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ENHANCEMENT OF TRANSMISSION LINE VOLTAGE MAGNITUDE AND PHASE ANGLE USING COMPENSATOR STATCOM

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ABSTRACT

In this paper, a STATCOM is used to raise the power factor at the load end. The amount of power used depends on the power factor of the loads connected to the network. The inductive nature of the majority of the loads in the distribution line necessitates a sizable quantity of reactive power. As a result, the power factor of the load deteriorates, which limits the active power flow in the line. A weak power factor will result in increased current, increased losses, and a drop in line voltage. Reactive power regulation is needed for load balancing. The objective of this study is to develop a STATCOM that makes use of a voltage-source converter to locally enhance the load's power factor by adding suitable reactive power to the power supply line. A H- controller controls the STATCOM. The D-STATCOM and hysteresis controller have been implemented in MATLAB/Simulink.

Keyword: - STATCOM, H-Controller, Load compensation, reactive power, voltage source converter.

1. INTRODUCTION

Since load centres are frequently situated far from power generation facilities, a transmission and distribution network is built to handle the load demand. "Due to overloaded transmission lines, the voltage profile degrades and the stability of the system is compromised. The amount of power used depends on the power factor of the loads connected to the network. Due to the inductive nature of the majority of the loads in the distribution line, reactive power is needed in substantial amounts [1]. As a result, the power factor of the load deteriorates, which limits the active power flow in the line. Reactive power management is required for load compensation in order to raise the power factor. A VSC-based STATCOM can be made to inject reactive power into the ac supply system to boost the power factor and for reactive power compensation by making the amplitude of its output voltage exceed the ac supply system voltage. For source current balancing, power factor correction, and harmonic abatement in a three-phase, three-wire distribution system supplying delta linked load under various source voltage scenarios, a three-phase voltage source converter with a dc bus capacitor is used as a D-STATCOM in this work. One of the primary justifications for selecting STATCOM as a load compensator is its ability to produce reference compensator currents. The compensator follows the reference currents [2]-[2] and injects three-phase currents into the ac system to counteract disturbances brought on by the load. This study provides the modeling of a STATCOM based on three-phase VSC to raise the load end power factor in light of the above situations. [3-5] describes how a PV solar farm is used as a STATCOM at night.

2. PROPOSED WORK

This study suggests a D-STATCOM based on a voltage-source converter (VSC) to locally enhance the load's power factor by adding suitable reactive power to the power distribution line. "The D-output STATCOM's voltage amplitude is made larger than the system voltage with the intention of managing the VAR generation. It can therefore internally provide capacitive reactive power for shunt rectification. The D-STATCOM is managed by a hysteresis controller [6]. The STATCOM is set up to monitor the power factor reference and maintain a constant value along the line. In MATLAB/Simulink, the D-STATCOM and associated controller are implemented. The spinning synchronous condenser's stationary counterpart, STATCOM, controls the inverted voltage in relation to the ac supply line voltage to generate or absorb reactive power more quickly. When used in distribution systems, like in fig. 1, it is referred to as D-STATCOM. It has the ability to generate sinusoidal voltages with any desired amplitude, frequency, or phase. Additionally, the converter is typically built on a type of energy storage that gives it a DC voltage. The fundamental parts of D-STATCOM are a controller, coupling transformer, three-phase inverter, and dc capacitor.

