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A Power Quality Improvement in Wind Energy system

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Abstract: Renewable energy sources are elective vitality source, can bring new difficulties when it is associated with the power framework. Created power from wind vitality framework is continually fluctuating because of the changes in the wind. By rules determined in IEC-61400 standard (Worldwide Electro-specialized Commission) gives a few standards and estimations. The execution of the wind turbine, power quality is resolved. The power quality estimations are-the dynamic power, active power, voltage sag, voltage swell, flicker, harmonics, and electrical conduct of switching operation and these are measured by national/international rules. The paper obviously demonstrates the presence of power quality issue because of establishment of wind turbine with the grid. In this STATCOM is utilized with energy storage system (BESS) to decrease the power quality issues. The STATCOM control scheme for the matrix associated wind vitality era framework to enhance the power quality is simulated utilizing MATLAB/SIMULINK in power system block set.

Keywords: Power Quality, Wind Generating System (WGS), STATCOM, BESS, IEC standard.

I. INTRODUCTION

The reasons for power quality issues are for the most part unpredictable and hard to recognize when we incorporate a wind turbine to the matrix. In fact talking, the perfect air conditioning line supply by the utility framework ought to be an immaculate sine wave of fundamental frequency (50/60Hz). We can in this manner presume that the absence of value power can bring about loss of creation, harm of hardware or apparatuses or can even be hindering to human wellbeing. It is in this manner basic that an elevated requirement of force quality is kept up. This undertaking exhibits that the force electronic based force molding utilizing custom force gadgets like P-STATCOM can be viably used to enhance the nature of force supplied to the clients. Power quality and dependability cost the business huge sums because of for the most part hangs and transient intrusions. Contorted and undesirable voltage wave frames, as well. What's more, the principle sympathy toward the customers of power was the unwavering quality of supply. Here we characterize the dependability as the congruity of supply. The issue of conveyance lines is partitioned into two noteworthy classifications. In the first place gathering is power quality, second is voltage sags and outages. Initially assemble comprises of consonant mutilations, motivations and swells. Second gathering comprises of voltage hangs and blackouts. Voltage droops is a great deal more genuine and can bring about a lot of harm. On the off chance that surpasses a couple cycle, engines, robots, servo drives and machine devices can't keep up control of procedure. Transmission lines are presented to the strengths of nature. Besides, every transmission line has its load capacity confine that is frequently controlled by either soundness limitations or by warm points of confinement or by as far as possible. Despite the fact that the power quality issue is dissemination side issue, transmission lines are frequently affecting the nature of the power supplied. It is however to be noticed that while most issues connected with the transmission frameworks emerge because of the strengths of nature or because of the interconnection of power frameworks, singular clients are in charge of more generous portion of the issues of power distribution systems.

II. POWER QUALITY IMPROVEMENT

A. Power quality standards, issues and its consequences

1) International electro technical commission guidelines:

A few rules of approximations and standards are specified under IEC 61400 standard which decides the power nature of wind turbines.

The standard standards are indicated.

1) IEC 61400-21: Measuring the power quality normal for network associated wind turbine.

2) IEC 61400-13: Wind Turbine—measuring system in deciding the power conduct.

3) IEC 61400-3-7: Measures as far as possible for fluctuating burden and IEC 61400-12: Wind Turbine execution.

2) Harmonics: It is because of the operation of power electronic converters. Symphonious voltage and current ought to be in restricted according to the IEC-61400-36 rule. The quick exchanging gives a substantial diminishment in lower request consonant present and higher request harmonics are sifted through by utilizing channels.

3) Voltage variation: This is because of the vacillations in the wind turbine because of wind. The voltage variation is specifically identified with real and reactive power variation.The voltage variety is normally delegated under:

• Voltage Sag/Voltage Dips.

• Voltage Swells.

• Short Interferences.

• Long span voltage variation.

The voltage flicker issue portrays dynamic varieties in the system brought on by wind turbine or by fluctuating burdens. Plentifulness of voltage variances relies on upon lattice quality, system impedance, and stage edge and power component of wind turbine.

4) Wind turbine area in power framework: It is found where the power quality is exceedingly impacted. Its operation and its impact on the power framework rely on upon the structure of the system.

