Power Distortion Improvement using DSTATCOM

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Abstract— **In this paper, we have basically dealt with the problems faced in Transmission line like Voltage sags, harmonics distortions and low power factors which in long run leads to Power Quality problems. We have analyzed some problem and thus with the help of D-STATCOM in the system, were able to upgrade the quality health of the overall system. D-STATCOM is known for its mitigation property, it's efficient of engrossing and producing reactive power which improves voltage flickering and peculiarity of power delivered. The analyzation was conducted by the usage of MATLAB SIMULATION variant R2007b.**

Catchword: D-STATCOM, VSC, Voltage Sags, LCL Passive Filters, Total Harmonics Distortion (THD), Controllers, Feeder.

I. INTRODUCTION

Nowadays power users are getting really solicitous regarding the standard of the power, that shall be delivered to it. Quick optimizations in modern era is enhancing the facility quality concerns. As we know that with time not only the demand of quantity of power has increased but also the quality of the power is concerned by consumers and the utilities, and the reason being the rising requirement of the reliable electrically power, high peculiarity and also the growing quantity of distortion load. Malfunctions and switch working in the system, mostly results in the disruption of voltage, commotion in transient & networks which will again lead to flickering i.e. rapid voltage alterations, harmonics and phase instability, and all of these overall deteriorates the power quality of the system. Majority popular PQ issues at present time are voltage sags, harmonic deformation and less PF. Voltage fall is a short time event within whereat reduction in the r.m.s magnitude occurs, it's an occurrence which last less then 1-6 of a second (1-cycle) which can be the reason of loss of really huge amount of dollars process which'll cause economical loss for the single industry client.

Developing of power electronics equipment's like Flexible AC Transmission System (FACTS) and more customed power tools has presented all of us to a rising branch of tech. which deals with the enhancement and growth of the power system with adaptable and flexible new regulate proficiencies. Out of the several methods of improving power quality troubles in transmissions and distributions system.

DSTATCOM's also sustainable device which can sustain at reactive current in low voltages and can also act as capacitor using energy storage in battery devices.

II. DISTRIBUTION STATIC COMPENSATOR (D-STATCOM)

Distribution static compensator, device which as we mentioned earlier is responsible for insertion & absorption of reactive power which is required by system. D-STATCOM is power electronic founded reactive power compensation equipment which is generally parallelly-connected with specific bus in distribution system. DSTATCOM primarily offers a continuous variable level of parallel compensation (by injecting current into the distribution system) that differs linearly over the distribution voltages. Its known for its feature that provides twain capacitive and inductive compensation to the MVA ratings of power electronic devices. Inverter is consisted with the capacitor as the DC input source. IGBTs are the best switching devices not only in power electronics field but also in case of distribution systems and the controller circuit provides the gating circuit for on and off control. The reason of injection of waveform is because of the high-speed switching of VSC, which synthesizes 50 Hz to 60 Hz signal using pulse width modulations (PWM). At operation time, the line at the primary terminal is monitored continuously by D-STACOM and is further compared with the reference signal. D-STATCOM consist of 2-level VSC, a PI controller, DC energy store device ,IGBT Circuit and finally a coupling transformer linked in parallel to distribution network.

Basic principle of Operation of D-STATCOM

The functioning precept of DSTATCOM's alike to that of the Synchronous machines. As Synchronous machines provides laggard current while it's under-excited (Ex < V) and lead current when it's over-excited (Ex> V) in that very same way DSTATCOM also generates and absorb reactive power and it may in addition replace the real power if it's provided with exterior active DC source.

Trade of Reactive Power: If o/p voltage of VSC is more prominent than the framework voltage, at that point DSTATCOM goes about as a capacitor and creates receptive force (for example gives driving current to the framework).

Though, whenever yield voltage of the VSC is not exactly the framework voltage, at that point DSTATCOM goes

about as an inductor associated in shunt with the dissemination framework and will consequently ingest the responsive force (for example gives slacking current to the framework). Consequently in this manner the trading of receptive force is finished.

