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Enhancement of Power Quality with Fuzzy Control of Dstatcom Supported Induction Generator

M. Venkataramana, I. Srinu, M.N.V.V. Brahmam

Abstract**:** ***The DC-link voltage of VSC used as DSTATCOM is regulated by the SMC which suppresses undershoots and overshoots in the DC-link voltage. This paper presents an implementation of sliding mode controller (SMC) along with a Fuzzy controller for a DSTATCOM (Distribution Static Compensator) for improving current induced power quality issues and voltage regulation of three-phase self-excited induction generator (SEIG). DSTATCOM is a shunt-connected custom power device specially designed for power factor correction, current harmonics filtering and load balancing and used for voltage regulation at a distribution bus. Here we are using the fuzzy controller compared to other controllers i.e. the fuzzy controller is the most suitable for the human decision-making mechanism, providing the operation of an electronic system with decisions of experts. The use of SMC for regulating the DC link voltage of DSTATCOM offers various advantages such as reduction in number of sensors for estimating reference currents and the stable DC link voltage during transient conditions. The SMC algorithm is successfully implemented on a DSTATCOM employed with a three-phase SEIG feeding single phase or three phase loads. In addition, using the fuzzy controller for a nonlinear system allows for a reduction of uncertain effects in the system control and improves the efficiency.***

Index Terms**:** ***SMC, SEIG, DSTATCOM, DC-Link, PCC, VSC.***

I. INTRODUCTION

Such problem loads to co-exist on the same feeder as more sensitive loads. The use of an The DSTATCOM can also be applied to industrial facilities to compensate for voltage sag and flicker caused by non-linear dynamic loads, enabling induction machine for the power generation has increased in past two decades due to popularity of distributed renewable energy resources. The induction machine is economical for small power generation in the aspects of low maintenance, brush-less operation, ruggedness, free from field excitation etc. Apart from these advantages, the induction machine requires leading volt ampere reactive (VAR) at its terminals for building up of the voltage. The machine requires variable capacitance across terminals for maintaining the constant terminal voltage from no load to full load condition. The DSTATCOM protects the utility transmission or distribution system from voltage sags and/or flicker caused by rapidly varying reactive current demand. In utility applications, a DSTATCOM provides leading or lagging reactive power to achieve system stability during transient conditions.

The use of single-phase loads on three-phase induction generator causes the unbalance voltages and currents in the phases. All these problems can be solved by using custom power device such as Distribution Static Compensator (DSTATCOM) for the induction machine.

In this paper, the sliding mode control with fuzzy control algorithm is used for control of the dynamic operation of the DSTATCOM in distributed generation which improves the power quality at the terminals of the induction machine with reduced number of sensors. The main advantage of using sliding mode controller (SMC) is that the reference supply currents are estimated from the DC-link voltage of voltage source converter (VSC) which gives the robust control during transient conditions [10].

The operation has to be single point voltage operation; therefore, a fuzzy controller is used to attain the reference voltage without any steady-state error. The operation below the knee voltage reduces the magnetizing current drawn by the generator and hence increases its capability and reduces the harmonic distortion caused by the magnetizing current. Moreover, the power quality issues are also mitigated. The generator currents are always balanced and free from harmonics; therefore, the utilization of the generator is further increased and the operation is observed noiseless

II. CONFIGURATION OF DSTATCOM SUPPORTED INDUCTION GENERATOR

The schematic diagram of an induction generator supported by VSC-based DSTATCOM in the distributed generating system is shown in Fig1. DSTATCOM is connected in parallel with the load and an induction generator at the point of common coupling (PCC) for improving the power quality. Once the voltage is built and it is feeding the load, DSTATCOM starts its operation. It regulates the voltage by supplying the total reactive power required by the load and the extra reactive power required for maintaining the terminal voltage of an induction generator.

The control algorithm gives the reference currents and the current tracking is carried out by hysteresis controller which generates gate pulses for VSC of DSTATCOM. The DC-link voltage and its capacitor of DSTATCOM are selected depending on the PCC voltage and rating of the load which is to be compensated for improving the power quality.

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* Correspondence Author (s)
Mr. M. Venkata Ramana*, M.Tech, Department of Electrical and Electronics Engineering, Pragati Engineering College, Surampalem (Andhra Pradesh)-533437, India.
Mr. I. Sreenu, Assistant Professor, Department of Electrical and Electronics Engineering, Pragati Engineering College, Surampalem (Andhra Pradesh)-533437, India.
Mr. M. N. V. V. Brahmam, Assistant Professor, Department of Electrical and Electronics Engineering, Pragati Engineering College, Surampalem (Andhra Pradesh)-533437, India.

