Analysis of Voltage Controlled DSTATCOM for Improving Voltage Regulation Capability by using External Inductor

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Abstract – Reactive power is produced when the current waveform is not in phase with the voltage waveform due to inductive or capacitive loads. The component of current which is in phase with voltage produces real or active power. Major industrial loads need reactive power for sustaining magnetic field. The main reason for reactive power compensation is the voltage regulation at the load side i.e. better utilization of machines connected to the system, reducing system losses, increased system stability. A distribution static compensator (DSTATCOM) is used for load voltage regulation and its performance mainly depends upon feeder impedance & its nature. This paper aims to provide extensive study of design, operation & flexible control of a DSTATCOM operating in voltage control mode. A complete analysis of the voltage regulation capability of a DSTATCOM under various feeder impedances is presented. Then, standard design procedure for computation of the value of external inductor is presented. A dynamic reference load voltage generation scheme is developed which allows DSTATCOM to compensate reactive power at load side during normal operation, in addition to provide voltage support during disturbances.

Index Terms - Distribution static compensator (DSTATCOM), current control, voltage control, power factor, power quality.

I. Introduction

In Distribution system, voltage disturbances such as sag and swell are often caused by faults occurs in widespread power system as well as switching of large loads [1]. This comes under power quality (PQ)problems which results in degradation of performance of sensitive loads like process-control industry, electronics equipment, adjustable drives, etc. Conventionally, for the purpose of load voltage regulation, compensation of reactive current, and improving of transient stability, Static var Compensator (SVC) is used. But the problem with the use of SVC is that it causes harmonic current injection in the system, harmonic amplification, and possible resonance with the source impedance [2] Distribution Static Compensator (DSTATCOM) has been proposed to overcome the limitations of SVC [3]-[9]. A Distribution static compensator is one of the most effective solutions for load voltage regulation. It can mitigate several power quality (PQ) problems depending upon the mode of operation like current control mode (CCM) and voltage control mode(VCM). In current control mode (CCM), it injects harmonic & reactive components of load currents to make source currents balanced, sinosuidal and in phase with load voltages. In voltage control mode(VCM) it regulates load voltage at a constant value to protect sensitive loads from voltage disturbances and transients. It provides regulation of load voltage by supplying fundamental reactive current into source. Most of the conventional DSTATCOMs used for load voltage regulation consider highly inductive or large feeder impedance[11].But in distribution system where feeder impedance used to be resistive in nature. In this scenario, the DSTATCOM will have small voltage regulation capability. Generation of reference load voltage is the another important issue. Reference load voltage is set at 1.0 p.u. for voltage regulation in conventional DSTATCOM application . VSI always exchanges reactive power with the source at this load voltage with leading power factor. This causes continuous power losses in the feeder and VSI. Also, conventional DSTATCOM requires high current rating voltage source inverter (VSI) to provide voltage support [11]. This high current requirement will increase the power rating of the VSI and produce more losses in the switches as well as in the feeder.

Based on the distance between source and load, a source is termed as stiff or non-stiff. If the distance is long, source is termed as non-stiff & has high feeder impedance whereas if the distance is very small, source is termed as stiff and has negligible feeder impedance. Upon the feeder impedance and its nature (resistive, inductive, stiff, non-stiff), the voltage regulation performance of DSTATCOM mainly depends. DSTATCOM regulates the load voltage by indirectly regulating the voltage across the feeder impedance. When a load is connected to nearly stiff source, feeder impedance will be negligible. Under these conditions, DSTATCOM cannot provide sufficient voltage regulation at load terminal. There is lack of literature addressing the feasibility of the VCM operation of DSTATCOM under stiff source. For VCM operation of DSTATCOM or grid connected inverters, the idea of inserting an external inductor in line has been reported[2]-[4]. In these schemes only the concepts has been introduced leaving large scope for further investigation & insight into design details. This paper focus on detail design procedure for selecting the external inductor which satisfy several practical constraints & allows DSTATCOM to regulate load voltage in stiff as well as resistive feeder, reduce the current requirement for mitigation of sag and reduce system losses. With coordinated control of load fundamental current, terminal voltage, and voltage across the external inductor, a dynamic reference load voltage generation scheme is presented. Complete simulation results are included to verify the DSTATCOM performance.