Trade of Real Power: As the switching equipment don't have less loss, subsequently there's demand for DC capacitor so it gives the necessary real power to switches. Thus, there's demand for real power trade with AC framework in order to make capacitor voltage continual subjected to of the Direct Voltage Control. A genuine power trade is there in addition to the AC framework if DSTATCOM is given a outer DC source to control voltage subjected to low voltage in the circulation system.

In the event that the yield voltage of VSC lingers behind the system voltage, at that point inverter will ingest real power from the AC framework/system to charge the capacitor.

Though if the VSC output voltage drives the framework/system voltage, at that point the real power from the DC source or capacitor will be issued to AC system so as to manage the system voltages to 1p.u. or otherwise again make the capacitor voltages continual.

These are likewise utilized for surge impedance compensation to compensate by separating a long transmission line. Additionally utilized for load compensation wherein they keep up constant voltage (I) under load dismissal, outages of generator and line (ii) under gradually differing load change and (iii) under quickly shifting loads. By and large improving the steadiness of the framework/system just as the power factor of the framework/system.
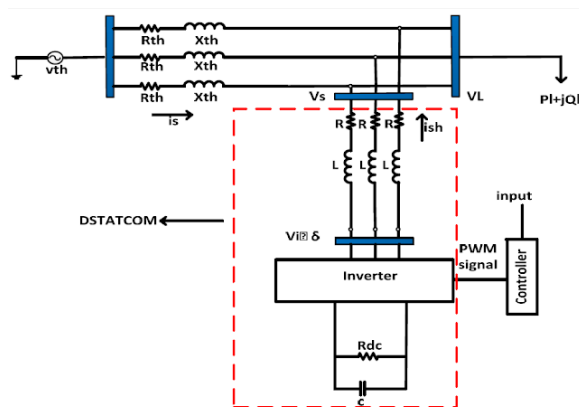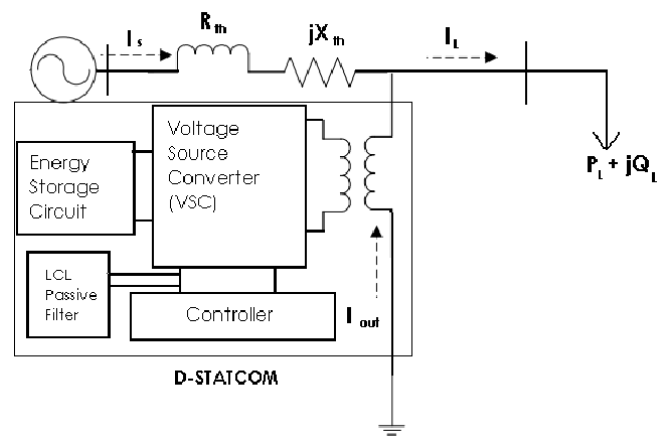

$Iout = iL - iS = iL - vth-VI/zth$ (a)

$Iout \ y = iL < (-\Theta)- vth/zth < (X - B) + vth/zth$ (b)

Thinking about condition (b), o/p current will address the voltage sags by changing the voltage drops over the framework impedance (=R+jX). We can make reference to that the viability of DSTATCOM in revising voltage droops relies upon:

• Estimation of Impedance = R+jX .
• Defficiency level of the load bus.