The DC-link voltage should sustain during the transient conditions and its value should be selected at least twice the peak value of the system phase voltage [9]. The DC-link voltage is estimated as

$$v_{dc} = \frac{2\sqrt{2}(V_L/\sqrt{3})}{m_a} = \frac{2\sqrt{2}(200/\sqrt{3})}{1} = 360v \quad (1)$$

where V_L is the line voltage at PCC, ma is the modulation index and its maximum value is 1.

The minimum value estimated as 360 V for 220 V AC system where as the reference DC-link voltage is selected as 400 V. The value of the capacitor should be selected in such a way that it should allow the energy exchange during transient conditions and computational delay of the control action.

From the name plate details of the induction generator, the value of full load reactive power required at the terminals can be computed as active component of current,

$$I_{active} = \frac{P_{gen}}{\sqrt{3}*V_L} = \frac{3700}{\sqrt{3}*230} = 9.28A \quad (2)$$

Reactive component of current,

$$I_{re} = \sqrt{I_{rated}^2 - I_{active}^2} = \sqrt{14.5^2 - 9.28^2} = 11.1A \quad (3)$$

The kilo volt ampere reactive (kVAR) required by an induction generator for maintaining terminal voltage at full load condition is computed as kVAR rating of induction generator

$$Q_{1G} = \sqrt{3} * V_L X_{re} = \sqrt{3} * 230 * 11.1 = 4.48kVAR \quad (4)$$

For having self-excitation, 1.7 kVAR (Q_{Cap}), 230 V, three-phase delta connected capacitor bank is connected across the terminals of the induction generator.

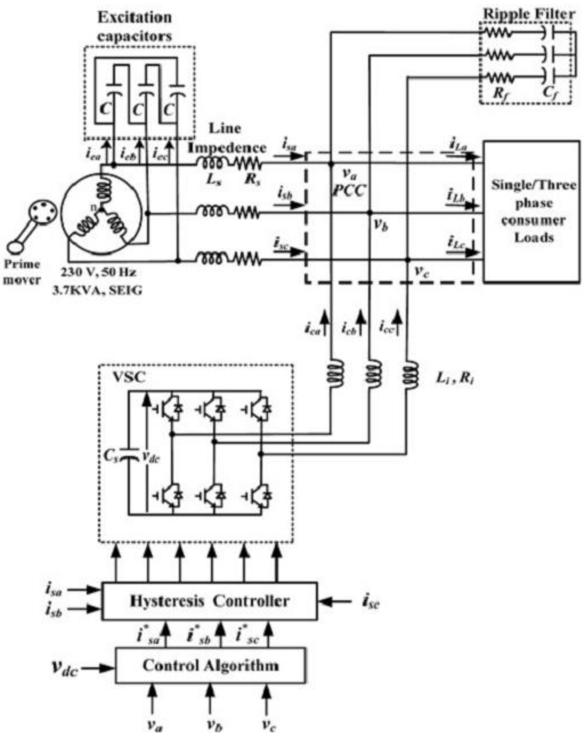

Fig. 1a. Configuration of DSTATCOM supported induction generator a Schematic diagram of induction generator supported by VSC-based DSTATCOM

The load reactive power is considered as 2 kVAR (Q_{load}) and the total reactive power supplied by the DSTATCOM is calculated as

$$Q_{DSTAT} = \{Q_{load} + (Q_{IG} - Q_{Cap})\} \quad (5)$$

$$KVAR = \{2 + (4.48 - 1.7)\} = 4.78kVAR \quad (6)$$

The reactive component of compensating current is calculated as

$$I_{com} = \frac{Q_{DSTAT}}{\sqrt{3}*V_L} = \frac{4780}{\sqrt{3*220}} = 12.54A \quad (7)$$

Generally, 10% of the total available energy is sufficient to make the energy exchange during transient conditions.

$$\Delta e_{dc} = 0.1 * 3 * v_{ph} * (a * I_{com}) * t = \frac{1}{2} C_{dc}\left(V_{dcsteady}^2 - v_{dc}^2\right) \quad (8)$$

where V_{ph} is the phase voltage of the system, a is the overloading factor, I is the phase current, t is the time allowed for DC-link voltage to recover during transient conditions, C_{dc} is the capacitance value of the capacitor in Farads, v_{dc} steady and v_{dc} are the steady-state voltages of DC-link and undershoot of DC voltage, respectively.

Substituting the system parameters in (7) gives

$$\Delta e_{dc} = 0.1 * 3 * \left(220/\sqrt{3}\right) * (1.2 * 12.5) * 30 * 10^{-3} = \frac{1}{2} C_{dc}(385^2 - 375^2) \quad (9)$$

The interfacing inductors help to mitigate the ripples in the compensating currents. The selection of interface inductor depends on the switching frequency of the pulse-width modulation and the allowable percentage ripple current through it.

