POWER QUALITY IMPROVEMENT IN DISTRIBUTION SYSTEM USING D-STATCOM

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ABSTRACT
In this paper we present DSTATCOM (static synchronous compensator) is a power electronics device using force commutated device like IGBT to control the reactive power. In power network voltage is stabilise while synchronizing with demand. The D-STATCOM used to mitigate the power quality issues like voltage sag, voltage swell, harmonics and compensation the reactive power. In VSC voltage source converter can act as either a source or sink of reactive power. The D-STATCOM has many features such as low power losses, less harmonics production, high regulatory capability, low cost and compact size. In matlab we can use distribution static compensator model.

KEYWORDS: DSTATCOM, Voltage Source Convertor, SIMULINK, Voltage Regulation, PWM.

INTRODUCTION

Electrical power quality can be loosely defined as a measure of how well electricpower poorly regulated , harmonics and flicker and present, or there are momentary events that distort the usually sinusoidal wave, and utilization is degraded one refers to these conditions as degradation of power quality.
The power quality engineering truly encompasses most area of electrical power engineering from generation to utilization and power quality engineering has been a topic of interest from inception of power-engineering field some contemporary factor have made it the subject of more focused interest, howener. The abvent and widespread use of high-power semiconductor switches at the utilization, distribution, and transmission and distribution system have come under greater scrutiny in recent years and certain types of power quality degradation result in losses.[1][5]

METHOD USE TO OVERCOME THE POWER QUALITY ISSUES.

A] Power Quality Problem:-

Problem are presented with their associated causes and consequences. The economic impacts associated with power quality are characterized.

Voltage sag:- Is defined as short duration reduction in rms voltage which can be caused by a short circuit,overload or starting of electric motor A voltage sag happens when the rms voltage decreased between 10 and 90% of nominal voltage of one half minute.

Voltage swell:- Is defined as increase of rms voltage from 1.1 to 1.8 PU for a period of 0.5 to 1 minute which is a momentary increase in voltage happens when a heavy load tuen of in power system.

Voltage Harmonics:- The voltage or current waveform assume non-sonusoidal shape. The waveform curresponds to the sum of different sine-waves with different magnitude and phase, having frequencies that are multiple of powetr-system frequency.

Voltage fluctuation:- Oscillation of voltage value, amplitude modulated by a signal with low frequency.[2]

B] Distribution Static Compensator (D-Statcom)

D-statcom is the facts controlled device is basically VSC. They have a capability to solve the power quality problems.

STATCOM is the same family as svc but more superior or good to svc for the reasons that SVC uses anti-parallel thyristors, but the STATCOM uses converter technology.

Principle-

When two ac sources of same frequency are connected to each other through series reactance then the power flow:

A) The active or real power flow from leading source to lagging sources.
B) Reactive (VAR) power flow from higher to the lower voltage magnitude source.

1) Operation:- D-STATCOM is a power elerctronic shunt connected device it connected towerd the load side. The D-STATCOM builted by using DC capacitor, 3 phase inverter, AC filter, coupling transformer and control strategy.

2) VSC:- VSC is power electronic device that connected in the system shunt or parallel. It create sinusoidal voltage and requid frquency, magnitude and phase angle, VSC supply or inject the voltage in the system.The supply voltage or injected voltage is nothing but the difference between actual voltage and nominal voltage.VSC is the very important in the DSTATCOM. It generate the required magnitude and frequency with phase angle in the form of sine wave.[3]

3) Operating principle of STATCOM:- Vo is less than the Vdc then the reactive power flows from D-STATCOM to power system or in the line system. When the Vo is geater than Vdc then the reactive power flows from power system to D-STATCOM.

3.1) NO-load mode (Vo=Vdc):- when the output voltage is equal to the dc voltage then thire is no flow of reactive power in the system means not genarate or not absorb the reactive power. Fig.

3.2) Capacitive mode (Vdc>Vo):- when the converter voltage (Vdc) is greater than the power system then STATCOM act in capacitive mode. Then that time the convert voltage lead the power system voltage.

The current flows from STATCOM to the power system and D-STATCOM to create the reactive power. In the system capacitive current leads angle by 90 degree to the system voltage.

