POWER FACTOR IMPROVEMENT USING CAPACITOR BANK

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***Abstract*—In modern power network, a wide variety of electrical load and power electronics load, which create a varying power demand on the supply system and less power distribution leads to loss of energy. It is necessary to improve the performance of electrical system and maintains power factor at higher value. This method of power factor correction maintain power factor at the high value also avoid over compensation during low load conditions and improve efficiency of a system due to reduction in losses.**

Keywords—*Apparent Power, APFC Panels, Inductive, Fixed capacitors, Power factor correction*.

I. INTRODUCTION

Power factor (p.f) plays an important role on economy of any industry. As they will be charged for low p.f and get incentive for high p.f. The definition of the power factor is the phase shift between the voltage and the current of the circuit. The value of power factor lies between -1 to +1.The most economical value of power factor lies between 0.9 to 0.95. If the value of power factor lies below 0.8 (approx.), then it draws more current from the load. The large current increases the losses and requires a large conductor, thus increases the cost of the system. The loss can be reduced by correcting the power factor improvement device to the system.

The majority of AC electrical machines and equipment draw, from the power, power (kVA) which exceeds the required useful power (kW). The principle cause of a low power factor is due to the reactive power flowing in the circuit. The reactive power depends on the inductance and capacitance of the apparatus. Capacitor banks designed for power factor correction are rated in kVAr (kilo-volt-ampere reactive) because it's convenient. One will typically know the reactive power required by some load, and then it's simply a matter of selecting a capacitor of the equal but negative reactive power to improve the power factor.

Low power results in:

1. Overloading of cables and transformer.
2. Power loss in the system.
3. Decreased line voltage at point of application.
4. Increase in current leads to increase in conductor size, thus increase the cost of a system.
5. Less power distribution.

This losses and wastage of energy may be overcome by power factor correction techniques. One of the popular methods is integration of capacitors. Hence, in this paper induction motor load connected system is simulated with considering capacitor banks and without capacitor banks. The results obtained are analyzed.

Placements of capacitors are important. It may be installed in different ways such as individual compensation, group compensation and central compensation.

The best possible power factor of an induction motor operating near its full load capacity is about 0.86 lag, whereas its no-load power factor varies from 0.1 to 0.3 lag. Since induction motor may be light loaded for a part of their operating time, their average operating power factor is low. At present, major industrial and agricultural loads consists of Poly-phase induction motors operating at average low power factor. For better performance, a large operating power factor is essential.

II. POWER FACTOR CORRECTION

When the AC Load is capacitive or inductive, the current waveform is out of phase with the voltage. So that we need extra amount of current that is not consumed by any connected load. So that capacitor is used to supply reactive energy to inductive loads. It must provide a certain amount of reactive power to avoid unnecessary flow of current in the circuit. This is known as Power factor correction.

$$Qneeded = P\ (tan\emptyset1 - tan\emptyset2) \quad (1)$$

Where,

$Qneeded$: $Reactive\ power\ needed$
P: $Total\ active\ power$
$\emptyset1$: $Actual\ angle\ of\ cos\emptyset$
$\emptyset2$: $Target\ angle\ of\ cos\emptyset$

III. SIMULATION

Matlab/Simulink platform has been used for the simulation purpose. The two cases have been simulated:

- Without connection capacitor bank
- With capacitor bank

1. Without connection capacitor bank

Under this study, the proposed work is simulated without connecting capacitor bank as show in Fig. 1. The results obtained are tabulated in Table I.