5) Self-excitation of wind turbine Generating system: The self-excitation of wind turbine producing framework (WTGS emerges a danger outfitted with commutating capacitor. It gives the responsive power remuneration to the actuation generator. The drawbacks of self-excitation are the security viewpoint and harmony in the middle of genuine and receptive power.

6) Outcomes of the issues:A Voltage variation, voltage flicker, causes the breakdowns of equipment's. It prompts stumbling of security gadgets, harming the delicate equipment's. General it corrupts the power quality in the grid.

B. GRID COORDINATION RULE

American Wind Energy Association (AWEA) led the effort to develop its own grid code for stable operation as per IEC-61400-21 for the interconnection of wind plants to the utility systems, after the block out in United State in August 2003. According to these, operator of transmission grid is responsible for the organization and operation of interconnected system.

1) Voltage rise (u)

The voltage rise at the point of common coupling can be approximated as a function of maximum apparent power Smax of the turbine, the grid impedances R and X at the point of common coupling and the phase angle.

2) Voltage dips (d)

The voltage dips is due to startup of wind turbine and it causes a sudden reduction of voltage. It is the relative % voltage change due to switching operation of wind turbine.

3) Flicker

The measurements are made for maximum number of specified switching operation of wind turbine with 10-min period and 2-h period.

4) Harmonics

The harmonic distortion is assessed for variable speed turbine with an electronic power converter at the point of common connection.

III. TOPOLOGY FOR POWER QUALITY IMPROVEMENT

The STATCOM based current control voltage source inverter injects the current into the grid will cancel The STATCOM based current control voltage source inverter infuses the current into the grid will offset the reactive part and harmonic part

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of the load and induction generator current, in this manner it enhances the power factor and the power quality. To finish these objectives, the grid voltages are detected and are synchronized in producing the current. The proposed grid associated framework is actualized for power quality change at point of common coupling (PCC), for grid associated framework in Fig.1.

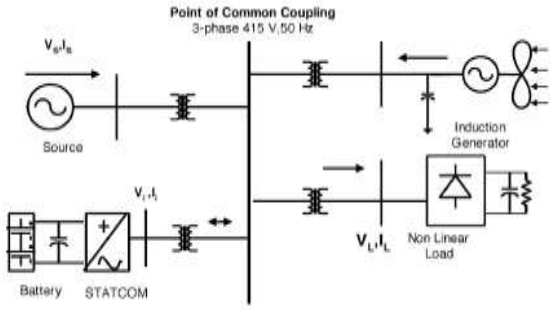

Fig.1. Grid connected system for power quality improvement.

A STATCOM can advance power-system performance in such areas as the following:

a. The power-oscillation damping in power transmission systems.

b. The dynamic voltage control in transmission and distribution systems.

c. The transient stability.

d. The voltage flicker control.

The shunt associated STATCOM with battery energy storage [9] is associated with the interface of the induction generator and non-linear load at the PCC in the grid framework. The STATCOM compensator yield is differed by controlled procedure, in order to keep up the power quality standards in the grid framework. The current control technique is incorporated into the control plot that characterizes the useful operation of the STATCOM compensator in the power framework. A solitary STATCOM utilizing insulated gate bipolar transistor is proposed to have a reactive power backing, to the induction generator and to the nonlinear load in the grid framework. The primary piece outline of the framework operational scheme is appeared in Fig.2.

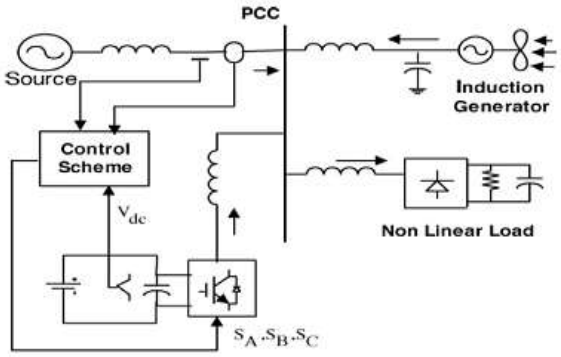

Fig.2. System operational scheme in grid system

The control scheme methodology depends on injecting the streams into the grid utilizing —PID controller. Utilizing such procedure, the controller keeps the control framework variable between limits of hysteresis region and gives right exchanging signals for STATCOM operation. The control framework plan for producing the switching signs to the STATCOM is appeared in Fig.3.