3.3) Inductive mode (Vdc<Vo):- In system capacitive current lags by an angle 90 degree to the system voltage.[4]

Simulation

1) Here we used a 33KV distribution network to regulate the voltage by using D-STATCOM. There are two feeders in that one feeder is to 30km at bus B2 and other feeder is connected to 7.6 km at bus B3.

2) The D-STATCOM regulates the bus B3 voltage, by injecting or absorbing reactive power. The reactive power is provided and it is leakage reactance coupling transformer is generate a secondary voltage in phase with primary voltage.

3) PWM inverter provided this type of voltage. D-STATCOM acts in a two first is than the bus voltage and in capacitor secondary voltage is more or higher than bus voltage.[5][8]

4) THE D-STATCOM CONSISTING THE FOLLOWING ELEMENTS :-

1) Coupling transformer:-

This type of transformer is coupled to the PWM inverter transformer network. This coupling transformer have rating is 25KV/1.25KV.

2) Voltage source PWM inverter:-

In AC side the PWM inverter is replaced by 3 equivalent voltage sources average frequency is 1.68KHZ.

It consists of 2 IGBT bridges, and this 2 inverter generates less harmonics than the single bridge, and improve the dynamic response. Inverter modulation frequency is 28*50=1.40 KHZ.

3) LC filter:-

Resistances and capacitors connected in series with each other and it provide a P.F of 40 at 60.

4) Voltage regulator:-

It controls the voltage at bus B3.

5) PLL (phase locked loop):-

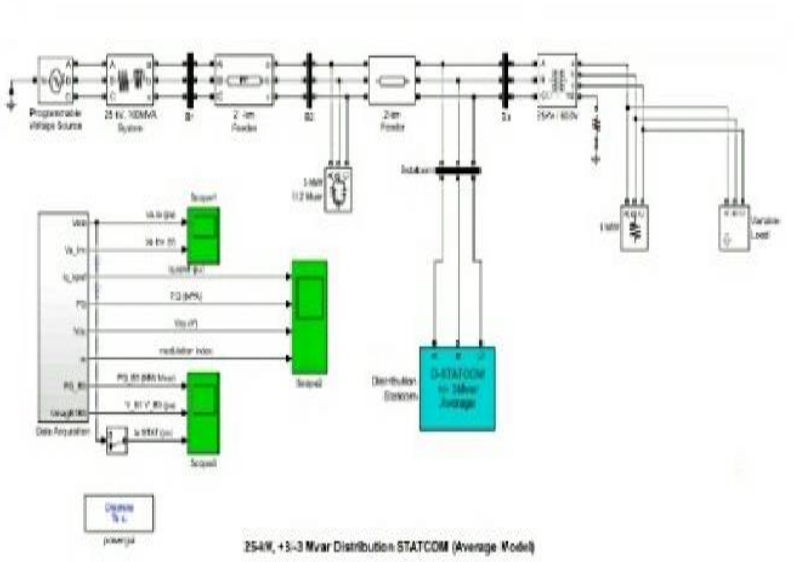
It is synchronized to the transformer primary voltages.

6) Regulation loop of inner current :-

There are 2 PI (proportional integral) controllers, that control the d-axis and q-axis currents. PWM voltages are synchronize by using Va,Vb,Vc phase voltages. And that phase voltages are obtain from Vd and Vq voltages.

7) Regulation loop of outer voltage:-

PI controller maintains the primary voltage equal to the reference value voltage. To keep the DC link voltage constant to its nominal value (Vdc=2.4) by using, DC voltage controller.



