A STATCOM-Control Scheme used for Power Factor Improvement of Grid connected weak bus System

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Abstract-- **Improvement of power factor of long weak distribution lines connected to grid is a challenging problem, particularly when it may not be economic to simply upgrade the network. The STATCOM (STATics synchronous COMpensator) offers an attractive alternative, with their potential to provide both steady state and transient voltage compensation for a limited capital investment. However, operation of these systems with weak networks needs careful attention to achieve a stable and fast response under all supply conditions. This paper proposes a new control strategy in the STATCOM to improve power factor at a distribution weak bus which is more robust and works well under all system conditions. Simulation results are presented to verify the stability of this control strategy across a range of operating conditions. The operation of the STATCOM with supply system makes the rural consumers healthy and wealthy.**

Index Terms-: **Controller design, PI Controller, STATCOM**

1. INTRODUCTION

Inductive loads and diode rectifiers are widely employed in industrial fields and consumer products thanks to advantages of low cost, simple structure, robustness and absence of control. However, this type of converters results in only unidirectional power flow, low input power factor, high level of harmonic input currents, malfunction of sensitive electronic equipment, increased losses and also contributing to inefficient use of electric energy. And also the inductive loads especially inductive motors create low power factor at the electric supply system. Recently, many promising power factor correction (PFC) techniques have been proposed for rectifiers and inductive loads. Apart from application of active and passive filters, the best solution is in using pulse width modulated (PWM) rectifiers. Research interest in three-phase PWM rectifiers has grown rapidly over the last few years due to some of their important advantages, such as power regeneration capabilities, control of dc-bus voltage over a wide range, and low harmonic distortion of input currents. In recent years power systems have become very complex with interconnected long distance transmission lines. The interconnected grids tend to become unstable as the heavy loads vary dynamically in their magnitude and phase angle and hence power factor. Commissioning new transmission systems are extremely expensive and take considerable amount of time to build up. Therefore, in order to meet increasing power demands, utilities must rely on power export/import arrangements through the existing transmission systems. In specially, the distribution networks supplying rural consumers are often quite weak because of the long distances involved and the relatively high R/X ratio of the cables that are used. Hence, as demand increases on these networks, power quality issues such as poor voltage regulation, voltage unbalance, low power factor and harmonics often become a significant problem. As is well known, the current is proportional to the voltage in case of a linear load as shown in Fig.1(a) where as the current is not proportional to the voltage in case of non-linear load (as shown in Fig.1(b)). A linear load draws active power from the grid with only fundamental component being present in the current and absorbs/injects reactive power from/to the grid. However, a non-linear load draws active power from the grid, where the current has fundamental and harmonics. These harmonics do not provide extra power but unnecessarily, yet unavoidably, increase the system volt-ampere (VA). This shows up as an increase in the rms current in the lines and leads to an extra heating of the transmission conductors and system elements. Hence, the compensation of reactive power is necessary for both linear and non-linear loads. Harmonic compensation upto standard values and power factor improvement are the main issues for such loads. The power factor PF is defined as the ratio of the active power P to the apparent power S. Thus

$$PF = \frac{P}{S} \qquad (1)$$

For purely sinusoidal voltage and current, the standard expression is obtained as

$$PF = \cos\phi \qquad (2)$$

where $\cos\phi$ is popularly known as the displacement factor. The survey of the power factor for a year of the rural consumers is given in Table.I

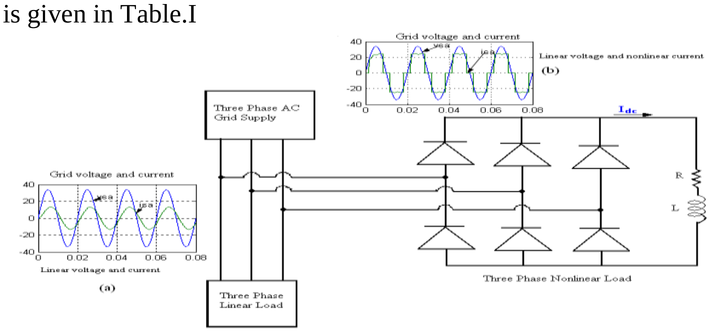

Fig.1: Linear and non-linear loads of consumers connected to supply system

Month of the Year	Demand (KW)	Demand (KVA)	Actual Power Factor (%)
January February	200 150	245 224	**81.63%** **66.69%**

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March	125	175	**71.43%**
April	224	256	**87.50%**
May	208	289	**71.97%**
June	210	299	**70.23%**
July	223	289	**77.16%**
August	211	278	**75.90%**
September	204	265	**76.98%**
October	198	245	**80.82%**
November	156	198	**78.79%**
December	201	265	**75.85%**

Table.I: It shows the power factor of the rural consumers

Power electronic devices are gaining popularity for applications in the field of power transmission and distribution systems. The reactive power (VAR) compensation and control have been recognized [1] as an efficient & economic means of increasing power system transmission capability and stability.