II. DSTATCOM IN POWER DISTRIBUTION SYSTEM

In today's scenario, to maintain the power quality in a power system, it is very essential to design appropriate compensators. The quality of the power is poor due to the increase in a wide variety of loads that pollute the power system. The DSTATCOM consists of a current-controlled VSI which injects current at the PCC through the interface inductor. The operation of VSI is supported by a dc storage capacitor. The transient response of the DSTATCOM is very significant while compensating ac and dc loads

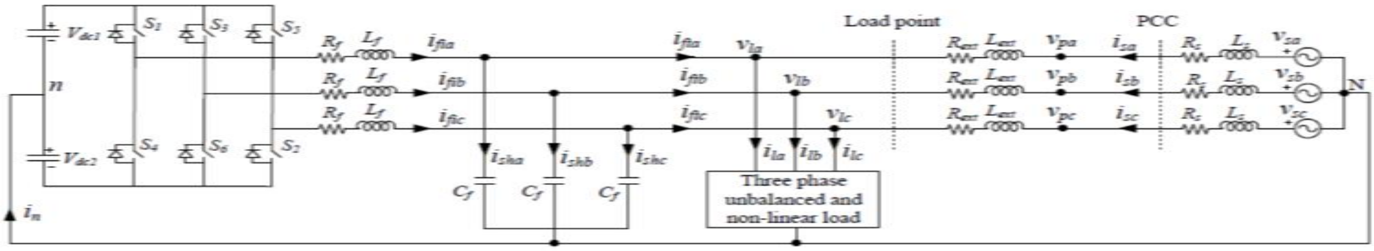

Fig. 1. Three phase equivalent circuit of DSTATCOM topology in distribution system.

Fig. 1 shows power circuit diagram of the DSTATCOM topology connected in distribution system. L_s and R_s are source inductance and resistance, respectively. An external inductance, L_{ext} is included in series between load and source points. This inductor helps DSTATCOM to achieve load voltage regulation capability even in worst grid conditions, i.e., resistive or stiff grid. From IEEE-519 standard, point of common coupling (PCC) should be the point which is accessible to both the utility and the customer for direct measurement . Therefore, the PCC is the point where L_{ext} is connected to the source. The DSTATCOM is connected at the point where load and L_{ext} are connected. The DSTATCOM uses a three-phase four-wire VSI. A passive LC filter is connected in each phase to filter out high frequency switching components. Voltages across dc capacitors, V_{dc1} and V_{dc2}, are maintained at a reference value of V_{dcref}

III. CHOICE OF EXTERNAL INDUCTOR FOR VOLTAGE REGULATION IMPROVEMENT AND RATING REDUCTION

A Distribution STATCOM (DSTATCOM) is a shunt compensation device used for reactive power compensation. The DSTATCOM consists of a current-controlled VSI which injects current at the PCC through the interface inductor. This section presents a generalized procedure to select external inductor for improvement in DSTATCOM voltage regulation capability while reducing the current rating of VSI.

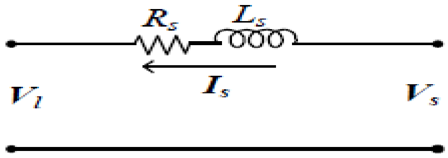
Fig. 2. Equivalent source-load model without considering external inductor.

An equivalent source-load model without considering external inductor is shown in Fig. 2. The current in the circuit is given as

$$I_s = \frac{V_S - V_l}{Z_S} \tag{1}$$

where $V_S = V_S\angle\delta$, $V_l = V_l\angle 0$, $I_S = I_S\angle\emptyset$, and $Z_S = Z_S\angle\theta s$, with Vs, V_l, I_s, Z_s, δ, $\emptyset$, and θs are rms source voltage, rms load voltage, rms source current, feeder impedance, load angle, power factor angle, and feeder impedance angle, respectively. The three phase average load power (P_l) is expressed As

$$P_l = Real[3V_l \times I_s^*] \tag{2}$$

Substituting V_l and I_s in (2), the load active power is

$$P_l = \frac{3V_l^2}{Z_s}\left[\frac{V_s}{V_l}\cos(\theta_s - \delta) - \cos\theta_s\right] \tag{3}$$

