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Development of A Novel Control Scheme For Integration Of Wind Energy Generation System Into Existing Power System To Mitigate The Power Quality Issues

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ABSTRACT*:* In this paper a new control strategy for integration of Wind energy into existing power system to improve power quality by using STATCOM is proposed. To have sustainable. growth and social progress, it is necessary to meet the energy need by utilizing the renewable resources like wind, biomass, hydrogenation, solar etc .In sustainable energy system, energy conservation and the use of renewable source are the key paradigm. The need to integrate the renewable energy like wind energy into power system is to make it possible to minimize the environmental impact on conventional plant. The Integration of the wind power into an electric grid affects the power quality issues. The influence of the wind turbine in the grid system concerning the power quality measurements are the active power, reactive power, variation of voltage, flicker, harmonics, and electrical behaviour of switching operation and these are measured according to international guidelines. The proposed work demonstrates the power quality problem due to integration of wind turbine with the grid. In this proposed scheme STATIC COMPENSATOR is connected at a point of common coupling with a battery energy storage system to mitigate the power quality issues. The battery energy storage is integrated to sustain the real power source under fluctuating wind power. The STATCOM control scheme for the grid connected wind energy generation system for power quality improvement is simulated using MATLAB/SIMULINK.The effectiveness of the proposed scheme relives the main supply source from the reactive power demand of the load and the induction generator. The development of the grid co-ordination rule and the scheme for improvement in power quality norms on the grid has been presented.. The development of the grid co-ordination rule and the scheme for improvement in power quality norms on the grid has been presented.

Keywords*:* power quality issues, wind energy generating system, novel control scheme, integration of wind energy system, grid coordination rule, power quality improvement

I.INTRODUCTION

The integration of the renewable energy like wind energy into existing power system is to make it possible to minimize the environmental impact on conventional power system. The integration of wind energy into existing power system presents a technical issues and that requires consideration of voltage regulation, stability, controllability and power quality issues[1][7]. The power quality is an essential measure and is highly affected by

the operation of a distribution and transmission system. The power quality issue is of great importance to the wind turbine. There has been a quick progress and development in the exploitation of wind energy worldwide in recent years. The wind turbine with fixed-speed operation, the fluctuation in the wind speed are transmitted as fluctuations in the mechanical torque, electrical power on the grid and leads to large voltage fluctuations. The wind turbine produces a continuous variable output power during the normal operation. The variations in output power are mainly caused by the effect of turbulence, wind shear, and tower-shadow and of control system in the power system. Thus, the network needs to manage for such fluctuations.[2].The power quality problems can be viewed with respect to the wind generation, transmission and distribution network, such as voltage sag, swells, flickers, harmonics etc. However the wind generator introduces disturbances in to the distribution network. The simplest method of running a wind generating system is to use the induction generator connected directly to the grid system .However induction generator require reactive power for magnetization. When the generated active power of an induction generator is varied due to wind, absorbed reactive power and terminal voltage of an induction generator can be varied. An effective control scheme in wind energy generation

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system is required under normal operating condition to allow the proper control over the active power generation. A STATCOM based control scheme has been proposed for improving the power quality which can improves the power level associates with the commercial wind turbines[3]. The proposed STATCOM control scheme for grid connected wind energy generation for power quality improvement improves the Unity power factor at the source side, Reactive power supply only from STATCOM to wind Generator and load, and Simple controller for STATCOM to achieve fast dynamic response[3]. The quality of power has often been characterized as "clean" or "dirty." Clean power refers to power that has sinusoidal voltage and current without any distortion and operates at the designed magnitude and frequency. Dirty power describes power that has a distorted sinusoidal voltage and current or operates outside the design limits of voltage, current, and/or frequency. Natural and man-made events in the power system provide sources or initiating events that cause clean power to become dirty. Categories of dirty power quality sources include power system events, nonlinear loads, and poor wiring and grounding. In solving power quality problems, the power quality engineer uses classical problem-solving techniques. Below is an example flow chart for Power Quality Problem Solving.