A ripple filter is made with the resistors and capacitors for filtering the switching noise at PCC due to switching of insulated gate bipolar transistors (IGBTs) of VSC. A three-phase three-wire VSC consists of six IGBTs along with the anti-parallel diodes. In the proposed control algorithm, the dynamic operation of DSTATCOM depends on the small variation in DC-link voltage and terminal voltage under sudden change in load conditions.

III. CONTROL OF DSTATCOM

This SMC with fuzzy controller-based algorithm used for control of three-phase VSC-based DSTATCOM is explained in the following section. The advantages offered by the SMC with fuzzy controller are as follows:

1. The use of SMC in the control of DC-link voltage can eliminate the load current sensors which make the DSTATCOM cost effective.

2. SMC gives the robust control during transient conditions and the fast dynamic response in terms of overshoot and undershoot of DC-link voltage of VSC during load variation/transient condition.

3. The SMC offers a disadvantage also, which is the steady-state error. SMC tracks the reference very robustly but with a small steady-state error. This is not a problem in the present case as the DC link has to be maintained at a certain minimum level and remains within a specified range, not at a given level.

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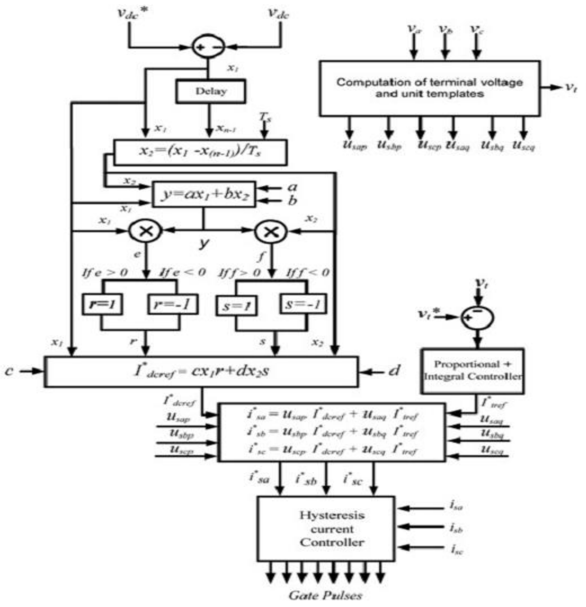

Fig. 1b. Configuration of DSTATCOM supported induction generator Control algorithm of DSTATCOM for estimation of reference currents using SMC with fuzzy controller

Fig. 1b shows the step-by-step procedure to estimate the reference supply currents using SMC and PI controller-based algorithm. The SMC gives in-phase component current for meeting the load active power, losses in the DSTATCOM, and fuzzy controller gives the quadrature component current for regulating the terminal voltage. In sliding mode control, the DSTATCOM compensating currents are controlled to track or slide along the reference or trajectory. The SMC control algorithm detects the deviation from the reference trajectory and promptly changes the switching control strategy to follow the reference trajectory. The SMC control gives the robust performance under parameter variations. The in-phase components of unit vectors are estimated from the PCC voltages (v_a, v_b, and v_c). The instantaneous amplitude of PCC is estimated as

$$V_t = \sqrt{2(v_a^2 + v_b^2 + v_c^2)/3} \qquad (10)$$

The in-phase components of unit templates are computed as

$$u_{sap} = v_a/V_t\,;\ \ u_{sbp} = {}^{v_b}/_{V_t}\,; u_{scp} = {}^{v_c}/_{V_t} \qquad (11)$$

The quadrature components of unit templates are computed as

$$u_{saq} = \left(-u_{sbp} + u_{scp}\right)/\sqrt{3}$$
$$u_{sbq} = \left(u_{sap}\sqrt{3} + u_{sbp} - u_{scp}\right)/2$$
$$u_{scq} = \left(-u_{sap}\sqrt{3} + u_{sbp} - u_{scp}\right)/2 \qquad (12)$$

In SMC algorithm, the amplitudes of in-phase reference currents are estimated from DC-link voltage. The sensed DC voltage (v_{dc}) is filtered using a low-pass filter and it is compared with the reference voltage (v∗ dc) to generate the error signal, x1 as

$$x_1 = v_{dc}^* - v_{dc} \qquad (13)$$

Moreover, the derivative of above equation gives

$$x_2 = \dot{x}_1 = \frac{1}{T}\{x_1 - x_{(n-1)}\} \qquad (14)$$

where x1, x2 are the state variables, x(n−1) is the previous sample value, and T is the sampling time. According to the slope of the DC-link voltage error, the switching parameters r and s are selected. The values of r and s are found from the logic decisions as follows

$$r = +1 \quad if\ yx_1 > 0 = -1 \quad if\ yx_1 < 0$$
$$s = +1 \quad if\ yx_2 > 0 = -1 \quad if\ yx_2 < 0 \qquad (15)$$

where ‘y’ is the switching hyper plane function,
y = ax1 + bx2. The amplitudes of reference active source currents are found as

$$I_{dcref}^* = cx_1r + dx_2S \qquad (16)$$

where a, b, c, and d are the constants of the SMC.