A. Voltage Source Converter (VSC)

A voltage-source converter is a power electronic equipment that is associated parallelly to the framework. It may produce a sinusoidal voltage of any necessary mag., frequency or phase angle. VSC is utilized either to totally supplant the voltage or to infuse/place the missing voltages. It can likewise change over DC voltages across capacity equipment's into a bunch of three stage AC output voltages. Moreover, D-STATCOM is likewise proficient to create or ingest receptive force. In the event that the o/p voltage of VSC is more than AC bus terminal voltages, DSTATCOM will be supposed to be in capacitive mode. All together that, it will compensate the responsive power through AC framework and regulate the missing voltage. These voltages are in phase and afterward combined with the AC framework through the reactance of coupling transformers. As a result of the sufficient change of the size and period of D-STATCOM output voltages, it'll permit compelling authority over the active and reactive force trades between the D-STATCOM and the AC framework. In incorporation, the converter is rooted on some sort of energy stockpiling, which will store and in this manner supply the converter with a DC voltage.
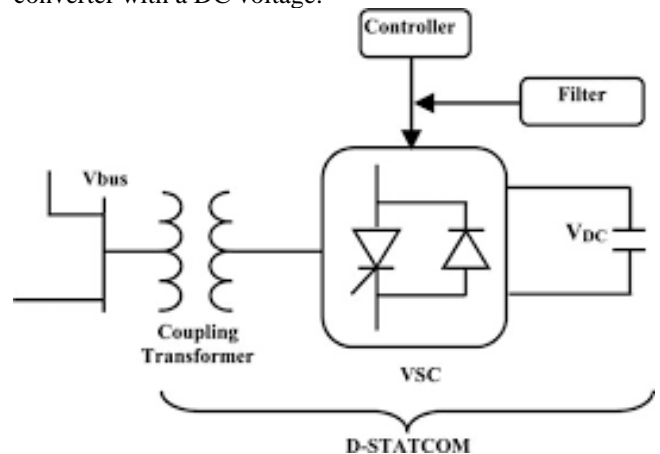
On the DC side, voltages are upheld by Capacitor. The capacitor's sufficiently enough to deal with a support charge or release current which go with the switching sequence of the converter valves and furthermore moves in phase angle of the switching valves with no critical changes in DC voltages. With the goal of conversation in this paper, the DC capacitor voltages would e accepted consistent. Wherein, AC side is thee

generated AC voltage associated with an AC system through an inductor.

B. Controller

PI Controller (Proportional Integral controller) in control system is a feedback controller which generally regulates the framework to be controlled with a weighted amount of blunder signal (which is the disparity between output and wanted set point) and thus the intrinsic of the value.

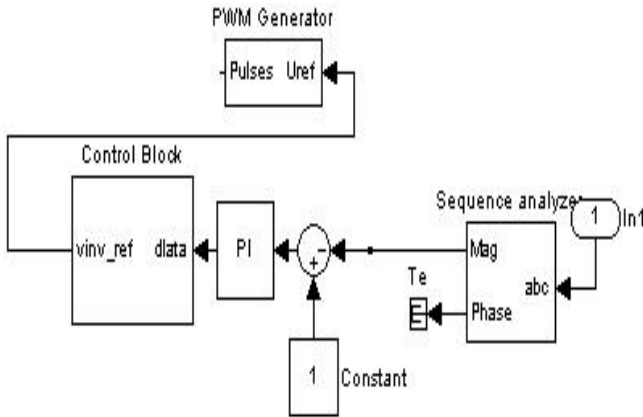For current situation, PI controller will be handling error sign to 0.

Fig. 2: Controller System

As Soon as Load R.m.s Voltage goes back to the reference point Final result comes only after comparision between reference point & Load point. Additionally wont to control the progression of reactive force from DC capacitor stockpiling circuit. Furthermore, as we probably are aware, PWM generator is the gadget which will produce Sinusoidal PWM waveforms or sign. For the activity of PWM generator, the angle is added along with that of the phase angle of equilibrium supplied voltage similarly at 120degree. Thusly,will have the option to deliver the ideal synchronizing signal. Thus likewise PI controller will give the error signal to PWM generators.

C. Energy Storage Circuit

Fig. 3: Circuit of Energy Storage (DC)

DC source will be associated parallelly with the DC capacitor. Its work is to convey the i/p ripple current of this converter also it's likewise the principle reactive energy stockpiling component, in accordingly manner storing energy for future use. It can either be charged by using a battery source or instead might be energized by converter only.

