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Improvement of Power Quality and Voltage Flicker Reduction using D-STATCOM

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Abstract- In Previous decade numerous research works presented for the improvement of flicker perturbations between different consumers. In this exploration work, an improved D-STATCOM is proposed for the improvement of the problems that are encountered which portrays better power quality of output when compared to other power improvement methods such as STATCOM and others. For the comparison of proposed method, different parameters such as active power, reactive power and the most important constraint with total harmonic distortion. Our THD of recommended method proves to be better and enhanced.

Keywords:- STATCOM, D-STATCOM, facts,vsc,power system

I. INTRODUCTION

1. D-Statcom Controller Principles: Utilization of power electronics based mostly equipment into electrical power systems, at varied voltage levels, is turning into progressively widespread since of the rapid progress of power electronic technology. The STATCOM is such equipment that may probably be utilized in the context of Flexible AC transmission systems (FACTS) at the transmission level.

D-STATCOM could be a user-defined power device (custom) acting on the STATCOM principle on distribution level. This device also may be used in top users' electrical installations. Potential applications in distribution level embrace voltage regulation, power factor correction, load reconciliation, and harmonic filtering.

This section contains a brief of a D-STATCOM management principles relating to various modes of functioning. D-STATCOM will include a Voltage Source Converter (VSC) at its core which may be used for a variety application by appropriate command algorithms. The D-STATCOM is modeled for voltage adjustment application victimization the PI controlled SPWM algorithmic rule and therefore bus. Productivity of D-STATCOM is studied for a SPWM and thus the SVPWM algorithms used for voltage adjustment application.

Figure stands for distribution system wherever the D-STATCOM is wired in shunt to the system by means of star-delta transformer in the PCC. The bus which is known as distribution bus is exemplified through voltage VG the Thevenin's equivalent and a Thevenin's equivalent resistor and is linked to a distribution line. Three entirely different masses have attached to the system over a transformer in the bus B-4.

The required voltage at the PCC is one Pu according to the grid demand. The voltage profile in the PCC is just full of rapid shifts inside the load. The voltage at the PCC is kept at 1 Pu through allowable control of D-STATCOM. Mitigating the effects of voltage sag and swell, a synchronized frame-based PI controller is employed to regulate a two-tier VSC. The system is developed in MATLAB Simulink power system block set.

The D-STATCOM is comprised of one VSC unit, one DC condenser and one pairing inductor or else one

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transformer. The VSC in the framework D-STATCOM will convert a voltage across the condenser on a collection of 3-phase voltages. Such voltages are in partition with AC system voltage and thus D-STATCOM is complementary to the AC distribution system over the leak reactance of coupling transformer.

Fluctuations of the load, collectively source voltage also affects voltages of bus, that take turns to influence sensitive masses linked to bus. The recital of the D-STATCOM to regulate of bus voltage. Voltage supply variation victimization SPWM methodology is outlined inside the literature. A PI controller will also be utilized in the cascade-controlled mode administer AC bus voltage. The VSC constructed predominant D-STATCOM, connected in paralleled with an AC system, would use to the voltage control or power problem rectification or removal of current harmonics.

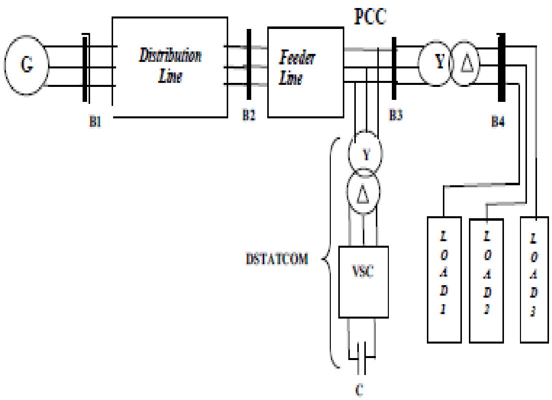

Fig 1. Representation of a D-STATCOM.

Cascading controller used for voltage regulation usage can be seen in figure For the voltage control, two voltages are controlled by D-STATCOM. First is that the AC voltage of power systems in the bus, no matter where the D-STATCOM is attached, and hence alternative is that the DC connection to the voltage around the capacitor. Each one of regulators have the Proportional Integral (PI) structure. The current exit from the VSC is converted into a d-axis and q-axis components by using the Park's transformation method.