II POWER QUALITY PROBLEMS

The power quality signature, or characteristic, of the disturbance identifies the type of power quality problem. The nature of the variation in the basic components of the sine wave, i.e., voltage, current, and frequency, identifies the type of power quality problem. Voltage sags are the most common type of power quality problem[4]. The voltage variation issue results from the wind velocity and generator torque. The voltage variation is directly related to real and reactive power variations. The voltage variation is commonly classified as Voltage Sag ,Voltage Swells, Short Interruptions Long duration voltage variation. For most consumers, power generated by many large generators comes to them through a high-voltage electrical transmission network, or grid. Power flows through this grid at voltages around 100 or 200 kV to a substation, where the voltage is reduced by a transformer to lower voltage, typically 12 to 25 kV. It then flows through an underground or overhead distribution system until it reaches a distribution transformer, where it is reduced further to the consumer voltage .The power then flows through a service conductor to the customer‘s meter and distribution panel and through the building electrical system to the outlet or light fixture. The voltage at the outlet is determined by two factors: the generator output voltage and the voltage drop, or loss, in the transmission and distribution system. Rapid variations in the generator output voltage occur very infrequently. BC Hydro manages voltages at different points in the grid to maintain maximum efficiency and proper flow of power, and changes to voltage and power flow are carried out slowly in a controlled manner. The flicker induced in a light source by a changing load depends on the impedance that the two loads share. Often the simplest solution to local flicker, or even to area flicker, is to change the source connections for the lighting load. Industrial and commercial sites often have several supply transformers, which allows for some flexibility. Recommended Standard Electric Power Quality, is a decrease in RMS voltage at the power frequency for durations from 0.5 cycles to 1 minute, reported as the remaining voltage[5]. The measurement of a Voltage Sag is stated as a percentage of the nominal voltage, it is a measurement of the remaining voltage and is stated as a sag to a percentage value. The power quality can be improved by Power factor correction, Harmonic filtering, Special line notch filtering, Transient voltage surge suppression Proper earthling systems. In most cases, the person specifying and/or buying a container crane may not be fully aware of the potential power quality issues. If this article accomplishes nothing else, we would hope to provide that awareness[6]. In many cases, those involved

with specification and procurement of container cranes may not be cognizant of such issues, do not pay the utility billings, or consider it someone else's concern. As a result, container crane specifications may not include definitive power quality criteria such as power factor correction and/or harmonic filtering. Also, many of those specifications which do require power quality equipment do not properly define the criteria. Early in the process of preparing the crane specification. The total distorted wave shape is cumulative. The resulting non-sinusoidal wave shape will be a combination of the fundamental 60-Hz sine wave and the various harmonics. The total distorted wave shape is cumulative. The resulting non-sinusoidal wave shape will be a combination of the fundamental 60-Hz sine wave and the various harmonics. Harmonic voltages result from the harmonic currents interacting with the impedance of the power system Harmonic currents and voltages have a detrimental effect on utility and end-user equipment. They cause overheating of transformers, power cables, and motors; inadvertent tripping of relays; and total harmonic distortion is a way to evaluate the voltage distortion effects of injecting harmonic currents into the utility's system.

The formula for calculating THD (for a voltage waveform) is as follows:

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$$V_{THD} = \frac{\sqrt{\sum_{h=2}^{50}}}{V_1} = \sqrt{\left(\frac{V_2}{V_1}\right)^2 + \left(\frac{V_3}{V_1}\right)^2 + \cdots \left(\frac{V_n}{V_1}\right)^2} \quad (1)$$

Where V_1 fundamental voltage value

And $V_n = V_2, V_3, V_4$, etc = Harmonic voltage value.

The THD can be used to characterize distortion in both current and voltage waves. However, THD usually refers to distortions in the voltage wave. For example, calculate the THD for a complex waveform with the following harmonic distortion as a percentage of the fundamental component for each harmonic: third harmonic distortion = 6/120 100% , 50%, fifth harmonic = 9/120 100% 7.5%, and seventh harmonic = 3/120 100% 2.5%. The THD would be calculated as follows:

$$THD = \sqrt{(0.5)^2 + (0.75)^2 + (0.25)^2} = 0.093 \quad \text{or} \quad 0.3\% \quad (2)$$

This exceeds the limit of 5 percent and would require some type of mitigating device, like filters, to reduce the harmonics to acceptable levels.TDD, on the other hand, deals with evaluating the current distortions caused by harmonic currents in the end-user facilities. The definition is similar to that of THD, except that the demand current is used in the denominator of TDD instead of simply the fundamental current of a particular sample. TDD of the current *I* is calculated by the formula;

$$TDD = \frac{\sqrt{\sum_{h=1}^{h=\infty}(I_h)^2}}{I_L} \quad (3)$$

Where I_L = rms value of maximum demand load current

h = harmonic order (1, 2, 3, 4, etc.)