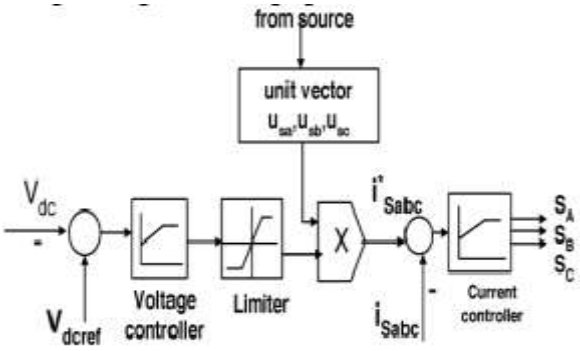

Fig.3 control scheme

IV. SYSTEM PERFORMANCE

The proposed control scheme is simulated using SIMULINK in power system block set. The system parameter for given system is given Table I. The system performance of proposed system under dynamic condition is also presented.

Table.I System parameters

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S.no	Parameters	Ratings
1	Grid Voltage	3-phase,415V,50Hz
2	Induction Motor/Generator	3.35 KVA,415 V,50 Hz, P=4, Speed =1440 rpm, R_s=0.01 Ω R_r=0.015 Ω, L_s=0.06 H, L_r=0.06H
3	Line series Inductance	0.05 mH
4	Inverter Parameters	DC Link Voltage =800V DC Link Capacitance = 100μF Switching Frequency =2 kHz
5	IGBT Rating	Collector Voltage = 1200V, Forward Current =50 A, Gate voltage = 20 V, Power dissipation =310 W
6	Load Parameter	Non-Linear Load 25 KW

B. STATCOM—Performance under Load Variations:

The wind vitality producing framework is associated with grid [11] having the nonlinear load.The execution of the framework is measured by exchanging the STATCOM at time t=0.7s in the framework and how the STATCOM reacts to the step change command for expansion in extra load at 1.0 s is appeared in the recreation. At the point when STATCOM controller is made ON, without change in some other burden condition parameters, it begins to alleviate for reactive demand and in addition harmonic current. This extra request is satisfy by STATCOM compensator [12].The simulation diagram of proposed control scheme with STATCOM is appeared in Fig.4.

