COMPENSATION OF REACTIVE POWER AND ENERGY SAVING USING CAPACITOR BANKS

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Abstract- *Reactive power management is a critical problem when commerce with the planning and operation of power systems with high wind energy infiltration. This paper is envisioned to present a synchronized reactive power planning approach using capacitor banks. According to this approach instead of using the reactive power limit as it is customarily done, the reactive power inoculation from static var compensator (SVC) is related to the standing physical limits of the control variables. The capacitor banks shall comprise a series of single-phase capacitor units suitably planned for the essential total amount of reactive power for the specified frequency and voltage. The guaranteed minimum values of losses of the capacitor units shall include losses due to discharge resistors which shall be mounted inside each unit to discharge each unit from peak voltage to maximum 75 V in less than 10 minutes. Internal fuses shall be provided in order to limit possible failure to a single capacitor element only. By reactive power compensation using capacitor banks can regulate the energy and diminish the consumption of electricity. This work is implemented using MATLAB.*

Key Words: Reactive Power, Energy, static Var compensator, frequency and voltage, discharge resistors.

1. INTRODUCTION

This work projects the management of reactive power using capacitor banks to compensate or to reduce reactive power drawn from the feeder and thus to improve power factor and hence resulting energy saving

1.1 NEED AND CAUSES OF REACTIVE POWER

Generally we know that Reactive power comes into picture, when there exists inductive loads, for working of inductive loads(motors etc) and to make use of Active Power(which is the actual power to run the inductive loads), the Reactive Power is utmost important

Here if the journey of reactive power is more or the high reactive power drawl causes some issues like undesirable losses rendering line efficiency to go down, poor voltage regulation, low power factor. To avoid these problems we use capacitor banks, these capacitor banks serves the reactive power needed for the loads

1.2 REACTIVE POWER COMPENSATION

The process of supplying reactive power at the load ends using capacitor banks to improve system performance is called the "Reactive Power Compensation or Reactive Power Management"

1.3 BLOCK DIAGRAM MONITORING OF CAPACITOR BANKS

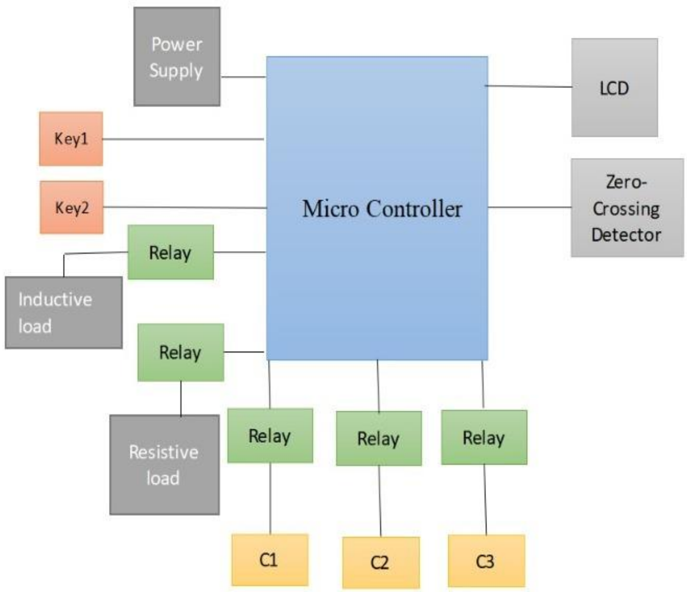

Fig.1 Block Diagram

Figure1 describes the block diagram of monitoring of capacitor in a 33KV/11KV substation.

2. CAPACITOR BANK

A number of capacitor units are combined to form capacitor banks in double star arrangement. The modules shall be arranged as an assembly on aptly designed enclosure and constructional members of aluminum to avoid any corrosion problem. The capacitor banks shall include all necessary internal connections and busbars, insulators and other fittings.The capacitor enclosure structure shall be designed to carry all required unit capacitors and facilities, and the conductors comprising the incoming and outgoing circuits under the loadings and factors of safety quantified and gives the minimum phase and earth clearances. The safe removal and safe replacement of capacitor units shall minimize the dismantling of any structural member, support, as well as insulators or main connections.