I_h = rms load current at the harmonic order h

There are several ways to reduce or eliminate harmonics. The most common way is to add filters to the electrical power system. Harmonic filters or chokes reduce electrical harmonics just as shock absorbers reduce mechanical harmonics. Filters contain capacitors and inductors in series. Filters siphon off the harmonic currents to ground[1] They prevent the harmonic currents from getting onto the utility's or end user's distribution system and doing damage to the utility's and other end users' equipment. There are two types of filters static and active. Static filters do not change their value. Active filters change their value to fit the harmonic being filtered. Other ways of reducing or eliminating harmonics include using isolation transformers and detuning capacitors and designing the source of the harmonics to change the type of harmonics.

III WIND POWER AND GRID COORDINATION RULE

Wind energy is the kinetic energy of air in motion. Total wind energy flowing through an imaginary area A during the time t is

$$E = \frac{1}{2}mv^2 = \frac{1}{2}(Avt\rho)\, v^2 = \frac{1}{2}At\rho v^3, \quad (4)$$

Where v is the wind speed; ρ is the air density; Avt is the volume of air passing through A (which is considered perpendicular to the direction of the wind); $Avt\rho$ is therefore the mass m passing per unit time. Note that ½ ρv^2 is the kinetic energy of the moving air per unit volume.

Power is energy per unit time, so the wind power incident on A (e.g. equal to the rotor area of a wind turbine) is:

$$P = E/t = \frac{1}{2}A\rho v^3. \quad (5)$$

Wind power in an open air stream is thus proportional to the third power of the wind speed; the available power increases eightfold when the wind speed doubles. Wind turbines for grid electricity therefore need to be especially efficient at greater wind speeds[8]. A Wind turbine is a device that converts kinetic energy from wind into mechanical energy. If the mechanical energy is used to produce electricity, the device may be called a wind generator or wind charger. If the mechanical energy is used to drive machinery, such as for grinding grain or pumping water, the device is called a windmill or wind pump. Developed for over a millennium, today's wind turbines are manufactured in a range of vertical and horizontal axis types. The smallest turbines are used for applications such as battery charging or auxiliary power on sailing boats; while large grid-connected arrays of turbines are becoming an increasingly large source of commercial electric power.

A quantitative measure of the wind energy available at any location is called the Wind Power Density (WPD) It is a calculation of the mean annual power available per square meter of swept area of a turbine, and is tabulated for different heights above ground. Calculation of wind power density includes the effect of wind velocity and air density. Color-coded maps are prepared for a particular area described, for example, as "Mean Annual Power Density at 50 Meters". In the United States, the results of the above calculation are included in an index developed by the National Renewable Energy Laboratory .The larger the WPD calculation, the higher it is rated by class. Classes range from Class 1 (200 watts per square meter or less at 50 meters altitude) to Class 7 (800 to 2000 watts per square meter). Commercial wind farms generally are sited in Class 3 or higher areas, although isolated points in an otherwise Class 1 area may be practical to exploit.

The American Wind Energy Association led the effort in the united state for adoption of the grid code for the interconnection of the wind plants to the utility system. The first grid code was focused on the distribution level, after the blackout in the United State in August 2003. The United State wind energy industry took a stand in developing its own grid code for contributing to a stable grid operation. The rules for realization of grid operation of wind generating system at the distribution network are defined as-per IEC-61400-21. The grid quality characteristics and limits are given for references that the customer and the utility grid may expect. According to Energy-Economic Law, the operator of transmission grid is responsible for the organization and operation of interconnected system.

