STATCOM Based Power Quality Improvement of Grid Connected Wind System

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***Abstrac*t:** *A power grid will consist of various types of generating sources connected to it, which include conventional and non-conventional types. When the non-conventional types of generating source such as wind power plants are connected to the grid, therefore an introduction of reactive power into the grid which will cause the harmonics. This will raise the power quality problems in the grid connected system. Hence this paper concentrate on the power quality problems which are involved in grid connected wind system and the mitigation of power quality problem using STATCOM techniques. The STATCOM based wind system is defined and simulated using MAT LAB simulink package and the power quality improvement is tested.*

Key words: WPP, STATCOM, Power Quality.

[1] Introduction

In the generation of power the present scenario gives more importance for the awareness of the non-conventional energy sources, as the conventional sources are exhausting and the increase in the demand from consumers. Hence this will lead to the alternate various methods of generation of power. As the demand is constantly increasing, there is a very much burden for meeting the demand which lead to light up on the generation sources such as wind power generation. The wind energy generation is one of the rapidly developing sectors because of the environmental free impacts and less running costs; there are various ranges of wind generating plants which varies from few watts to 8MW. As the utilization of wind power is increasing the technologies used for generation is also improving because of which the wind energy has got an firm market in the renewable energy generations and also the overall cost of generation of power is much more smaller when compared to other forms such as coal, nuclear, oil etc. due to this, many researches are taking place for the improvement of the aerodynamics and generating techniques. If we analyze the production, the production depends upon the wind, hence there is an fluctuations in the voltage developed when this power generated by the wind power plants is connected to the grid and the power quality problems gets raised due to which stability, reliability problems of the grid is affected.

Therefore an STATCOM based mitigation technique is proposed in this paper which absorbs the reactive power from the grid and makes the grid more stable. The STATCOM are more effective fast responding economical devices which maintain unity power factor also.

[2] Power Quality problems in grid connected WPP

The main power quality problems that arise when the WPP is connected with the grid are:

1. Voltage swell
2. Voltage sag
3. Short interruption
4. Flicker
5. Harmonics

1. Voltage swell: it is the phenomenon of abrupt increase of the voltage in the grid when the power developed is more, hence due to which the equipment's which are connected will get malfunctioned, basically electronic devices are the major part which gets affected by this problem.

2. Voltage Sag: voltage sag the abrupt decrease in the magnitude of the voltage by which an heavy current will gets flowed into the equipment and hence the equipment gets damaged if it exceeds the rated value.

3. Short Interruption: short interruptions are the loss of the supply for the short duration due to which the performance of the equipment's

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connected will be affected due to the short interruptions the life of the equipment gets reduced.

4. Flickers: It is the dynamic variation of the voltage of the grid which is due to the variation of the supply and demand parameters it is one of the most heavily affecting parameters which has the tendency to shut down the entire power network if the voltage crosses its maximum permissible value.

5. Harmonics: The most common power quality of all is the harmonics. Harmonics are the distortions in the waveforms of the voltage and current of the grid due to which the equipment connected with grid work at critical conditions such as making noise in machines, Introduction of unwanted signals in amplifiers etc.

[3] Mitigation using SATCOM technique.

The method to improve the wind power plant is by making the plant to have ability to supply or absorb the reactive power this process is done with the help of STATCOM/synchronous static compensators. For the system to be protected the solid state static compensator is connected in parallel. Hence by this the magnitude of voltage and the reactive power injection to the bus can be controlled.

Static compensators are the improvement techniques of the reactive power compensators which have the characteristics similar to the synchronous condenser. As the STATCOM has lower investment, less maintenance and stable so STATCOM is used widely.

Figure 3.1 shows the STATCOM which contains the voltage source convertor which are mainly built on GTO's or IGBT's. The capacitors connected on a DC side of the convertor and the whole is connected with a shunt transformer.

