IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
Research Paper **© 2012 IJFANS. All Rights Reserved, Journal Volume 11, Iss 12, 2022**

ADAPTIVE PI CONTROL: CONTROLLING POWER SYSTEM VOLTAGE WITH STATCOM

#1DR.MUDDASANI SAMPATH KUMAR, ***Associate Professor,***
#2Mr.AITHA RAJASHEKER, ***Asst. Professor,***
Department of Electrical and Electronics Engineering,
Sree Chaitanya Institute Of Technological Sciences, Karimnagar, Ts.

ABSTRACT: A reliable power supply is one that can maintain voltage within a predetermined safety margin. Power systems need to be able to handle voltage well in order to keep up with the increasing demand for electricity and maintain safety. In this study, STATCOM's adaptive PI control is implemented to regulate power system voltage. The gains of the controller can be adjusted rapidly using this knob. Using this approach, the correct system response can be accomplished in the presence of delays. The effectiveness of the developed controller is evaluated for non-linear loads.

Keywords: **FACTS, Proportional-Integral (PI) Controller, STATCOM, Voltage Regulation.**

1. INTRODUCTION

Electrical power systems are increasingly adopting sophisticated networking to gain an advantage in long-distance transmission. These connections are necessary not only for the transmission of electricity, but also for the sharing of resources, the distribution of loads, the reduction of costs, the improvement of reliability, the availability of additional resources, and the reduction of fuel prices. In the last several years, researchers and planners of power systems have paid increased attention to voltage instability as one of the key factors that makes power systems vulnerable. The importance of the power being sent has increased as nonlinear loads become more widespread in manufacturing.

Keeping the voltage steady is essential for the security and dependability of power supply systems. Power networks can be made more efficient at transmitting power, regulating the flow of energy, and dampening waves with the use of FACTS technology, which modifies the way power networks normally conduct electricity. Static synchronous compensators, or

STATCOMs, are used in transmission and distribution networks to maintain consistent voltage at the point of common coupling (PCC). STATCOM's primary function is to supply reactive power adjustment in real time and maintain an appropriate voltage on the associated bus. Static synchronous compensators are physically smaller than dynamic ones since they don't need to house large energy storage devices. This improves their responsiveness and other characteristics.

There have been a number of proposed ways for controlling STATCOM in the past. Researching proportional integral (PI) control gains was not a major focus of the literature we looked at [4,5]. The control code for many STATCOM models is derived from PI controllers. Gains are the control factors that determine whether or not STATCOM operates. Setting control parameters is an area where little research has been conducted thus far. Linear optimal controls using linear quadratic regular (LQR) control are demonstrated in the following example. The designer's skill in selecting appropriate control parameters is crucial to the system's performance. The study describes an innovative zero-set-inspired state feedback approach for STATCOM. The designer of a STATCOM status feedback controller, as with any other controller, must determine the desired outcomes.

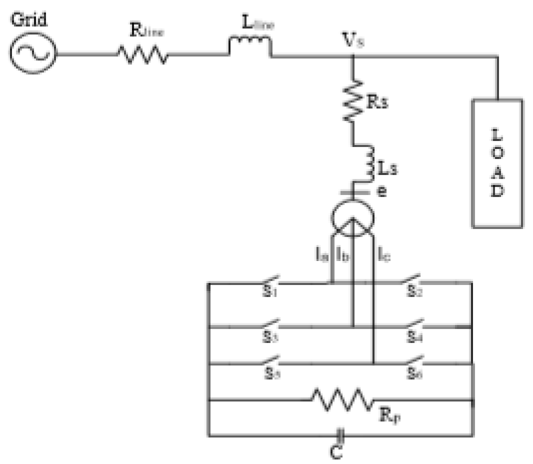

Fig.1.Basic Structure of STATCOM

STATCOM has been run with PI controllers from the start. There is a narrow operating window in which a typical PI controller will function. Doing nonlinear processes is quite inefficient. Using STATCOM's flexible PI control, this research demonstrates voltage regulation in a power grid. Using this adaptive PI control technology, a power system's PI control settings can be adjusted instantly and automatically. In the event of a system disturbance, PI control settings for STATCOM can be generated automatically. Therefore, STATCOM may consider this a viable option for addressing the issue of voltage stability. Figure 1 depicts the overarching framework of