Rearranging (3), expression for load angle is computed as follows

$$\delta = \theta_s - \cos^{-1}\left[\frac{V_l}{V_s}\left(\cos\theta_s + \frac{P_l Z_s}{3V_l^2}\right)\right] \tag{4}$$

For power transfer from source to load with stable operation in an inductive feeder, δ must be positive and less than 90^0. Also, all the terms of the second part of (4), i.e., inside $\cos^{-1}$, are amplitude and will always be positive. Therefore, value of the second part will be between '0' to 'π/2' for the entire operation of the load. Consequently, the load angle will lie between θs to (θs - π/2) under any load operation, and therefore, maximum possible load angle is θs.

The vector expression for source voltage is given as follows:

$$V_s = V_l + I_s Z_s < (\theta_s + \emptyset) \tag{5}$$

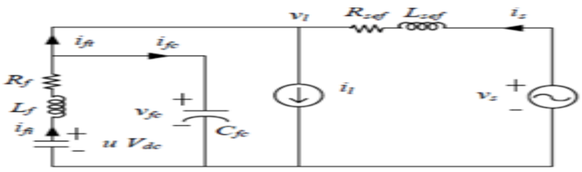

Fig. 3. 1∅ equivalent circuit of DSTATCOM topology with external inductor in distribution system.

With balanced voltages, source current will be

$$I_s = \frac{V_s<\delta-V_l<0}{(R_s+R_{ext})+j(X_s+X_{ext})} = \frac{V_s<\delta-V_l<0}{R_{sef}+jX_{sef}} \quad (6)$$

where R_{sef} = R_s+R_{ext} and X_{sef}= X_s+X_{ext} are effective feeder resistance and reactance, respectively. R_{ext} is equivalent series resistance (ESR) of external inductor, and will be small. With θ_{sef} = $\tan^{-1} X_{sef}/R_{sef}$ and $Z_{sef} = \sqrt{R_{sef}^2 + X_{sef}^2}$ as effective impedance angle and effective feeder impedance, respectively, the imaginary component of I_s is given as

$$I_s^{im} = \frac{V_l \sin\theta_{sef} + V_s \sin(\delta-\theta_{sef})}{Z_{sef}} \quad (7)$$

With the addition of external impedance, the effective feeder impedance becomes predominantly inductive. Hence, $Z_{sef} \approx X_{sef}$. Therefore, approximated I_s^{im} will be

$$I_s^{im} = \frac{V_l \sin\theta_{sef} + V_s \sin(\delta-\theta_{sef})}{X_{sef}} \quad (8)$$

DSTATCOM Power rating (S_{vsi}) is given as follows [21]:

$$S_{vsi} = \sqrt{3}\frac{V_{dc}}{\sqrt{2}} I_{vsi} \quad (9)$$

where I_{vsi} defines the rms phase current rating of the VSI and V_{dc} symbols for the voltage maintained at the dc capacitors. The DSTATCOM aims to inject harmonic and reactive current component of load currents. Suppose I_l^{im} is the maximum rms reactive and harmonic current rating of the load, then the value of compensator current used for voltage regulation (same as I_s^{im}) is obtained by subtracting I_l^{im} from I_{vsi} and given as follows:

$$I = I_{vsi} - I_l^{im} = \frac{\sqrt{2S_{vsi}}}{\sqrt{3V_{dc}}} - I_l^{im} \quad (10)$$

Comparing (8) and (10) while using value of load angle from (4), following expression is obtained

$$X_{sef} = \frac{V_l \sin(\theta_{sef} - V_s \sin[\cos^{-1}[\frac{V_l}{V_s}(\cos\theta_{sef} + \frac{P_l X_{sef}}{3V_l^2})]]}{\frac{\sqrt{2S_{vsi}}}{\sqrt{3V_{dc}}} - I_l^{im}} \quad (11)$$