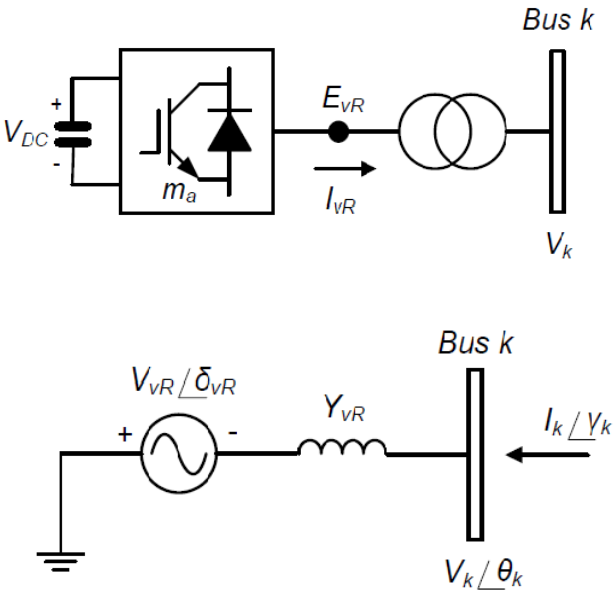

Fig 3.1: STATCOM scheme with equivalent representation.

[4] Operating Principle

The operating principle of the STATCOM is that it acts as a synchronous voltage source, because the output of the STATCOM can be controlled in any ways. During the operation of STATCOM it is assumed that there is no usage of active power. And the controller and grid voltages are in phase.

The operation contains two parts one, is when the voltage of the coupling point is greater than the voltage of the compensator at this condition current will flow from the grid to STATCOM and hence reactive power is consumed and if it is opposite to the above case STATCOM provides reactive power to the grid.

Schematic representation of this is shown in the fig below.

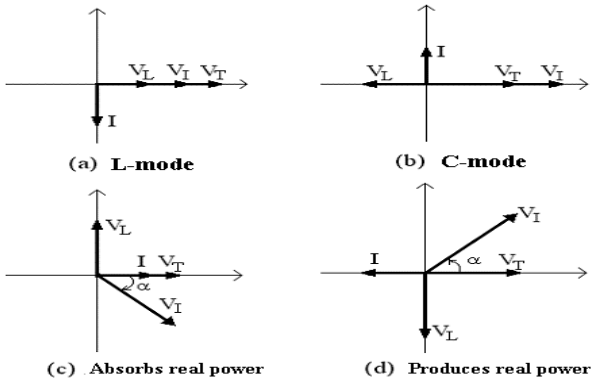

Fig 4.1:Operation of STATCOM

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[5] Simulation

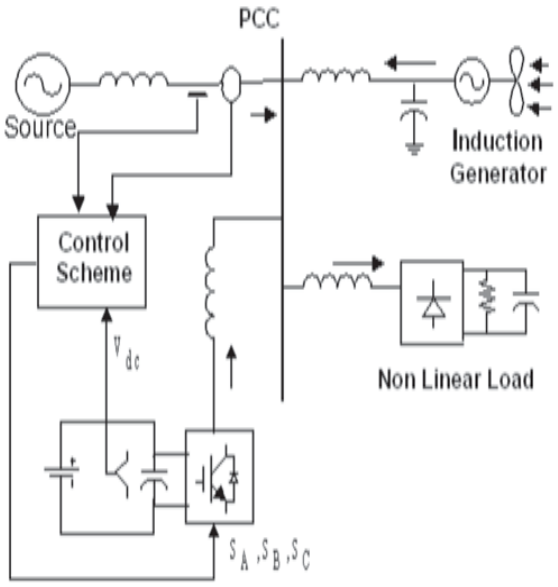

Fig 5: Simulated Circuit Block Diagram.