IV POWER QUALITY IMPROVEMENT

The STATCOM based current control voltage source inverter injects the current into the grid in such a way that the source current are harmonic free and their phase-angle with respect to source voltage has a desired value. The injected current will cancel out the reactive part and harmonic part of the load and induction generator current, thus it improves the power factor and the power quality[9]. To accomplish these goals, the grid voltages are sensed and are synchronized in generating the current command for the inverter. The proposed grid connected system is implemented for power quality improvement at point of common coupling . The grid connected system consists of wind energy generation system and battery energy storage system with STATCOM.In this configuration, wind generations are based on constant speed topologies with pitch control turbine. The induction generator is used in the proposed scheme because of its simplicity, it does not require a separate field circuit, it can accept constant and variable loads, and has natural protection against short circuit. The basic circuit for power quality improvement is shown in Fig: 1

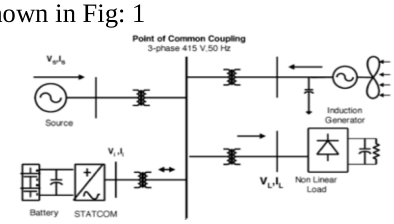

Fig :1 Basic system for power quality improvement.

where (kg/m) is the air density and A (m) is the area swept out by turbine blade, $\mathbf{V_{wind}}$ is the wind speed in mtr/s. It is not possible to extract all kinetic energy of wind, thus it extract a fraction of power in wind, called power coefficient *Cp* of the wind turbine.where *Cp* is the power coefficient, depends on type and operating condition of wind turbine. This coefficient can be express as a function of tip speed ratio and pitch angle . The mechanical power produce by wind turbine is given as

$$P_{mech} = \frac{1}{2} \rho \Pi R^2 V^3_{wind} C_p \qquad (6)$$

Where R is the radius of the blade (m).

V SYSTEM OPERATION

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The shunt connected STATCOM with battery energy storage is connected with the interface of the induction generator and non-linear load at the PCC in the grid system. The STATCOM compensator output is varied according to the controlled strategy, so as to maintain the power quality norms in the grid system. The current control strategy is included in the control scheme that defines the functional operation of the STATCOM compensator in the power system. A single STATCOM using insulated gate bipolar transistor is proposed to have a reactive power support, to the induction generator and to the nonlinear load in the grid system. The main block diagram of the system operational scheme is shown in Fig:2

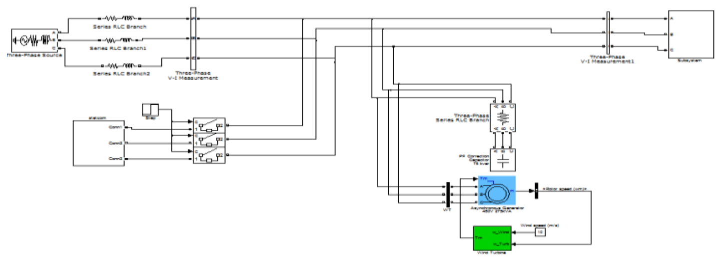

Fig: .2.System operational scheme in grid system.

The control scheme approach is based on injecting the currents into the grid using "bang-bang controller." The controller uses a hysteresis current controlled technique. Using such technique, the controller keeps the control system variable between boundaries of hysteresis area and gives correct switching signals for STATCOM operation. The control system scheme for generating the switching signals to the STATCOM is shown in Fig :3.

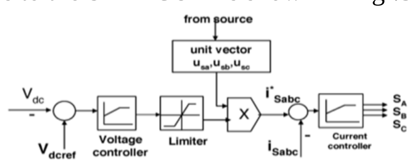

Fig: 3 Proposed Control system scheme.

The control algorithm needs the measurements of several variables such as three-phase source current $\mathbf{i_{Sabc}}$, DC voltage $\mathbf{V_{dc}}$, inverter current $\mathbf{i_{iabc}}$ with the help of sensor. The current control block, receives an input of reference current $(\mathbf{i_{Sabc}})^*$ and actual current $\mathbf{i_{Sabc}}$ are subtracted so as to activate the operation of STATCOM in current control mode.In three-phase balance system, the RMS voltage source amplitude is calculated at the sampling frequency from the source phase voltage (V_{sa}, V_{sb}, V_{sc}) and is expressed, as sample template Vsm, sampled peak voltage is written as

$$V_{sm} = \left\{ \frac{2}{3} \left(V_{sa}^2 + V_{sb}^2 + V_{sc}^2 \right) \right\}^{1/2} \qquad (7)$$

The three phase injected current into the grid from STATCOM will cancel out the distortion caused by the nonlinear load and wind generator. The IGBT based three-phase inverter is connected to grid through the transformer. The generation of switching signals from reference current is simulated with in hysteresis band of 0.08. The choice of narrow hysteresis band switching in the system improves the current quality. The choice of the current band depends on the operating voltage and the interfacing transformer impedance. The compensated current for the nonlinear load

and demanded reactive power is provided by the inverter. The real power transfer from the batteries is also supported by the controller of this inverter.