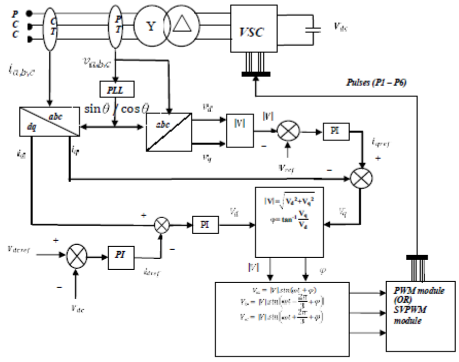

Fig 2. Block diagram for full control of the D-STATCOM.

The error or the distinction between the Vdc_ref and Vd care regulated by using a PI controller to obtain theld_ref. Itslq_refis obtained through regulating the miscalculation due to Vrms_ref (pu) and Vrms (pu) signals through a different PI controller. These benchmark currents are subsequently regulated through the comparison between the d and q component parts of currents with corresponding constituent parts of reference current in the second set of PI regulators.

The voltage magnitude (enormity) and phase angle are calculated from voltage Vd and voltage Vq, as stated into equations. The calculated voltage magnitude (enormity) and phase angle will be used to create three phase sinusoidal referral signals, without requiring the use of the reverse Park's transformation, to lower the calculation time, as noted in equations.

$$|V| = \sqrt{V_d^2 + V_q^2}$$

$$\varphi = tan^{-1}(\frac{V_q}{V_d})$$

$$V_a = |V|\sin(\omega t + \varphi)$$

$$V_b = |V|\sin(\omega t - \frac{2\pi}{3} + \varphi)$$

$$V_c = |V|\sin(\omega t + \frac{2\pi}{3} + \varphi)$$

Following reference signals are compared to a saw tooth wave generating the SPWM signals within the SPWM module. By using the same reference signal, a switching pulses created by SVPWM algorithm in a SVPWM component.

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II. SIMULATION AND RESULTS

The upcoming section will discuss the simulation model and result of proposed D- STATCOM based power quality improvement is discussed. In the table 5.1 shows the input parameters for D- STATCOM based model. The table shown the value of Generator (Sending End), Generator (Receiving End), Transformer (Sending End), Transformer (Receiving End), 3 phase mutual Inductance, Pi Network, 3 phase line (Transmission line), Resistance and Resistor &Inductor (Parallel).

Simulation study has been performed in ensuing steps to examination and analysis purpose:
Step 1: Voltage sag is produced in the model with 3-phase fault.
Step 2: Voltage sag and swell using programmable voltage source will be generated for analysis purpose.

Step 1.Voltage Sag's Generation:

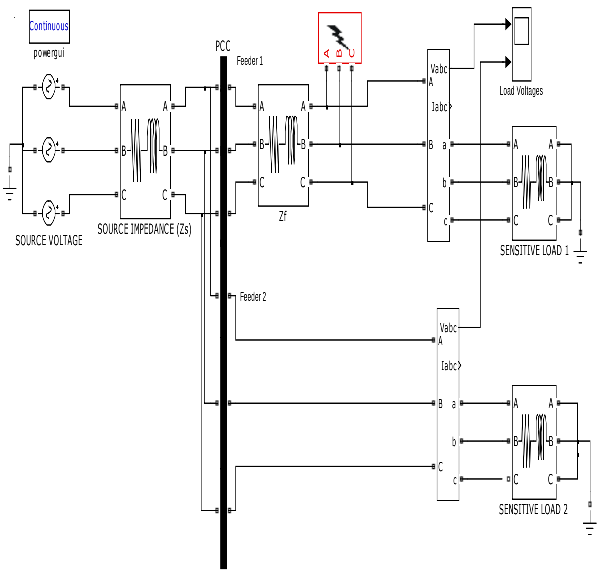

Fig 3. MATLAB model of Generation of voltage sag with three phases to ground fault.

The magnitude and period of voltage sag depends on fault type and point of fault. To comprehend the conception a simulation is done to scrutinize voltage sag due to a three phase to ground fault duration of 1.015sec. The diagram of a model of the system is shows up in Fig 6. is the source impedance and is the feeder impedance. The peak voltage on PCC is about 225V and at "load-1" is 200V. Assume sensitive load slinked to the system hence it is requisite to normalize the voltage. A fault is created at "load-1" terminal.

