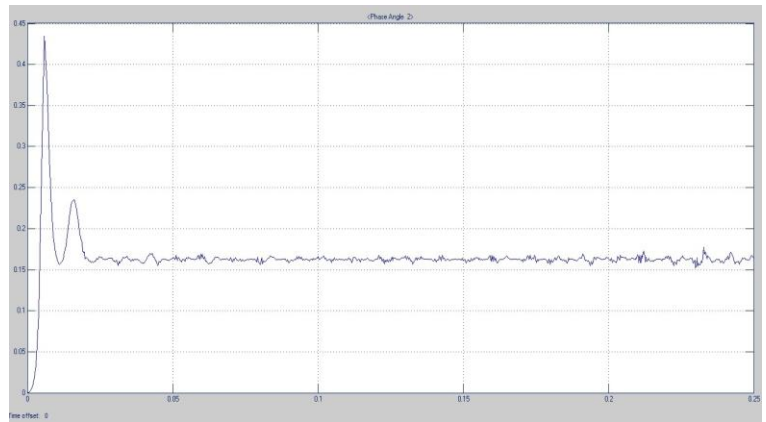
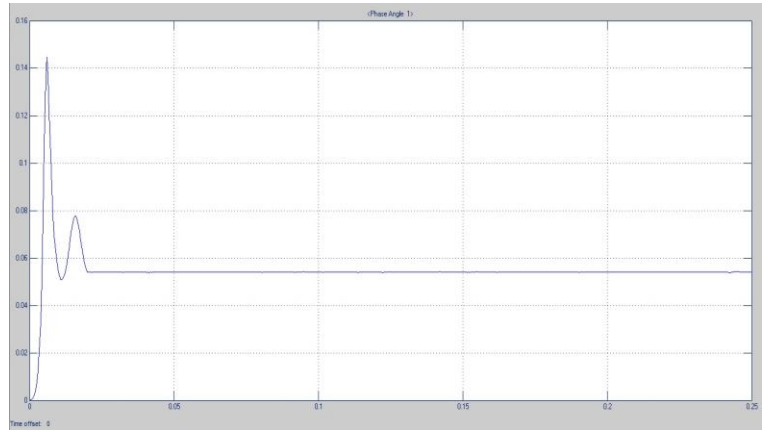
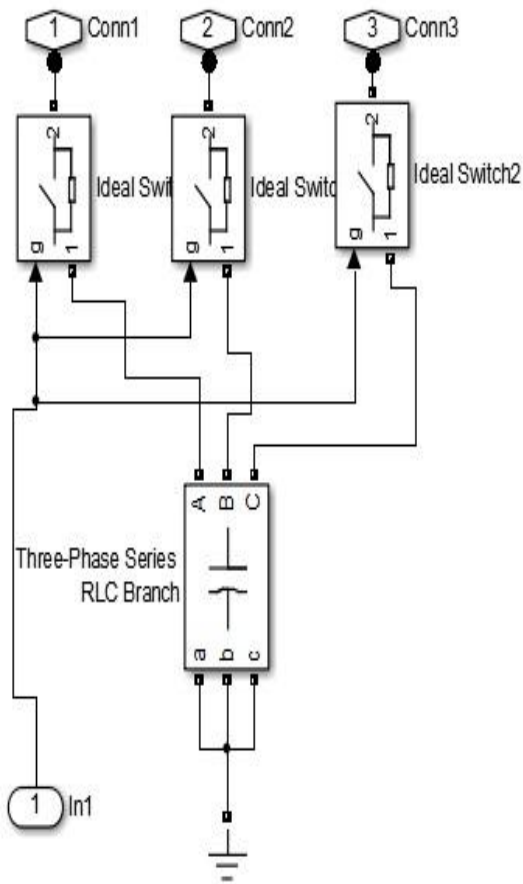
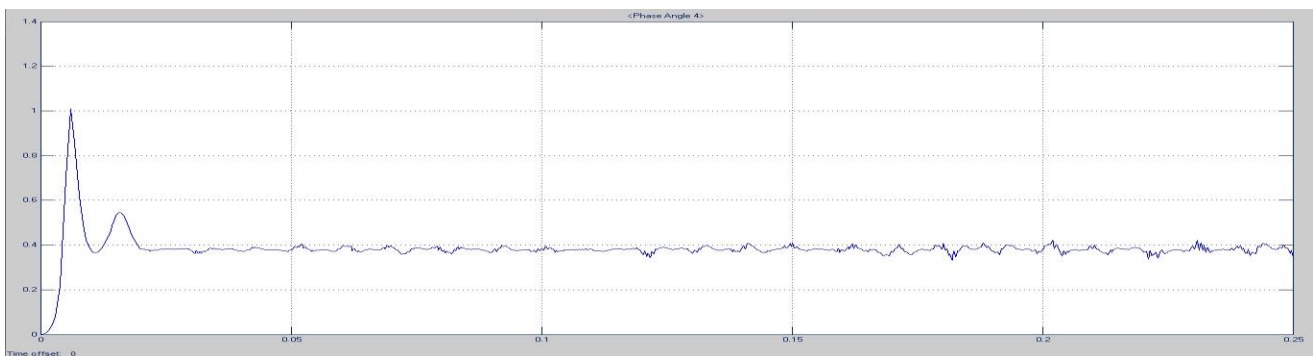