The use FACTS (Flexible AC Transmission System) devices in a power system can potentially overcome limitations of the present mechanically controlled transmission systems. By facilitating bulk power transfers, these interconnected networks help minimize the need to enlarge power plants and enable neighboring utilities and regions to exchange power. The stature of FACTS devices within the bulk power system will continually increase as the industry moves toward a more competitive posture in which power is bought and sold as a commodity. As power wheeling becomes increasingly prevalent, power electronic devices will be utilized more frequently to insure system reliability and stability and to increase maximum power transmission along various transmission corridors. The FACTS device, such as STATCOM has been introduced more recently which employs a VSI with a fixed DC link capacitor as a static replacement of the synchronous condenser. In a traditional synchronous condenser, the field current of the synchronous motor controls the amount of VAR absorbed/injected and hence in a similar way, the firing instant of the 3-phase inverter controls the VAR flow into or out of the STATCOM. Large numbers of capacitor banks or inductor banks are no more required. Only a fixed set of capacitor provides the required VAR control, with a rapid control of bus voltage and improvement of utility power factor. It offers several advantages over conventional thyristorised converters [2] in terms of speed of response. The STATCOM is a voltage source inverter (VSI) based device, which regulates distribution bus voltage using reactive power compensation. The potential of STATCOM to improve supply quality and increase line utilization in weak distribution networks is well documented [3, 4]. However, many of the proposed control strategies assume a stiff, balanced grid source, and this is often not the case in practice. Recently, there has been some research focus on the performance of STATCOM devices operating under unbalanced supply conditions. Direct voltage control algorithms used to compensate for supply unbalance in distribution networks were proposed in [5] and [6]. However, the results in [6] show a relatively slow dynamic response because of the filters employed. Also, both algorithms have been developed for a VSI device interfaced to the distribution network through a simple inductive filter, and have not been tested for the more complex LCL filter considered in this work. A multi-variable control strategy was proposed in [7] for a STATCOM with a LCL filter interface. Although this strategy is shown to achieve good steady state and dynamic responses under balanced and unbalanced supply conditions, it is complex and sensitive to variations in system parameters. The penalty paid for this improvement is in terms of introduction of some harmonics, which requires separate handling using active filtration techniques. Moran et al [8] have shown in details how the utilization of Sinusoidal Pulse Width Modulation (SPWM) techniques reduces harmonic distortion. It has also been shown that an increase of modulation index reduces the size of the link reactor and stress on switches which are significant issues in practical implementation. The modeling and analysis of STATCOM steady state and dynamic performance with conventional control method have been studied by Schauder and Mehta [9] using non-linear controller. In [10, 11] the dynamic responses and steady state behavior of STATCOM with Space Vector Pulse Width Modulation (SVPWM) has been studied and the advantages of introducing SVPWM inverter with higher values of modulation index are highlighted.

The controllable reactive power allows for a rapid control of bus voltage and power factor at the system or at the load end. To compensate for the distorted current drawn by the rectifiers from the utility grid, the STATCOM and its current controller must have the capability to track source PWM (Pulse Width Modulation) converters. The linear control is more suitable for STATCOM application reported in [13, 14]. The present paper suggests the design of a linear current controller and voltage controller on the basis of gain and time constant adjustment along with the parameter of the coupling inductor and storage capacitor.

The present paper goes on to develop closed loop model for investigating transient performance of the STATCOM by using controller parameter. First, in Section 2 focuses on modeling of the power system and Section 3 gives state space model of the STATCOM with the system. Secondly, in Section 4, a current and voltage controllers are designed. The simulated responses with the designed controller parameters are presented in Section 5. This scheme is both an extension and a significant improvement of the scheme suggested by Shauder et al [9] and Sensarma et al [4].The results obtained have been compared and appropriate conclusions have been drawn.

2. MODELING OF THE POWER SYSTEM

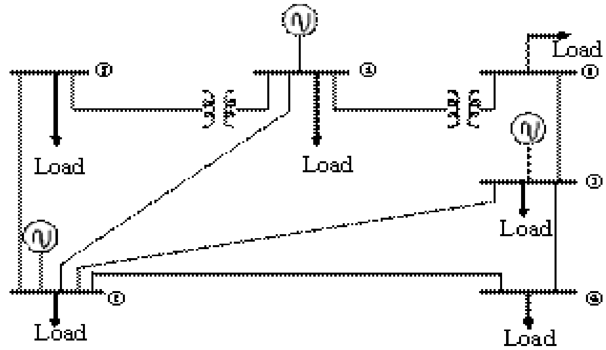

Fig.2: Interconnected Six Bus system

The 6-bus system is a simple power system network given in Fig.2 and scaled model of a bus is shown in Fig.3.The 6-bus system is intended to illustrate in a simple context notions of transfer capability and the impact that various actions have on the given transfer capability. Buses 1, 2, 3 of the system diagram are generators and buses 4, 5, 6 of the diagram are loads. The primary flow of power is from the top of the diagram to the bottom of the diagram and also from left to right. Reactive demand by the loads (signified by the empty portion of the load arrows) is large. The network has 10 branches and each branch represents a transmission line. The model is an AC power flow model; it represents real and reactive power flows and power system nonlinearity. Operational limits relating to transmission line flow, voltage magnitude, and voltage collapse are represented. The weak bus no 5 is connected to industrial area and also local consumers. The power factor of this grid (Bus no.5) is poor and hence its power factor can be improved as the model given in Fig.4.