2. MODELING OF STATCOM CONNECTED TO A GRID

All FACTS devices feature the sophisticated STATCOM component. Reactive power is supported without an actual inductor or capacitor, unlike SVC. A STATCOM is a device for rapidly transferring reactive power from one phase of an AC system to another. Switching devices can be either an IGBT, IGCT, or a GTO. The open and closed positions of these valves can be adjusted. Instead of the single degree of freedom afforded by thyristors in SVCs, you now have two. This improves its responsiveness and manageability.

In Figure 1, we see a simplified diagram of the electrical connections that keep STATCOM running. The transfer line connects the electrical grid to the requirements of the network. A STATCOM connects a voltage source inverter (VSI) and a capacitor in a direct current (DC) circuit. Its purpose is to provide the load with reactive power support. Insulated Gate Bipolar Transistors (IGBTs) and Gate Turn-Off Thyristors (GTOs) are two types of electrical switches that make up the Voltage Source Inverter (VSI), along with a series inductance (transformer). Power is lost by both the transformer and the capacitor as they switch modes, as depicted in the image. The leakage reactance is the combined effect of the transformer and smoothing reactor. The letter "e" represents the VSI output voltage, and the letter "PCC" represents the PCC voltage.

The phase output voltages from the VSI can be calculated using the provided formulas. Phase voltages at the Point of Common Coupling (PCC) are denoted by "and" here. After that:

$$e_a - V_a = R_s I_a + L_s \frac{dI_a}{dt} \quad (1)$$

$$e_b - V_b = R_s I_b + L_s \frac{dI_b}{dt} \quad (2)$$

$$e_c - V_c = R_s I_c + L_s \frac{dI_c}{dt} \quad (3)$$

$$\frac{d}{dt}\left(\frac{1}{2} C V_{dc}^2(t)\right) = -[e_a I_a + e_b I_b + e_c I_c] - \frac{V_{dc}^2(t)}{R_p} \qquad (4)$$

Applying transformation from abc reference frame to synchronously rotating dq reference frame from (1) to (4):

$$\frac{d}{dt}\begin{bmatrix} I_d \\ I_q \\ V_{dc} \end{bmatrix} = \begin{bmatrix} \frac{-R_s}{L_s} & \omega & \frac{K}{L_s}\cos\alpha \\ -\omega & \frac{-R_s}{L_s} & \frac{-R_s}{L_s}\sin\alpha \\ \frac{-3K}{2C}\cos\alpha & \frac{-3K}{2C}\sin\alpha & -\frac{1}{RpC} \end{bmatrix}\begin{bmatrix} I_d \\ I_q \\ V_{dc} \end{bmatrix} - \frac{1}{L_s}\begin{bmatrix} V_d \\ V_q \\ 0 \end{bmatrix}$$

How do I locate the d and q currents associated with a given circumstance? How the dc voltage is coupled to the ac side's maximum phase-to-neutral voltage is represented by a value called K. The dc side power is displayed. It also demonstrates the rotational velocity of the voltage vector when operating in synchronous mode and the phase angle at which the STATCOM's output voltage lags behind the bus voltage. The values for the d and q axes that correspond with are displayed by and. The definitions of instantaneous active and reactive power allow us to verify that (6) is correct.

$$p = \frac{3}{2} V_d I_d \qquad (5)$$

$$q = \frac{3}{2} V_d I_q \qquad (6)$$

3. ADAPTIVE PI CONTROL FOR STATCOM

A STATCOM with fixed PI control settings may not function properly in the power system if the operating conditions change, such as when loads or transmissions increase or decrease. This section discusses an adaptive Proportional-Integral (PI) control approach that seeks to get the required response and eliminate the need for trial-and-error studies to identify the appropriate parameters for PI controllers when a new Static Synchronous Compensator (STATCOM) is added to a power system. Adaptive PI control allows for real-time adjustments to the system's PI control parameters.