The sensed source currents (i_{sa}, i_{sb}, i_{sc}) are compared with these estimated reference source currents (i^*_{sa}, i^*_{sb}, i^*_{sc}) and the current error signals are given to the hysteresis current controller and the gating pulses are generated for the three legs of VSC used as DSTATCOM. 4

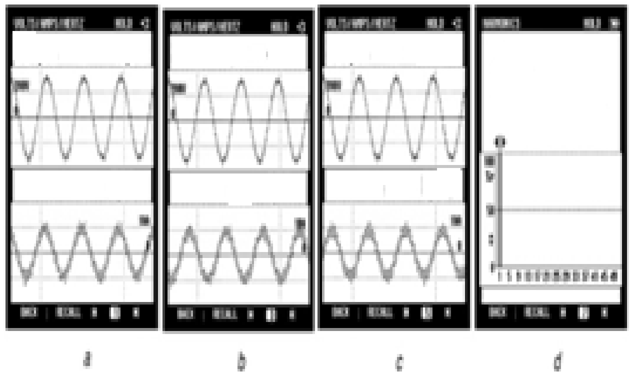

Fig. 2 Performance of DSTATCOM under single-phase non-linear load a–c vab with isa, isb, and isc d vsab harmonic spectra

IV. FUZZY LOGIC CONTROLLER

In FLC, basic control action is determined by a set of linguistic rules. These rules are determined by the system. Since the numerical variables are converted into linguistic variables, mathematical modeling of the system is not required in FC.

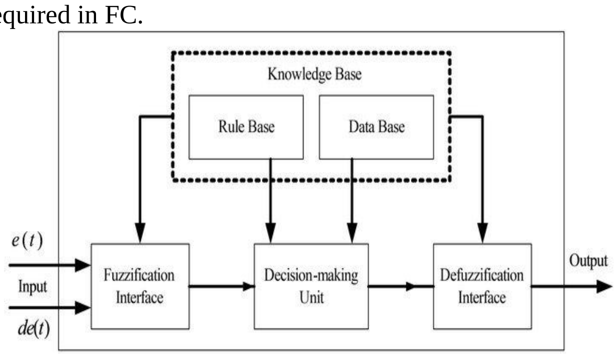

Fig.6. Fuzzy logic controller

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The FLC comprises of three parts: fuzzification, interference engine and defuzzification.

The FC is characterized as i. seven fuzzy sets for each input and output. ii. Triangular membership functions for simplicity. iii. Fuzzification using continuous universe of discourse. iv. Implication using Mamdani's, 'min' operator. v. Defuzzification using the height method.

TABLE I: Fuzzy Rules

Change in error	Error						
	NB	NM	NS	Z	PS	PM	PB
NB	PB	PB	PB	PM	PM	PS	Z
NM	PB	PB	PM	PM	PS	Z	Z
NS	PB	PM	PS	PS	Z	NM	NB
Z	PB	PM	PS	Z	NS	NM	NB
PS	PM	PS	Z	NS	NM	NB	NB
PM	PS	Z	NS	NM	NM	NB	NB
PB	Z	NS	NM	NM	NB	NB	NB

A. *Fuzzification:* Membership function values are assigned to the linguistic variables, using seven fuzzy subsets: NB (Negative Big), NM (Negative Medium), NS (Negative Small), ZE (Zero), PS (Positive Small), PM (Positive Medium), and PB (Positive Big). The Partition of fuzzy subsets and the shape of membership CE(k) E(k) function adapt the shape up to appropriate system. The value of input error and change in error are normalized by an input scaling factor.In this system the input scaling factor has been designed such that input values are between -1 and +1. The triangular shape of the membership function of this arrangement presumes that for any particular E(k) input there is only one dominant fuzzy subset. The input error for the FLC is given as

$$E(k) = \frac{P_{ph(k)} - P_{ph(k-1)}}{V_{ph(k)} - V_{ph(k-1)}} \quad (17)$$

$$CE(k) = E(k) - E(k\text{-}1) \quad (18)$$

Inference Method: Several composition methods such as Max–Min and Max-Dot have been proposed in the literature. In this paper Min method is used. The output membership function of each rule is given by the minimum operator and maximum operator. Table 1 shows rule base of the FLC.