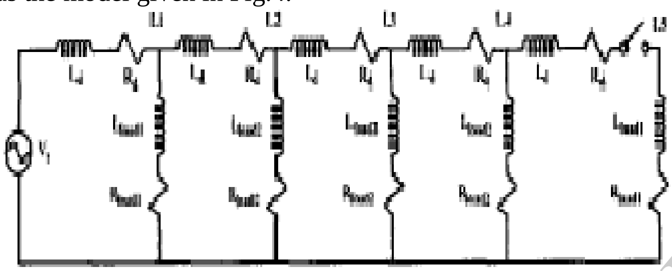

Fig.3: Scaled distribution network model

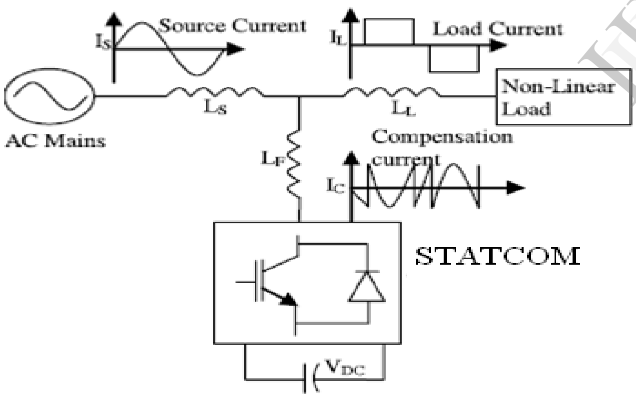

Fig.4: A single Bus connected with STATCOM

3. MODELING OF THE STATCOM AND ANALYSIS

3.1. Operating principle

As is well known, the STATCOM is, in principle, a static (power electronic) replacement of the age-old synchronous condenser. Fig.5 shows the schematic diagram of the STATCOM at PCC through coupling inductors. The fundamental phasor diagram of the STATCOM terminal voltage with the voltage at PCC for an inductive load in operation, neglecting the harmonic content in the STATCOM terminal voltage, is shown in Fig.6. Ideally, increasing the amplitude of the STATCOM terminal voltage $\vec{V}_{oa}$ above the amplitude of the utility voltage $\vec{V}_{sa}$ causes leading (capacitive) current $\vec{I}_{ca}$ to be injected into the system at PCC as shown in Fig.5.

3.2. Modeling

The modeling of the STATCOM, though well known, is reviewed in the lines below, for the sake of convenience. The modeling is carried out with the following assumptions:

1) All switches are ideal
2) The source voltages are balanced
3) R_s represents the converter losses and the losses of the coupling inductor
4) The harmonic contents caused by switching action are negligible

The 3-phase stationary abc coordinate vectors with 120^0 apart from each other are converted into $\alpha\beta$ 2-phase stationary coordinates (which are in quadrature). The α axis is aligned with a axis and leading β axis and both converted into dq two-phase rotating coordinates. The Park's abc to dq transformation matrix is

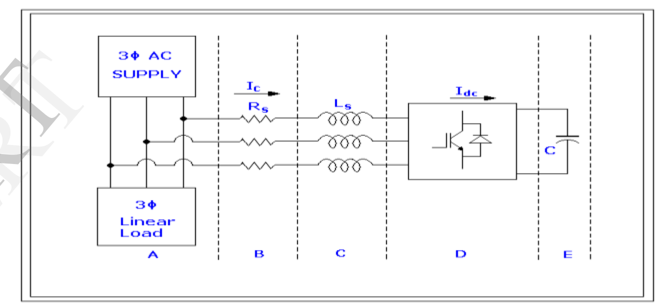

Fig.5: Schematic diagram of STATCOM

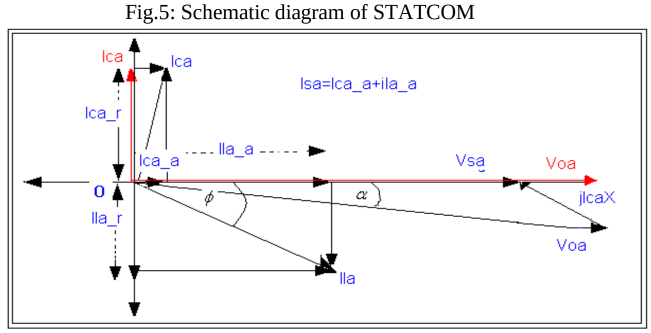

Fig.6: Phasor diagram for inductive load operation

$$K = \sqrt{\frac{2}{3}}\begin{bmatrix} Cos(\varpi t) & Cos(\varpi t - 2\pi/3) & Cos(\varpi t + 2\pi/3) \\ Sin(\varpi t) & Sin(\varpi t - 2\pi/3) & Sin(\varpi t + 2\pi/3) \\ 1/\sqrt{2} & 1/\sqrt{2} & 1/\sqrt{2} \end{bmatrix} \quad (3)$$