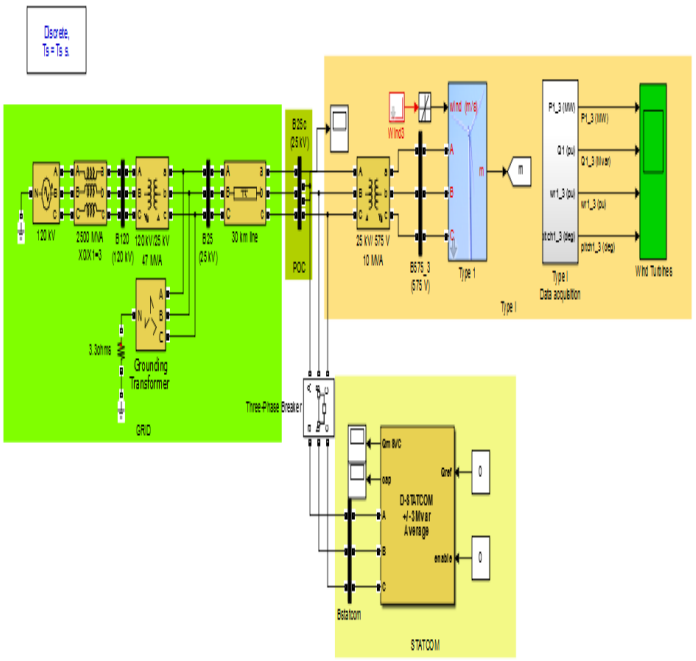

Fig5.1: Simulation in MAT LAB SIMULINK

The above circuit diagram is simulated in the MAT LAB Simulink software package with the following parameters

S.N.	Parameters	Ratings
1	Grid Voltage	3-phase, 415V, 50 Hz
2	Induction Motor/Generator	3.35 kVA, 415V, 50 Hz, P = 4, Speed = 1440 rpm, Rs = 0.01Ω, Rr = 0.015Ù, Ls = 0.06H, Lr = 0.06H
3	Line Series Inductance	0.05mH
4	Inverter Parameters	DC Link Voltage = 800V, DC link Capacitance = 100 iF. Switching frequency = 2 kHz,
5	IGBT Rating	Collector Voltage = 1200V, Forward Current = 50A, Gate voltage = 20V, Power dissipation = 310W
6	Load Parameter	Non-linear Load 25kW.

The wind power generator consists of the induction generators and the STATCOM consist of IGBT's and nonlinear load. The output is simulated once without STATCOM and again with STATCOM.

When the STATCOM is not connected the current at the coupling point will be fluctuating as shown in the fig6.1. and when simulated with STATCOM there is a reactive power correction which leads to the removal of fluctuations

[6] Results and Analysis

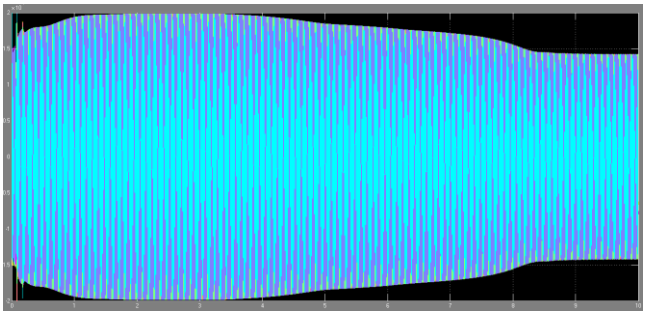

Fig 6.1: Current at coupling point without STATCOM.

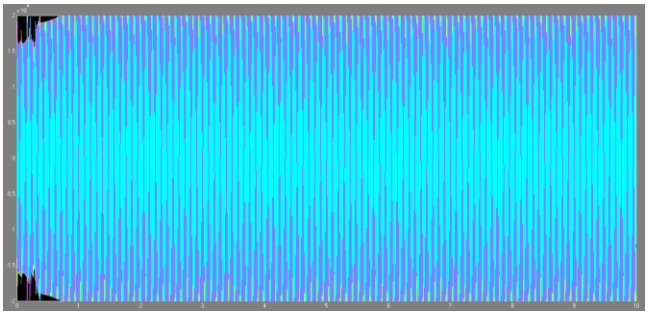

Fig 6.2: Current at coupling point with STATCOM.

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The STATCOM based grid connected wind system has an effective controlled reactive power injection and absorption phenomenon and hence mitigates the power quality problems occurring in WPP connected grid.

[7] Conclusion

From the above simulation case studies we can conclude that the voltage magnitude of the grid can be maintained at 1 PU I.e. the problem of voltage dip can be eliminated.

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