Necessary, approved means be provided upon the capacitor equipment for setting and tie of external connections to secure efficient earthing. Steel work and all objects of the capacitor equipment shall be bonded as necessary with copper straps of adequate cross-section. In case of outdoor open rack installation tinned copper be used. Approved facilities will be provided for earth connections besides apparatus during maintenance.

3. CASE STUDY ON HOW ENERGY IS SAVED

A case study is considered for calculating energy saving by improving the power factor of the existing feeders using capacitor banks in the substation. In a 33kv /11kv substation having 5MVA Power transformer with 3 to 4 Agriculture 11kv feeders. A 11KV Agriculture feeder load is of 160 Amperes is considered.

Case A:

Power factor of an agriculture feeder (Capacitor Bank OFF) =0.8.

No of KWH units consumed during 7 hours period of feeder ON =1.732* V*I *Cos hours.

=1.732* 11kv *160* 0*8*7

= 17070.59 KWH units (This is the consumption for an Agriculture feeder ON for 7hrs with a Power factor of 0.8)

Case B:

Power factor (PF) of an agriculture feeder (Capacitor Bank ON) = 1 For same number of KWH units 17070.59

for PF =1

Load (1) = 17070.59/(1.732*11*1*7) =128Amps

i.e., By improving power factor, we can supply the required amount of KWH units with reduced load

Energy saved =(160-128) Amps*1.732*11kv*1*7hours = 4267.6 KWH Units

Hence it is observed that by improving power factor energy saved is 4268 KWH units in a period of 7hours for ONE Agriculture feeder Cost of 4268 KWH Units= 4268*5 (Assume 1Kwh unit = Rs 5) = 21,338/-

If all Capacitor Bank are OFF due to some problem, for a single feeder of 7hrs period a distribution company is going to lose 21,338/- . It is visualized that the amount of loss to a distribution company because of non-functioning of the capacitor banks in a 33/11KV substation. Hence energy conservation is very important factor mainly in power distribution network.

4. FLOW CHART

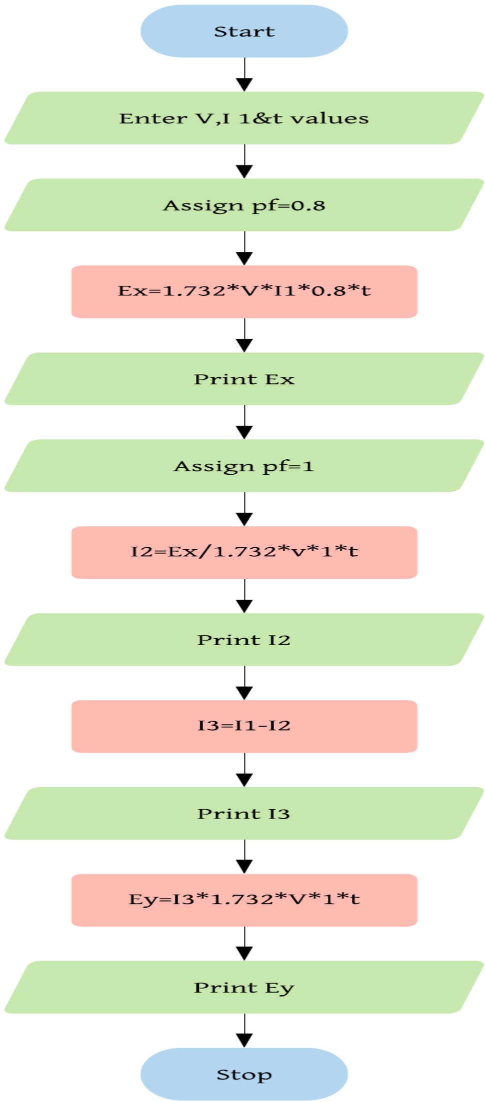

Fig 2. Flow Chart of the Implementation

5. RESULT

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Enter the value of voltage rating at feeder in
kV