The actual proposed circuit is too complex to analyze as a whole, so that it is partitioned into several basic sub-circuits, as shown in Fig.5. The 3-phase system voltage $v_{s,abc}$ lagging with the phase angle α to the STATCOM output voltage $v_{o,abc}$ and differential form of the STATCOM currents are defined in (4) and (5).

$$v_{s,abc} = \begin{bmatrix} v_{sa} \\ v_{sb} \\ v_{sc} \end{bmatrix} = \sqrt{\frac{2}{3}} V_s \begin{bmatrix} Sin(\omega t - \alpha) \\ Sin(\omega t - \alpha - \frac{2\pi}{3}) \\ Sin(\omega t - \alpha + \frac{2\pi}{3} \end{bmatrix} \quad (4)$$

$$L_s \frac{d}{dt}\left(i_{c,abc}\right) = -R_s i_{c,abc} + v_{s,abc} - v_{o,.abc} \quad (5)$$

where , V_s, ϖ, R_s and L_s have their usual connotations. The above voltages and currents are transformed into dq frame

$$L_s \frac{d}{dt}\left(i_{cq}\right) = -R_s i_{cq} - wL_s i_{cd} + v_{sq} - v_{oq} \quad (6a)$$

$$L_s \frac{d}{dt}\left(i_{cd}\right) = wL_s i_{cq} - R_s i_{cd} + v_{sd} - v_{od} \quad (6b)$$

The switching function *S* of the STATCOM can be defined as follows

$$S = \begin{bmatrix} S_a \\ S_b \\ S_c \end{bmatrix} = \sqrt{\frac{2}{3}} m \begin{bmatrix} Sin(wt) \\ Sin(wt - \frac{2\pi}{3}) \\ Sin(wt + \frac{2\pi}{3}) \end{bmatrix} \quad (7)$$

The modulation index, being constant for a programmed PWM, is given by,

$$MI = \frac{v_{o,peak}}{V_{dc}} = \sqrt{\frac{2}{3}} m \quad (8)$$

The STATCOM output voltages in dq transformation are

$$v_{o,qdo} = m\begin{bmatrix} 0 & 1 & 0 \end{bmatrix}^T v_{dc} \quad (9)$$

The dc side current in the capacitor in dq transformation

$$i_{dc} = m\begin{bmatrix} 0 & 1 & 0 \end{bmatrix}\begin{bmatrix} i_{cq} & i_{cd} & i_{co} \end{bmatrix}^T \quad (10)$$

The voltage and current related in the dc side is given by

$$\frac{dv_{dc}}{dt} = \frac{m}{C} i_{cd} \quad (11)$$

The complete mathematical model of the STATCOM in dq frame is obtained as given in (12)

$$\frac{d}{dt}\begin{bmatrix} i_{cq} \\ i_{cd} \\ v_{dc} \end{bmatrix} = \begin{bmatrix} -\frac{R_s}{L_s} & -w & 0 \\ w & -\frac{R_s}{L_s} & -\frac{m}{L_s} \\ 0 & \frac{m}{C} & 0 \end{bmatrix} \begin{bmatrix} i_{cq} \\ i_{cd} \\ v_{dc} \end{bmatrix} + \frac{V_s}{L_s}\begin{bmatrix} -Sin\alpha \\ Cos\alpha \\ 0 \end{bmatrix} \quad (12)$$

3.3. *Steady State and transient Analysis*

The detailed steady state and transient responses with the Table.II are given in Fig.7-10 and responses suggest the static and dynamic conditions of the STATCOM. It can be seen that the transient responses take about one and half power cycle to reach at their steady state values.

Sl	Parameters	Symbol	Values
1	Frequency	f	50 Hz
2	Angular Frequency	w	314 rad/sec
3	RMS line-to-line Voltage	V_s	230V
4	Coupling Resistance	R_s	1.0 Ω
5	Coupling Inductance	L_s	5.0mH
6	DC-link capacitor	C	500 μF
7	Modulation Index	M	0.979
8	Phase angle	α	$\mp 5^0$
9	Load Resistance	R_L	52Ω
10	Load Inductance	L_L	126mH
11	Load Power factor	ϕ	0.79