The above expression is used to compute the value of external inductor. Here, it is assumed that the considered DSTATCOM protects load from a voltage sag of 60%. Hence, source voltage Vs = 0.6 p.u. is considered as worst case voltage disturbances. During voltage disturbances, the loads should remain operational while improving the DSTATCOM capability to mitigate the sag. Therefore, the load voltage during voltage sag is maintained at 0.9 p.u., which is sufficient for satisfactory operation of the load. In the present case, maximum required value of Iim l is 10 A. With the system parameters given in Table I, the effective reactance after solving (11) is found to be 2.2 (Lsef = 7 mH). Hence, value of external inductance, Lext, will be 6.7 mH. This external inductor is selected while satisfying the constraints such as maximum load power demand, rating of DSTATCOM, and amount of sag to be mitigated. In this design example, for base voltage and base power rating of 400 V and 10 kVA, respectively, the value of external inductance is 0.13 p.u. Moreover, with total inductance of 7 mH (external and actual grid inductance), the total impedance will be 0.137 p. u. The short circuit capacity of the line will be 1/0.13 = 7.7 p.u. which is sufficient for the satisfactory operation of the system. Additionally, a designer always has flexibility to find suitable value of Lext if the constraints are modified or circuit conditions are changed. Moreover, conventional DSTATCOM operated for achieving voltage regulation uses large feeder inductances [11]

IV. FLEXIBLE CONTROL STRATEGY

The major problem associated with the design of the controller for the DSTATCOM is the selection of appropriate circuit components. The second major problem is to understand the proper working of the controller and control algorithms. This sections presents a flexible control strategy for improving the performance of DSTATCOM in presence of the external inductor Lext. At first, a dynamic reference load voltage based on the coordinated control of the load fundamental current, PCC voltage, and voltage across the external inductor is computed. Then, a proportional integral (PI) controller is used to control the load angle which helps in regulating the dc bus voltage at a reference value. Finally, three phase reference load voltages are generated. The block diagram of the control strategy is shown in Fig. 4.

TABLE I

SIMULATION PARAMETERS

System quantities	Values
Source voltage	230 V rms L-N (1.0 p.u.), 50Hz
Feeder impedance	$R_s = 0.3\ \Omega$, $L_s = 0.3$mH, $\frac{R_s}{X_s} = 3.185$
External impedance	$L_{ext} = 6.7$Mh, $R_{ext} = 0.07\Omega$
Linear Load	$Z_{la} = 30 + j62.8\Omega, Z_{lb} = 40 + j78.5\Omega, Z_{lc} = 50 + j50.24\Omega$
Nonlinear load	Three phase rectifier supplying RL load of 50Ω and 200 mH
VSI parameters	$V_{dc} = 520\ V, C_{dc} = 2600\ uF, L_f = 5mH, C_f = 20uF,$ $S_{vsi} = 30\ KVA$
PI gains	$K_{p\delta} = 8.5e^{-7}, K_{i\delta} = 1.8e^{-6}$

A. Derivation of Dynamic Reference Voltage Magnitude (V_l^*)

In conventional VCM operation of DSTATCOM, the reference load voltage is maintained at a constant value of 1.0 p.u. [8]–[9]. Source currents cannot be controlled in this reference generation scheme. Therefore, power factor will not be unity and source exchanges reactive power with the system even at nominal supply. To overcome this limitation, a flexible control strategy is developed to generate reference load voltage. This scheme allows DSTATCOM to set different reference voltages during various operating conditions. The scheme is described in the following.

1) Normal Operation: It is defined as the condition when load voltage lies between 0.9 to 1.1 p.u. In this case, the proposed flexible control strategy controls load voltages such that the source currents are balanced sinusoidal and VSI does not exchange any reactive power with the source. Hence, the source supplies only fundamental positive sequence current component to support the average load power and VSI losses. Reference source currents (i* sj where j = a; b; c are three phases), computed using instantaneous symmetrical component theory , are given as

$$i_{sj}^* = \frac{v_{pj1}^+}{\Delta_1^+}(P_l + P_{loss}) \tag{12}$$

where $\Delta_1^+ = \sum_{j=a,b,c}(v_{pj1}^+)^2$. The voltages v_{pa1}^+, v_{pb1}^+, and v_{pc1}^+ are fundamental positive sequence components of PCC voltages. Average load power (Pl) and VSI losses (Ploss) are calculated using moving average filter (MAF) as follows:

$$P_l = \frac{1}{T}\int(v_{la}i_{la} + v_{lb}i_{lb} + v_{lc}i_{lc})dt \tag{13}$$

$$P_{loss} = \frac{1}{T}\int(v_{la}i_{fta} + v_{lb}i_{ftb} + v_{lc}i_{ftc})dt \tag{14}$$

