

APPLICATION OF STATCOM IN GOVERNING THE GRID CONNECTED WIND ENERGY SYSTEM FOR POWER QUALITY IMPROVEMENT

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ABSTRACT

Significantly increases the penetration of wind energy as one of the renewable energy sources to cover the load on the demand side of electricity. Therefore, it is important to study the effect of wind energy on the dynamic stability of the electrical system. The growing demand for energy has led to the development of new technologies, which play a leading role in shaping the future of the energy market. Due to the constraints of the particular medium surrounding the wind turbine is connected to a network, they promise to improve the reliability of the system. When the wind is introduced into the grid, it affects the quality of the energy. Power Quality measurements effects are active power, reactive power, voltage fluctuation, flicker, harmonic and electrical behavior of switching operations. This paper presents the effect of static compensators (STATCOM) as the stability of power systems associated with wind power conversion systems. STATCOM (synchronous static compensator) is connected to a voltage source Converter (VSC) with the automatic switching device and can be used effectively to compensate reactive power. This article presents a STATCOM wind energy system at the general connection point to mitigate power quality problems. A STATCOM control system for a grid connected wind system is modeled using MATLAB / Simulink to improve network power quality. The results of the simulation show the performance of STATCOM.

KEYWORDS: Wind Energy, STATCOM, Reactive Power Compensation, Power Quality Improvement etc.

I. INTRODUCTION:

With power demand due to population growth and industrialization, energy production is a real challenge today. It is necessary to meet needs by the use of renewable energy, such as wind energy, biomass, hydropower and other. Both electric utilities and end users of electric power more and more concerned about the quality of electricity. The power quality can be defined as "any power problem at the voltage, current, and frequency, results in damage or improper operation of the customer's equipment." The input of wind power into the network

affects the quality of electricity. The key issue of power quality is the voltage drop, swell, flickering, harmonics and other power quality are a focus on customer and distribution network and mobile operation greatly affected a key measure. The power quality problem is important for the fan. The operation of a simple wind energy system is to use a direct connection to a network induction generator. The induction generator has inherent advantages in terms of cost efficiency and robustness. However, induction generators require magnetized reactive power. When the induction generator generates the active power change due to the wind, the induction generator's absorbed reactive power and voltage terminals can be significantly affected. Here we propose a STATCOM control technology to reduce the power quality problems; we integrated the wind turbine power generation.

Based on STATCOM control techniques have been proposed to improve the quality of electricity, which can manage the power level with commercial wind turbines with connected. Power control system connects wind power STATCOM to grid improve power quality and proposed the following objectives.

- Unity power factor at the source side.
- Reactive power support only from STATCOM to wind Generator and Load.

This work analyzes the performance of STATCOM with the wind power generation system and the power supply system before the common coupling point associated with power quality issues. However, the performance of the proposed system compares with the PI controller. It compares the results of the system, highlighting the benefits of STATCOM.

II. LITERATURE SURVEY:

Sharad W. Mohod introduced research on the improvement of the quality of control systems for grid connected wind energy system. The dissertation shows that power quality problems due to the installation of wind turbines with a network. In this proposed system, the STATCOM connects to the point of common coupling with a battery energy storage system (BESS) to address power quality issues. Energy storage battery is built to maintain the actual fluctuations of wind power. STATCOM control scheme for wind power generation connected to grid to

improve network power quality which is analyzed using / SIMULINK module of MATLAB power supply system[1].

GauravTembhurnikar, AjitChaudhari, NileshWani, AtulGajare, PankajGajaresuggests various reactive power compensation techniques required by the use of FACTS devices. They representresearch on the FACTS device, the parallel operation of the STATCOM, and how to help make better use of network under abnormal condition. First of all, many documents on events and the control of reactive power and literature reviewon STATCOM were studied and analyzed. The principle of operation and control of STATCOM, which includes phase-angle control and PWM technology, has been studied. However, these systems are useful for determining behavior under fault conditions [2].

Ahmed Abu Hussein and Mohd. Hasan Ali, have presented comparison between series connected auxiliary devices, like Superconducting Fault Current Limiter (SFCL), Dynamic Voltage Restorer (DVR), Thyristor Switched Series Capacitor (TCSC), and Series Dynamic Braking Resistor (SDBR), is achieved in terms of fault ride through competency improvement, harmonics suppression, controller complexity, and cost of a fixed speed wind generator system [3].

ShervinSamimianTehrani et al. present the Simulation of a 14-bus system using STATCOM compensated by applying the blunder and see the impact of the voltage compensator buses. Voltage stability of a system is exaggerated by reactive power limit of the system. FACTS devices advance the reactive power flow in system thereby successful voltage stability. In article explores the effect of STATCOM on static voltage stability [4].

P. Venkata Kishore and Prof. S. Rama Reddy represents Eight bus system is demonstrated using Matlab SIMULINK. The models are developed for eight bus system with and without D-STATCOM. The two D-STATCOM systems are compared with respect to THD and VAR comparison. The D-STATCOM is deliberate with respect to the voltage stability improvement at the load busses. The outcomes of VSI based D-STATCOM system are compared with those of Push pull inverter based D-STATCOM system [5].

Parimal Borse, Dr.A. G. Thosar and Samruddhi Shahatested modeling and simulation systems Flexible Alternating Current Transmission Systems (FACTS) device namely, Static Synchronous Compensator (STATCOM). The STATCOM a solid-state voltage source inverter and DC side capacitor are tied to a transmission line. STATCOM is injected almost sinusoidal currentvariable amplitude at the point of common coupling. The current injection is almost perpendicular to the line voltage, so emulating reactor at one point is connected to the transmission line. STATCOM model to verify functionality by setting the idle current

through it. This is useful for adjusting line voltage. STATCOM verifies the model by adjusting the reactive power flow and defines IGBT based converter using 6 pulses (two levels). Mathematical Modeling of STATCOM was rated 10kVA in MATLAB software [6].

III. TOPOLOGY FOR POWER QUALITY IMPROVEMENTS:

The voltage fluctuation 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 under:

- Voltage Sag/Voltage Dips.
- Voltage Swells.
- Short Interruptions.
- Long duration voltage variation.

Problem of voltage flicker describes the dynamic change in the network caused by the wind turbine or by changing the load. Thus, the power fluctuation by the continuous operation of the wind turbine power changes. The range of voltage fluctuations depends on the grid, impedance and phase angle and power factor of wind turbines. It is defined as a voltage variation ranges between 10-35 Hz.

The voltage deviation, flicker, harmonics resulting in equipment failure, i.e. a microprocessor based control system, programmable logic controller; Adjustable speed drives, flickering of light and screen.

It may leads to tripping of contractors, tripping of protection devices, stoppage of sensitive equipment like personal computer, programmable logic control system and may stop the process and even can damage of sensitive equipment. Thus it degrades the power quality in the grid.

The STATCOM is a three-phase voltage source inverter that has the capacitance of a DC linker and is connected to a common coupling point. The STATCOM is injected a compensating current at the bus of common coupling with a variable extent and the frequency. 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. The current is injected to cancel the reactance and the harmonic current of the load current and the induction generator, thereby increasing the power factor and the power quality.

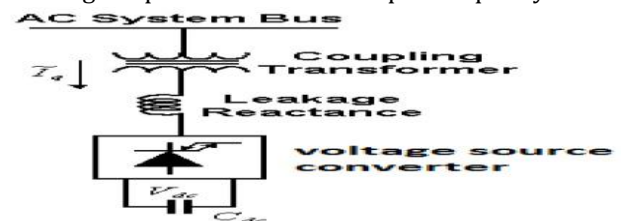


Figure 1 shows a basic model of STATCOM connected to the system bus through the AC coupling transformer. STATCOM is the reactive power

compensating device to generate and/or absorb reactive power are connected in parallel, the output can be varied to control the power system's specific parameters. Typically, the state of the solid-state converter can generate or absorb independently controlled active and reactive power at its output when its output is fed from the power source or energy storage device.

In particular, such as the STATCOM voltage source converter, when input from a given DC input terminal, to generate a three-phase AC output voltage, each of the phase corresponding to the voltage phase AC system and a relatively low reactive resistor. From (the interface is provided by the leakage inductance of the coupling reactor or a transformer). DC voltage is provided by the storage capacitor.

A STATCOM can improve power-system Performance like:

- The dynamic voltage control in transmission and distribution systems
- The power-fluctuation damping in power transmission systems
- The transient stability
- The voltage flicker control
- The control of not only reactive power but also (if needed) active power in the connected line, needing a dc energy source.

Furthermore, a STATCOM does the following:

- It occupies a small footprint, for it replaces passive banks of circuit elements by compact electronic converters
- It offers modular, factory-built equipment, thereby decreasing site work and executing time; and
- It uses encapsulated electronic converters, thereby minimizing its environmental impact.

A STATCOM is similar to an ideal synchronous machine, which produces a balanced group of three sinusoidal voltages at a fundamental frequency with controllable amplitude and a phase angle. This ideal machine has no inertia, which is actually instantaneous, does not significantly alter the existing impedance of the system, and can produce reactive (capacitive and inductive) power.

IV. WIND ENERGY GENERATING SYSTEM:

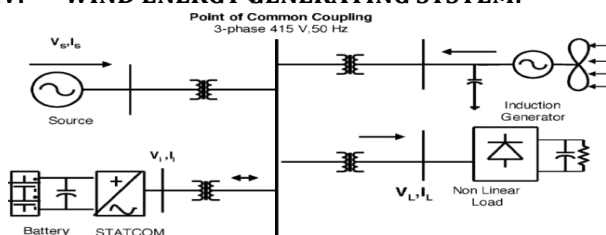


Fig.2 GRID CONNECTED SYSTEM FOR POWER QUALITY

IMPROVEMENT

In this configuration, wind energy production is based on having a constant speed control of propulsion of turbine topology. In the proposed scheme, due to the simplicity induction generator being used, no separate field circuit can accept a fixed and a variable load, and having short circuit protection to prevent physical. The available wind power of the system is as follows:

$$P_{wind} = 1/2 \rho A V_{wind}^3 \quad (1)$$

Where ρ (kg/m^3) is the air density and $A(m^2)$ is the area removed out by turbine blade, V_{wind} is the wind speed in m/s. It is not conceivable to extract all kinetic energy of wind, thus it abstract a fraction of power in wind, called power coefficient C_p of the wind turbine, and is given in (2):

$$P_{mech} = C_p P_{wind} \quad (2)$$

Where C_p is the power coefficient, be subject to on type and operating condition of wind turbine. This coefficient can be express as a function of tip speed ratio λ and pitch angle θ . The mechanical power produce by wind turbine is given in (3)

$$P_{mech} = 1/2 \rho A V_{wind}^3 C_p \quad (3)$$

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

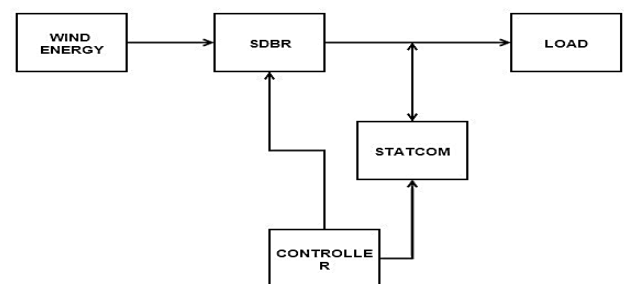


Fig.3 BASIC BLOCK DIAGRAM OF PROPOSED SYSTEM

Here, the pooled SDBR and STATCOM are connected to the terminal connected to the wind farm power system to observe the effectiveness of the proposed system under normal conditions and fault conditions in the grid. Figure 3 shows an overall diagram of the base system. It consists of a wind power generation system, SDBR, STATCOM and a controller to control the operation of STATCOM and SDBR. Series Dynamic Brake Resistance (SDBR) directly contributes to balance of active power during the failure; STATCOM help regulates the reactive power flow.

V.MATLAB SIMULATION AND RESULTS:

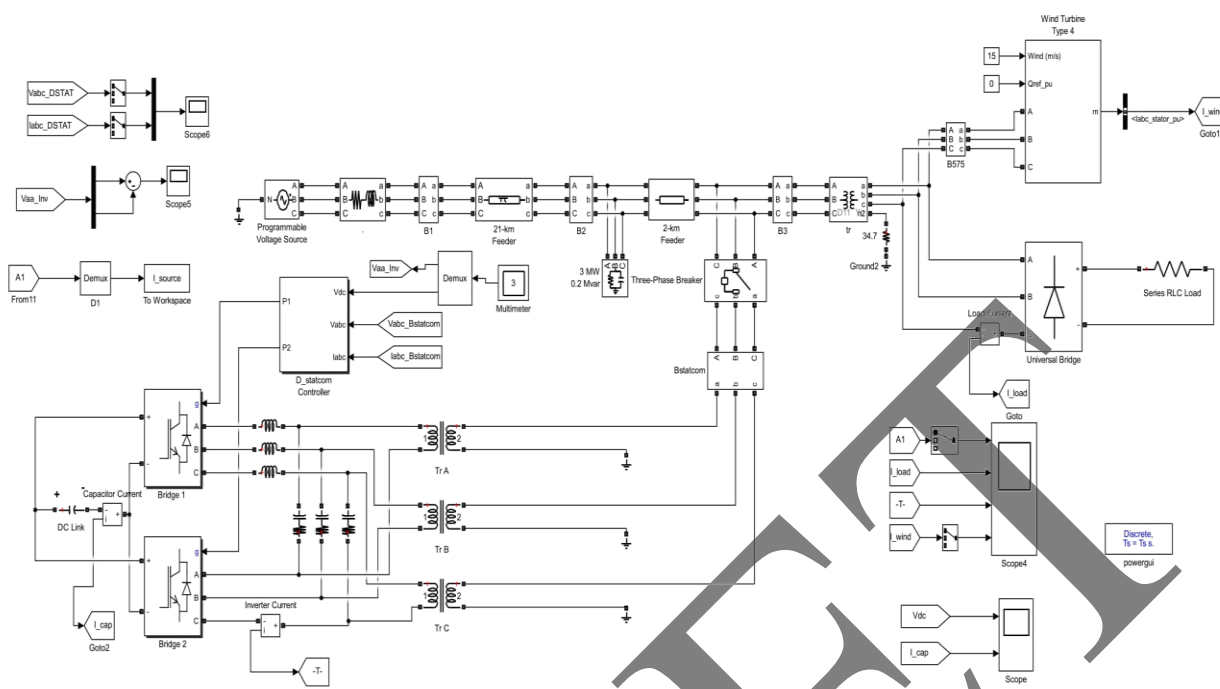


Fig.4 MATLAB SIMULATION DIAGRAM

Fig.4 shows Matlab simulation diagram of STATCOM in controlling the grid connected wind energy system for power quality improvement by FFT and analyzed waveforms are shown in Fig.5. STATCOM regulate the available real power from source. The result

of source current, load current are shown in Fig. 5(a) and (b) respectively. While the result of injected current from STATCOM is shown in Fig. 5(c) and the generated current from wind generator at PCC are depicted in Fig. 5(d).

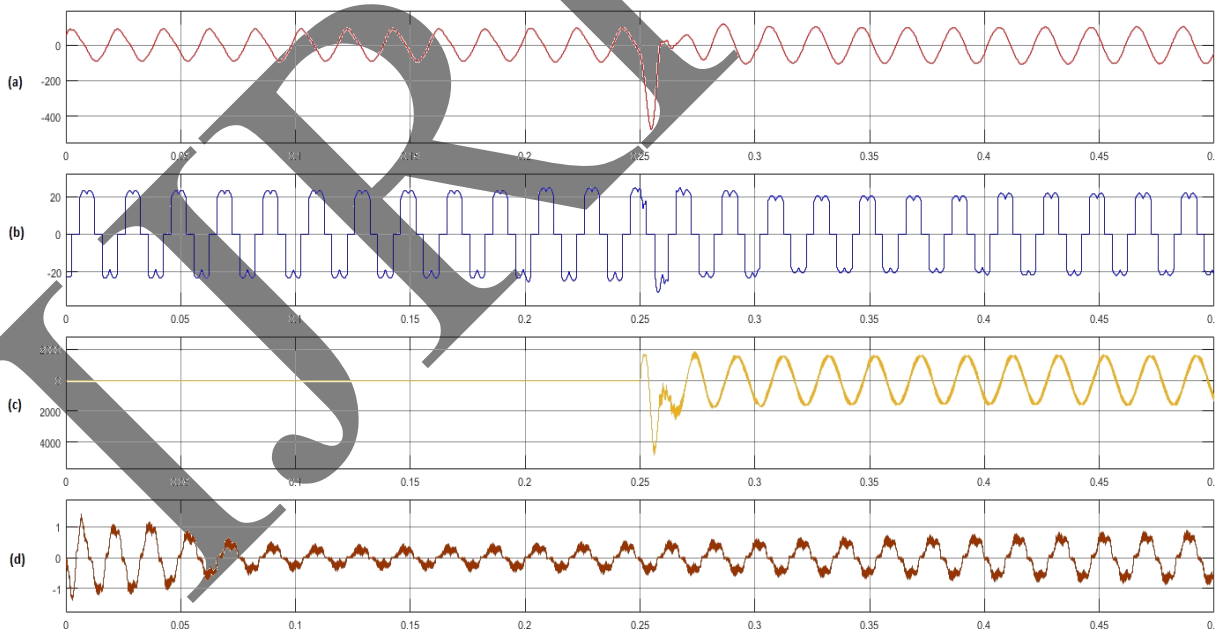


Fig.4 MATLAB SIMULATION RESULT

VI. CONCLUSION:

In this way, the article describes an improved state of the STATCOM power control status based on the wind energy power system and the non-linear load. It introduces power quality issues and their impacts on consumers and electricity companies. Simulation of MATLAB / SIMULINK for STATCOM-BESS is developed to control the system to maintain power quality. Has the ability to eliminate the portion of the load current harmonic. It also maintains source and the power voltage, and in support of the PCC grid system, the demand for reactive power of the wind turbine and the load, thus providing opportunities for increased use of the transmission line. Integrated wind power and STATCOM and BESS were excellent. Therefore, the system proposed network connection to meet the power quality standards.

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