The wind energy generating system is connected with grid having the nonlinear load. The performance of the system is measured by switching the STATCOM at time s in the system and how the STATCOM responds to the step change command[10] for increase in additional load at 1.0 s is shown in the simulation. When STATCOM controller is made ON, without change in any other load condition parameters, it starts to mitigate for reactive demand as well as harmonic current. The dynamic performance is also carried out by step change in a load, when applied at 1.0 s. This additional demand is fulfil by STATCOM compensator. Thus, STATCOM can regulate the available real power from source. While the result of three phase injected current from STATCOM are shown in Fig. 6 and the generated current from wind generator at PCC are depicted in Fig. 7.The DC link voltage regulates the source current in the grid system, so the DC link voltage is maintained constant across the capacitor as shown in Fig.4

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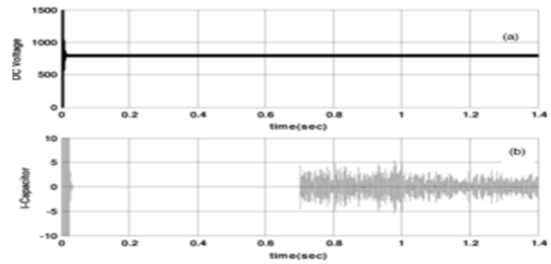

Fig:4 DC link voltage..

It is observed that the source current on the grid is affected due to the effects of nonlinear load and wind generator, thus purity of waveform may be lost on both sides in the system. The inverter output voltage under STATCOM operation with load variation is shown in Fig.

The power quality improvement is observed at point of common coupling, when the controller is in ON condition. The STATCOM is placed in the operation at 0.7 s and source current waveform is shown. It is shown that the THD has been improved considerably and within the norms of the standard. The above tests with proposed scheme has not only power quality improvement feature but it also has sustain capability to support the load with the energy storage through the batteries.

VI MATLAB DESIGN PRACTICAL RESULTS

The shunt connected STATCOM with battery energy storage is connected with the interface of the induction generator and non-linear load at the PCC in the grid system. The STATCOM compensator output is varied according to the controlled strategy, so as to maintain the power quality norms in the grid system. The matlab simulated main block diagram of the system operational scheme is shown in Fig: 5

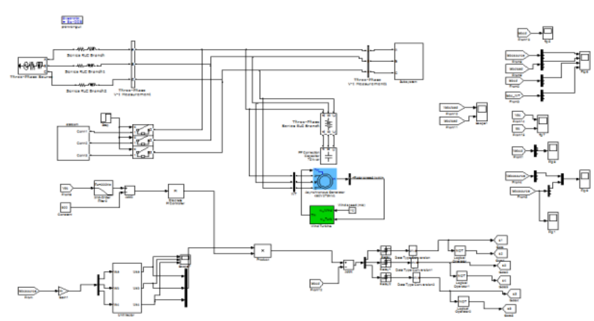

Fig 5 system operational scheme

The three phase injected current into the grid from STATCOM will cancel out the distortion caused by the nonlinear load and wind generator. The IGBT based three-phase inverter is connected to grid through the transformer. The generation of switching signals from reference current is simulated within hysteresis band of 0.08.

The choice of narrow hysteresis band switching in the system improves the current quality. The compensated current for the nonlinear load and demanded reactive power is provided by the inverter. The real power transfer from the batteries is also supported by the controller of this inverter. The three phase source current is shown in Fig 8 and the STATCOM operational diagram is shown in Fig 9

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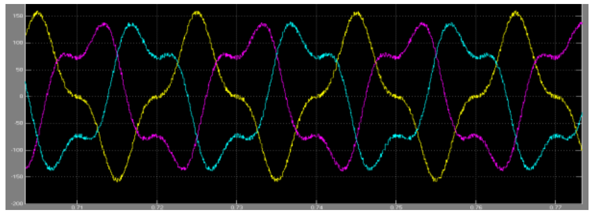

Fig.6 Three phase injected inverter Current.