D. LCL Passive Filters

LCL Passive channels are one of the best on diminishing harmonic deformation. To plan it, condition (c), (d) and (e) are utilized.
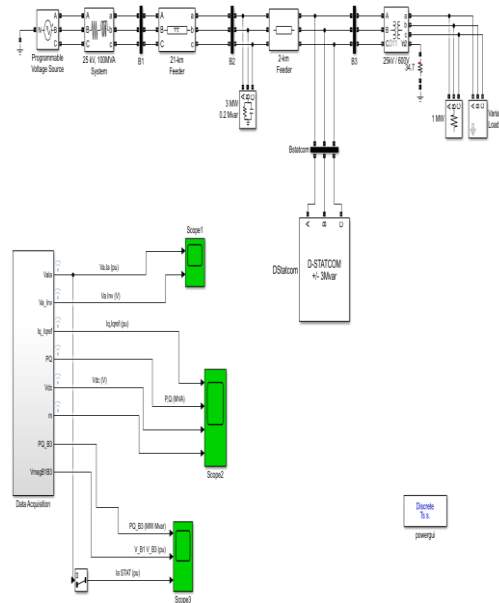
$$L_g = \frac{E_n}{2\sqrt{6}i_{ripm}f_{sw}} \qquad (c)$$

$$L_c = \frac{L_g}{2} \qquad (d)$$

$$C_f = \frac{L + L_g}{LL_g(2\pi f_{res})^2} \qquad (e)$$

To plan a productive LCL Passive channels, we need to ensure that,

$$10f_n \le f_{res} \le 0.5f_{sw}$$

MATLAB SIMULATION MODEL

E. Results & Discussions

To make deformation in the distribution framework, the various categories of fault which are injected are as follows – Ground-ground fault, 3phase-ground fault, single phase-ground fault. Load is connected to the system for balancing system by the usage of feeder line in which currents are always constant. After placing D-STATCOM, the distortion occurred due to active power & reactive power will decease & will be getting sinusoidal waveform because of the usage of the LCL Passive filter which is responsible for correction of signals in voltage form. D-STATCOM works as a mediator in the system which is accountable for generation or absorption of reactive power when reactive power is higher than the load which is connected to the system. Also, a DC capacitor is connected in

parallel with the source. Harmonic distortion is reduced by LCL Passive filters. One controller is also connected to system named PI controller which generally regulates the framework to be controlled with a weighted amount of the blunder signal and it is thus also the inherent of the value. PI Controller has one more feature in which controller measures error signal to zero. Controller is totally responsible for producing desired synchronizing signal which is required by system.

In Above MATLAB model, results clearly shows the distortion which were then corrected, comparison of both conditions with absence of DSTATCOM and presence of DSTATCOM also pulse modulation in the system arise due to Voltage source converter which is the main reason and responsible for forming of sinusoidal waveforms accurately. Some more techniques are also available but the results are less accurate which will result the System not to give desired voltages to the end customer, hence is not considered. We can conclude thus by saying that by using this technique we were able to deteriorate or mitigate the problem of voltage sags upto quite a good considerable range and improve the PQ as and thus aim of our paper have been so far completed.

Below are the graphs with and without insertion of DSTATCOM:

Before Insertion of DSTATCOM
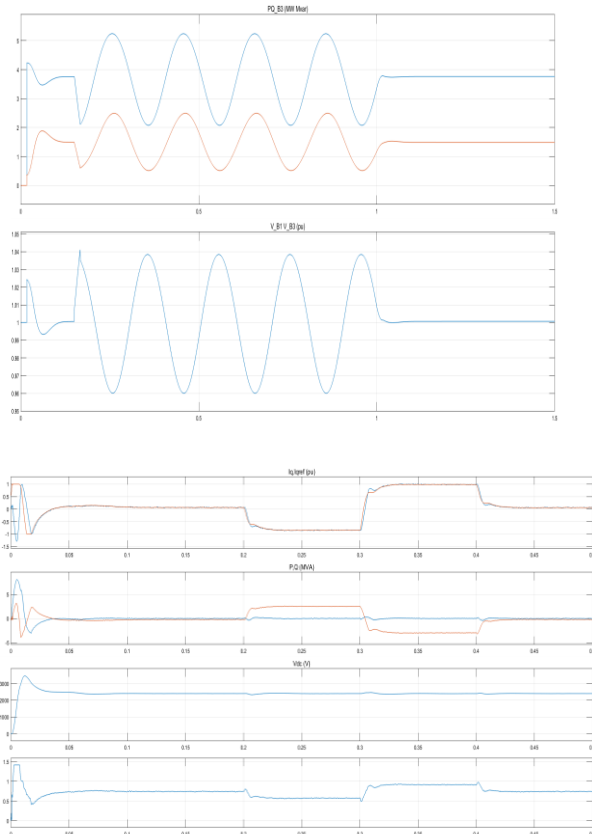
fter Insertion of DSTATCOM
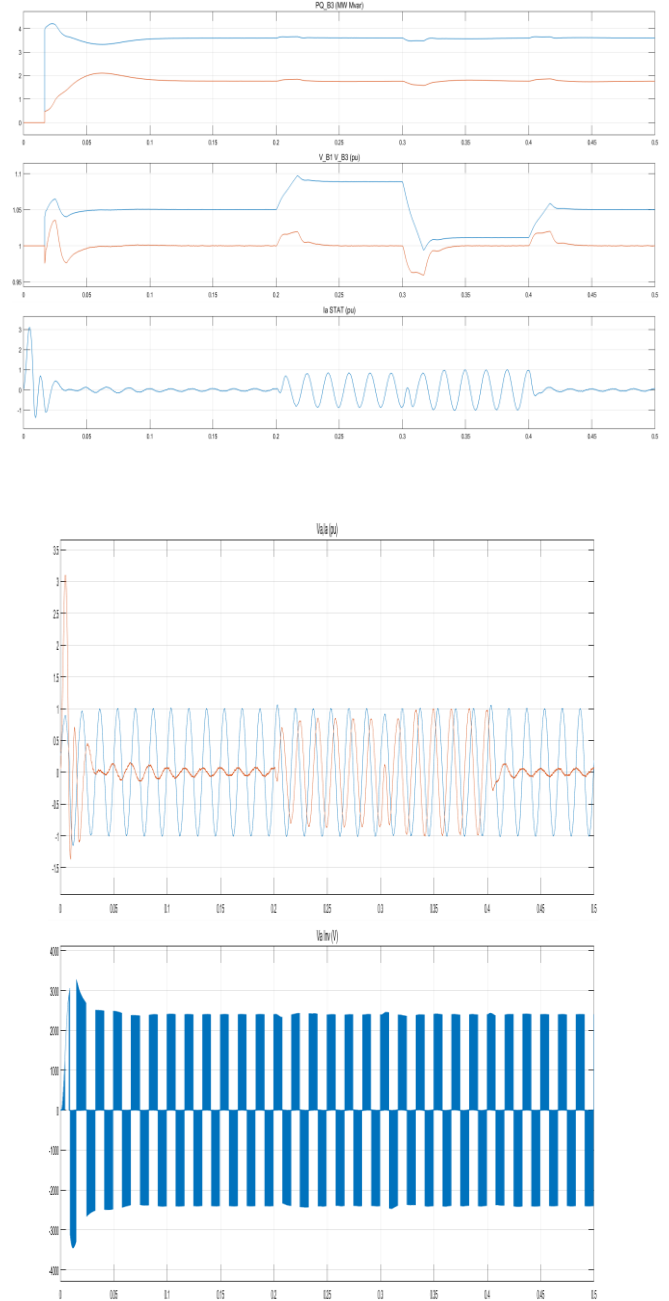
V. CONCLUSIONS:

We can conclude by saying that the voltage sags perhaps could be alleviated by embeddings DSTATCOM in distribution framework/system (simulation outcome). Additionally by accumulating LCL Passive channel to DSTATCOM, THD is diminished. The power factors expanded near solidarity(unity). Accordingly, it very well may be presumed that after the addition of DSTATCOM along with LCL channel, force nature of the framework/system is improved.

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