The reference source currents must be in phase with the respective phase fundamental positive sequence PCC voltages for achieving UPF at the PCC. Instantaneous PCC voltage and reference source current in phase-a can be defined as follows:

$$v_{pa1}^+ = \sqrt{2}V_{pa1}^+\sin(wt - \varphi_{pa1}^+)$$
$$i_{sa}^* = \sqrt{2}I_{sa}^*\sin(\text{wt-}\varphi_{pa1}^+) \tag{15}$$

where V_{pa1}^+ and φ_{pa1}^+ are rms voltage and angle of fundamental positive sequence voltage in phase-a, respectively. I* sa is the rms reference source current obtained from (12). With external impedance, the expected load voltage is given as follows:

$$V_{la} = V_{pa1}^+\text{-}I_{sa}^*Z_{ext.} \tag{16}$$

From (15) and (16), the load voltage magnitude will be

$$V_{la} = \sqrt{[(V_{pa1}^+\cos\varphi_{pa1}^+ - I_{sa}^*Z_{ext}\cos(\theta_{ext} - \varphi_{pa1}^+))^2 + (V_{pa1}^+\sin\varphi_{pa1}^+ - I_{sa}^*Z_{ext}\sin(\theta_{ext} - \varphi_{pa1}^+))^2]} \tag{17}$$

With UPF at the PCC, the voltage across the external inductor will lead the PCC voltage by 90^0. Neglecting ESR of external inductor, it can be observed that the voltage across external inductor improves the load voltage compared to the PCC voltage. This highlights another advantage of external inductor where it helps in improving the load voltage. As long as V_{la} lies between 0.9 to 1.1 p.u., same voltage is used as reference terminal voltage (V * l), i.e., From (15) and (16), the load voltage magnitude will be

$$\text{if } V_{la} \in [0.9 - 1.1\text{ p.u.}],\ \text{then } V_l^* = V_{la}. \tag{18}$$

2) *Operation During Sag:* Voltage sag is considered when value of (17) is less than 0.9 p.u. To keep filter current minimum, the reference voltage is set to 0.9 p.u. Therefore ,

$$V_l^* = 0.9 \text{ p.u.} \quad (19)$$

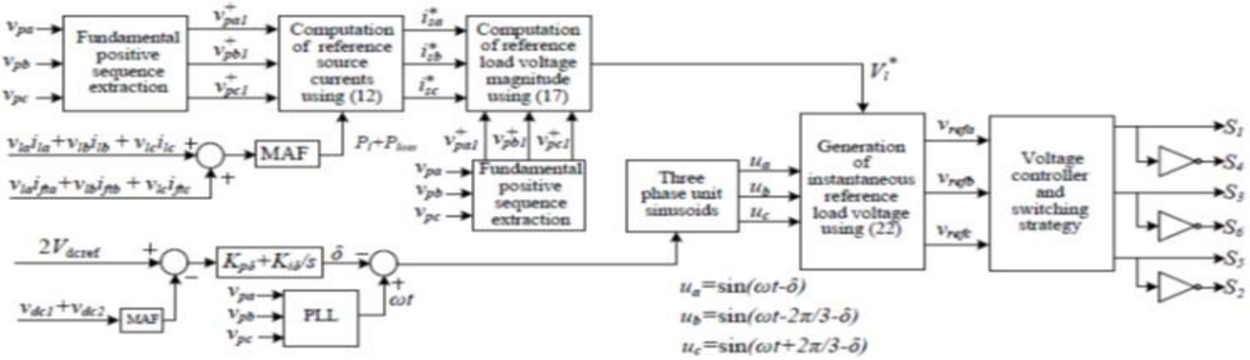

Fig.4.Block diagram of proposed flexible control strategy.

