Performance Analysis of Statcom in Grid Connected Wind Energy Conversion System using Softcomputing Techniques

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***Abstract*:- To meet the power demand and to control the power flow in the system the Flexible Ac Transmission System Devices (FACTS) are used. It increases the capacity of the transmission line and improve the power flow control. In FACTS device Static Compensator(STATCOM) is the shunt FACTS device can be used for voltage regulation in power system, to control power flow and make better transient stability. It regulates the terminal voltage by changing the amount of reactive power in or out from the power system. Due to its less carbon emission and no depleting nature wind energy in the power system is most preferable.The interconnection of the wind energy conversion system (WECS) with the grid causes the power quality problems because of variable nature . The power quality problems are the variation in the voltage, frequency, real power, reactive power, flickering and harmonics. The STATCOM is implemented in Wind Energy Conversion System .The static compensator is used to improve the Total harmonic distortion (THD) level in the point of common coupling point. In Soft computing techniques fuzzy controller are used which gives better performance.**

Keywords : Flexible Ac Transmission System; Static Compensator; Wind Energy Conversion System; Total harmonic analysis

I. INTRODUCTION

In recent days due to the increasing demand and high cost and less availability of the conventional energy sources and also the transportation cost and storage problem the wind energy production technology is a major role in the electrical system. Synchronous generator equipped with a gear used for the variable speed applications [1].The principle of the wind machine is the electromechanical conversion process. The components present in the wind energy conversion system are the turbine, gearbox and the generator which maybe synchronous or the asynchronous machines. based on requirements the generator type is selected. The speed and torsional oscillations even occurs in the direct driven wind energy system, by the elimination of assistant damping device. In grid connected WECS The power quality problems are arrived such as variation in real and reactive power, changes in sinusoidal nature of the waveform, voltage and frequency changes which makes power quality problems and produce the harmonics.

The active damping strategy used for the speed and torsional oscillations suppression occurs in the permanent – synchronous generator (PMSG) based wind energy conversion system(WECS) [5].The pole-assignment approach used to design the damping controller for the STATCOM to provide better damping under different fault conditions in four parallel-operated offshore wind turbine generators (WTGs) connected to an onshore power system [6]. Soft computing techniques used for better performance.

II. STATCOM

To meet the power quality problems and to maintain the stability and reliability of the system the FACTS used to maintain the power flow in interconnected AC transmission systems It provides the power flow control with higher transmission capacity. Power flow in a system depends on line impedance of the line and the sending and receiving end voltage magnitude and phase angle between the voltages.The control of above parameters necessary to control the active and the reactive power flow in the transmission line. During the fault and contingency conditions or at any abnormal or transient conditions this devices operates and maintain the power flow to enhance the system performance in secured limits. In wind energy conversion system the variable nature of the wind velocity conditions causes the variation in the system parameters which is reduced by FACTS devices connected to the system.

STATCOM is the shunt FACTS device can be used for voltage regulation in power system, to control power flow and make better transient stability. It regulates the terminal voltage by changing the amount of reactive power in or out from the power system. STATCOM gives better transient stability and it regulates the terminal voltage by changing the amount of reactive power in or out from the power system. The construction of static compensator is shown in the below diagram,

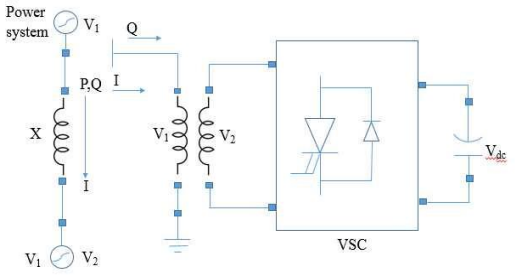

Fig 1 construction of STATCOM

At low voltage conditions in the system, the STATCOM inject reactive power. At high voltage conditions, it absorbs reactive power. Reactive power variations done through a Voltage-Sourced Converter (VSC) connected on the secondary side of a coupling transformer. VSC is a power electronics based converter. It generates 3–phase voltage with power system frequency V2 from a DC voltage source furnished by the charged capacitor.