Table.II: It shows the system parameters

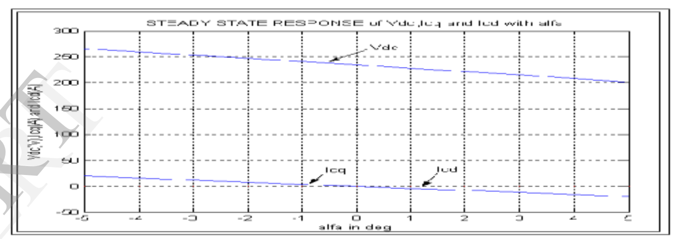

Fig.7: Steady state responses of I_{cq} , I_{cd} and V_{dc}

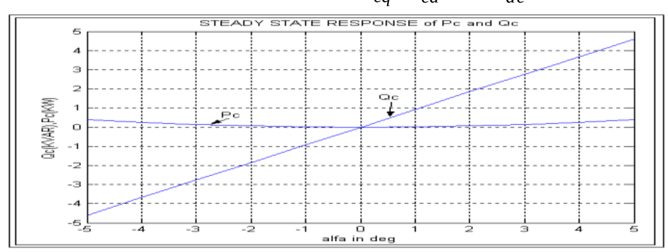

Fig.8: Steady state responses of P_c and Q_c

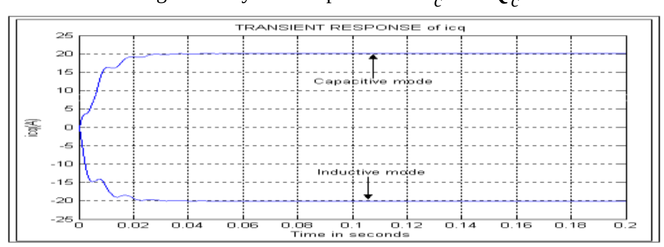

Fig.9: Transient responses of i_{cq} in capacitive and inductive

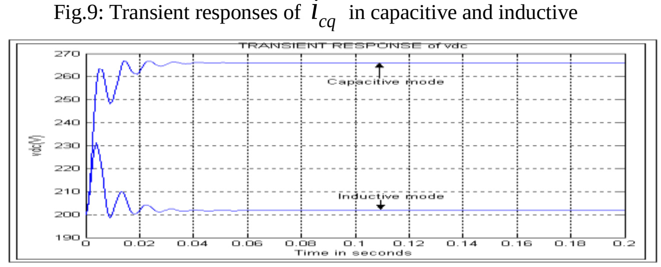

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Fig.10: Transient responses of V_{dc} in capacitive and inductive

4. DESIGN OF CONTROLLERS:

With the assumption of the system voltage and STATCOM output voltage are in phase and hence the equation (12) can be modified as given in equation (13)

$$\frac{d}{dt}\begin{bmatrix} i_{cq} \\ i_{cd} \end{bmatrix} = \begin{bmatrix} -\frac{R_S}{L_S} & -\omega \\ \omega & -\frac{R_S}{L_S} \end{bmatrix}\begin{bmatrix} i_{cq} \\ i_{cd} \end{bmatrix} + \frac{1}{L_S}\left[\begin{bmatrix} v_{sq} \\ v_{sd} \end{bmatrix} - \begin{bmatrix} v_{oq} \\ v_{od} \end{bmatrix}\right] \quad (13)$$

So the equation (13) is a Multiple Input and Multiple Output (MIMO) system and its input and output are given as

$$[u] = \begin{bmatrix} v_{oq} \\ v_{od} \end{bmatrix}, [y] = \begin{bmatrix} i_{cq} \\ i_{cd} \end{bmatrix} \quad (14)$$

The block diagram of the STATCOM in d-q transformation as per (13) is shown in Fig.11.The instantaneous voltage of the system and the STATCOM are independent, but the active and the reactive currents are coupled with each other through the reactance of the coupled inductor. So it is very essential to decouple the active and reactive current from each other and design the controller for tracking the required value.

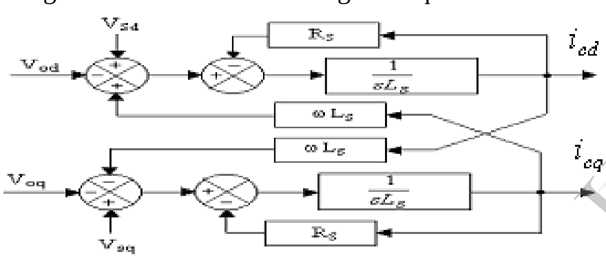

Fig.11: Equivalent Diagram on a.c.side of STATCOM

4.1 Design of current controller:

The current controller design for the above system can be done using the strategy [8-9] attempts to decouple the d and q axes equations, so that the MIMO system reduces to two independent Single Input Single Output (SISO) system. Hence, the control inputs v_{od} and v_{oq} are configured as

$$\begin{aligned} v_{oq} &= -v_{oq}^{*} - wL_S i_{cq} + v_{sq} \\ v_{od} &= -v_{od}^{*} + wL_S i_{cd} + v_{sd} \end{aligned} \quad (15)$$

The equation (16) can be obtained by replacing (13) by (15). Hence each row of (16) is independent of each other and thus defines an independent SISO system. Conventional frequency-domain design methods can now be directly applied for current controller. Taking the Laplace transformation of both sides of (17) and rearranging terms are given by (18) and their decoupled SISO system is shown in Fig.12.

$$\begin{bmatrix} i_{cq} \\ i_{cd} \end{bmatrix} = \begin{bmatrix} -\frac{R_S}{L_S} & 0 \\ 0 & -\frac{R_S}{L_S} \end{bmatrix}\begin{bmatrix} i_{cq} \\ i_{cd} \end{bmatrix} + \frac{1}{L_S}\begin{bmatrix} v_{oq}^{*} \\ v_{od}^{*} \end{bmatrix} \quad (16)$$

$$G_q(s) = \frac{I_q(s)}{V_{oq}^{*}(s)} = \frac{1}{R_S + sL_S}, G_d(s) = \frac{I_d(s)}{V_{od}^{*}(s)} = \frac{1}{R_S + sL_S} \quad (17)$$