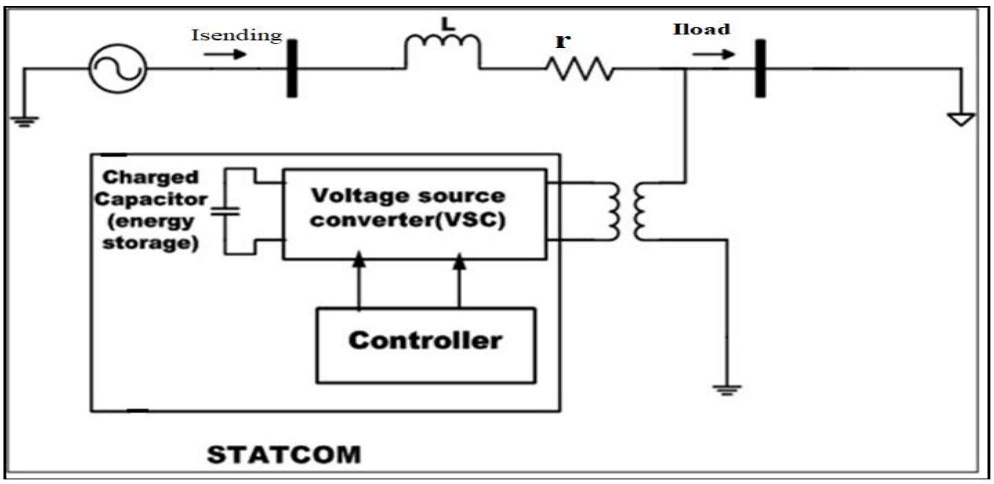

Fig. 1 STATCOM with system

3. STATCOM CONTROLLER

Capacitive type: When its output voltage exceeds the voltage of the ac system, the VSC injects reactive power into the system. As a result, it works in the capacitive mode, drawing capacitive current from the ac system that precedes the system voltage.

Inductive type: The VSC collects reactive power from the ac system when the ac system voltage is higher than the VSC's output voltage. It works inductively in this situation as a result.

Floating type: The VSC operates in floating mode, creating and absorbing no reactive power, when its output voltage is equal to the ac system voltage.

The real current follows the command current with a hysteresis band in the Hysteresis-band PWM form of instantaneous feedback current control [7-9]. The control circuit produces a sine reference current wave with the appropriate amplitude and frequency, and it contrasts it with the actual phase current wave. When the current reaches a specified hysteresis band, the upper switch in the half-bridge is switched off, and the lower switch is turned on. As soon as the current reaches the lower band limit, the top switch is activated and the bottom switch is switched off.

As soon as the current reaches the lower band limit, the top switch is activated and the bottom switch is switched off. A lock-out time(td) is offered at each transition to stop a shoot-through fault. The real current wave is made to follow the sine reference wave inside the hysteresis area by repeatedly switching the upper and lower switches [10–14].

Without respect to variations in Vd, the inverter essentially converts into a current source with peak-to-peak current ripple that can be controlled within the hysteresis band. The switching frequency and peak-to-peak ripple are influenced by the hysteresis band's width [15].The suggested hysteresis controller is shown in Fig. 2. by modulating the voltage while introducing the reactive component current into the system. Based on the load current, the reactive current needed for power factor modification is determined.