III.WECS WITH STATCOM

The simulation diagram of the synchronous generator based wind energy conversion system is given below ,

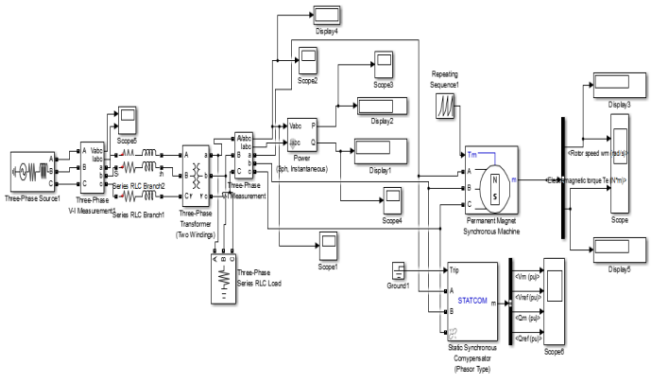

Fig 2.WECS with STATCOM

This variable wind speed imposes the power quality problems and cause the harmonics and cause the voltage distortion. To meet and reduce the harmonic problems the STATCOM used at the PCC point to control the voltage, real power and reactive power. Under the variable wind speed condition the STATCOM operates to improve the system voltage and to reduce the harmonic levels.

The STATCOM operates and maintain the system voltage and which is used to reduce the harmonic levels The power quality issues that arise when wind turbine is connected to distribution system is minimized by fuzzy controlled STATCOM. STATCOM with fuzzy controller works with a set of fuzzy rules which are implemented in the MATLAB program. It is rule-based expert systems which is based on fuzzy rules and fuzzy inference. In grid connected WECS the power quality problems are imposed under variable wind speed conditions. Due to the features of fuzzy logic controller it used in the WECS to manage the power quality problems. The fuzzy logic controller needs the error and change in error for that operation and it compute a control signal depending on the measured inputs error (e) and change in error (dE).Finally the fuzzy gives the value what should be the input of the system with respect to the e and dE. STATCOM with fuzzy controller is given.

TABLE I. LINGUISTIC FUNCTION

dE/dt / E	VS	S	M	B	VB
VS	VS	M	B	VB	VB
S	M	S	B	VB	VB
M	M	B	M	B	VB
B	B	B	VB	VB	VB
VB	VB	VB	VB	VB	VB

IV. RESULTS AND DISCUSSION

Due to the variable wind speed conditions, the changes occurred in the system parameters and it causes the power quality problems and produce harmonics in the system. So to maintain the system parameters by reducing the harmonics the FACTS connected at the PCC The reactive power, real power and the voltage waveform are given below,

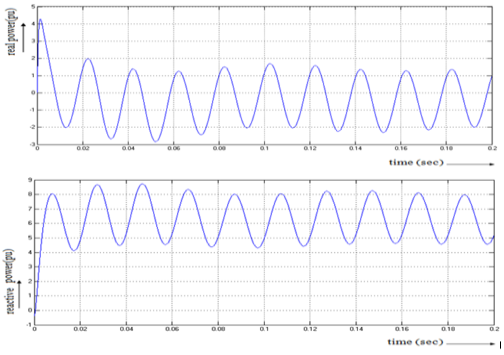

Fig 3.Real power, reactive power waveform without STATCOM

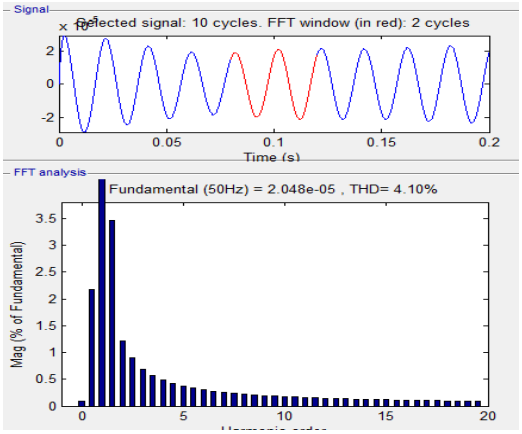

Fig 4.THD in DFIG without STATCOM

can observe that the Real power, Reactive power in WECS without STATCOM controller harmonics level is 4.10%