3) Operation During Swell: A voltage swell is considered when any of the PCC phase voltage exceeds 1.1 p.u. In this case, reference load voltage (V * l) is set to 1.1 p.u. which results in minimum current injection. Therefore,

$$V_l^* = 1.1 \text{ p.u.} \quad (20)$$

B. Computation of Load Angle (δ)

Average real power at the PCC (Pcc) is sum of average load power (Pl) and VSI losses (Ploss). The real power Ppcc is taken from the source depending upon the angle between source and load voltages, i.e., load angle δ. If DSTATCOM dc bus capacitor voltage is regulated to a reference value, then in steady state condition Ploss is a constant value and forms a fraction of Ppcc. Consequently, δ is also a constant value. The dc link voltage is regulated by generating a suitable value of δ. The average voltage across dc capacitors (Vdc1 +Vdc2) is compared with a reference voltage and error is passed through a PI controller. Output of PI controller, δ, is given as

$$\delta = K_{p\delta} e_{vdc} + K_{i\delta} \int e_{vdc} dt \quad (21)$$

where $e_{vdc} = 2V_{dcref} - (V_{dc1} + V_{dc2})$ is the voltage error. Kp δ and Ki δ are proportional and integral gains, respectively.

C. Generation of Instantaneous Reference Voltage

Selecting suitable reference load voltage magnitude and computing load angle from (21), the three phase balanced sinusoidal reference load voltages are given as follows:

$$V_{ref\,a} = \sqrt{2}V_l^* \sin(\omega t - \delta)$$
$$V_{ref\,b} = \sqrt{2}\, V_l^* \sin(wt - \tfrac{2\pi}{3} - \delta)$$
$$V_{ref\,c} = \sqrt{2}V_l^* \mathrm{Sin}(\omega t + \tfrac{2\pi}{3} - \delta) \quad (22)$$

These voltages are realized by the VSI using a sinusoidal pulse width modulator.

V. SIMULATION RESULTS AND DISCUSSION

A) CONVENTIONAL RESULTS

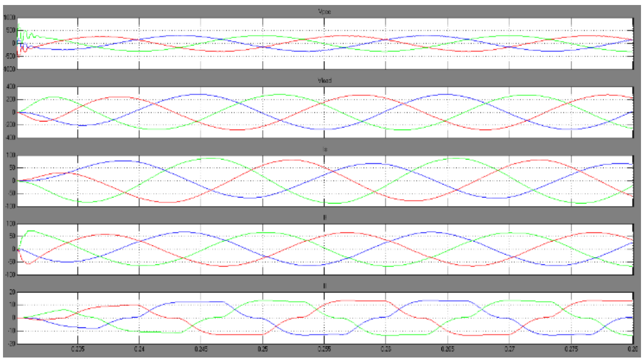

Fig.5 Normal operation

B) PROPOSED SYSTEM RESULTS:

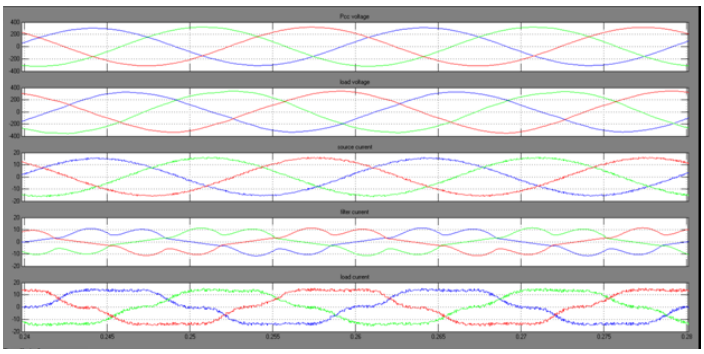

Fig.6.a Normal Operation

Fig.5.Voltage regulation performance of conventional DSTATCOM with resistive feeder. (i) PCC voltages. (ii) Load Voltages. (iii) Source currents. (iv)Filter currents. (v) Load currents.