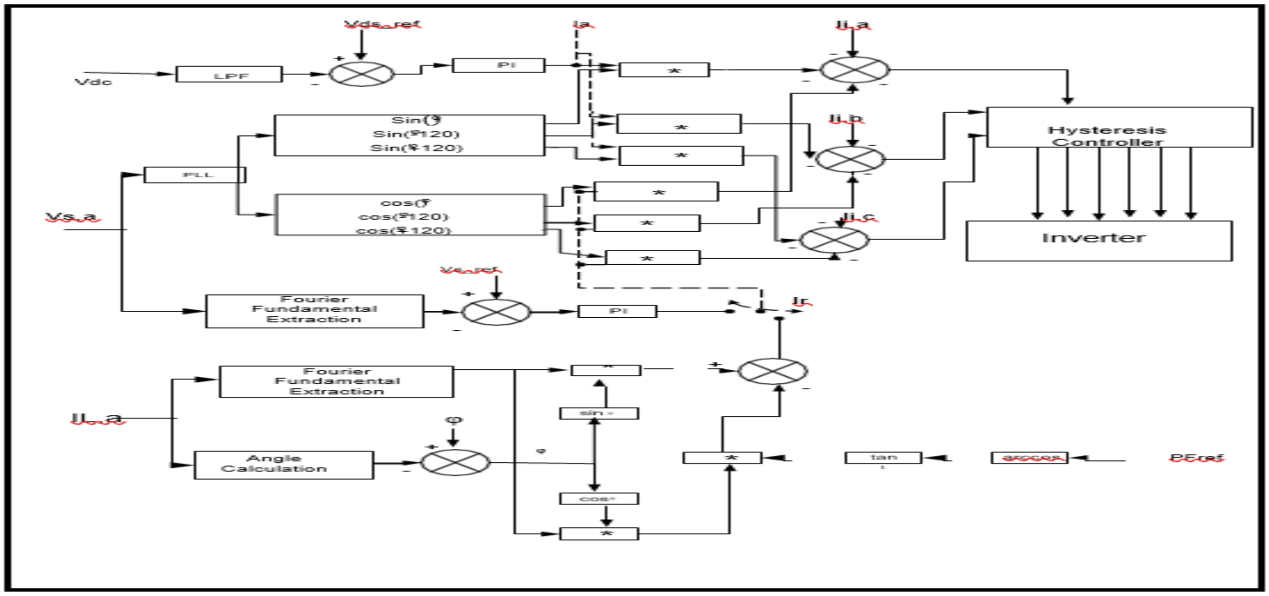

Fig.2 H-controller

4. SIMULATION RESULT

"A MATLAB/Simulink model feeding a single r-l load from a three-phase source and transmission line has been developed here, as illustrated in fig. 3. Various levels of inductive reactive power are measured for the pertinent power factor at the load end, as given in TABLE 1. It has been observed that the load's power factor declines as inductive reactive power increases. The power factor will decrease because the phase angle between the current and voltage will be more lagged due to the inductive load. As the inductive load increases, it uses up a lot of reactive power, further delaying the angle and producing a very low power factor.

Reactive power for r-l load (var)	Power factor (PF) angle (deg)	PF With r-l load	Capacitive reactive power (var)	PF angle(deg)	PF after capacitive compensation
1000	-42.97	0.71	0	-45.9	0.76
			50	-44.5	0.78
			100	-42.9	0.79
			500	-28.5	0.88
			800	-13.1	0.98