B. *Defuzzification:* As a plant usually requires a non-fuzzy value of control, a defuzzification stage is needed. To compute the output of the FLC, „height" method is used and the FLC output modifies the control output. Further, the output of FLC controls the switch in the inverter. In UPQC, the active power, reactive power, terminal voltage of the line and capacitor voltage are required to be maintained. In order to control these parameters, they are sensed and compared with the reference values. To achieve this, the membership functions of FC are: error, change in error and output

The set of FC rules are derived from

$$u = -[\alpha E + (1-\alpha)^*C] \quad (19)$$

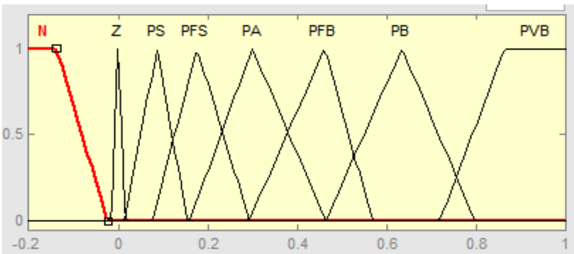

Fig 7 input error as membership functions

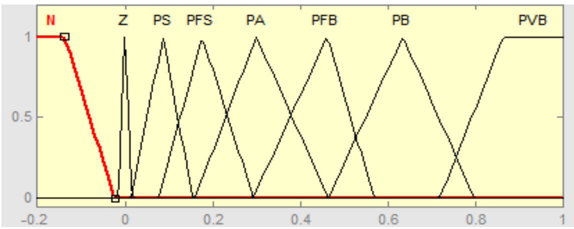

Fig 8 change as error membership functions

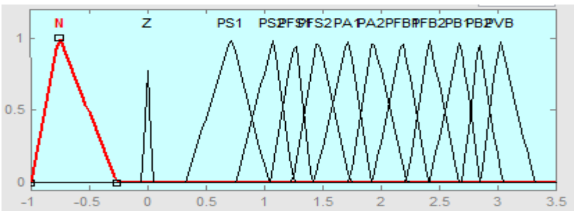

Fig.9 output variable Membership functions

Where α is self-adjustable factor which can regulate the whole operation. E is the error of the system, C is the change in error and u is the control variable

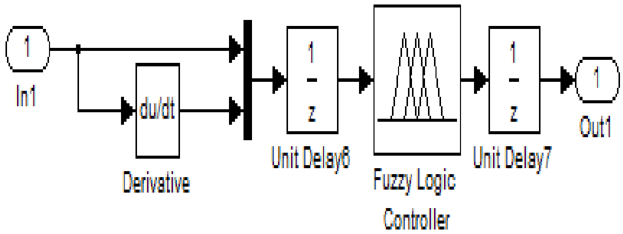

Fig 13.fuzzy logic controller in simulation

V. RESULTS AND DISCUSSION

The SMC with PI controller-based algorithm is validated experimentally and by simulation on a DSTATCOM supported induction generator.

A. Steady-state performance of DSTATCOM:

under single-phase non-linear load: A single-phase non-linear load is connected in between two terminals of the induction generator which causes unbalanced currents in the winding of the induction generator as the third phase is not loaded. An R–L load with a diode rectifier serves as a non-linear load which causes power quality problems such as injection of harmonics into the system. However, with the support of the DSTATCOM, these power quality problems such as unbalanced load, harmonics, and reactive power requirement are mitigated. Figs. 2a–c show the waveforms of PCC voltages (vab, vbc, and vca) with three-phase source currents (isa, isb, and isc) which are balanced irrespective of the type of the load connected.

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The operation of DSTATCOM helps in harmonics mitigation and source currents are relieved from harmonics content.

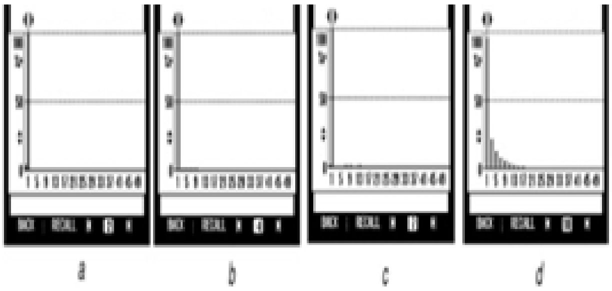

Fig. 3 Performance of DSTATCOM under single-phase non-linear load a–d i_{sa}, i_{sb}, i_{sc}, and i_{Lab} harmonic spectra.

In Figs. 3a and d, the THD of ‘a’ phase source current and load current are observed as 3.6 and 3.48%, respectively.

