Enhancing Reactive Power Compensation with STATCOM using SVPWM

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Abstract: The enormous growth in the renewable energy sector has shown tremendous improvement in the energy sector which also paves the way for huge transmission traffic in transmission and distribution networks. In addition to this transmission traffic, misbehavior also happens in energy transmission and distributions. The reactive power compensation failure results in power block out. This paper provides proper solutions for compensating reactive power with help of STATCOM and its control strategies. The power quality had been improved with help of various control strategies, PWM variations, Apply Algorithm are efficient methods.

Keywords: STATCOM, SVPWM Techniques, Reactive Power.

I. INTRODUCTION

Power generation is an essential one for growing countries especially like as India. Power can be generated from so many resources. It may be renewable or nonrenewable one. Power cannot be generated at every place. Generated power should be transmitted to other places. During power transmission, various components are associated with it. Associated components are operated well for smooth conduction of electrical power from one place to other place. Power system is not a static one because various environmental conditions may make impact on power system transmission and distribution networks. So its properties are strictly monitored. Electrical power is energy related quantity which can flow in power system. Power is nothing new one as a product of voltage and current instantaneously but obviously both are not synchronized in every places. When phase difference occurs in between voltage and current, then power classified as Real (active) and reactive (apparent) power [1]-[2]. In AC system, power can be classified into Real and reactive power either producing or consuming. Real power is converting into some kind of power after its usage. Apparent power is a byproduct from power generation. Reactive power was helped lot for supporting the system to consume real power. Reactive power needed to generate electrical power with more efficient and reliable [4]-[5]. Reactive power is an imagined power which does not do any useful work. Reactive power can be freely flow back and forth in power transmission lines. The following points can make watermark the importance of reactive power. It helpful the circulating power in grid, prevent voltage collapses, empower the equipment efficiency and system reliability. Transformers, motors and transmission lines are properly working with help of reactive power.

Power systems components are designed with +5 or -5 percent voltage fluctuations. Voltage fluctuations may lead system components to malfunctioning. Because higher voltages may be cause insulation failure in system equipment’s and also low voltage can make impact in performance of the components such as low illumination in lamps, over heating of coils where motors or generators used. Reactive power management skills needed to depress the voltage fluctuations. All fluctuations are works under supply and demand correlations. If power demand is over than supply then current drawn from supply is increased enormously at the same time voltage fall drastically into very low. Low voltage leads to overheating of inductive appliances and also trips the generator units. To overcome this effect, better device can be connected in the power system to operate it smoothly [9]-[11].

Fig. 1. Real power flow without Reactive power help

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Three phase sources

Non-Linear loads

STATCOM

STATCOM

FIG. 1.3. Block diagram

This paper focused on controlling method and SVPWM based inverter for provides better solution for reactive power compensation.

IV. SVPWM

Varieties of PWM Techniques are used for generating gate pulses an inverter. Among from various techniques, SVPWM is a sophisticated and optimum method for gate pulses that provides with low Total Harmonic Distortion (THD) [3]-[4]. In SVPWM a complex reference signal generated and act as reference vector that should intents to produce remaining vectors. Here \( V_a(t) \), \( V_b(t) \) and \( V_c(t) \) represents three phase system.

In SVPWM method

\[
\begin{align*}
V_a(t) &= V_m \sin(\omega t) \\
V_b(t) &= V_m \sin(\omega t - \frac{2\pi}{3}) \\
V_c(t) &= V_m \sin(\omega t + \frac{2\pi}{3})
\end{align*}
\]

Here \( V_\alpha \) & \( V_\beta \) forms orthogonal system contains two phases. The following vector diagram describes on SVPWM.
Fig. 4. SVPWM Representation

In above vector diagram figure 1.3 represents SVPWM. Where ‘0’ negative phase voltage level & ‘1’ positive phase voltage level.

Six Non-zero vectors starting from $V_1$ to $V_6$ makes the hexagonal shape and angle between adjacent would be 60 degrees. Here $V_0$ and $V_7$ make short circuit in the output and remains in alpha beta complex plane. PWM is an ancient method for providing gate pulses. But SVPWM can generate pulses with fewer harmonic with high switching speed.

V. SIMULATION

The simulation diagram for SVPWM is given in figure 1.4. It provides gate pulses to the inverter. Inverter converts DC into AC. Here DC may be get it from solar or any other sources such as wind or other AC sources after that converts into DC. STATCOM is nothing but a inverter connected with Capacitor or DC link. So STATCOM controller provides instantaneous values as feedback then controller generate gate pulses according to the feedback.

VI. SIMULATION OUTPUTS

The simulation outputs are get it from MATLAB. SVPWM provides better gate pulses than other PWM methods. This gate pulses have less THD ie., Less harmonics. In this proposed SVPWM generate pulses have THD 5.36% only. It would be better with other PWM methods because SPWM may generated pulses with more than 20% THD. Figure shows that Voltage and current waveforms after generate pulses from SVPWM, SVPWM is one of the best method to eliminate/decrease harmonics.

The proposed system contains Solar as DC source that power converted into AC like as inversion. DC link inductor can used for link the inverter output and loads. Two sources are connected via link inductor. Where apparent power can flow from higher magnitude to lower magnitude sources.

The hardware setup is ongoing for STATCOM setup with help of...
Intelligent Power Module (IPM). IPM has in-built gate driver circuit and also combined over voltage & over current protection circuits.

VII. CONCLUSION

This paper provides simulated solution for reactive power compensation with help of STATCOM. The efficiency is increased while pulses are generated with help of SVPWM method. The resulted waveform clearly shows about the stability of voltage and current. The resulted values are tabulated. The proposed system provides better solution for reactive power related problems occurred in home, industries or electricity board. This would be grateful in transmission and distribution for maintaining higher power factor approximately unity power factor.

REFERENCES


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S.Rajendran received his UG degree in Electrical Engineering from Anna University, Chennai with First Class Distinction in 2009 and M.E. degree in Power Electronics and Drives from Anna University, Tiruchirappalli with First Class Distinction in 2011. Now He was pursuing Ph.D in the field of reactive power compensation. Since July 2011, he has been working as an Assistant Professor in the Department of Electrical & Electronics Engineering, Kalasalingam Academy of Research and Education, Krishnan Koil, Virudhunagar District, Tamil Nadu and India. He has attended several international conferences and he has been actively involving himself in research since 2015. His current research interests include reactive power compensation in FACTS devices. He has actively participated in various faculty development programs, symposiums, orientation programs, workshops and national seminars. He has received Teaching Competency Award in the year 2017. He completed CLAD (Certified Lab view Associate Developer) in 2018.

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