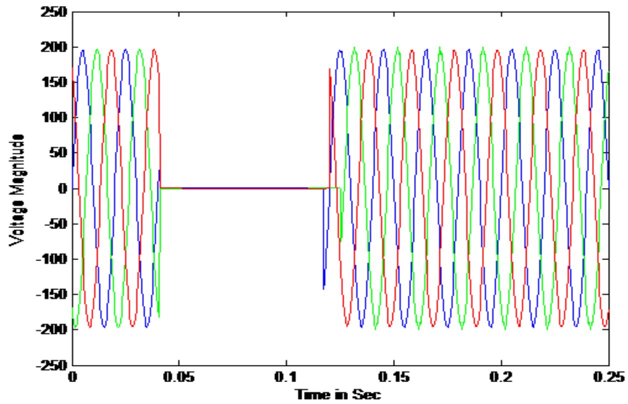

Fig 4. Voltage waveform at LOAD 1

The voltage waveforms at load-1 and PCC are shown in Figure 4 and Fig. 5 respectively. From the waveform it is clear that voltage at "load-1" is zero during fault condition and the voltage in the PCC is less than the voltage during normal operation. This means that, there is voltage sag at PCC and voltage interruption at load 1 during fault.

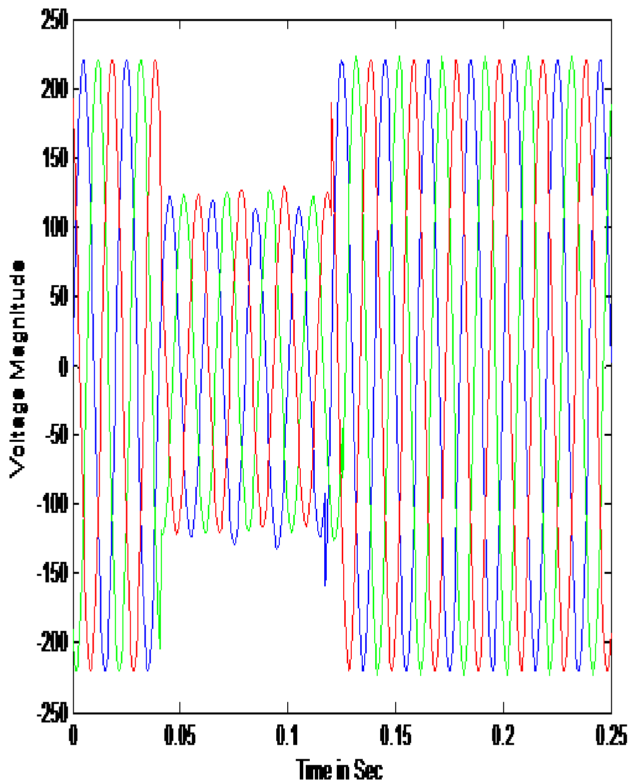

Fig 5. Voltage waveform at PCC.

Step 2.Voltage sag and swell using programmable voltage source will be generated for analysis purpose.

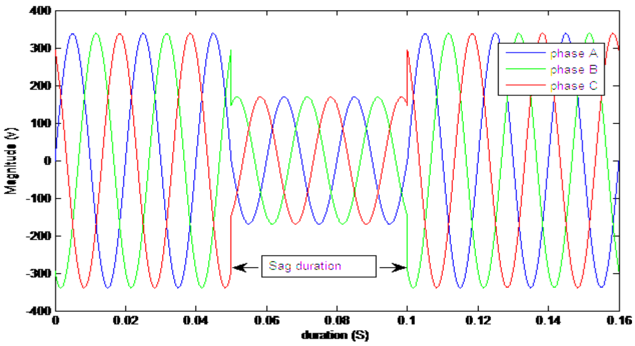

Fig 6. Waveform of voltage sag generated using programmable voltage source.

For analysis reason voltage sag is being formed using programmable voltage source. The Simulink paradigm of programmable device for voltage sag of magnitude 50% of insignificant voltage and duration is 0.05sec considered. The output voltage waveform of programmable voltage resource(source) is on display at the Fig6that is the analogous to the voltage sag as in power system.

III. IMPORTANT PARAMETERS USED IN ANALYSIS

This section deals with calculations of active power (P) in wattage (watts), and also reactive power (Q) also in wattage (watts), a voltage-current combining in the harmonic. To execute the calculation on this, the block initial will determine fundamental values i.e. Phase and magnitude of its 2 input signals V and I. The P and Q are then processed by using subsequent equalities:

$$P = \left(\frac{V}{2}\right)^2 \times \left(\frac{I}{G}\right)^2 \times \mathrm{Cos}(\varphi)$$

$$Q = \left(\frac{V}{2}\right)^2 \times \left(\frac{I}{G}\right)^2 \times \mathrm{Sin}(\varphi)$$

Where $\varphi = \angle V - \angle I$

Since this is a moving average window, a single cycle of simulation should be finish prior to outputs provide the best value. For primary simulation/ recreation of the system, the output will control constant values such as to enable by a voltage's initial input and current initial inbound or input parameters.