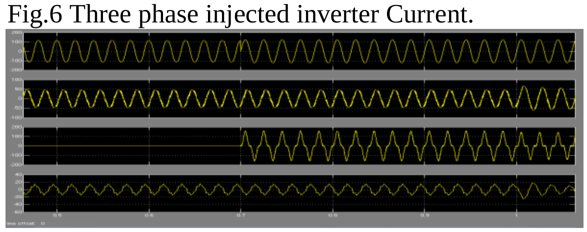

Fig.7 (a) Source Current. (b) Load Current. (c) Inverter Injected Current. (d) Induction generator current.

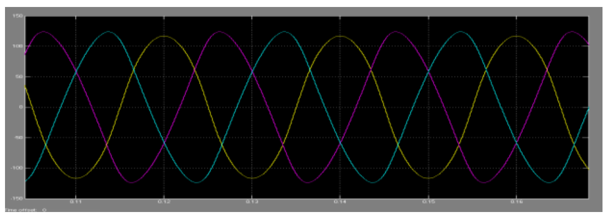

Fig 8Three phase Source Current

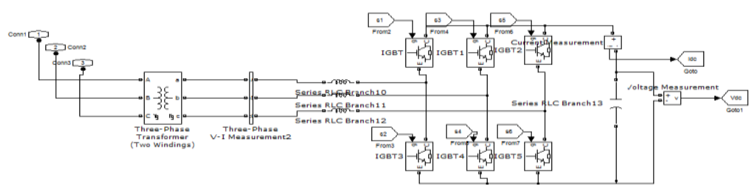

Fig.9. (STATCOM Operational Diagram)

performance of the system is measured by switching the STATCOM at time s in the system and how the STATCOM responds to the step change command for increase in additional load[11] at1.0 s is shown in the simulation. The inverter output voltage under STATCOM operation with load variation is shown using simulation below Fig 10 The simulated current waveform before and after the STATCOM operation is shown in Fig 11 and Eigen values of voltage sources is shown in Fig 14

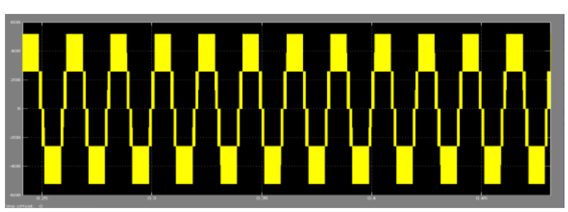

Fig.10 STATCOM output voltage

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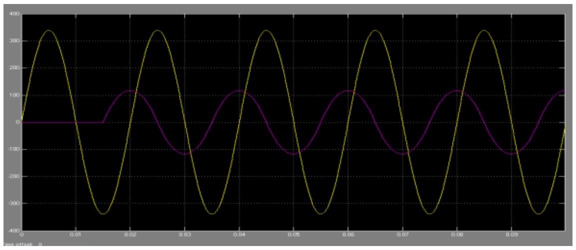

Fig.11 Supply Voltage and Current at PCC.

