

SIMULATION OF IMPROVEMENT OF POWER QUALITY USING STATCOM-CONTROL SCHEME WITH GRID CONNECTED WIND ENERGY SYSTEM

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ABSTRACT

The use of wind energy generation in electrical grid is increasing worldwide. Injection of the wind power into an electric grid affects the power quality. The generated wind power is always not constant due to its time varying nature and causing stability problems. This weak interconnection of wind generating source in the electrical network affects the power quality and reliability. In this paper the power quality problem due to installation of wind turbine with the grid is determine. In this proposed scheme Static Compensator (STATCOM) is connected at a point of common coupling to reduce the power quality problems. The STATCOM gives reactive power support to wind generator and also load. The proposed system maintains the grid voltage free from distortion and harmonics. In this paper the effect of STATCOM is presented. The behavior of STATCOM is studied under reactive loading condition.

KEYWORDS— Static Synchronous Compensator (STATCOM), Insulated-Gate Bipolar transistor (IGBT), Voltage Source Converter (VCS), Static Voltage Compensator (SVC), wind generating system (WGS).

INTRODUCTION

Now-a-days the distribution system suffer from many power quality problems such as voltage sag, voltage swell, voltage spikes, voltage fluctuation, harmonics etc., STATCOM (Static synchronous compensator) is also called as Synchronous Compensator. STATCOM is shunt connected reactive power compensation; it is used to generate or absorb the reactive power to the transmission and distribution line. The STATCOM will provide the reactive power to the line only if the load is suffer from lack of reactive power at given bus location and vice versa[1]. STATCOM is a voltage source converter (VSC) device. The voltage source is in

behind the reactor of the SATACOM. The STATCOM has DC capacitor from which the voltage source is created. Hence the STATCOM has little very little active power. If suitable source is coupled across the DC capacitor, then STATCOM will give active power to the line. Depending upon the amplitude of the voltage source, it will provide reactive power/ absorb reactive power [2]. The main aim of using STATCOM is to regulate the voltage and to improve power quality. The response time of STATCOM is very short when compared with SVC. This is happened due to the present of IGBT. Since IGBT have fast switching time. The STATCOM will give best reactive power support at low voltage than the SVC. This is because of the reactive power from the STATCOM decrease linearly with the AC voltage [3].

In this paper we discuss about the grid connected wind energy system using STATCOM and it is modeled using MATLAB/SIMLINK.

FUNDAMENTALS OF STATCOM

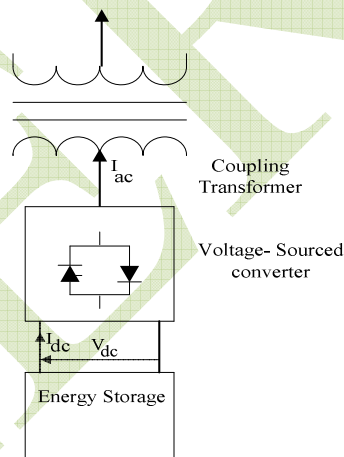


Fig.1. Functional model of STATCOM

The STATCOM is made up of VSC, coupling transformer and dc energy storage devices. The output voltage of VSC controls the VAR flow into or out of the STATCOM [4][5]. The basic scheme of the STATCOM is shown in the figure 1.

POWER EXCHANGE IN STATCOM

The amount and type of power exchange between the STATCOM and the PCC (Point Of Common Coupling) can be adjusted by controlling the magnitude of STATCOM output voltage with respect to the system voltage as shown in fig. The STATCOM is connected at the PCC where V_O is the magnitude of STATCOM output voltage V_{pcc} is the magnitude of

the system voltage at PCC and X_S is the equivalent reactance between STATCOM and the system [4]. The reactive power supplied by the STATCOM is given by

$$Q = \frac{V_O - V_{pcc}}{X_S} V_{pcc}$$

STATCOM supplies or absorbs reactive power based on the Q value either positive or negative as shown in figure 2.

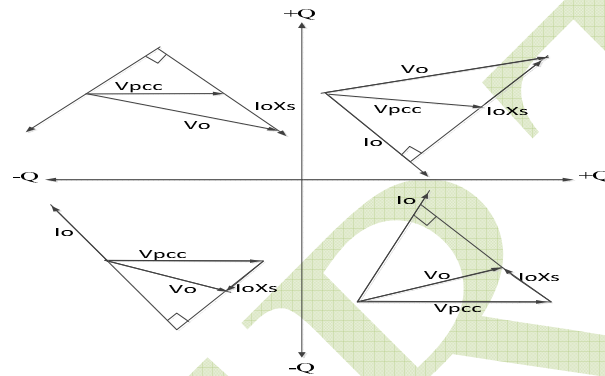


Fig 2. Operating modes of STATCOM

Figure 3 shows the STATCOM output current and voltage diagram where phasors I_Q and I_P represent the AC current I_{ac} components that are in quadrature and in phase with the AC system voltage V_{ac} respectively. If both real and reactive power flows are positive, then the power is absorbed by the STATCOM while negative means that the power is injected by the STATCOM. The corresponding reactive power exchanged can be expressed as follows.

$$Q = \frac{V_{out}^2 - V_{out} V_{ac} \cos \alpha}{X} \quad (2)$$

Where the angle α is the angle between the AC system bus voltage V_{ac} and the STATCOM output voltage V_{out} [4].