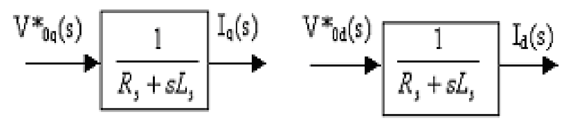

Fig.12: Current control of inverter of equivalent decoupled SISO systems

For similar dynamic behaviour of the d and q - axis currents, both the d and q - axis controllers are identical and its transfer function is given in (21)

$$G_i(s) = \frac{I_{cq}(s)}{V_{oq}^{*}(s)} = \frac{I_{cd}(s)}{V_{od}^{*}(s)} = \frac{1}{R_S + sL_S} \quad (18)$$

The transfer function of a PI controller is

$$G_{pi}(s) = K\left(1 + \frac{1}{s\tau_i}\right) = K_p + \frac{K_i}{s} \quad (19)$$

With $K_p = K, K_i = \frac{K}{\tau_i}$. The transfer function in open loop of PI controller associated with the transfer function on the a.c. system is

$$\left[G_{pi}(s).G_i(s)\right] = K\left[1 + \frac{1}{s\tau_i}\right]\left[\frac{1/R_S}{1 + s\,{L_S}/{R_S}}\right] \quad (20)$$

While taking $\tau_i = \frac{L_S}{R_S}$ and on simplification reduces to

$$\left[G_{pi}(s).G_i(s)\right] = \frac{K}{sL_S} \quad (21)$$

The closed loop transfer function is

$$T = \frac{1}{1 + s\frac{L_S}{K}} \quad (22)$$

Thus the system behaves like a first order with an apparent time constant as

$$\tau_i = \frac{L_s}{K} \quad (23)$$

The gain of K can be adjusted such a way that if it is increased too high then the system behaves as second order, otherwise responses very slow. Hence the numerical values for K_p and K_i are decided from the circuit parameters L_S and R_S from the required value of K. So the parameters of PI controller are defined as

$$K_p = K, K_i = \frac{KR_S}{L_S} \qquad (24)$$

where, $\tau_i = \frac{L_s}{K_p}$ which is taken as 0.3mseconds and with the parameters given in Table-II, value of $K_{pi} = 16.9$ and $K_{ii} = 3.3\times10^3$ are calculated. These parameters are used in d and q - axis current controller. The structure of the effective closed loop system is shown in Fig.13 and is replicated in both the d and q - axis current controllers.

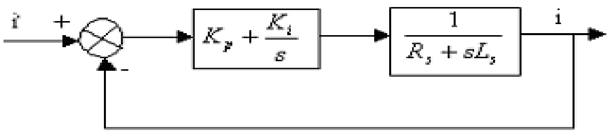

Fig.13: Effective closed loop current control system

4.2. Design of voltage controller:

The relation between dc voltage v_{dc} and dc current i_{dc} is

$$v_{dc} = \frac{1}{C}\int i_{dc}dt \qquad (25)$$

The transfer function can be written as

$$G_V(s) = \frac{V_{dc}}{I_{dc}} = \frac{1}{sC} \qquad (26)$$

Neglecting the power loss in the source resistance and power losses in the switches, balancing the power on both sides,

$$v_{sd}i_{cd} = v_{dc}i_{dc} \qquad (27)$$

From the above equation, we have

$$\frac{i_{dc}}{i_{cd}} = \frac{v_{sd}}{v_{dc}} = \frac{V_s}{V_{dc}} = \frac{230}{500} = 0.46 \qquad (28)$$

With V_{dc} as the reference, the voltage control loop is shown in Fig.14 and it consists of inner d - axis current control loop. The active power is supplied by the d -axis current which is nothing but the ripple current of the capacitor. To make the steady state error of the voltage loop zero Proportional control is adopted here and it produces the reference d -axis current for the control of the d -axis current. The design of voltage controller is as follows:

The open loop transfer function of DC bus voltage controller is

$$G_{op} = \frac{K*K_{dc}}{sC} \qquad (29)$$

The closed loop transfer function with unity feed back gain is

$$G_{cl} = \frac{1}{1+\frac{sC}{K*K_{dc}}} \qquad (30)$$

where , $\tau_v = \frac{C}{K*K_{dc}}$ and taking $\tau_v = 1$msecond and with the parameters of Table. I, the value of $K_{dc} = 1.08$

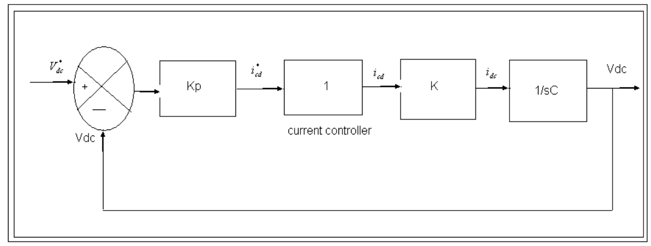

Fig.14: DC link voltage control loop

Then Proportional Integral controller is considering for the voltage control. Hence, the transfer function of PI controller in (19) is associated with the transfer function on dc side is

$$\left[G_V(s).G_{pi}(s)\right]_{ol} = K\left(1+\frac{1}{s\tau_v}\right)\left(\frac{1}{sC}\right) \qquad (31)$$

