iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** XI **Month of publication:** November 2017

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue XI November 2017- Available at www.ijraset.com

Voltage Oscillation Mitigation Of Wind Farm Using An Statcom

Mr. GauravMishra[1] ,Prof. Prabhodhkumar Khampariya[2]
[1]*M. Tech. Research Scholar, Department of Electrical Engineering,*
[2]*HOD, Department of Electrical Engineering,SriSatyaSai University of Technology and Medical Sciences, Sehore (MP), INDIA*

Abstract: This paper presents the MATLAB analysis of voltage oscillation mitigation by using STATCOM to reduce voltage variation in grid connected wind power system. Injection of wind farm power into an electrical power grid must changes the power quality parameter and also affects the reactive power of electrical network. Variable speed wind turbine using power converters should be assessed against given or calculated limits for harmonics. The presence of voltage flicker is harmful to the power system because it will cause additional power losses. Due to very fast time response characteristics of FACT's devices , here we use STATCOM to improve the power quality of electrical networkThe FACTS device are basically based on power electronic controllers that enhances the capacity of the transmission line Here STATCOM is use to reduce the voltage fluctuation and improve power quality. In this research MATLAB simulation shows the analysis of STATCOM connected wind farm.

Index Terms: STATCOM; wind power system; induction generator; voltage control; Reactive power.

I. INTRODUCTION

Wind energy is best alternative of conventional energy resources in the world .wind energy growing as an main electricity sources . Wind energy result from the movements of air due to atmospheric gradient. The first wind turbine in the world was designed and built by Charls brush in 1988. It was generated 12 MW power . To generate the electricity from wind , we use wind turbine . The total power generated from by the wind park is the sum [1] of the power produced by all wind turbine system. The power produce by a group of wind turbine called as wind farm .As we know that power generated from wind turbine is proportional to the wind velocity cube[2]. So the power output of induction generator is fluctuating. This power fluctuation causes voltage fluctuation[3] which can be mitigated by STATCOM.Windpark generate active power with serious oscillation due to continue change in wind speed. As we know that the wind power turbine electrical output is proportional to cube of wind speed. So a small change in wind speed causes the big disturbance in the power output of wind power field. These power inconstancy causes voltage oscillation or voltage oscillation. Because of improve power quality requirement from the servicethese voltage oscillations must be reduces as soon as possible [4]. If voltage changeraises beyond the specify limit, the wind power systemis disconnected from the grid.

We get the reduce the voltage oscillation by using dynamic reactive compensation. The mainly used dynamic reactive compensators are STATCOM and static Varcompensator. The STATCOM has many advantages over other Fact's devices. STATCOM has fast time response and superior voltage support capability.

STATCOM are connected to electrical transmission line in order to improve their performance of the network. This application is based on injecting reactive power into the grid, so the reactive and active power exchanged by STATCOM has to be controlled simultaneously.purpose of STATCOM. MATLAB software is used to check the performance of STATCOM connected wind. All result carried out in simulation.

A. Power Quality Factors

1)Voltage Variation-Voltage variation occurs in power system due to continues change in wind speed. The voltage variation is directly affecting the stability of power system. We can classify the voltage variation as follows.

2) Voltage sag
3) Voltage swells
4) Study state fault
5) Transient fault

For proper continues transmission, it is necessary that the power quality should be slandered.

6) *Harmonics* - The power electronics converters are mainly responsible for harmonic generation. Even Harmonics in wind generation can arises due to unsymmetrical half wave and may appear at fast load changes. Voltage source converter providing reactive power control and reduce harmonics for large turbine.[5] The greater number of turbine, the lower is the magnitude of armnics and sub harmonics especially of the lower order.
7) *Reactive Power* – Reactive power is an amplitude of power oscillation with no net transfer of energy and is caused by energy storage components, such as a capacitor and an inductor[6].