These are the main values and parameters used in the intended modal, which are shown in below table 5.1

Table 1. Input Parameters of STATCOM based proposed Modal.

S. No.	Parameters	Values
1	Source Voltage	25kV/50Hz
2	Source Power	100MVA
3	Total Line length	23Km
4	Coupling Transformer	25kV/1.25kV
5	3 phase mutual Inductance	[R1 (OHMS) L1 (H)][2 2*pi*50] [R0 (OHMS) L0(H)] [4 2*pi*50]/2
6	D – STATCOM (Vdc)	2400 Volt
7	Frequency	50 Hz

IV. SIMULATION RESULT'S ANALYSIS AND DISSCUSSION

The system runs at 50Hz and total simulation time is chosen to be 0.5 seconds in each case. The scope which are providing the output and that is attached to the V-I measurements on the supply side. The load side gives the simulations of supply voltage having sag and voltage alongside the load. We have adopted D-STATCOM and three-phase programmable resources.

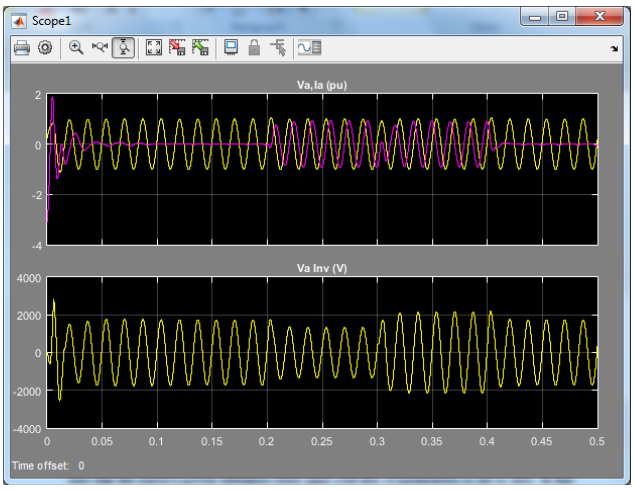

Fig 7. Waveform of Current and Phase-Voltage of D – STATCOM.

Illustration above i.e. 5.5 demonstrates the phase voltage of D-STATCOM and current waveform of intended D-STATCOM model. By the figure showing above it's clearly visible that in the period between the scheduling of timing between 0.2 and 0.3 Seconds, the voltage flicker occurs and repeats itself again at 0.4 second.

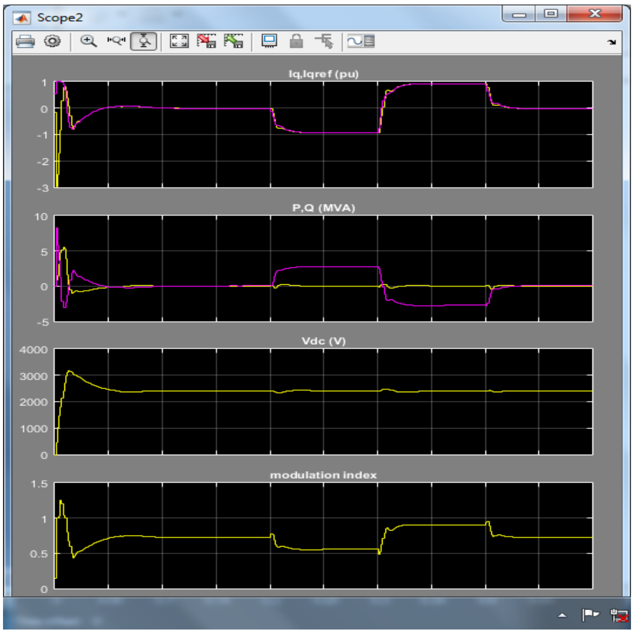

Fig 8. Steady State and Dynamic response of D-STATCOM.

Following at transitory or transient which lasts for up to 0.15 sec, at time (t) = 0.2s, source voltage will be increased at this juncture by about 6%. D-STATCOM will compensate for the voltage rise by absorption by reactive power as of form network (Reactive Power (Q) =2.7(+) MVAR on tracing or track 2 of second scope i.e. scope no. 2). On timing t = 0.3s, the source voltage is shrinking or decreased by about 6%.