After taking $\tau_v = C$ and on simplification

$$\left[G_v(s).G_{pi}(s)\right]_{ol} = K\left(\frac{1+s\tau_v}{s^2\tau_v^2}\right) \qquad (32)$$

The transfer function in closed loop

$$\left[G_v(s).G_{pi}(s)\right]_{cl} = \left(\frac{1+s\tau_v}{1+s\tau_v+\frac{s^2\tau_v^2}{K}}\right) \qquad (33)$$

So the system behaves like a second order system. As $\tau_v >> \frac{\tau_v^2}{K}$ and the initial slope in magnitude plot at break point is approximately –20db/decade and hence it reduces to first order system. The value of K can be determined form root locus with approximate settling time as given in (34) and implementation block diagram is shown in Fig.15.

$$K_{pv} = K = 0.15, K_{vi} = \frac{K}{C} = 200 \qquad (34)$$

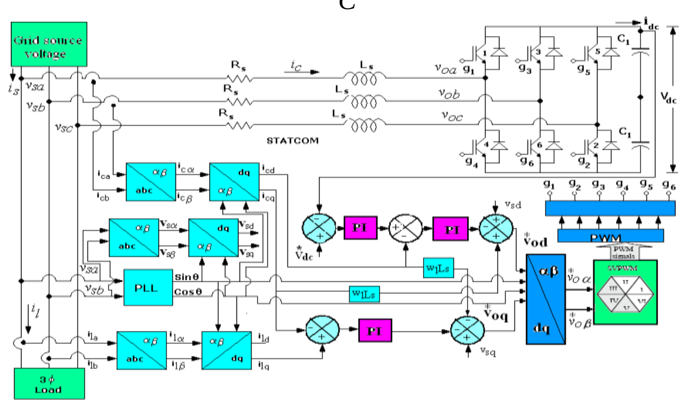

Fig.15: Implementing scheme for linear loads

5. SIMULATION RESULT

5.1: Simulation Result of the load:

A linear load, simulated with $R-L$ parameters (given in Table.II), is connected to the grid at Bus no.5. The waveforms of the grid side phase-a voltage (v_{sa}) and current (i_{sa}) at point of common connection (PCC) (without the STATCOM in operation) are shown in Fig.16. It may be mentioned that here and elsewhere (unless otherwise mentioned) v_{sa} is plotted to a reduced scale of 10:1. Under steady state it is seen that the power angle is 39.64^0 (so that power factor is 0.77). The STATCOM will now act in closed-loop with this system along with the proposed controllers in order to improve this power factor.

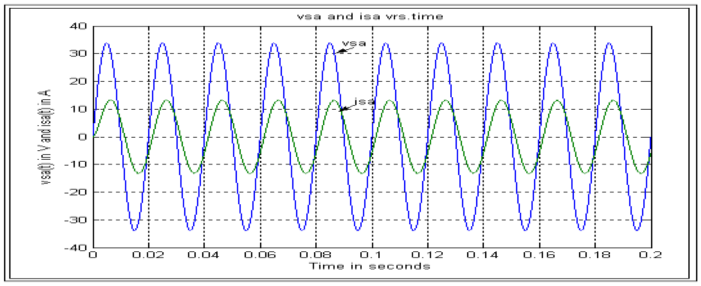

Fig.16: Grid phase a voltage and current

5.2. Simulation Results with STATCOM:

Then after PI controller is applied to control DC link voltage and PI controllers are used to control d and q axis current of STATCOM using the same control block as above. These controllers work and STATCOM functions at initial value of DC link voltage less than 550V. The relevant outputs at initial DC link voltage of 550V are shown in Fig.17 to 23.Fig17 shows the dynamics of system voltage and system current after using PI controller at DC link voltage and it shows the over shoot of only 20A and the same dynamics is obtained in case of STATCOM current as shown in Fig.18. Figs.19 and 20 show the dynamics of DC link voltage and current. Figs.21 and 22 show the change of STATCOM current and DC link voltage due to change of reference current (reactive current of load).The system voltage and the STATCOM voltage are shown in Fig.23 and both are in-phase as it signifies for linear model. These controllers work well without spike at initial voltage of 700V as shown in Fig.24 of system voltage.