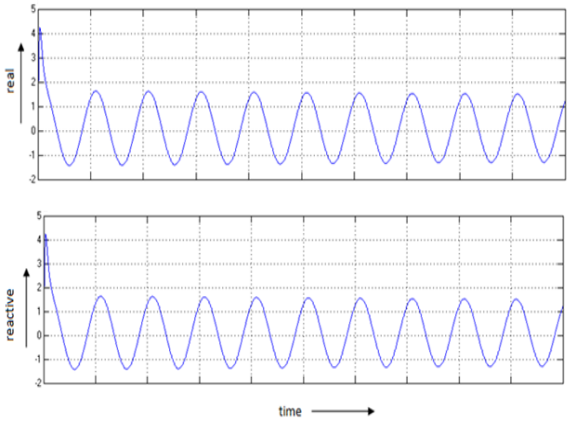

Fig 5.Real power, reactive power waveform with STATCOM

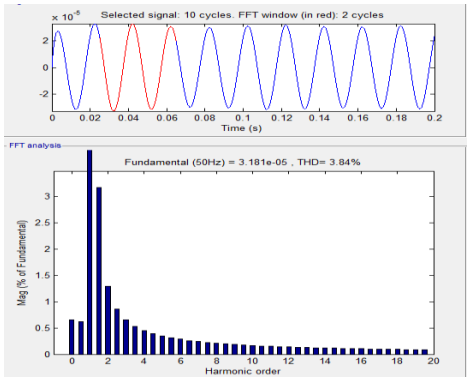

Fig 6.THD with STATCOM

. The THD level at the PCC point with STATCOM created harmonics level is 3.64%

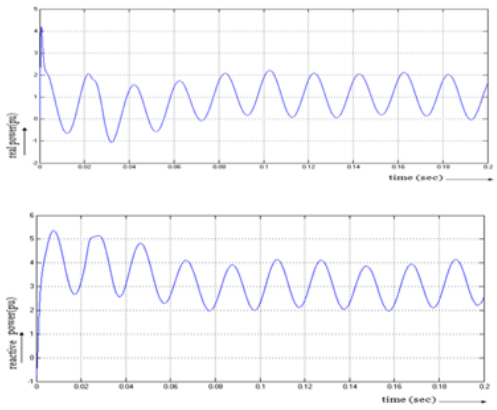

Fig 7. Real power, reactive power waveform With FUZZY

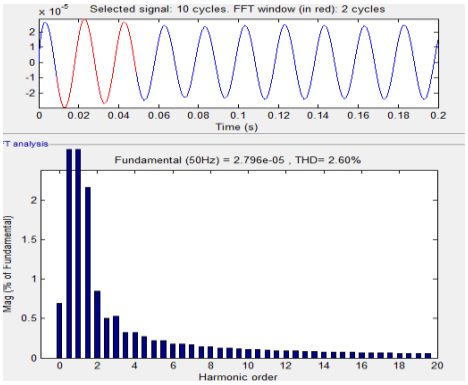

Fig 8.THD with FUZZY

Real and reactive power and THD is better than the with STATCOM to compare the with FUZZY at the pcc in grid connected WECS. the harmonic laevel is 2.60%

TABLE IV. HARMONIC LEVELS

WITHOUT STATCOM	WITH STATCOM	WITH FUZZY
4.10%	3.64%	2.60%

V. CONCLUSION

The main issue of the integration of the wind energy system with the grid is the power quality problems because of the variable wind speed conditions. This power quality problems affects the system parameters and produce the harmonics. The STATCOM connected at the PCC in wind energy conversion system to reduce the harmonics. The simulation done by the MATLAB/SIMULINK and the results concluded that THD in the system are reduced by the connection of STATCOM and FUZZY controller at PCC point.

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