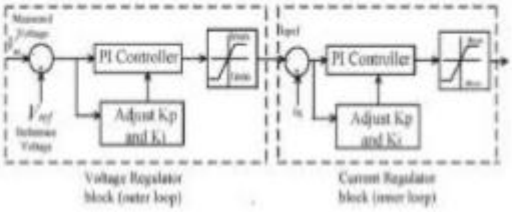

Fig3.1Adaptive PI Control Block for STATCOM.

Figure 2 depicts a STATCOM-configurable PI control block. Measured and reference voltages, as well as reference and q-axis currents, are displayed as numerical values in Figure 2. Results from the voltage regulator are shown as integral and proportional components, respectively, by the symbols and. Gains and represent the proportional and global components of the current regulation, respectively. The voltage error of 0 can be tolerated by this control mechanism. The remaining parameters can be set to any beginning value, such as 1.0. A suggested method of increasing the voltage, which is the norm for the outer loop, is depicted in Figure 3. If the measured voltage reaches the target steady-state voltage within the allotted period, then the depicted exponential curve is not necessary. An exhaustive description of the STATCOM adaptive voltage-control system is provided below.

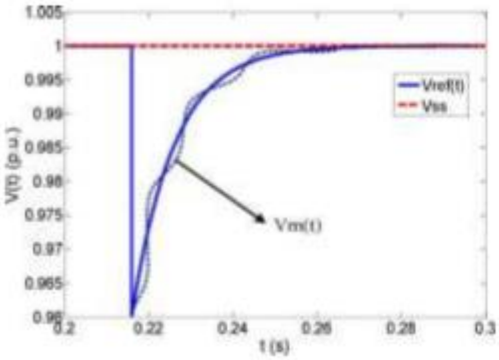

Fig3.2. Reference Voltage Curve

4. SIMULATION RESULTS

The voltage during the travel is measured instantly.

The steady-state bus voltage is compared to the steady-state voltage assumed in the description and examples, where it is set to 1.0 p.u. On-the-fly adjustments to the q-axis reference current are made using the appropriate reference voltage curve.

The q-axis current is compared to the l-axis current in the l-loop. Altering the parameters in a manner analogous to the outer loop of control will resolve the issue. Finding the proper vantage point is the first step. The Static Synchronous Compensator's (STATCOM) dc voltage is then adjusted to maintain the system's preferred bus voltage by injecting the necessary amount of reactive power.

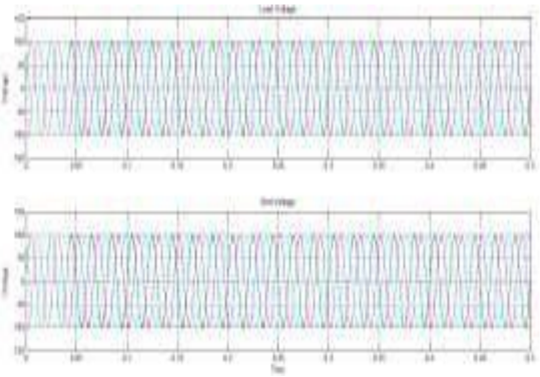

Fig.4.1 Load Voltage, Grid Voltage.

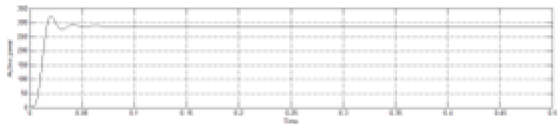

Fig.4.2.Active Power.

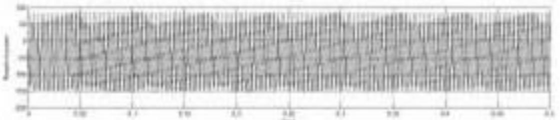

Fig.4.3.Reactive Power

As can be seen in Figure 4, the voltage at the load is identical to the voltage at the grid. Active power and reaction power of the STATCOM are depicted in Figures 5 and 6, respectively.