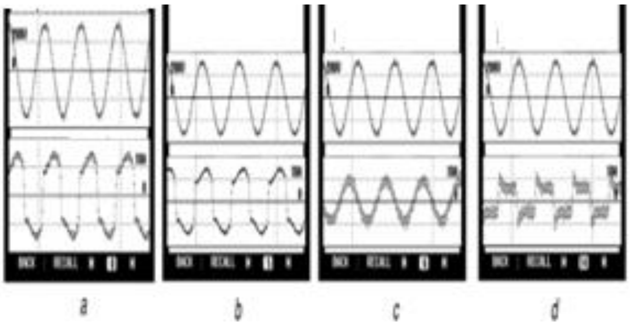

Fig. 4 Performance of DSTATCOM under single-phase non-linear load a. v_{ab} with i_{Lab} b. P_L and Q_L c.PS and QS d. PC and QC

Fig. 4a shows vab with non-linear load current (iLab). Figs. 4b and c show load power (PL and QL) and source power (PS and QS). The load reactive power 1.03 kVAR as shown in Fig. 4b is compensated by the DSTATCOM and the source currents in Fig. 4c are relieved from the reactive power burden with an improved power factor. Fig. 4d gives information about the nature of the reactive power that is injected at the PCC through compensating currents. Figs. 5a–d show DSTATCOM compensating currents (ica, icb, and icc) and DC-link voltage vdc with isab. Figs. 5a–c demonstrate the shapes of the compensator currents to make the source currents balanced and sinusoidal.

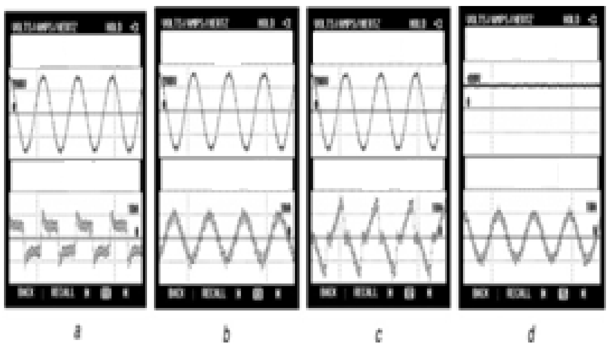

Fig. 5 Performance of DSTATCOM under single-phase non-linear load a–c v_{sabc} with i_{ca}, i_{cb}, and i_{ca} d. v_{dc}

B. Dynamic performance of DSTATCOM:

Under induction motor starting and non-linear load: The dynamic response of the DSTATCOM is recorded during the starting of a three-phase induction motor along with the pre-existing non-linear load.

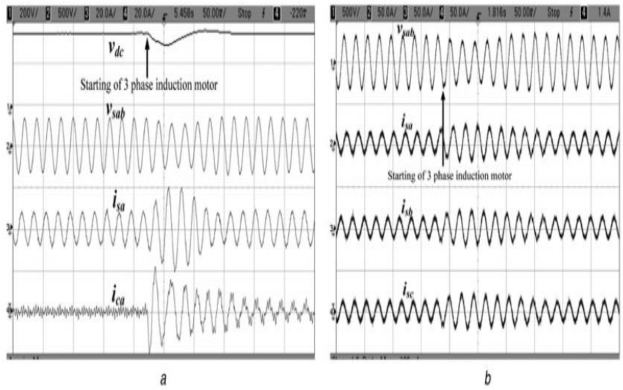

Fig. 6 Dynamic response of DSTATCOM under induction motor starting along with non-linear loads a, b Variation of parameters such as vdc, vsab, isa, isb, isc, and ica during starting of one horse power three-phase induction motor

Figs. 6a and b show variation of various indices of DSTATCOM such as PCC voltage (vsab), source currents (isa, isb, and isc), compensating current (ica), and DC-link voltage (vdc) during the starting of the induction motor. Since of the dynamic operation of the DSTATCOM, the terminal voltage of the induction generator is not collapsed and the DC-link voltage and terminal voltage are quickly recovered from the dips. Fig. 6b shows the variation of source currents (isa, isb, and isc) and PCC voltage (vsab) at the time of starting of the induction motor. From Fig. 6, it can be inferred that DSTATCOM-based induction generator is able to feed an induction motor load without collapsing the voltage of an induction generator during starting of the motor.

C. Steady-state and dynamic performances of DSTATCOM:

Under three-phase non-linear load: The dynamic performance is evaluated under three-phase non-linear load condition. A three diode rectifier with R–L load is used as the non-linear load.

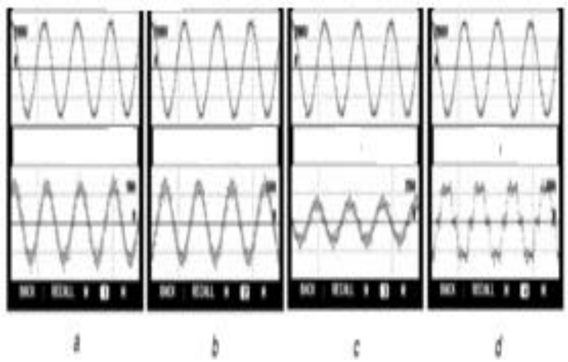

Fig. 7 Performance of DSTATCOM under three-phase non-linear load a–d vsab with isa, isb, isc, and iLa

Figs. 7a–c show the waveforms of PCC voltage (vab) with three balanced phase source currents (isa, isb, and isc). Fig. 7d shows the PCC voltage (vab) and non-linear natured load current (iLa).