RESULTS AND DISCUSSION

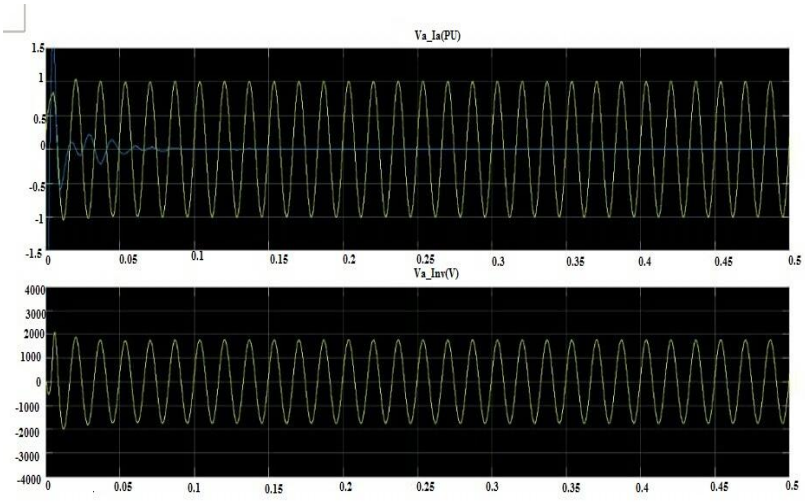


Figure . Input, Voltage, Input Current and Inverting Voltage V/S Current

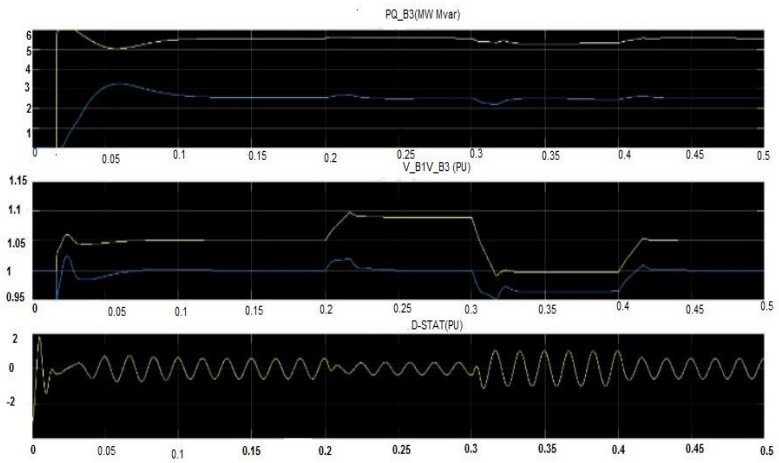


Fig. Real and Reactive Power, Bus B1 and Bus B3 Voltage and STATCOM current V/S time.

Variable Load in modulation is not in service (Modulation Timing [start time (Ton) end time (Toff)] = [0.15 1]*100 > Simulation Stop time). The Programmable Voltage Source block is used to modulate the internal voltage. The voltage is first programmed at 1.077 pu in order to keep the D-STATCOM initially floating (B3 voltage=1 pu and reference voltage Vref=1 pu). There are 3 steps of time their variations of vottage,at 0.2sec increase the source voltage by 6% and at 0.4sec increase the source voltage by 6% and bring it back to its initial value(1.077 PU) then voltage source will kept constant and we will enable the modulation of variable load then we observe that how D-STATCOM work. Means that how it mitigate the voltage flicker in to the system. [6] In simulink diagram to use the block of programmable voltage source change the "time variation" of parameter to "none "And the load side block of the variable load block set the modulation timing parameters to [starting time (Ton) ending time(Toff)] = [0.15 1] and in this result to remove the multiplying factor of 100,and finally the main block in the simulink of DSTATCOM. To change the "mode of operation" parameters "Q regulation" and second line parameter of this block to change the reactive power reference value [Qref] is set to "zero". The DSTATCOM is floating and performance of DSTATCOM voltage correction is not starting of the simulink to give the supply voltage of DSTATCOM is inactive. They do not absorb or provide the reactive power to the network. At point t=0.2s, the source voltage increases by 6% also DSTATCOM absorbing the reactive power (Q= +3Mvar on trace 2 of scope 2).At t=0.3s, the source voltage decreases by the 6% from the value corresponding to Q=0, then the DSTATCOM generate the reactive power to maintain a 1pu voltage (Q changes from +3Mvar to -3.1Mvar).when the DSTATCOM changes from inductive to capacitive operation the PMW inverter modulation index is increased from 0.6 to 0.92. it is due to proportional increase in inverter voltage. The reactive powers reverse very fastly about one cycle.

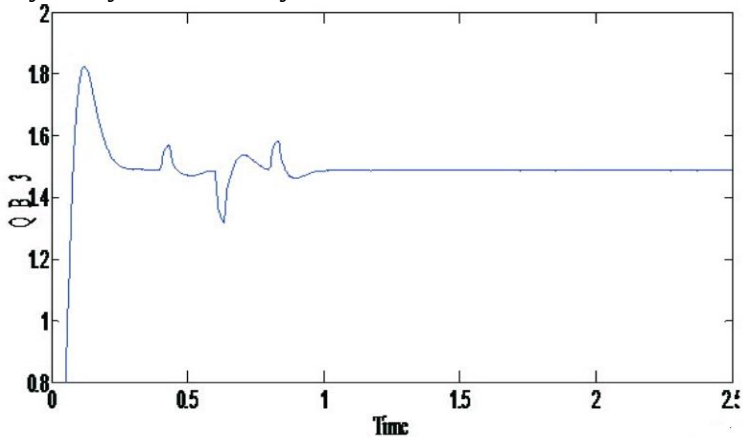


Fig1. Reactive power demand at Bus B3.