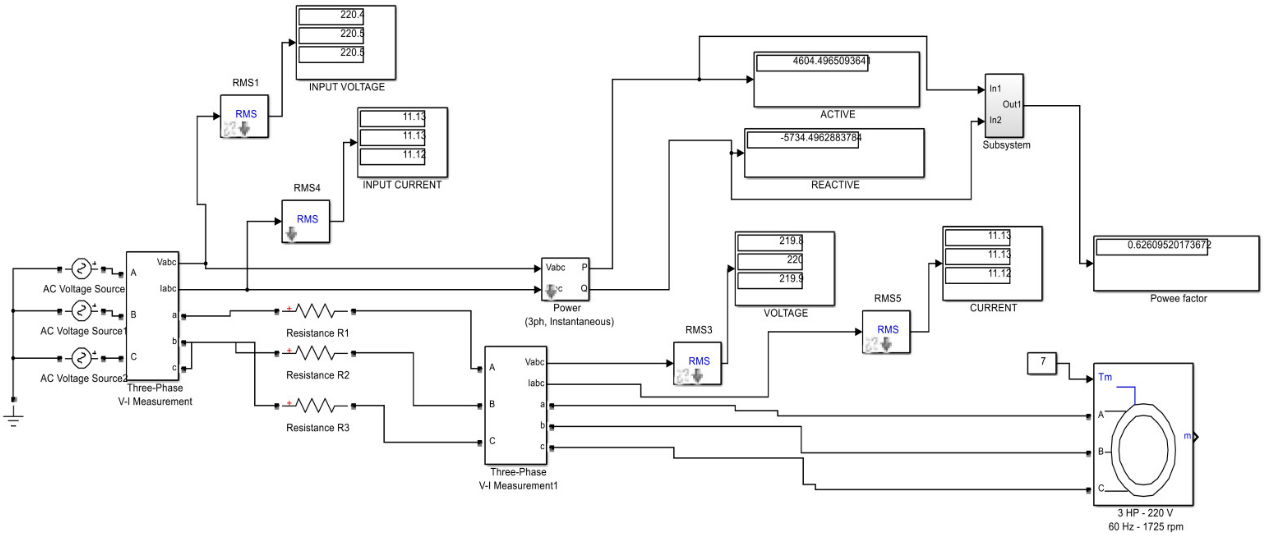

Fig. 1. Simulation diagram of the system before connecting capacitor bank

2. With connection capacitor bank

Under this study, the proposed work is simulated with connecting capacitor bank as show in Fig. 2. The results obtained are tabulated in Table I.

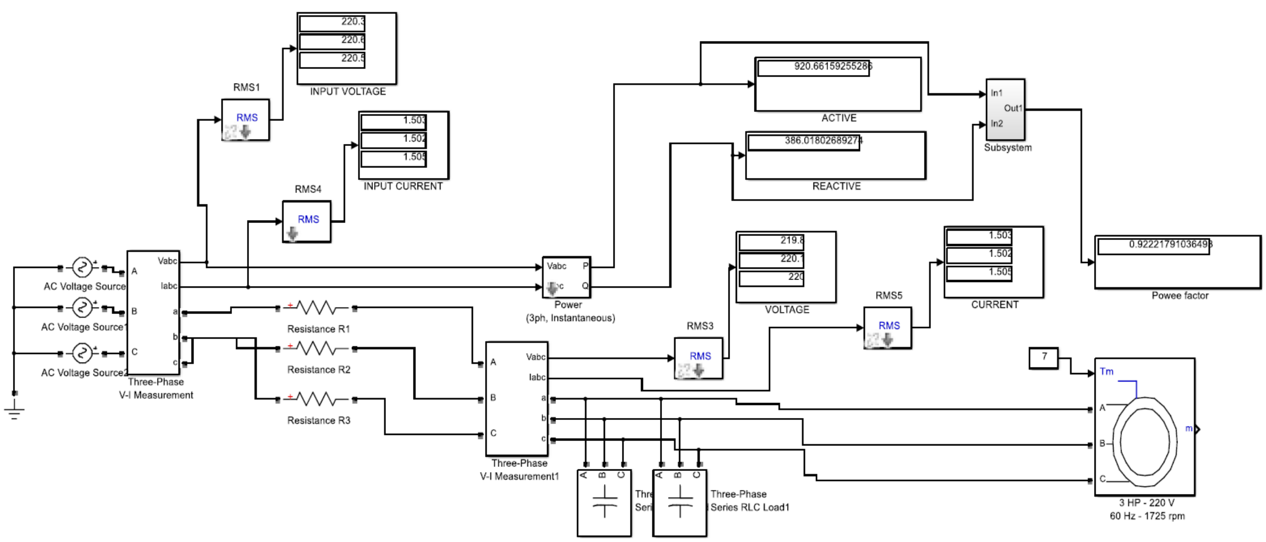

Fig. 2. Simulation diagram of the system with capacitor bank connected

TABLE I. OVERALL SIMULATION RESULTS

Sr. No	Motor rating	Torque (N-m) Mechanical Input	Unimproved reactive power (kVAr)	Unimproved power factor cos Ø	Capacitor rating (kVAr)	Improved reactive power (kVAr)	Improved power factor cos Ø
1	3 H.P $(3 \times 746\ W)$	7	-5.734	0.6260	3 kVAr (1 stage) 1.5 kVAr (1 stage)	-386.015	0.9222
2	3 H.P $(3 \times 746\ W)$	8	-5.961	0.6088	3 kVAr (1 stage) 1.5 kVAr (1 stage)	-155.2799	0.9850
3	3 H.P $(3 \times 746\ W)$	9	-6.186	0.5927	3 kVAr (1 stage) 1.5 kVAr (1 stage)	-71.6529	0.9963
4	3 H.P $(3 \times 746\ W)$	10	-6.407	0.5774	3 kVAr (1 stage) 1.5 kVAr (1 stage)	-295.1561	0.9427
5	3 H.P $(3 \times 746\ W)$	11	-6.627	0.5638	3 kVAr (1 stage) 2 kVAr (1 stage)	182.3421	0.9144
6	3 H.P $(3 \times 746\ W)$	12	-6.841	0.5509	3 kVAr (1 stage) 2 kVAr (1 stage)	-39.8815	0.9950
7	3 H.P $(3 \times 746\ W)$	13	-7.056	0.5389	3 kVAr (1 stage) 2 kVAr (1 stage)	-256.244	0.8366

Above data shows the power factor rating before and after connecting capacitor bank across the terminal at various mechanical inputs varying from 7 N-m to 13 N-m and the rating of capacitor to be connected. This also shows the capacitors are best over other power factor compensating device because of its greater reliability and flexible in operation (kVAR can be adjusted to the load conditions).

CONCLUSION

From the simulation it is noted that power factor of the induction motor is increased by connecting static capacitors across its stator terminals. Also the power factor is improved from 0.6 to approximately 0.95.

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