C. PROPOSED SYSTEM RESULTS:

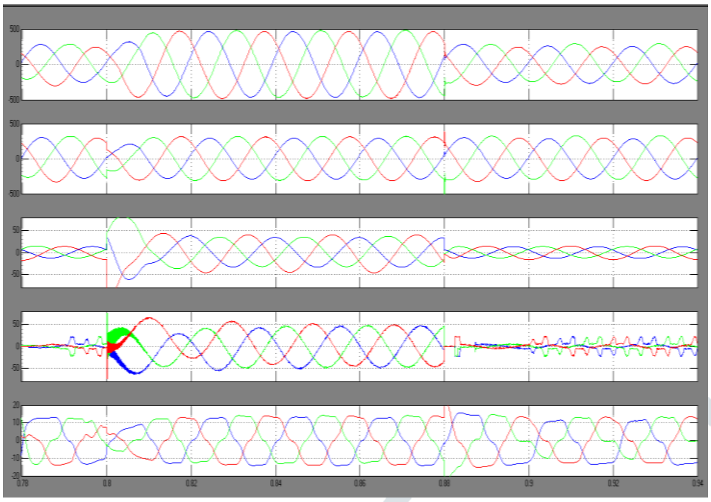

Fig.6. c. During Voltage Swell

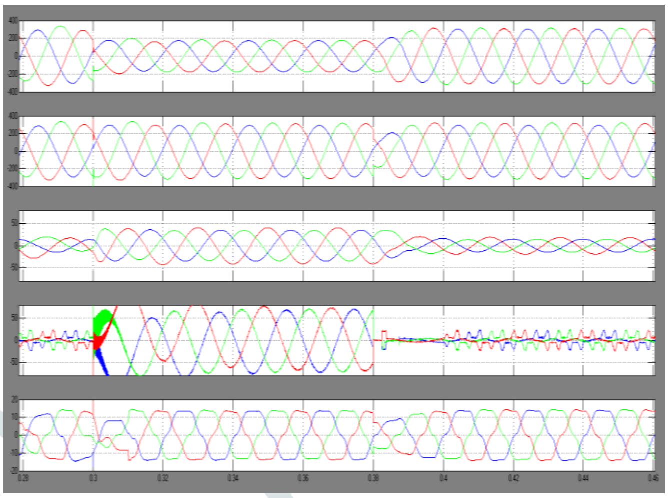

Fig.6. b. During Voltage sag

Fig.6.Voltage regulation performance of proposed DSTATCOM with inductive feeder. (i)PCC voltages. (ii) Load Voltages. (iii) Source currents. (iv)Filter currents. (v) Load currents.

The parameters of DSTATCOM compensated distribution system are given in Table I. Usual scenario in distribution system having resistive feeder impedance is considered. MATLAB software is used to simulate the system. Firstly, the DSTATCOM is operated in conventional VCM, i.e., 1) without external inductor and 2) with a reference voltage of 1.0 p.u. or 230 V rms. The steady state waveforms of three phase PCC voltages, load voltages, source currents, filter currents, and load currents are shown in Figs. 5(i)-(v), respectively. Here, the DSTATCOM has to compensate only for feeder drop. However, from the load voltage waveform shown in Fig. 5(ii), its magnitude is found to be 227.7 V. It confirms that the DSTATCOM has limited voltage regulation capability in a resistive feeder. It can be noticed from Fig. 5(iii) that the magnitude of source current is very large and almost leading load voltage by 90^0. This large reactive current is supplied by the VSI, as shown in Fig. 5(iv), which increases its current rating. These waveforms confirm that a DSTATCOM cannot provide voltage regulation in resistive feeder, requires high current rating VSI for small voltage regulation, and exchanges reactive power with source even at nominal operation. Further, the high current produces excessive losses in the system. Figs. 6.a(i)-(v) provide the steady state waveforms with the designed external inductance and flexible control strategy. This scheme simultaneously controls load voltages and source currents. The three phase normal PCC voltages are shown in Fig. 6.a(i). The load voltages and source currents waveforms are shown in Figs. 6.a(ii) and 6.a(iii), respectively. These waveforms are balanced and sinusoidal. Thus, UPF is achieved at the PCC. Hence, compensator supplies only load harmonic and reactive power in addition to reactive power requirement of the Lext. The THDs in the load currents are 14.5%, 15.3%, and 13.6% for phases a; b; and c, respectively. After the compensation, the THDs in source currents are reduced to 2.4%, 2.7%, and 2.4%, respectively in phases a; b; and c. The filter and load currents are shown in Figs. 6.a(iv) and 6.a(v), respectively. These waveforms validate the performance of flexible control strategy as 1) source does not exchange reactive power from the system, 2) filter does not supply additional current and reduces system losses, and 3) UPF is maintained at the PCC. These features are not available in conventional DSTATCOM operating in VCM.
Approximate losses in the system are given as follows:

$$P_{loss} = 3\left(I_{f1}^2 R_f + (I_s^{im})^2 R_s + (I_s^{real})^2 R_s\right) \tag{23}$$