The D-STATCOM should produce reactive power to preserve it at 1 per-unit voltage (Reactive Power (Q))the change between negative (-) 2.8MVAR to and positive (+)2.7MVAR). Here it is also notable that once D-STATCOM that will be changed from inductive to capacitive procedure/operation, a modulation index of our PWM inverter has inflated among the0.56 and 0.9 (trace four of second scope i.e. scope no. 2) corresponding to proportional upsurge in/during inverter voltage.

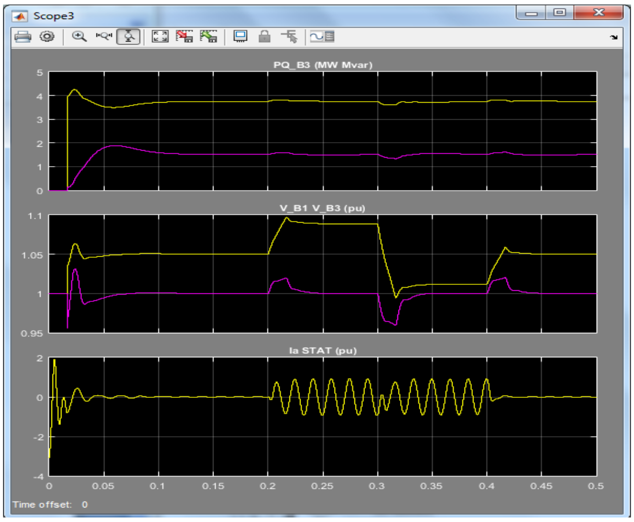

Fig 9. D-STATCOM output with reduced Flicker.

Scope no.3 demonstrates the changes in Active Power (P.) and Reactive Power (Q.) at B-3continues to be as voltage at B-1 and B-3. Voltage at B-3 is being altered there after between 0.96 per unit to 1.04 per unit (four variations). Now, within the Controller of D-STATCOMs, modifying" Operation Mode" to return to "Voltage regulation" and will then again revive the simulation. Observe again on Scope three which is the voltage fluctuation on a bus B-3 and it is observed that currently it is reduced to about 0.4 percent. The D-STATCOM recompensing the voltage by introducing the reactive current that are modulated at 5 Hz (3-trace of Scope three) and ranges between 0.6 per unit when the system is capacitive and when voltage is low and 0.6 per unit inductive once voltages is higher.

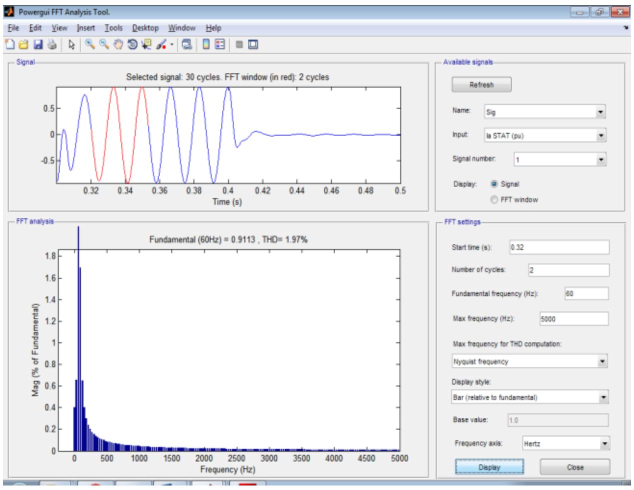

Fig 10. D-STATCOM output with Reduced THD.

The illustration shows above is the output of projected work in terms of Total Harmonics Distortion (T.H.D), The T.H.D of D-STATCOM generated wave is very low (only 1.97%) the flicker of sine wave is also low.

V. CONCLUSION

In this anticipated work a power system is attached to a variable load by making a SIMULINK model in MATLAB. In the anticipated research it is concluded that how D-STATCOM applied successfully to power system for effectively mitigates the power quality of suggested system and improves the flicker problem. When system voltage is less, D-STATCOM produces reactive power. When the system voltage is greater or higher than it is absorbing reactive power.

Here in this work we have come to the conclusion that D-STATCOM is better as compare to SVC and STATCOM based systems. It is also noted that D-STATCOM discussed during this work contains lower harmonics compared with SVC and STATCOM.

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