Table 1. Power Factor

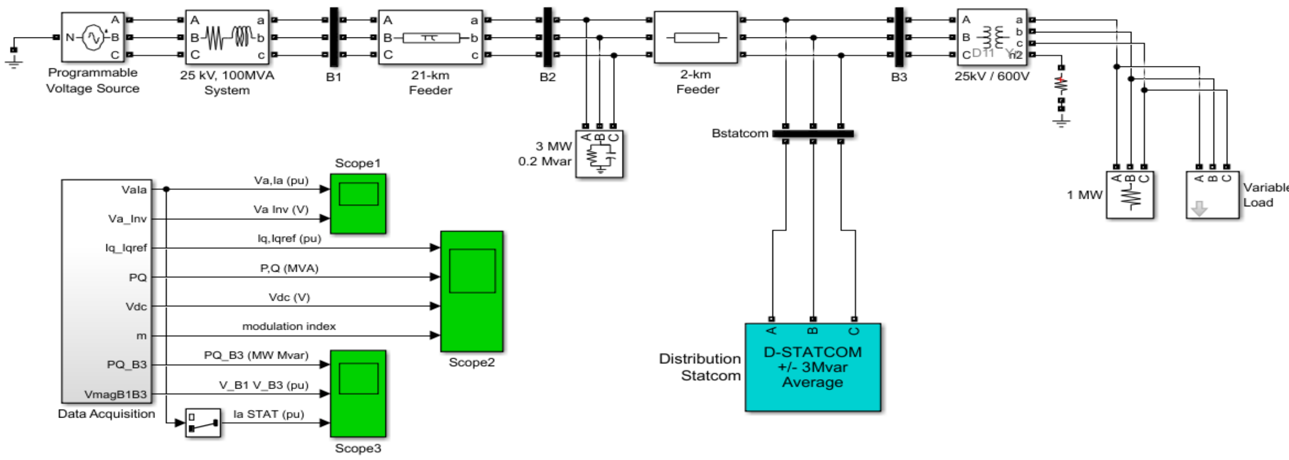

Fig. 3 Simulation with compensation

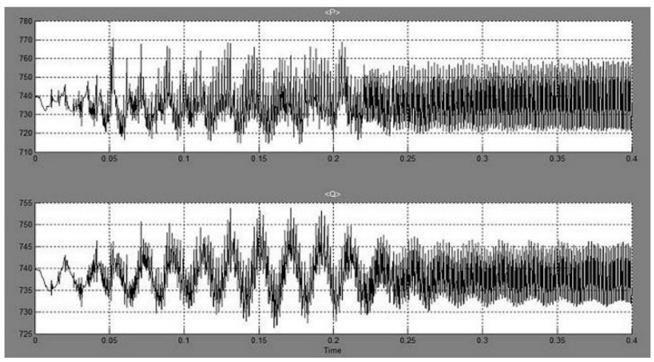

Fig.4 Real and Reactive power without capacitor

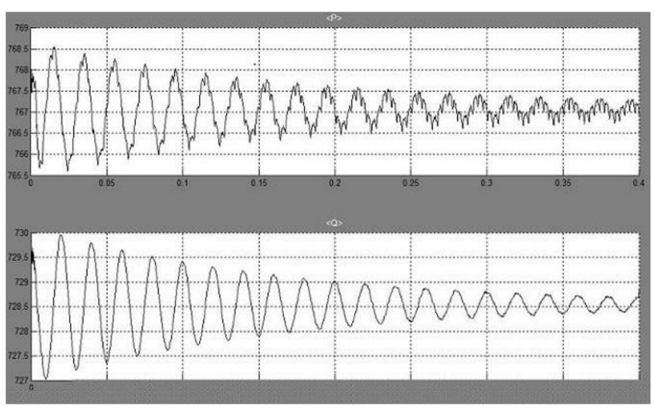

Fig.5 Real and Reactive power with capacitor

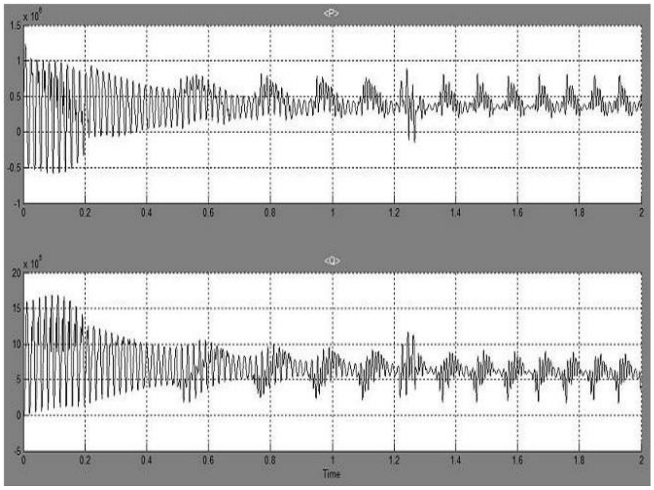

Fig.6 Real and Reactive power with STATCOM

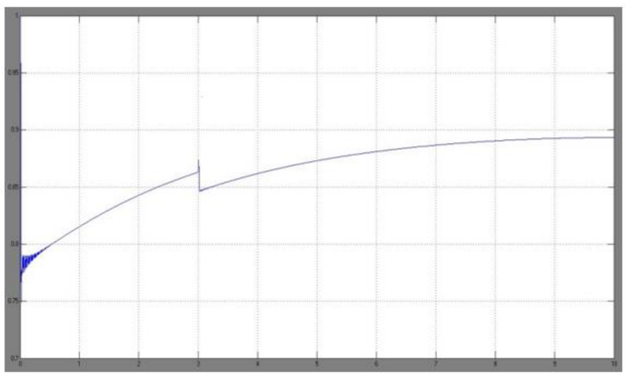

Fig. 7 Power factor improvement

The actual and reactive power are shown in Figs. 4 and 5 before and after the capacitor was added. The capacitor reduces the reactive power absorbed by the line by injecting it into the line. In this instance, the switching is mechanical. The capacitance can only be altered in small steps, and the response time is slow. It is not possible to constantly modify the capacitance value. This method cannot be applied in circumstances requiring a high amount of compensation. FACTS, a power electronics-based technology, is employed as a result. D- STATCOM can control reactive power as necessary. Here, one can exercise precise control and prompt reaction. The D-STATCOM-enabled system is shown in Fig. 7. Instead of capacitive compensation, D- STATCOM is employed to improve the power factor. A hysteresis band controller for generating pulses, reference current generation, power factor generation, estimation of the current required to inject reactive power, and a reference current generator are all components of the D-STATCOM controller. The controller receives measurements of the system's current and voltages. The required power factor is offered as a point of reference. Reactive power in the line is used to calculate the reactive power required to maintain the reference power factor.

5.CONCLUSION

In this work, a simulation-based implementation of D-STATCOM and associated controller is demonstrated. The hysteresis controller controls voltage regulation by introducing reactive component current into the system. The load current is then used to compute the reactive current needed for power factor modification. The suggested method improves the load's local power factor by adding the proper amount of reactive power to the power distribution line. Because of the improved power factor, line losses are reduced, which enhances the performance of the entire electrical system.

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