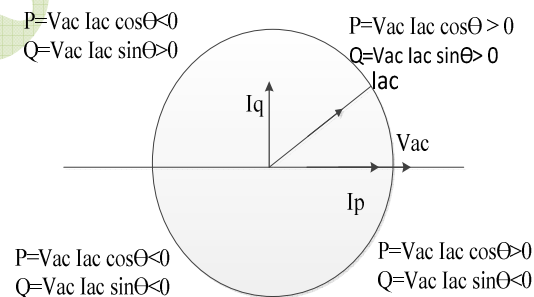


Fig.3. At AC terminal

POWER SYSTEM UNDER STUDY

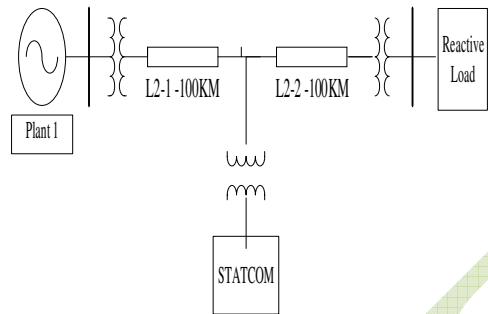


Fig.4. System under study

Figure 3 represents 138 Kv system with STATCOM and reactive load. STATCOM provides mid-point configuration between line L2-1 and L2-2 having length 100Km each. STATCOM connected to the system using Zig Zag phase shifting transformer. It's application for creation of a missing neutral connection from an underground system to permit the grounding of that neural to an earth reference point and also harmonic mitigation.

WIND ENERGY GENERATING SYSTEM

In this system induction generator is used since separate field circuit is not required, it accepts constant and variable load. Induction generator and energy storage system are interface at point of common coupling. STATCOM is connected to the system in parallel. This system has natural protection against short circuit.

The battery storage system and shunt connected STATCOM is connected with the interface of induction generator and non-linear load at PCC in grid system as shown in figure 5. In order to maintain power quality in the grid, the STATCOM compensator output is varied depends on control strategy [6].

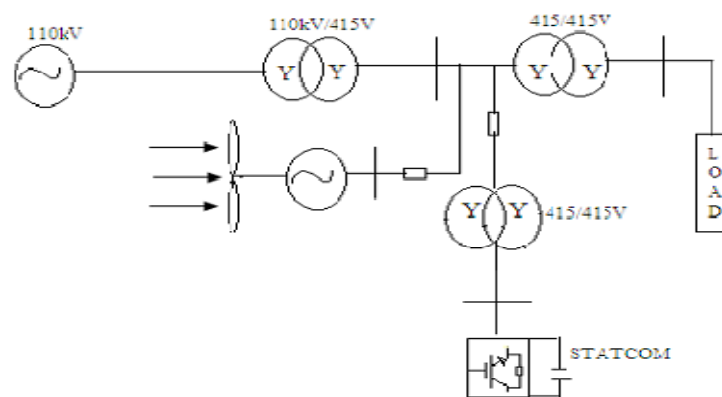


Fig.5 Operation of Wind farm connected to grid

VOLTAGE SAG COMPENSATION

SAG INITIATION

Voltage sag has been defined as a reduction in the voltage magnitude from its nominal value for a duration ranging from a few milliseconds to one minute [7]. Here, reactive load induced voltage sag is analyzed and the STATCOM is expected to reduce the intensity of the voltage sag.

SAG MITIGATION

The compensation is provided for 0.2 sec to 0.4 sec when reactive load connected to the system. For this duration voltage sag is compensated. The STATCOM based current controlled voltage source inverter inject the current into system in such way that the injected current will cancel out the reactive part of the load thus it improves the power quality.

CONCLUSION

STATCOM is analyzed and the circuit model for the system is developed using MATLAB SIMULINK. The wind energy connected to the grid along with shunt connected STATCOM will provide better performance. Hysteresis control is used to produce switching signal for IGBT in STATCOM. Hence conclude that STATCOM will give better performance for wind energy connected to grid.

REFERENCES

1. B. Singh, R. Saha, A. Chandra, K. Al-Haddad, "Static Synchronous Compensators (STATCOM): a review" Published in IET Power Electronics 22nd April 2008.
2. M. Molinas, J. A. Suul, and T. Undeland, "Low voltage ride through of wind farms with cage generators: STATCOM versus SVC," IEEE Trans. Power Electron., vol. 23, no. 3, pp. 1104–1117, May 2008.
3. Sharad W. Mohod, Mohan V. Aware, "A STATCOM-Control Scheme for Grid Connected Wind Energy System for Power Quality Improvement" IEEE SYSTEMS JOURNAL, VOL. 4, NO. 3, SEPTEMBER 2010
4. N. G. Hingorani, L. Gyugyi, "Understanding FACTS concepts and Technology of flexible AC transmission, IEEE Press 2000
5. Chong Han, Alex Q. Huang, Mesut E. Baran, Subhashish Bhattacharya, Wayne Litzenberger, Loren Anderson, Anders L. Johnson and Abdel-aty Edris "STATCOM impact study on the integration of a large wind farm into a weak loop power system" IEEE transactions on energy conversion. VOL, NO. 1, MARCH 2008

6.C. Han, A. Huang, M. Baran, S. Bhattacharya, W. Litzemberger, L.Anderson, A. Johnson, and A.-A. Edris, “Statcom impact study on the integration of a large wind farm into a weak loop power system,” *IEEE Trans. Energy Convers.*, vol. 23, no. 1, pp. 226–233, Mar. 2008.

7.P.S.Sensarma,K.R.Padiyar and V.Ramanarayanan” *Analysis and performance evaluation of a distribution STATCOM for compensating voltage fluctuations”IEEE tranasactions on power delivery*,VOL.16.NO.2,APRIL 2001

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