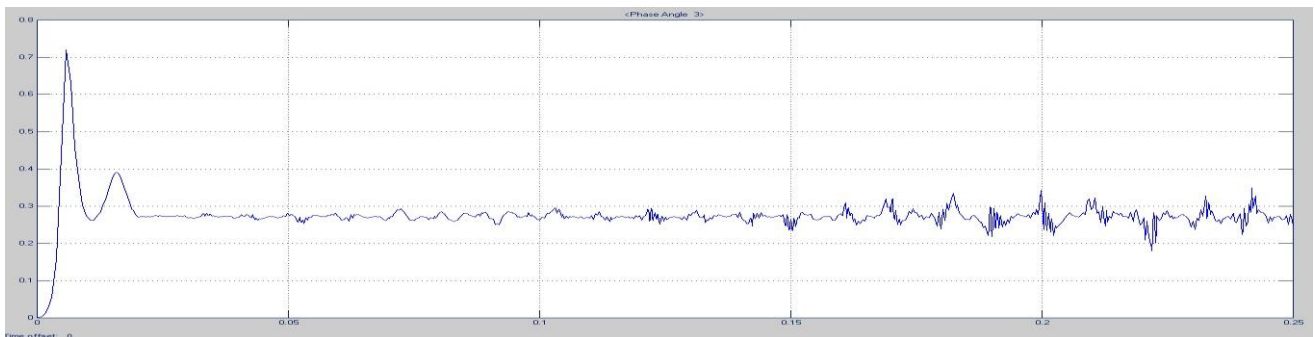
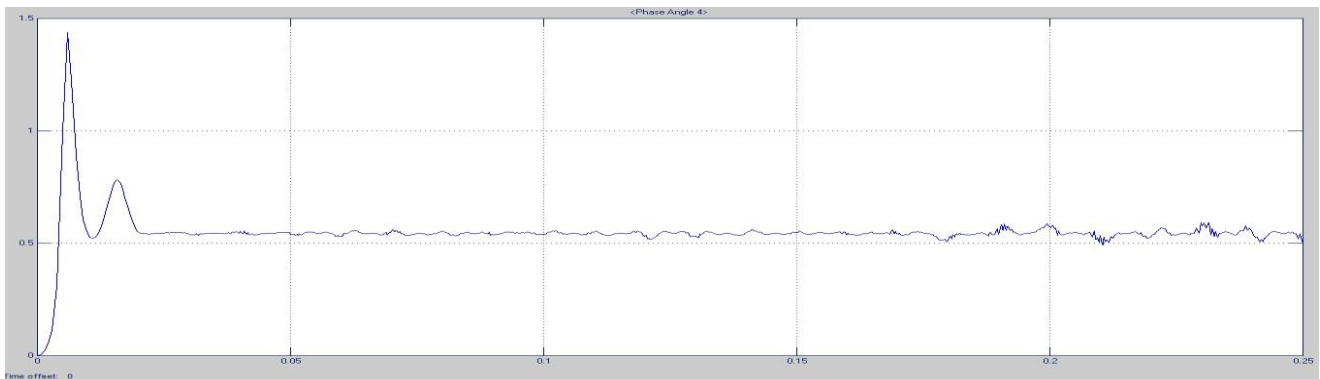
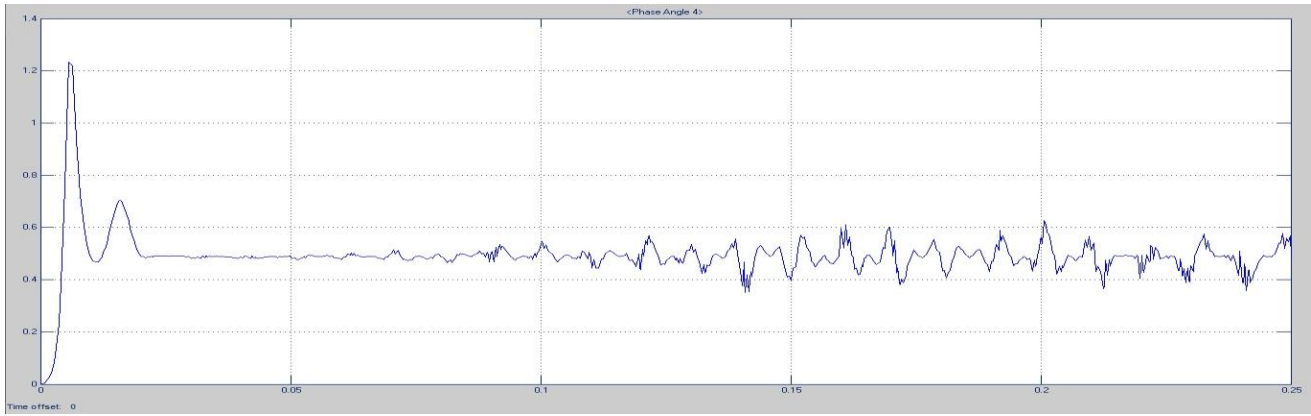