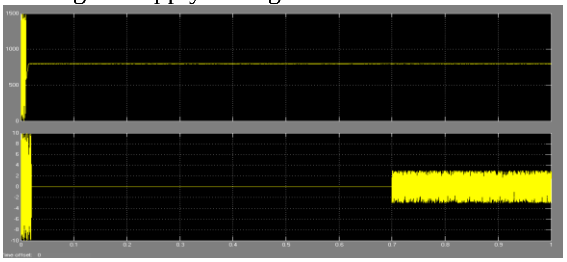

Fig.12 (a) DC link voltage. (b) Current through Capacitor

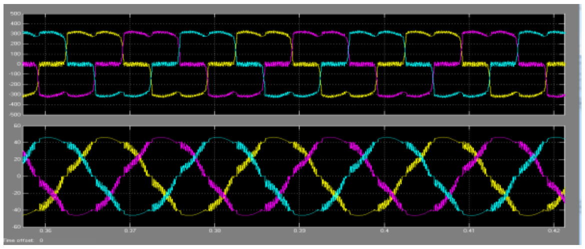

Fig.13 V-I characteristics of load current

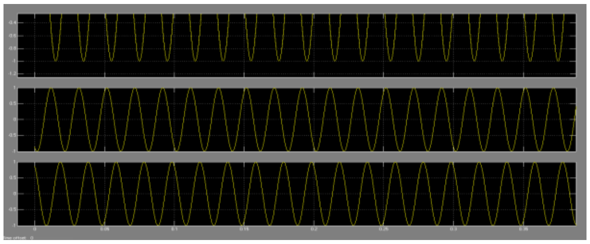

Fig:14 Unit Vectors or Eigen Values of Voltages sources

VII CONCLUSION

This paper presents the STATCOM-based control scheme for power quality improvement in grid connected wind generating system and with non linear 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-BESS in MATLAB/SIMULINK for maintaining the power quality is 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 STATCOM with BESS have shown the outstanding performance. Thus the proposed scheme in the grid connected system fulfils the power quality norms as per the IEC standard 61400-21.

REFERENCES

[1] Singh,K AL-Haddad,A Chandra "A Review of Active Filters for Power Quality Improvement" " IEEE Transactions on Power, Electronics Vol46,pp.960-971,1999

[2] M.P. Kazmierkowski, L. Malesani, "Current control techniques for three-phase voltage source PWM converters: a survey," IEEE Transactions on Industrial Electronics vol. 45, pp. 691–703, 1998.

[3] M. I. Milands, E. R. Cadavai, and F. B. Gonzalez, "Comparison of control strategies for shunt active power filters in three phase four Wire system IEEE Trans. Power Electron., vol. 22, no. 1, pp. 229–236, Jan., 2007.

[4] A. Sannino, "Global power systems for sustainable development," in IEEE General Meeting, Denver, CO, Jun. 2004.

[5]. K. S. Hook, Y. Liu, and S. Atcitty, "Mitigation of the wind generation integration related power quality issues by energy storage," epqu j., vol. xii, no. 2, 2006.

[6] . Billiton and y. gao, "energy conversion system models for adequacy assessment of generating systems incorporating wind energy," ieee, trans. on e. conv., vol. 23, no. 1, pp. 163–169, 2008

[7] J. Manel, "Power electronic system for grid integration of renewable energy source: A survey,"IEEE Trans. Ind. Electron., vol. 53, no. 4, pp. 1002–1014,,2006, Carrasco.

[8] M. Tsili and S. Papathanassiou, "A review of grid code technology requirements for wind turbine," Proc. IET Renew.power gen., vol. 3, pp. 308–332, 2009.

[9] S. Heier, Grid Integration of Wind Energy Conversions. Hoboken, NJ: Wiley, , pp. 256–259, 2007

[10]. J. J. Gutierrez, J. Ruiz, L. Leturiondo, and A. Lazkano, "Flicker measurement system for wind turbine certification," IEEE Trans. Instrum. Meas., vol. 58, no. 2, pp. 375–382, Feb. 2009

[11] C. Han, A. Q. Huang, M. Baran, S. Bhattacharya, and W. Litzenberger, "STATCOM impact study on the integration of a large wind farm into a weak loop power system," IEEE Trans. Energy Conv., vol. 23, no. 1, pp. 226–232, Mar. 2008.

BIOGRAPHY

K Prasada Rao received his B.Tech in the year 1997 from JNTU Hyderabad. He received ME(Electronic Devices)from Jadavpur University Kolkata in the year 2000 and M.Tech (Power Electronics) from JNTU Hyderabad in the year 2008 and presently he is pursuing Ph.D from JNTU Hyderabad. At present he is an Associate professor in Electrical& Electronics engineering Dept, Christu jyoti Institute of Technology and science, Jangaon,A.P, India. He is having 13 years of experience in teaching .He published 6 research papers in reputed international journals. His research interest includes Power Electronics, Electrical Machine Drives, Renewable energy sources and FACTS.

Dr.JBV Subrahmanyam is a Doctorate in Electrical Engineering from JNTU- Hyderabad, India, with two decades of rich experience in teaching, training, research, industry, projects and consultancy. He published 30 research papers in reputed international journals and 20 papers in international and national conferences. His research interest is in automation of power systems. He is an expert in condition monitoring of industrial equipment through modern diagnostic techniques. He implemented the latest GPS and GIS technologies in many power utilities in India successfully. He executed many international and national level technical projects effectively funded by Power Finance Corporation, Ministry of Power, Government of India, APDRP, DRUM, USAID and DFID-UK.At present he is a professor,Electrical Engineering Dept, Salman Bin Abdul Aziz University,Alkharj,Saudi Arabia.

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