B. System description

Figure 1 shows a wind park connected power system. There are several devices are connected in power system.In following single line diagram a 65 MW wind park is used for power generation. This wind farm is connected to grid through step up transformer and 180 km transmission line. Power factor is one of the most important parameter to control the power quality of power system, so to improve the power factor and voltage fluctuation we connect a compensating capacitor near the wind park at 11 KV bus, it provides 25 MVAr reactive power but due to slow response of this device the result is not satisfactory so to get a significant result we connect STATCOM. A STATCOM has several advantages, so here we connect a 33 MVAr STATCOM as a compensator, it connected with 132 kv transmission bus.

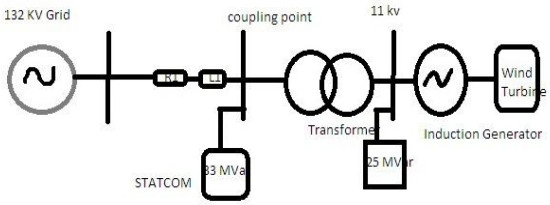


Figure 1.Wind Farm Connected grid\

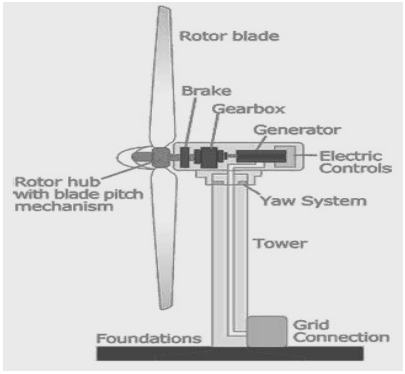


Figure 2 Wind Turbine Layout

C. Parameter Table

Table 1.shows the all parameter used for this analysis. Here a 65 MW Induction generator is used to generate electricity from wind farm. Transform rating is 132 KV.

Induction generator	
Rated Power	65MW
Rated stator Voltage	11KV
Stator Resistance	0.0108 PU
Rotor Resistance	0.01214 PU
Stator Leakage Inductance	0.107 PU
Rotor Leakage inductance	0.1407 PU

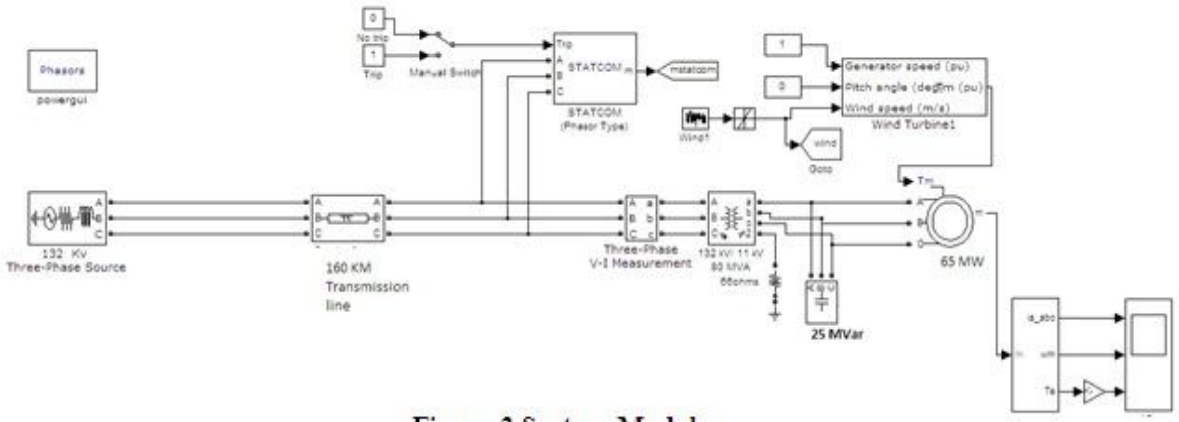


Figure 3 System Model

Transformer

Transformer Turns Ratio	11/132 KV
Leakage Inductance	0.025 PU
STATCOM	
DC line Capacitor	350 micro F
DC line Voltage	40 KV

Table 1 Parameter Table

C. Wind farm system

Wind energy is playing an increasing important role in the supply of energy of most industrialized countries [7] .Figure 2 shows the basic layout diagram of wind turbine.Wind result from the movements of air due to atmospheric pressure gradient. Wind flows from higher pressure regions to lower pressure regions. The generation and movements of wind are complicated due to number of factos . Kinetic energy in moving air can be determined as

$$E=\frac{1}{2}mV_W^{\ 2}$$

Where m is the air mass and V_W is wind speed over a suitable time period. The wind power can be obtained by differentiating the kinetic energy of wind with respect to time.