Fig. 3 Ideal Switch





CONCLUSION:

From the simulation result, I conclude that the Power Factor Angle is very useful in the Power System and which is measured by the Phase Difference of the Voltage & Current. The Output Waveform of the Phase Angle to the Switch is connected, because the Two value Compared By the Switch. The Individual Switch Output is Connected to the Individual Capacitor Bank Also. So, the Automatic Power Factor Correction are Use in this Waveform.

REFERENCES

- [1] ABB "Power factor correction and harmonic filtering in electrical plants".
- [2] Mr.A Kumar Tiwari, Mrs. Durga Sharma, Mr. Vijay Kumar Sharma " Automatic Power Factor Correction Using Capacitive Bank " Int. Journal of Engineering Research and Applications www.ijera.com ISSN : 2248-9622, Vol. 4, Issue 2(Version 1), February 2014, pp.393-395.
- [3] Thomas M. Blooming, P.E, Daniel J. Carnovale, P.E " Capacitor Application Issues" IEEE.
- [4] Md. Raju Ahmed, M. J. Alam " Power Factor Improvement by Pulse Width Modulated Switched Single Capacitor" Proceedings of India International Conference on Power Electronics 2006
- [5] "Guide To Reactive Power Compensation With Capacitors" High voltage technology.
- [6] T. W. Schroeder, W. C. Bloomquist "Automatic Control and Switching Equipment for Capacitor Banks and Its Application" AIEE.
- [7] M. H. Shwehdi , M. R Sultan "Power Factor Correction Capacitors; Essentials and Cautions".