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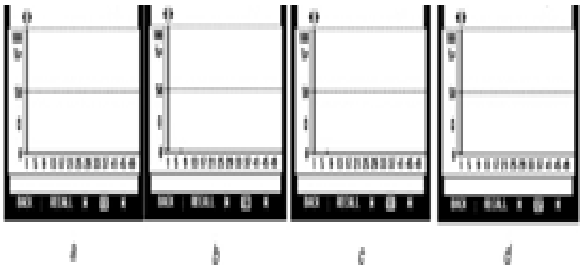

Fig. 8 Performance of DSTATCOM under three-phase non-linear load a–d vsa, isa, isb, and isc harmonic spectra

Figs. 8a–d show harmonic spectra of PCC voltage (vab) and source currents (isa, isb, and isc). Figs. 9b and c show load power (PL and QL) and source power (PS and QS). The load reactive power 0.79 kVAR as shown in Fig. 9b is compensated by the DSTATCOM and the source in Fig. 9c are relieved from the reactive power burden.

Fig. 9d shows the DSTATCOM compensating current (iCa). The phase 'a' compensating current is turned from sinusoidal to non-sinusoidal with the reinsertion of the load on phase 'a'. Figs. 10c shows the dynamic response of DSTATCOM during phase 'a' load removal. Fig. 10d shows the variation of various indices vdc, isa, ica, and ila with respect to change in the load.

It shows that with sudden change in load magnitude and shape, the compensator current is responding immediately to keep the source current sinusoidal. Moreover, during all this dynamics, there is a little dip in DC-link voltage and it is regulated back. From Figs. 7–10, it can be inferred that DSTATCOM-based induction generator is able to feed the three-phase unbalanced/balanced non-linear loads without affecting the power quality standards.

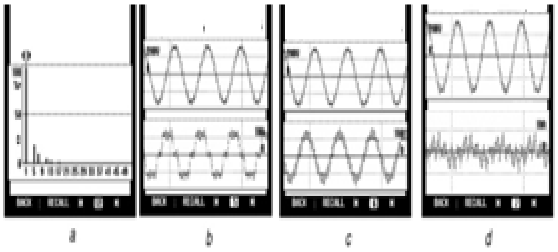

Fig. 9 Performance of DSTATCOM under non-linear load a iLa harmonic spectra b PL and QL c PS and QS d vsab and ica

Steady-state performance of DSTATCOM under linear load: The dynamic response of DSTATCOM is validated by connecting three-phase unbalanced linear load (R–L load) at the PCC. The power factor at the source side is improved and maintained at unity power factor using DSTATCOM.

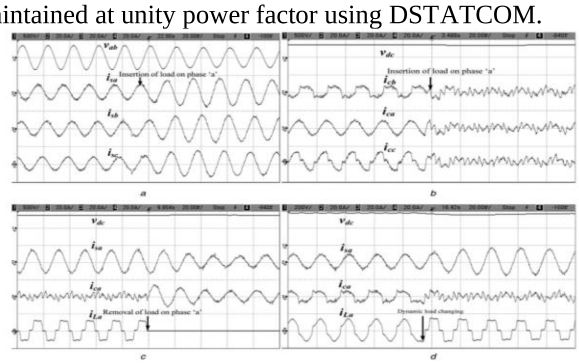

Fig. 10 Dynamic response of DSTATCOM a Removal of load on phase 'a' b, c Insertion of load on phase 'a' d Sudden load change

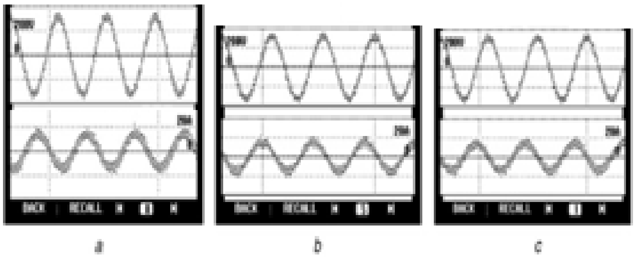

Fig. 11 Performance of DSTATCOM under linear load a Waveforms of vsa and isa b PL and QL c PS and QS

Fig. 12a shows the performance of DSTATCOM under three-phase and single-phase loading conditions, also the dynamic performance during load switching. It can be seen that the overshoot is of order of 1% with the SMC. Moreover, the terminal voltage is also regulated and maintained at the reference value.

Figs. 12b and c show the harmonic spectra and THDs of load current and generator current. It shows that the harmonic content of the generator current is within acceptable range. This has reduced the unwanted heating, noise, and derating of the generator.