11

Enter the load at feeder in amps

160

Enter the time in hours when the feeder is ON

7

The energy consumed when PF is 0.8 if 17070.59
#####Energy when capacitor banks are
installed#####
Energy saved when pf is 1 is 4267.65For same
number of 1.707059e+04 units the load consumed
when pf 1 is 0.00
For same number of 32 units the load consumed
when pf 1 is 64.00
For same number of 9.600000e+01 units the load
consumed when pf 1 is 128.00
For same number of 1.600000e+02 units the
load consumed when pf 1 is *******Hence when
capacitor banks are installed load consumption
is less*******
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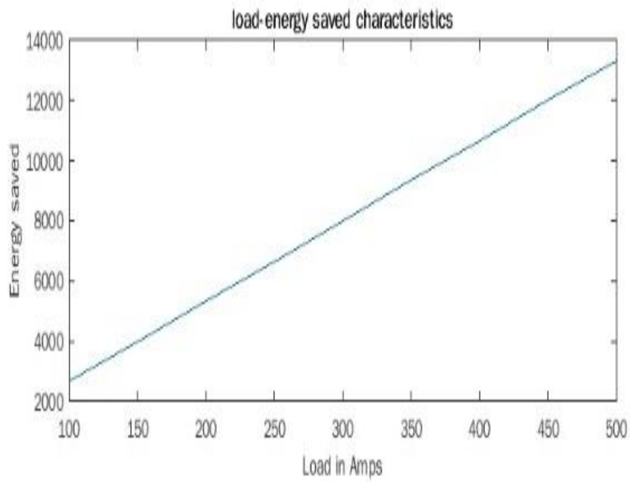

Fig. 3 load-energy saved characteristics

From figure 3 we can say as load decreases the reactive power requirement decreases, hence energy will be saved

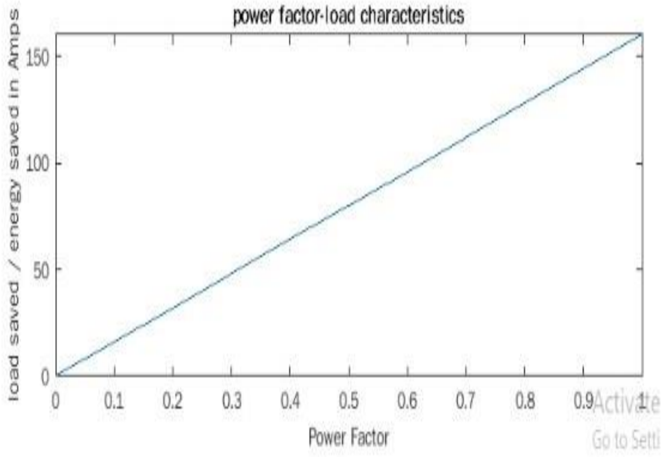

Fig.4 power factor - energy saved characteristics

From Figure 4 , it is noticed that the improved power factor will enhances energy saving, hence cost per unit can be minimized.

6. CONCLUSION

This work titled "COMPENSATION OF REACTIVE POWER AND ENERGY SAVING USING CAPACITOR BANKS "supports in improving power factor and the performance of the AC system. Power factor improvement is achieved with the use of synchronous motor. Capacitor banks are implemented to improve the power factor as well as for the compensation of reactive power. This work enlightens the power factor correction for distribution substation and calculation of size of capacitor banks to improve P.F and voltage regulation. By reactive power compensation using capacitor banks control of energy and reduction in the consumption of electricity can be done and it is verified in the case study, all this is implemented in MATLAB.

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BIOGRAPHIES

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