However, only a small portion of wind power can be converted into electrical power. When wind passes through wind turbines and drives blades to rotate the corresponding wind mass flow rate.

$$M=pAV_W$$

Where p is the air density and A is the swept area of blades. So power generated from wind farm is

$$Pw = \frac{1}{2}\rho A v_w^3$$

II. STATCOMSYSTEM MODELLING

A STATCOM is called an advanced static synchronousVar generator . Its function is basically same as SVC with wider operation range and faster operation. SVC is a semi-controlled device that can only be turned off when valve current crosses zero but STATCOM is a fully controlled device because it uses force commuted circuit.[8]

The basic circuit of STATCOM is shown in Fig 4. It control element (IGBT) is the fully controlled operation. [9] A IGBT can manage the switch off by gate control in comparison with thyristor where switch off is only possible at current zero crossing. The

capacitor DC voltage act as a ideal DV Voltage source to support the inverter .The inverter normal operation is to transfer the DC voltage into AC voltage having controlled magnitude and phase angle at the same frequency as the AC system

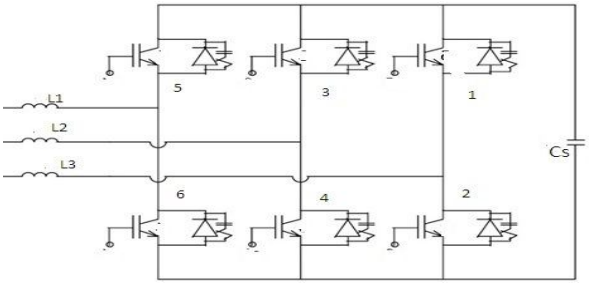


Figure 4 Six pulse IGBT VSC model

The Fig. 5.shows the basic equivalent circuit of a STATCOM. The IGBT converter with a dc voltage source and the power system are illustrated as a variable ac voltage in the circuit. These two voltages are connected by a reactance representing the transformer leakage reactance. In Fig STATCOM consist of one Voltage source converter with a DC capacitor and one shunt connected transformer. Where V2 is Voltage source converter output voltage and V1 is the voltage generated of centralized source.

$$Q_c = \frac{V1(v_2 - V1)}{X_T} \quad (2)$$

If the magnitude of *V1*become higher than V_2 , reactive power is absorbed by STATCOM from the line. Thus STATCOM supply better reactive power control to the system connected.

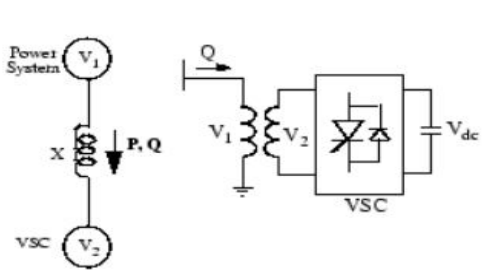


Figure 5 Basic circuit of STATCOM

III. SIMULATION RESULTS

Figure 6 shows the wind speed variation with time. The variation in wind speed is 5-14 m/s with average value of 10 m/s. Wind speed variations applied for 14 seconds. When these wind speed variations are happen to wind turbine[10], it causes power fluctuations. These power fluctuation results voltage oscillation which are shown in fig 7.