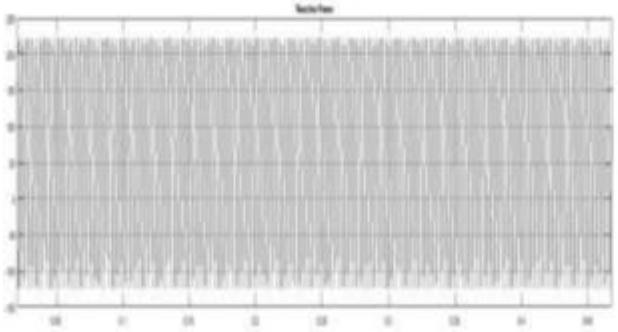

Fig.4.4.Reactive Power before Compensation

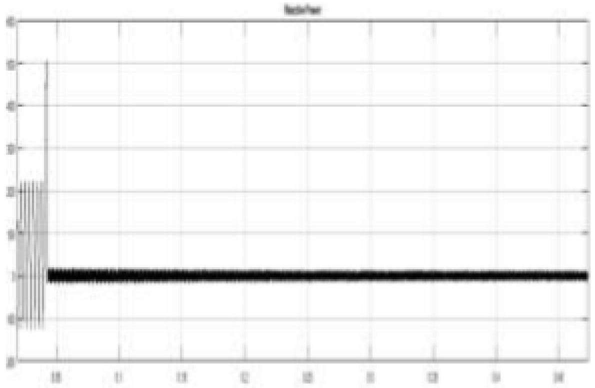

Fig.4.5.Reactive Power after Compensation.

The reactive power of the transmission line at the source before and after rectification is shown in Figures 7 and 8. These findings indicate that the STATCOM is responsible for absorbing the reactive power following the transition.

5. CONCLUSION AND FUTURE WORK

In this study, STATCOM is handled for voltage regulation using the Adaptive PI control approach. This technique allows for dynamic adjustments to the control gains in reaction to perturbations, guaranteeing that the system will always react as intended. The modification is "plug-and-play" for implementing STATCOM because it is self-contained.

The STATCOM can be improved with the use of a sophisticated fuzzy logic controller in a subsequent study.

REFERENCES

1. G. Hingorani and L. Gyugyi, “Understanding FACTS, Concepts, and Technology of Flexible AC Transmission Systems”, Piscataway, NJ: IEEE Press, 2000.
2. P. Rao, M. L. Crow, and Z. Yang, “STATCOM control for power system voltage control applications,” IEEE Trans. Power Del., vol. 15, no. 4, pp. 1311–1317, Oct. 2000.
3. W. L. Chen and Y. Y. Hsu, “Controller design for an induction generatordriven by a variable speed wind turbine,” IEEE Trans. Energy Convers., vol. 21, no. 3, pp. 625–635, Sep. 2006.
4. Jain, K. Joshi, A. Behal, and N. Mohan, “Voltage regulation with STATCOMs: Modeling, control and results,” IEEE Trans. Power Del., vol. 21, no. 2, pp. 726–735, Apr. 2006.
5. Y. Han, Y. O. Lee, and C. C. Chung, “Modified non-linear damping of internal dynamics via feedback linearization for static synchronous compensator,” IET Gen. Transm. Distrib., vol. 5, no. 9, pp. 930–940,2011.
6. V. Spitsa, A. Alexandrovitz, and E. Zeheb, “Design of a robust state feedback controller for a STATCOM using a zero set concept,” IEEETrans. Power Del., vol. 25, no. 1, pp. 456–467, Jan. 2010.
7. C. Schauder and H. Mehta, “Vector analysis and control of the advanced static VAr compensators,” Proc. Inst. Elect. Eng., Gen.,Transm., Distrib., vol. 140, no. 4, pp. 299–306, Jul. 1993.
8. Papic, P. Zunko, and D. Povh, “Basic control of unified power flow controller,” IEEE Trans. Power Syst., vol. 12, no. 4, pp. 1734–1739,Nov. 1997.