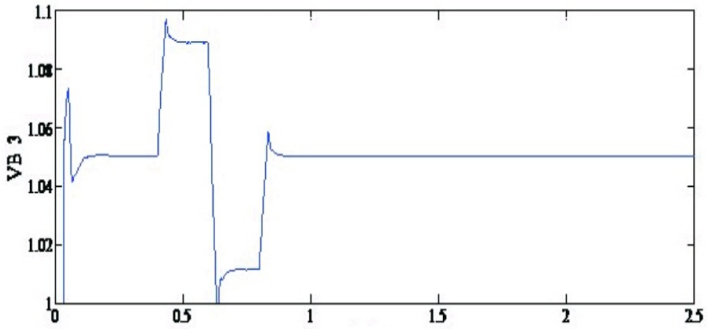


Fig2.Voltage Change at Bus B3 Due To Change In Load Of Induction Furance.

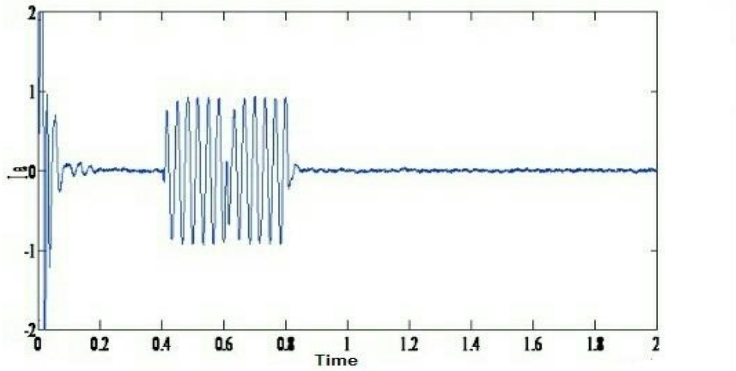


Fig.3 D-STATCOM Current To Respond The Change In Voltage At Bus B3

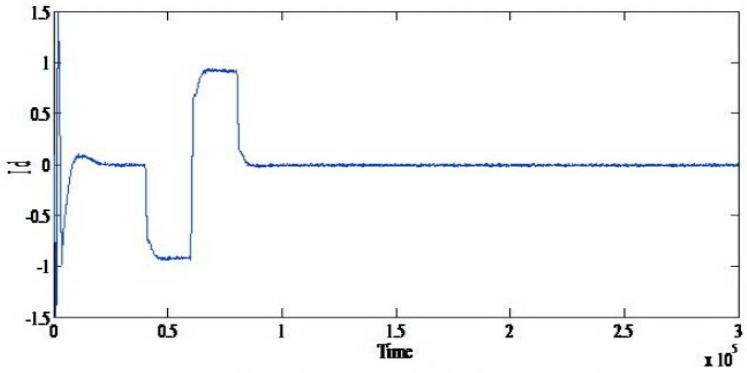


Fig:-4 D-STATCOM d-axis Current.

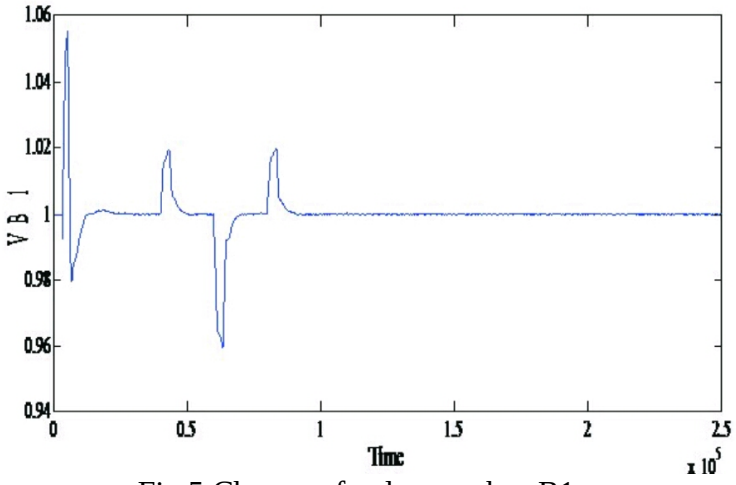


Fig.5 Change of voltage at bus B1.