In conventional scheme, the source always exchanges reactive power. Hence, I_l^{im} will be non-zero. Also, this current is supplied by the filter i.e., I_{f1} will be higher. However, in proposed scheme, it is seen that the source does not exchange reactive power in normal operation. Hence, I_s^{im} = 0 and I_{f1} is reduced. Hence, proposed scheme reduces losses in the system and utilizes smaller VSI ratings. Small power losses will be there due to the ESR of the external inductor. However, the losses in the ESR will be much smaller than that of reduction of power losses from the conventional DSTATCOM operation. Voltage sag is created by reducing the source voltage to 0.6 p.u. at t = 0.3 s for 4 cycles. Fig. 6.b(i) shows the PCC voltages. Control of reference load voltage based on the coordinated control of fundamental load current, PCC voltage, and voltage across the external inductor allows DSTATCOM to set different constant reference voltage.
The proposed scheme detects voltage sag and load voltage is changed to 0.9 p.u. The waveforms of load voltages are shown in Fig. 6.b(ii). This guarantees continuous, flexible, and robust operation of the load. The source currents are increased during sag period as illustrated in Fig. 6.b(iii). Fig. 6.b(iv) shows the filter currents which increase during sag period to support the load voltage. The load currents waveforms presented in Fig. 6.b(v) are nearly constant during entire operation. Once the sag is removed at t = 0.38 s, slowly all the waveforms reach the pre-sag values. With the results of Figs. 6.b(i)-(v), it can be concluded that the proposed scheme makes load operation continuous. Source voltage is increased to 1.4 p.u. at t = 0.8 s to create swell. The PCC voltages are shown in Fig. 6.c(i). The algorithm detects swell and maintains load voltage at 1.1 p.u. The waveforms are shown in Fig. 6.c(ii).

The waveforms of the source, filter, and load currents are shown in Figs. 6.c(xiii)- (xv), respectively. The filter currents increase during swell which increases the source currents as well. Load currents are nearly constant throughout the operation. Once sag is removed, it is detected by the algorithm and system is brought to the steady state conditions. It confirms effectiveness of the proposed scheme.

VI. CONCLUSIONS

This paper has presented design, operation, and control of a DSTATCOM operating in voltage control mode (VCM). After providing a detailed exploration of voltage regulation capability of DSTATCOM under various feeder scenarios, a benchmark design procedure for selecting suitable value of external inductor is proposed. An algorithm is formulated for dynamic reference load voltage magnitude generation. The DSTATCOM has improved voltage regulation capability with a reduced current rating VSI, reduced losses in the VSI and feeder. Also, dynamic reference load voltage generation scheme allows DSTATCOM to set different constant reference voltage during voltage disturbances. Simulation and experimental results validate the effectiveness of the proposed solution. The external inductor is a very simple and cheap solution for improving the voltage regulation, however it remains connected throughout the operation and continuous voltage drop across it occurs. The future work includes operation of this fixed inductor as a controlled reactor so that its effect can be minimized by varying its inductance.

VI. FUTURE SCOPE

In this project Proportional Integral (PI) controller based DSTATCOM has been proposed, the controller can be extended by Fuzzy Logic Controller (FLC) along with multilevel inverter based DSTATCOM, which can give much more robust operation and better DC link voltage regulation over that used in the project. The FLC has the advantage of using the everyday assumptions such as the less error, high error, medium error, etc., and also it is cheaper for designing. The utilization of this controller will give better control over the wide range of error values. The controllers will provide faster and precise control for the DSTATCOM. The DSTACOM operation is depended on the control of the device hence, the better the controller the precise is the output. Also the multilevel inverter will give a robust and continuous operation. The output of the inverter will be more in shape and will match all the predetermined measures. Hence the multilevel inverter along with the FLC will improve further the performance of DSTATCOM.

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