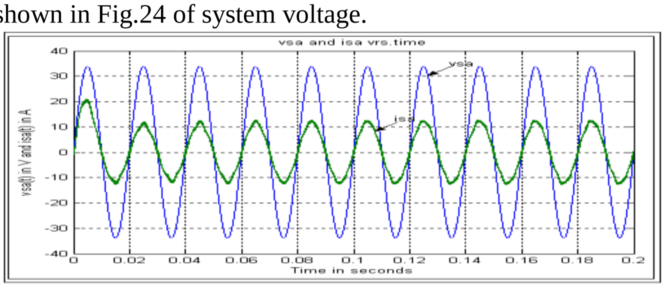

Fig.17: System voltage and system current

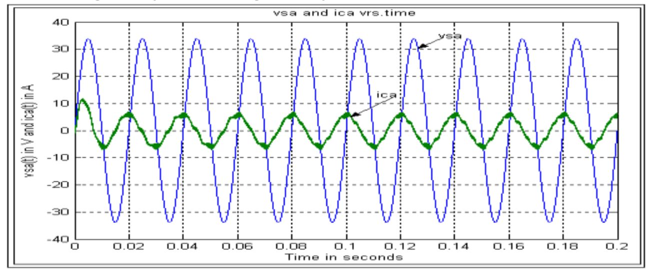

Fig.18: System voltage and STATCOM current

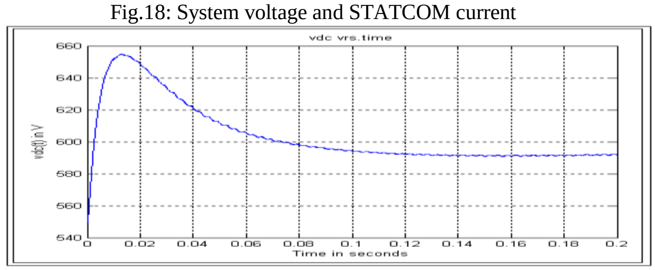

Fig.19: DC link voltage

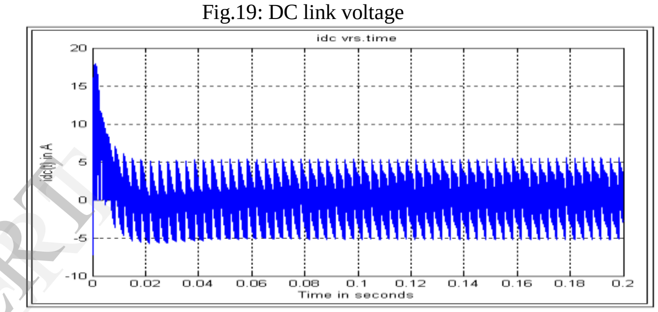

Fig.20: DC link current

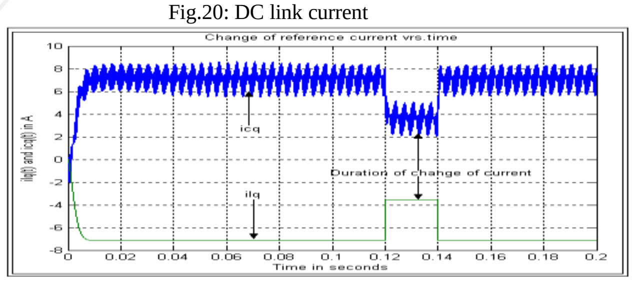

Fig.21: Reference current

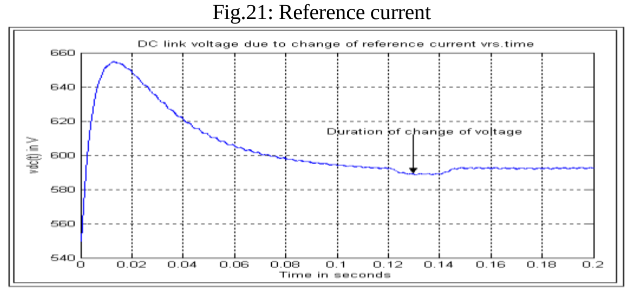

Fig.22: DC link voltage due to change of reference current

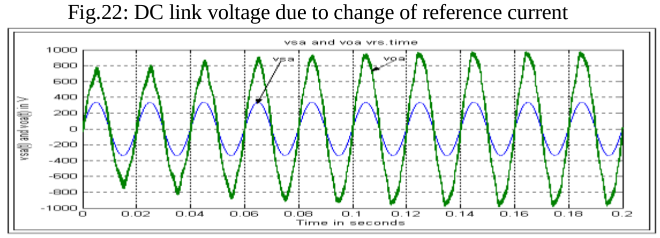

Fig.23: System and STATCOM output voltage

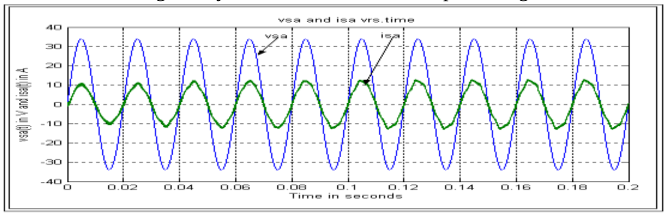

Fig.24: System voltage and system current

6. CONCLUSION

The investigation of performances of the STATCOM for the power factor improvement with linear loads at weak bus connected to the grid has been carried out. The proposed control strategy has been simulated. The STATCOM works as a power factor compensator. It has also been shown that the interaction between a STATCOM device and a supply system makes the rural consumers healthy and wealthy.

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