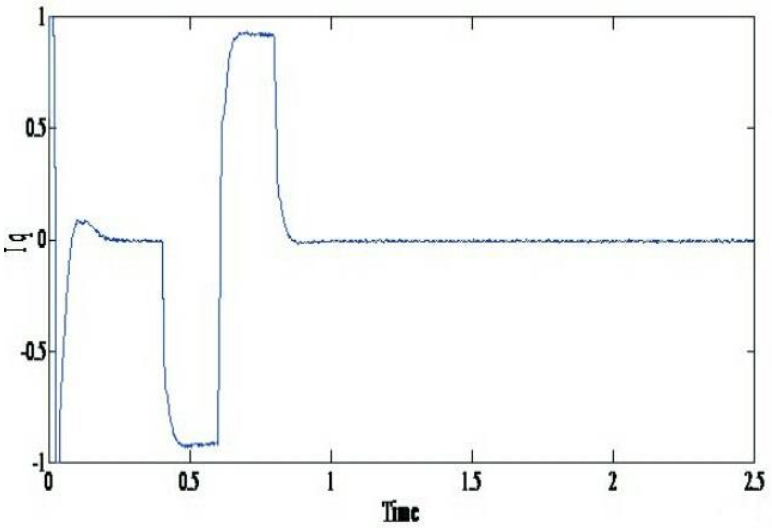


Fig.6 D-STATCOM q-axis current

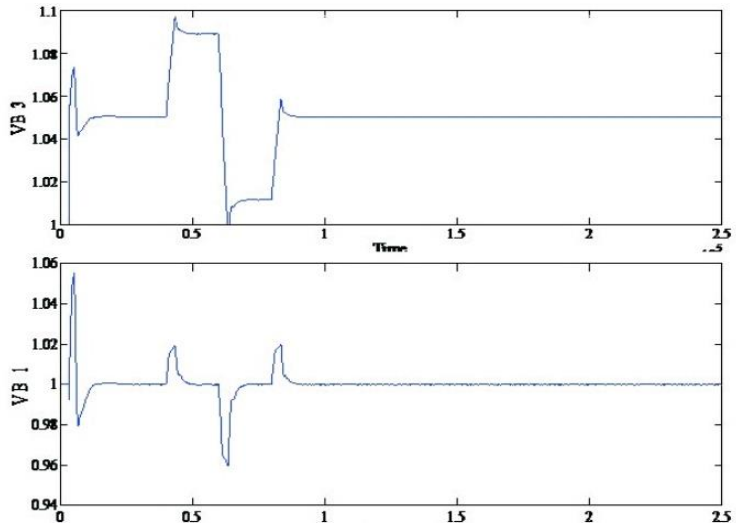


Fig.7 Comparison of voltage at bus B3 and B1

At t = 0.2 s, the source voltage is increased by 10%. The D-STATCOM compensates for this voltage increase by absorbing reactive power from the network (Q=+3 Mvar on trace 2 of Scope2). At t = 0.3 s, the source voltage is decreased by 10% from the value corresponding to Q = 0. The D-STATCOM must generate reactive power to maintain a 1 Pu voltage (Q changes from +3 MVAR to -3.1 MVAR). When the D-STATCOM changes from inductive to capacitive operation, the modulation index of the PWM inverter is increased from 0.6 to 0.92 it is due to a proportional increase in inverter voltage. Reversing of reactive power is very fast, about one cycle, as observed on D-STATCOM current as in fig 5. By using DSTATCOM we can see that the change in bus voltage 3 is more than bus voltage 1 due to change in DSTATCOM current as fig 6 and 7.

CONCLUSION

The power quality improvement by using DSTATCOM has been presented in this paper.The analyzed the DSTATCOM model and developed it in simulink diagram with power system blocks. Here a control system is designed in MATLAB Simulink. So DSTATCOM provides fast acting dynamic reactive compensation for voltage support during voltage flicker events.

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