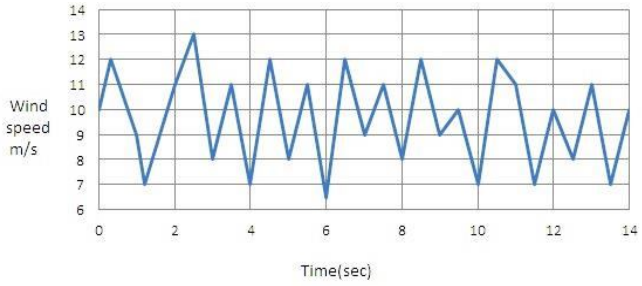


Figure 6. Wind speed variations for 14 sec

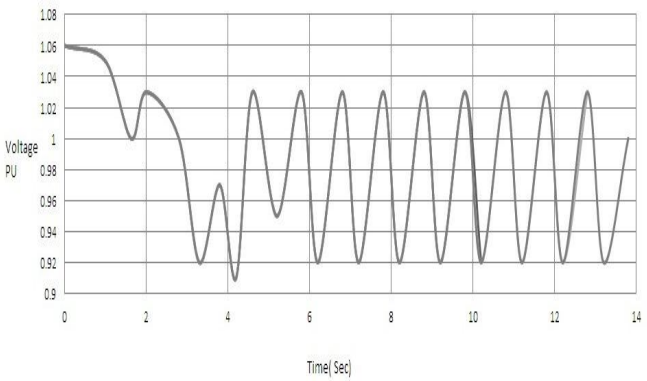


Figure 7. Voltage oscillation (without STATCOM)

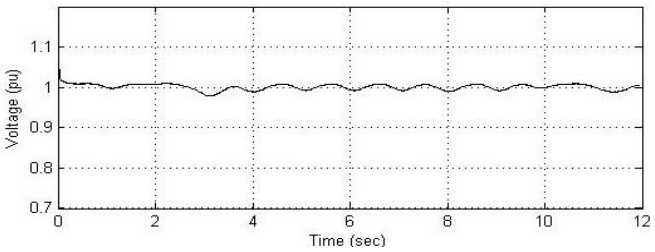


Figure 8voltage using STATCOM

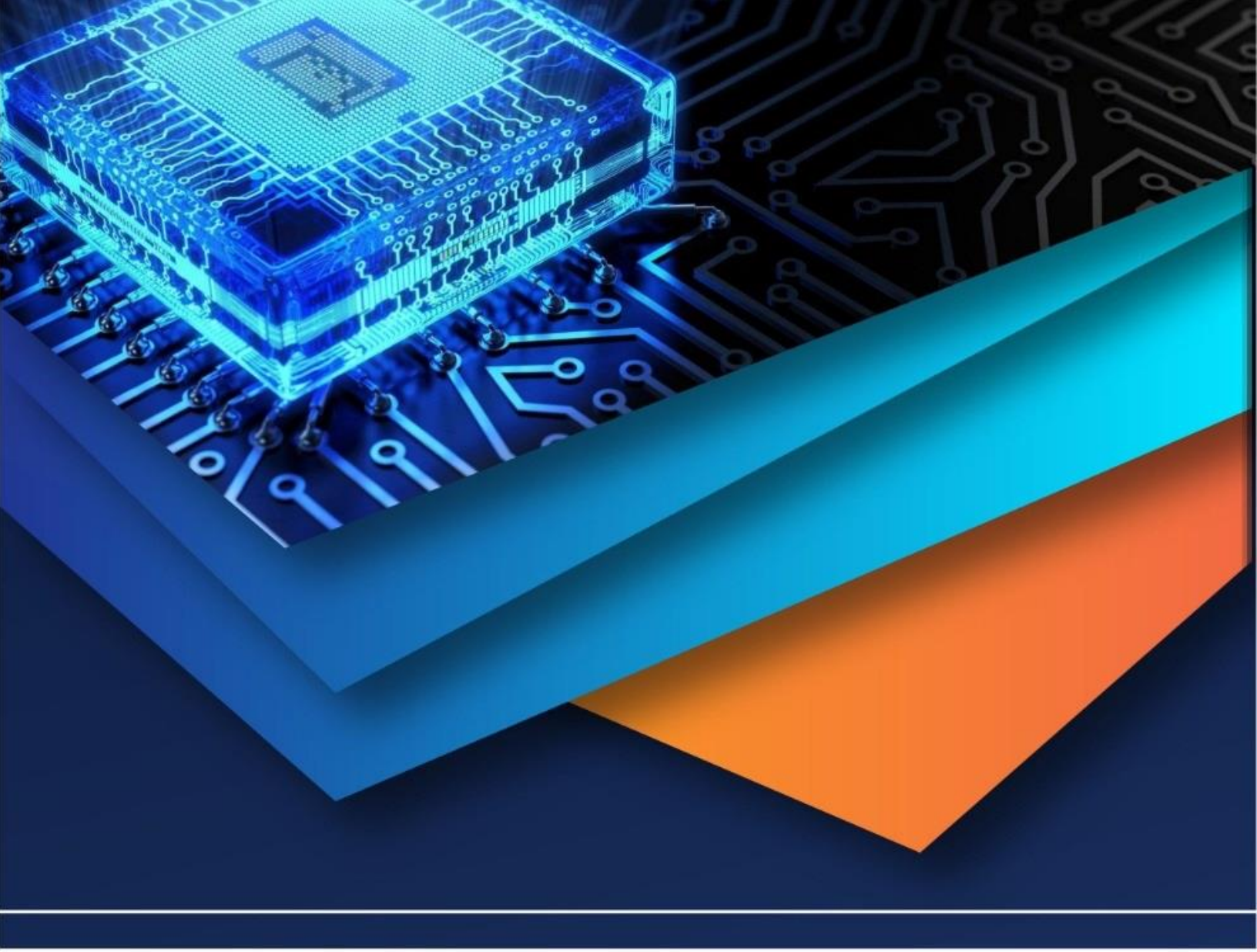
Figure 7 presenting the voltage magnitude waveform without using STATCOM, so from waveform it is clear that the voltage oscillations are very high. The magnitude voltage varies from 90 % to 101 % of its base value that is 1 pu.. These oscillations may affect the power quality of connected power system with grid.Figure 8 show that the STATCOM can solve the voltage fluctuation problem. The voltage oscillation are mitigated to range of value 0.99-1.005 pu.Thus the power quality of overall system has improved. STATCOM supply or absorb the reactive power[11], according to system requirement. If voltage raises more then base value, then STATCOM absorbing reactive power[12] and vise versa, .