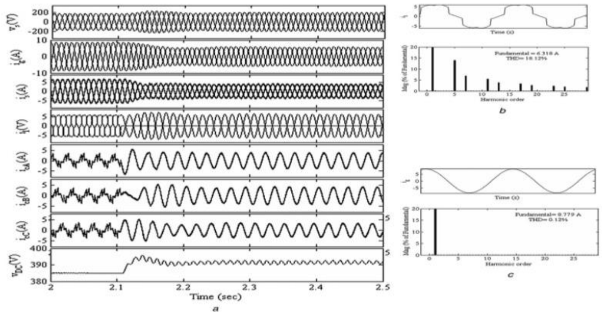

Fig. 12 Simulation results of DSTATCOM a Performance of DSTATCOM under three-phase and single-phase non-linear load b, c Harmonic content of load current ila and generator current

VI. CONCLUSION

Distribution STATCOM (DSTATCOM) exhibits high speed control of reactive power to provide voltage stabilization, flicker suppression, and other types of system control. The DSTATCOM utilizes a design consisting of a GTO- or IGBT-based voltage sourced converter connected to the power system via a multi-stage converter transformer. A DSTATCOM supported induction generator has been implemented with the SMC with fuzzy control algorithm for mitigating the power quality problems and it has enhanced the active power capability of the generator. In FLC, basic control action is determined by a set of linguistic rules. These rules are determined by the system. The SMC has been verified for the dynamics in the DC-link voltage and found robust and acceptably fast to avoid large variations in DC-link voltage.

REFERENCES

1. Bansal, R.C.: 'Three phase self-excited induction generators: an overview', IEEE Trans. Energy Convers., 2005, 20, (2), pp. 292–299

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2. Murthy, S.S., Singh, B., Gupta, S., et al.: 'General steady-state analysis of three-phase self-excited induction generator feeding three-phase unbalanced load/ single-phase load for stand-alone applications', IEE Proc. Gener. Transm. Distrib., 2003, 150, (1), pp. 49–55
3. Rai, H., Tandan, A., Murthy, S.S., et al.: 'Voltage regulation of self-excited induction generator using passive elements'. Proc. IEEE Int. Conf. Electric Machines and Drives, September 1993, pp. 240–245
4. Singh, B., Shilpakar, L.: 'Analysis of a novel solid state voltage regulator for a self-excited induction generator', IEE Proc. Gener. Transm. Distrib., 1998, 145, (6), pp. 647–655
5. Singh, B., Murthy, S.S., Gupta, S.: 'A solid state controller for self-excited induction generator for voltage regulation, harmonic compensation and load balancing', J. Power Electron., 2005, 5, (2), pp. 109–119
6. Rao, S., Murthy, S.S., Bhuvaneswari, G., et al.: 'Design of a microcontroller based electronic load controller for self-excited induction generator supplying single phase loads', J. Power Electron., 2010, 10, (4), pp. 444–449
7. Singh, B., Murthy, S.S., Gupta, S.: 'An improved electronic load controller for self-excited induction generator in micro-hydel applications'. Proc. IEEE Annual Conf., November 2003, vol. 3, pp. 2741–2746
8. Rao, S., Abhishek, K.: 'Mitigation of unbalanced currents in three-phase asynchronous generator supplying single-phase nonlinear load'. Proc. IEEE ICSET, 2012, pp. 246–251
9. Singh, B., Murthy, S.S., Chilipi, R.S.R.: 'STATCOM-based controller for a three phase SEIG feeding single phase loads', IEEE Trans. Energy Convers., 2014, 29, (2), pp. 320–331
10. Ghosh, A., Ledwich, G.: 'Power quality enhancement using custom power devices' (Springer International Edition, Delhi, 2009)
11. Singh, B., Solanki, J.: 'A comparison of control algorithms for DSTATCOM', IEEE Trans. Ind. Electron., 2009, 56, (7), pp. 2738–2745
12. Singh, B., Kant, K., Arya, S.: 'Notch filter based fundamental frequency component extraction to control DSTATCOM for mitigating current related power quality problems', IET Power Electron. 2015, Early Access.

AUTHOR PROFILE

Mr. M.Venkata Ramana, graduatedfrom JNTUK affiliated college, He is presently pursuing M.Tech in Department of Electrical and Electronics Engineering, Pragati Engineering College,surampalem, Peddapuram. His research areas include Power Electronic Drives, FACTS , and FOC techniques.

Mr. I. Sreenu, Obtained M.Tech degree in Power Electronics from JNTUK. He is presently working as Assistant Professor at the Department of Electrical and Electronics Engineering, Pragati Engineering College,surampalem, Peddapuram. His research areas include Power Electronic Drives, FACTS, and FOC techniques.

Mr. M.N.V.V.Brahmam, Obtained M.Tech degree in Power Electronics from JNTUK. He is presently working as Assistant Professor at the Department of Electrical and Electronics Engineering, Pragati Engineering College,surampalem, Peddapuram. His research areas include Power Electronic Drives, FACTS, and FOC techniques.

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