AUTOMATIC POWER FACTOR IMPROVEMENT USING EMBEDDED SYSTEM

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ABSTRACT

The objective of this project is to moniter and control the cosine angle between the voltage and current in order to save the electric energy.This project is very useful in the industries where heavy inductive loads are used.If the powerfactor is less than unity the line current is greater and increases the KVA demand.This attracts penalty imposed by Electricity Board.

Keywords: Electric Energy, Power Factor, Cosine Angle, KVA.

I.INTRODUCTION

1.1 Need of Project

This project is used to monitor and control the cosine angle between the voltage and current in order to save the electric energy. If the power factor is less than unity, the line current is greater than the load current, which causes heating of switch contacts, cables etc. As also it causes to rise in reactive power, the KVA demand increases.

This leads to double payment to EB office and this leads to penalty charges. So this project is very useful to the industries where inductive loads are used.

At present maximum number of industries use power factor controller to maintain the power factor. Those power factor controller use normal relays in their circuits for the switching purposes. Since those normal relays have a low switching speed, the power factor cannot be controlled continuously without steps.

When compared to our circuit design the normal relay circuit cost is greater. The relay will have some chattering in its contacts and they will get damaged soon. In industries the power factor control circuit uses relays for switching. By understanding the problem of the relay circuit we made a different design. In this project we have replaced the relay by a Thyrister.

II. OVER VIEW OF AUTOMATIC POWER FACTOR IMPROVEMENT USING EMBEDDED SYSTEM

2.1 Block Diagram
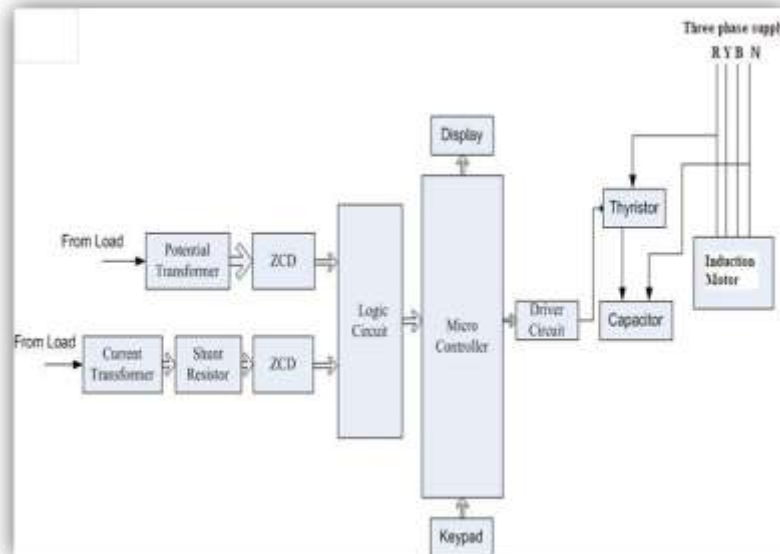
Fig 1.1 Block diagram of Automatic Power Factor Improvement Using Embedded System

2.2 Block Diagram Description

1.Potential transformer

Voltage to the motor is measured with the help of a potential transformer. The potential transformer will convert the mains supply voltage to low voltage ac. That ac voltage is given to zero crossing detectors

2. Current transformer

The current transformer will convert the load current in to lower values that current output will be converted in to voltage with the help of the shunt resistor. Then the corresponding the ac voltage is given to zcd.

3. Zero crossing detectors

The zero crossing detectors are used to convert the input sine wave signal to corresponding square wave signal. For power factor measurement, the sensing of ct and pt are taken from any one of the phases and given to zero cross detector (zcd) and both voltage and current are converted square wave, ic741 compare the square wave and the resultant output is given to the micro controller.

4. Logic circuit

In this logic circuit an ex-or gate is used. This ex-or gate is used for calculation. This intakes the output from the two comparators and makes a calculation. Then the square wave signal is given to logic circuit in order to find timing between the two pulses. Then the corresponding pulse output is given to microcontroller.

5. Micro controller

The microcontroller is the flash type reprogrammable microcontroller in which we have already programmed with our objectives the microcontroller received the corresponding square pulse from the logic circuit and performs the mathematical calculation on the pulse to find the cosine angle.

6. Lcd display

2x16 lcd display used to display the power factor value.

7. Driver circuit

This circuit is used to drive the thyristor.

8. Thyristor

Thyristor is a semiconductor switching device and it is used for adding and cutting the capacitor.

9. Capacitor

The capacitor is mainly used to improve the power factor when normal power factor is going lagging condition.

III.WORKING PRINCIPLE

Voltage to the motor is measured with the help of a potential transformer. The potential transformer will convert the mains supply voltage to low voltage AC. That AC voltage is given to zerocrossing detectors. Current consumed by the motor is measured with the help of a current transformer.

The current transformer will convert the load current in to lower values that current output will be converted in to voltage with the help of the shunt resistor. Then the corresponding the AC voltage is given to Zero crossing detectors.

The zero crossing detectors are used to convert the input sine wave signal to corresponding square wave signal. Then the square wave signal is given to logic circuit in order to find timing between the two pulses. Then the corresponding pulse output is given to microcontroller.

Here the microcontroller is already programmed with our objectives. The microcontroller receives the corresponding square pulse from the logic circuit and performs the mathematical calculation on the pulse to find the cosine angle.

The cosine value is displayed on the LCD display which is equal to the monitored power factor.If the monitored power factor is less then unity, then the microcontroller activates the Thyrister driver circuit.

The fixed capacitor is connected across the Thyrister output terminal. When Thyrister output terminal is shorted through the capacitor the lagging angle is compensated through lading angle due to the capacitor. If the cosine angle crosses the unity and moves towards the leading angle suddenly the capacitor is cut off and the angle moves towards the unity. Thus the power factor is maintained efficiently

IV.TEST RESULTS

4.1 Load Test (Without Capacitor)

Load status	Line voltage	Line current	Input power	cosφ	% ofŋ
No load	230	0.5	20	0.2	-
Full load	230	0.75	130	0.7	85

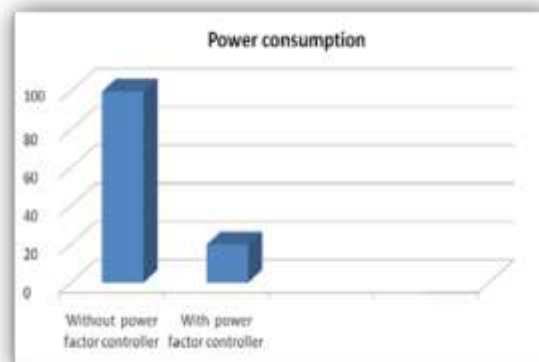**Table:1.1 Test results**

4.2 Load Test (With Capacitor)

Load status	Line voltage	Line current	Input power	cosφ	% ofŋ
No load	230	0.5	20	0.9	-
Full load	230	0.75	130	0.9	89

Table:1.2 Test results

4.3 Bar Chart

Fig:1.2 Bar chart

From the bar chart we can understand that when an industry run without a power factor controller the power consumption will be high and so much loss will occur to the EB and to the industry. By introducing the power factor controller the power will be 80% saved and power losses will be no more.
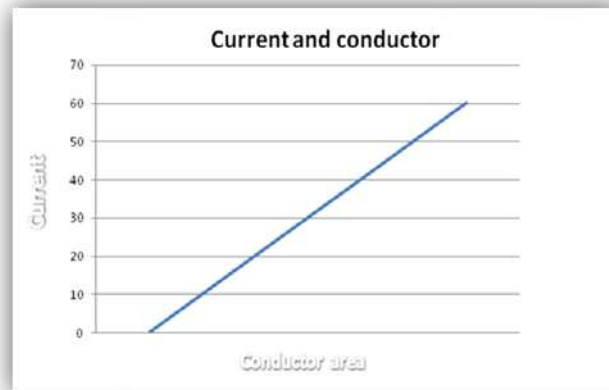
4.4 Graph

Fig:1.3 Graph

The above graph shows relation between the current and the conductor. From the graph we can know that when the current increases the conductor size also increases.

Thus when a power factor controller is fixed the current in the line is too minimum so the size of conductors will reduces and the initial cost also reduced.

V. DRAWBACK

5.1 HARMONIC DISTORTION

1. The Harmonic Problem

Any device with non-linear operating characteristics can produce harmonics in your power system. If you are currently using equipment that can cause harmonics or have experienced harmonic related problems, capacitor reactor or filter bank equipment may be the solution. Harmonic distortion and related problems in electrical power systems are becoming more and more prevalent in electrical distribution systems.

2.Problems Created by Harmonics

- Excessive heating and failure of capacitors, blowing of capacitor fuses, heating of transformers, motors and fluorescent lighting ballasts, etc.

- Nuisance tripping of circuit breaker or blown fuses
- Presence of the third harmonic & multiples of the 3rd harmonic in neutral grounding systems may require the de-rating of neutral conductors
- Noise from harmonics that lead to erroneous operation of control system components
- Damage to sensitive electronic equipment
- Electronic communications interference

The following is a discussion of harmonics; the characteristics of the problem; and a discussion of our solution.

3.Harmonic Solution

Capacitor, De-tuned Capacitor & Filter Bank products from ABB Control:

Asea Brown Boveri (ABB) is the world's largest manufacturer of dry type low voltage capacitors. ABB Control utilizes this experience in recommending three options to solve the problems associated with applying capacitors to systems having harmonic distortion:

1. Apply the correct amount of capacitance (kvar) to the network to avoid resonance with the source. This may be difficult, especially in automatic systems as the capacitance is always changing.
   This solution usually means connecting less capacitance to the system than is actually needed for optimum power factor correction.
2. Install reactors in series with capacitors to lower the resonance below critical order harmonics; i.e., 5th, 7th, 11th & 13th. This design tunes the resonant frequency of the system well below the 5th harmonic and is called a detuned filter bank.
   This solution allows the capacitors to operate in a harmonic environment.
3. Filters are recommended if a problem exists with harmonic distortion before the application of power factor correction, or if the harmonic distortion is above the limits recommended in IEEE 519, Guide for Harmonic Control and Reactive Compensation of Static Power Converters.
   Tuned filters sized to reduce the harmonic distortion at critical frequencies have the benefits of correcting the power factor and improving the network power quality.

VI.ADVANTAGES
- Low power consumption.
- The parameters are acquired effectively.
- High Efficiency.
- Long life of machines.
- Money will be saved.

- Maintenance is less.
- Much useful for industries.

VI.CONCLUSION

Now days, in industries 70% of motors are induction motors. In this motor the no load power factor will be low due to the magnetizing current. And so in industries large amount of loss occurs.This project will be helpful in maintaining the power factor of an industry. By adopting this project, mutual benefit is gained over consumer and Electricity Board. We have given clear details about each and every section of this project. The project is economically beneficial one.

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