IV. CONCLUSIONS

In this paper, the wind park voltage fluctuation problem has been examined. Dueto temperature difference on earth and pressure difference, wind energy generated, so due to geographical and climate it is an uncontrollable source of renewable energy. Continue change in wind speed causes voltage fluctuation. The compensating capacitor could not reduce the fluctuation problem. As we know that the FACT's devices have very fast time response characteristics, so here STATCOM is used to improve the power quality of wind farm. STATCOM produces reactive power, this reactive power reduces the oscillation. Thus it is clear that the wind park system power quality can be improved by using STATCOM.

REFERENCE

[1] James F. Manwell, Jon G. Mcgowan, Anthony (2009) Wind Energy Explained: Theory, Design and Application,2nd Edition
[2] Tony Burton, Nick Jenkins, David Sharpe (2011) Wind Energy Handbook , 2nd Edition
[3] Jürgen Schlabbach, Dirk Blume, Thomas Stephanblome (2008) Voltage Quality in Electrical Power Systems
[4] T. Thiringer ,(2004) ,Flicker contributionfrom wind turbineinstallations , IEEE Transactions on Energy Conversion (Volume: 19, Issue: 1, March 2004)
[5] David Rivkin, Laurel Silk (2011) wind turbine operations, maintenance, diagnosis and Repair
[6] Taare (2004) Reactive Power Management Published in Tata McGraw-Hill Education India
[7] Robert W. Righter (2008):Wind Energy in America: A History
[8] MirceaEremia, Chen-ChingLIU (2007)Advanced Solutions in Power Systems: HVDC, FACTS, 3rd Edition.
[9] Chen-chingliu, Stephen Mcarthur, seung-jae lee (2011) Smart Grid Handbook, 3 Volume Set, Volume 1
[10] Muhammad H. Rashid (2008) Power Electronics , 4th Edition
[11] VikasGoyal, Rakesh Singh Lodhi(2016) Reactive power compensation through upfc and statcom at linear & non-linear load , International Journal of Scientific & Engineering Research, Volume 7
[12] Enrique Acha(2005) Power Electronic Control in Electrical Systems , 4th Edition



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY