POWER QUALITY IMPROVEMENT OF WIND GENERATOR USING STATCOM

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ABSTRACT:

The wind energy generation, utilization and its grid penetration in electrical grid are increasing worldwide. Injection of the wind power into an electric grid affects the power quality. The main power quality issue which has gained its concentration is the harmonic behaviour of the system. This paper suggests a scheme in which a VSC based STATCOM is used to reduce the harmonic content. A MATLAB simulink model is prepared to demonstrate the STATCOM control scheme which can effectively reduce the harmonic content in the system.

Key words: Wind energy, Power Quality, Hamonics, PWM Technique, Voltage Source Converter, STATCOM,

INTRODUCTION:

Renewable energy is increasing its importance and will become an integral part of the world energy in the future. Apart from solar and biomass wind energy is one of the most significant renewable source of electrical power. Wind power has been used for centuries with different purposes the remarkable contribution to the electricity supply started in the mid 1980s. Since then the interest in wind power has increased with the new demand for clean and sustainable energy sources. Due to the increasing demand on electrical energy, a considerable amount of effort is being made to generate electricity from new sources of energy. Wind energy is now achieving exponential growth and has great potential.

POWER QUALITY ISSUES

One of the major technical challenges for wind power plant is power fluctuation at the output. The power fluctuation is caused by the variations of the wind speed inducing the generator to produces different power levels at varied time. With the increasing amount of wind power

generation connected to the power grid, the importance of measuring the wind turbines power characteristics and power quality characteristics is growing.

There are various power quality issues which are concerned with a wind power system are voltage sag, voltage swell, flicker, interruption, transients, over voltages, harmonics, inter harmonics. The main problems related to power quality are Harmonic distortion and reactive power compensation. Most industries and companies prefer electrical energy with high quality. Power quality issues are a deviation from this ideal system waveform, and limits have been adopted through various standards and guidelines for maintaining continuity, voltage magnitude, harmonic limits, and transient nature of electric power systems. Power quality issues are a deviation from this ideal system waveform, and limits have been adopted through various standards and guidelines for maintaining continuity, voltage magnitude, harmonic limits, and transient nature of electric power systems.

The power fluctuation from wind turbine occurs during continuous operation. The amplitude of voltage fluctuation depends on network impedance, phase-angle, grid strength and power factor of the wind turbines. A large number of non-linear power electronic devices can have significant effect on the harmonic emissions. These harmonics can form a serious threat for power quality.

CAUSES & EFFECT OF HARMONIC:

The major contributor of harmonics in a wind power system are non linear loads, induction motors, power transformers, converter switching action these are some major sources for introducing harmonic content in the system.

Harmonic currents in wind power system can cause harmonic distortion, low power factor and additional losses as well as heating in the electrical equipment. It also can cause vibration and noise in machines and malfunction of the sensitive equipment's namely microprocessor based control system, programmable logic controller; adjustable speed drives. It may leads to tripping of contractors, tripping of protection devices, and stoppage of sensitive equipment's. Thus it degrades the power quality in the grid.

REDUCTION TECHNIQUE:

A Voltage Source Converter (VSC) based Static Compensator (STATCOM) i.e. VSC based STATCOM is one the solution for reducing the harmonic content in the system as well as

helps in compensating the reactive power requirement of the system. The current control voltage source inverter based STATCOM 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. A voltage-source converter is a power electronic device, which can generate a sinusoidal voltage with any required magnitude, frequency and phase angle. 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 VSC connected in shunt with the ac system provides a multifunctional topology which can be used for up to three quite distinct purposes: Voltage regulation and compensation of reactive power, Correction of power factor and Elimination of current harmonics.

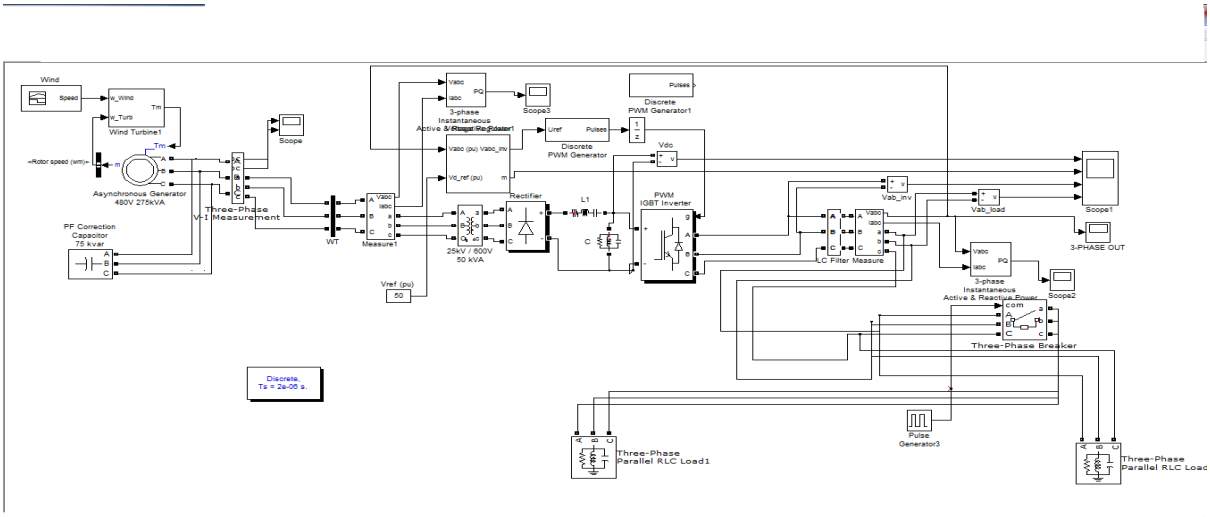
The objective of this research work was prepare a simulink model to reduce the harmonic content of the wind power system.

MATLAB SIMULINK MODEL:

The simulink model was prepared in MATLAB software, in this model variable wind speed was given to wind turbine which converts the kinetic energy of wind into electrical energy using a induction generator, for power factor correction a power factor correction capacitor was connected across the generator, the output of the generator was sent to converter where the ac was converted into dc and the ripples are removed further this dc was sent to a inverter working on PWM (Pulse Width Modulation) technique . A control system was designed in order to generate a error signal which was applied as a gate pulse to the IGBT of the inverter. This inverter uses PWM technique for the reduction of the harmonic content. The simulink model for the reduction of harmonic content in the wind power system is shown in fig.1

Paramters:

Induction generator	480V, 50Hz, 1800rpm.
Operating frequency	50 Hz
Rs and Ls	0.016 and 0.06 p.u.
Rr and Lr	0.015 and 0.06 p.u.
Lm	3.5 p.u.
Inverter snubber resistance	7000 ohms



SIMULATION OUTPUT:

The waveform obtained from the simulink model without connecting statcom in the wind power system is shown in the figure 2, this waveform shows three phase output waveform without statcom which shows the harmonic content in the output because of the switching action.

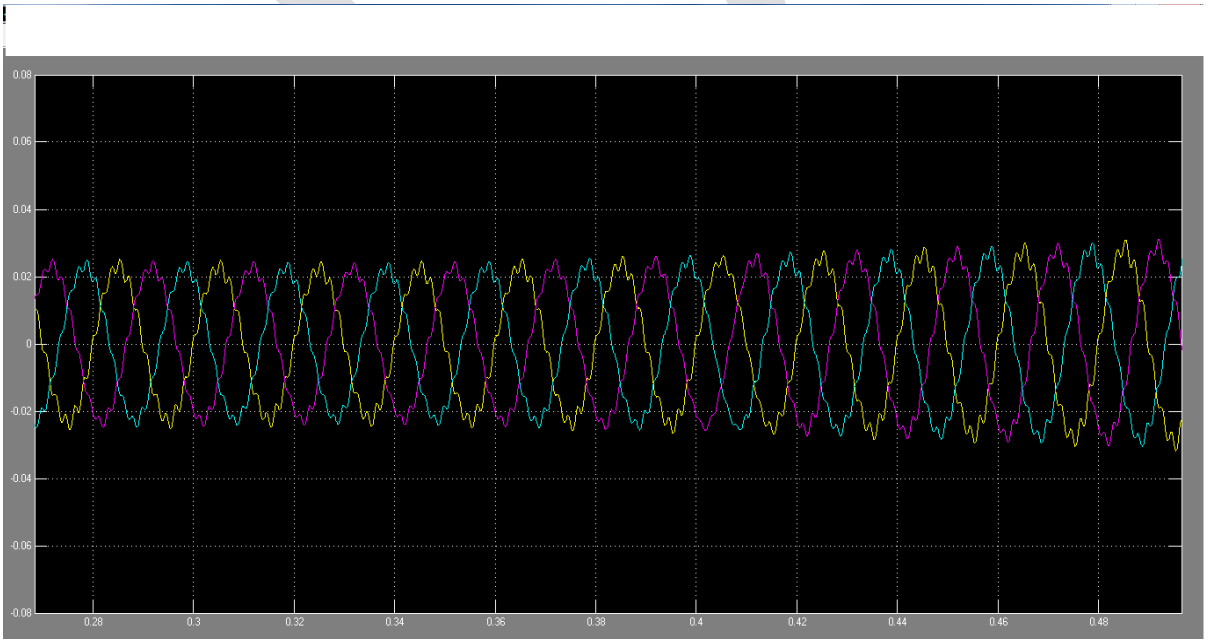


Fig.2 Three phase output without statcom

The waveform obtained by connecting statcom in the wind power system in the simulink model is shown in the figure 3 which was the three phase output and clearly shows that the harmonic content reduces with statcom.

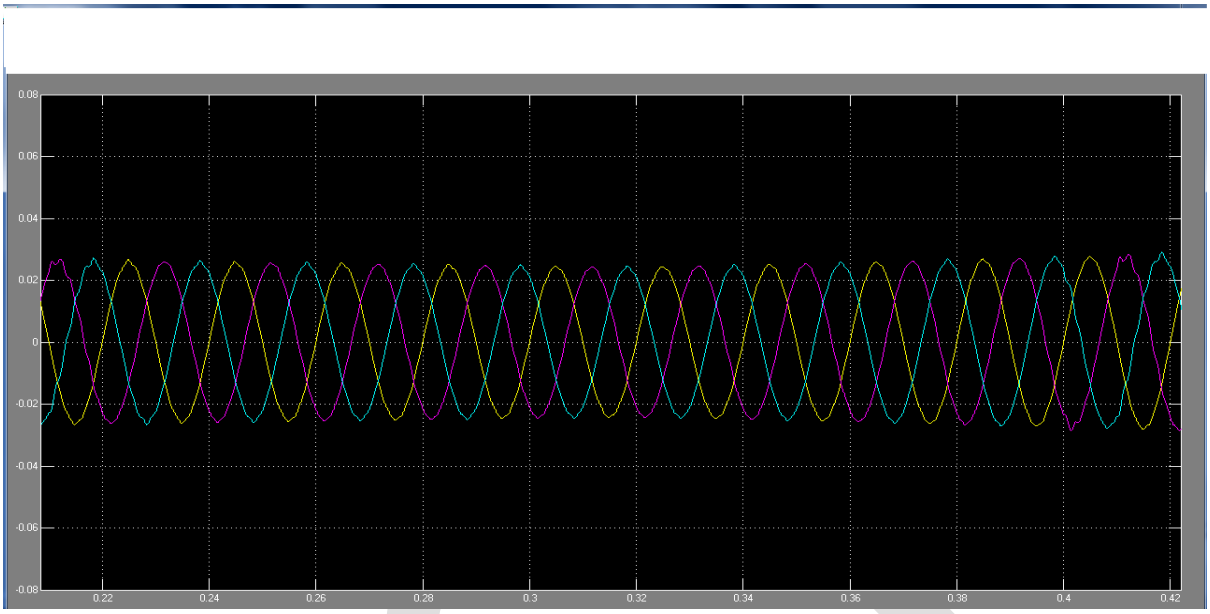


Fig.3 Three phase output with statcom

The FFT analysis of the simulink model is analysed and the graph in the figure 4 shows the FFT analysis of the wind power system without statcom and it is observed that the total harmonic distortion in the system is 8.49%.

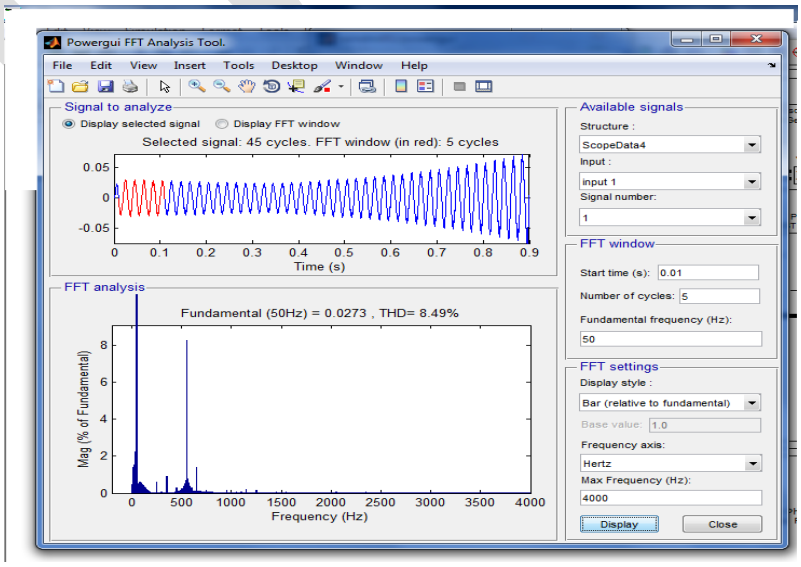


Fig.4 FFT analysis without statcom (THD = 8.49)

The FFT analysis of the wind power system connected with statcom is shown in figure 5 which shows that the total harmonic content in the wind power system is 1.36%.

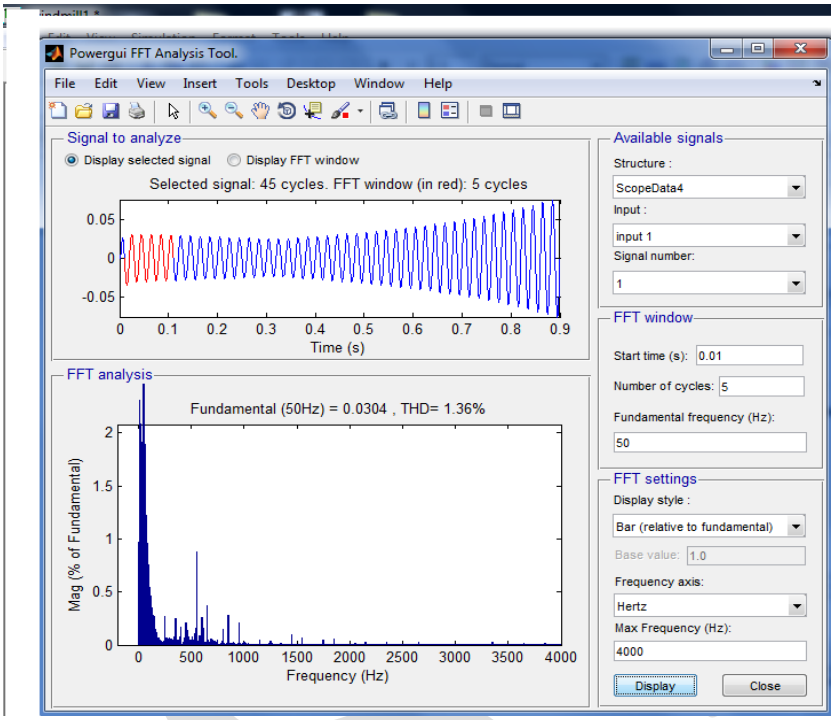


Fig.5 FFT analysis with statcom (THD = 1.36%)

RESULT:

From the above waveforms in the fig.1 and fig.2 the thee phase output of a wind power system can be examined which clearly shows that the waveform is not purely sinusoidal and contains harmonic which are produced because of the switching action, and in fig.2 it can be seen that the harmonic content reduces with a statcom. Further from the FFT analysis of the system the total harmonic content (THD) find out to be 8.49% without statcom and 1.36% with statcom.

CONCLUSION:

Thus from the simulation results of the above simulink model it can be concluded that a VSC based STATCOM when connected in a wind power system not only reduces the harmonic content but also provides reactive power compensation to the system.

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