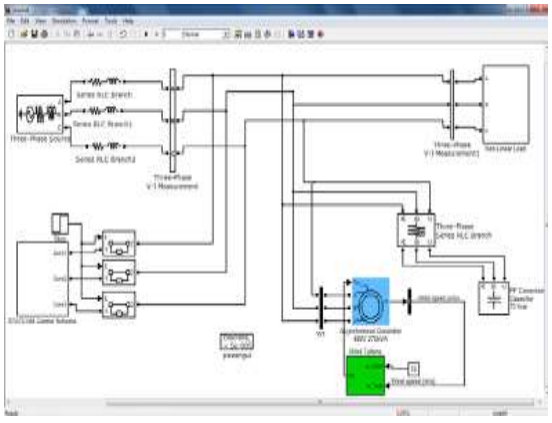

Fig.4 Proposed control scheme with STATCOM

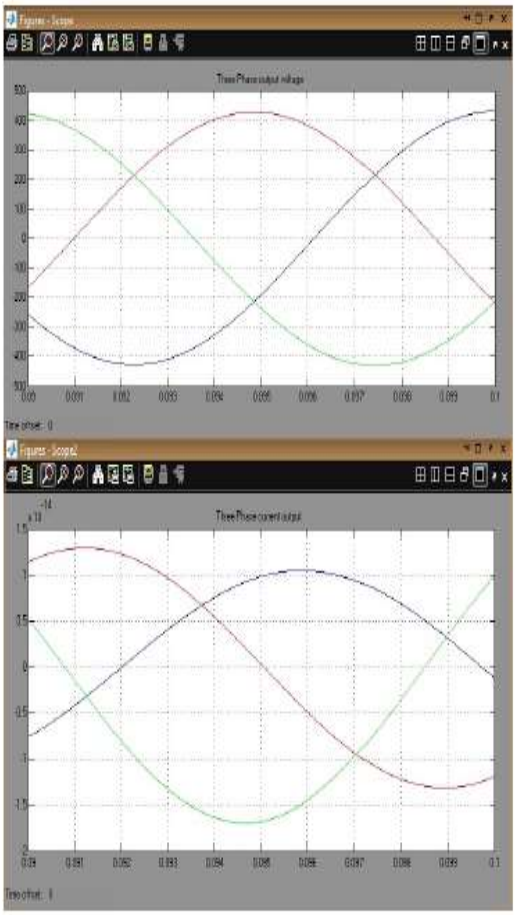

Fig.5. Wind Turbine Model Output

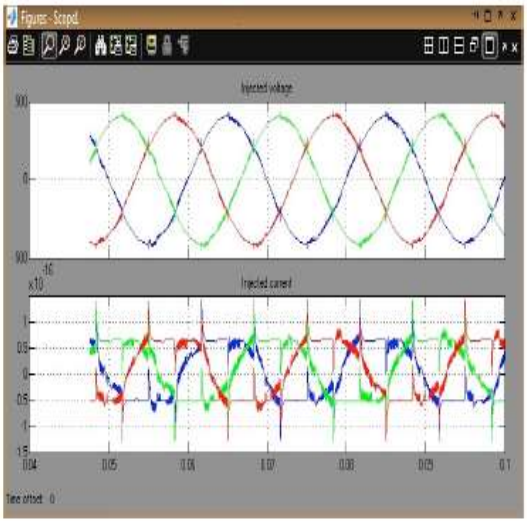

Fig.6 6-Pulse STATCOM OUTPUT

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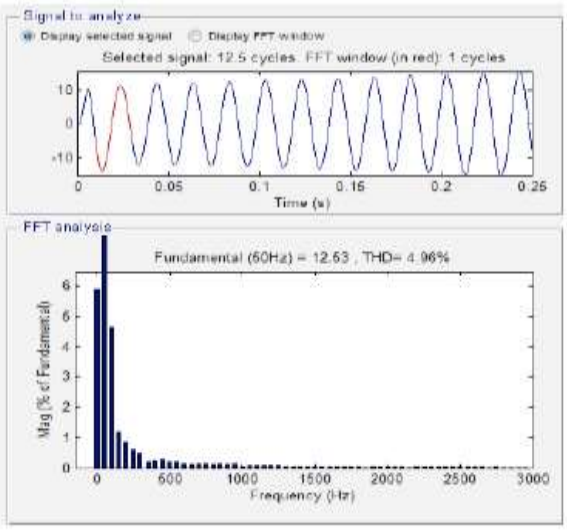

Fig. 7 FFT analysis without Controller (THD=4.96%)

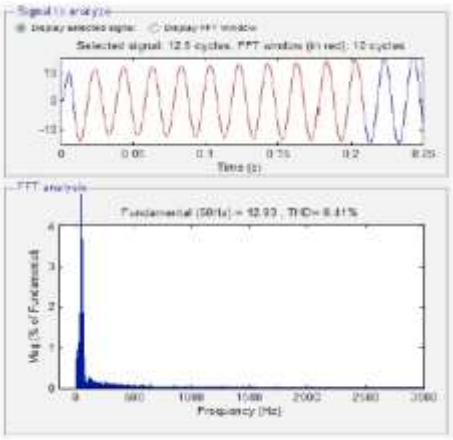

Fig.8 FFT analysis with Controller (THD=0.41%)

V. CONCLUSION

In this paper we present the FACTS device (STATCOM) -based control scheme for power quality improvement in grid connected wind generating system and with nonlinear load. The power quality issues and its consequences on the consumer and electric utility are presented. The operation of the control system developed for the STATCOM in MATLAB/SIMULINK for maintaining the power quality is to be simulated. It has a capability to cancel out the harmonic parts of the load current. It maintains the source voltage and current in-phase and support the reactive power demand for the wind generator and load at PCC in the grid system, thus it gives an opportunity to enhance the utilization factor of transmission line. The integrated wind generation and FACTS device with BESS have shown the outstanding performance.

In this paper we display the FACTS device (STATCOM) - based control plan for power quality change in grid associated wind producing framework and with nonlinear load. The power quality issues and its results on the buyer and electric utility are exhibited. The operation of the control framework created for the STATCOM in MATLAB/SIMULINK for keeping up the power quality is to be reproduced. It has an ability to counteract the harmonic parts of the load current. It keeps up the source voltage and current in-stage and backing the receptive power interest for the wind generator and burden at PCC in the grid framework, along these lines it gives a chance to improve the utilization factor of transmission line. The incorporated wind generation and FACTS device with BESS have demonstrated the remarkable execution.

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