International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 2 Issue 6, June-2013, pp: (69-71), Available online at: **www.erpublications.com**

Analysis of DFIG in wind energy system: A Review

Shailendra kumar[1], Mrs.Preeti Jain[2]

[1]M.E. Scholar, JEC, Jabalpur, Madhya Pradesh, INDIA

[2]Assistant. Professor, Dept. of Electrical Engineering, JEC, Jabalpur, Madhya Pradesh, INDIA

Abstract: **The demand of electricity is increased day by day, but the source of energy is limited in the earth like coal, gas, wind, uranium and others conventional source of energy. This problem can be solved by using non conventional sources of energy like solar energy wind energy, geothermal energy and any others non conventional sources. Wind is the useful non conventional source of the energy in India and others countries, which demands additional transmission capacity and better means of maintaining system reliability.**

Introduction

The conventional energy sources are limited and have pollution to the environment. So more attention and interest have been paid to the utilization of renewable energy sources such as wind energy, fuel cell and solar energy etc.Wind energy is the fastest growing and most promising renewable energy source among them because it is cheap, inexhaustible, widely distributed, clean, and climate-benign, a set of attributes that no other energy source can match. Wind turbine generators (WTGs) can be divided into two basic categories (i) fixed speed and (ii) variable speed. The fixed-speed generator has a low of wind power conversion and no ability to provide reactive power support. It also imposes mechanical stress on the turbine and requires complex pitch control to maintain a constant rotor speed. During the last few years, the variable speed wind turbines with Doubly-fed induction generator (DFIG) dominant the wind energy conversion system(WECS) .There are several reasons for using variable-speed DFIG based wind turbines; among those are (i) Possibilities to reduce stresses of the mechanical structure, (ii)Acoustic noise reduction and (iii) The possibility to control active and reactive power. In DFIG the power processed by the power converter is only a fraction of the total wind turbine power, and therefore its size, cost and losses are small.

Description

Electrical power is the most widely used source of energy for our homes, work places and industries. Population and industrial growth have led to significant increases in power consumption over the past three decades. Natural resources like coal, petroleum and gas that have driven our power plants, industries and vehicles for many decades are becoming depleted at a very fast rate. This serious issue has motivated nations across the world to think about alternative forms of energy which utilize inexhaustible natural resources. The wind energy generation system is generate the electrical power with the help of following parts like turbine, doubly fed induction generator, back to back AC/DC/AC convertor etc.

I. Turbine

Wind turbines are systems that harness the kinetic energy of the wind for useful power. Wind flows over the rotor of a wind turbine, causing it to rotate on a shaft. The resulting shaft power can be used for mechanical work, like pumping water, or to turn a generator to produce electrical power. Wind turbines span a wide range of sizes, from small rooftop turbines generating less than 100 kilowatts up to large commercial wind turbines in the megawatt power range, many of which operate in large clusters called wind farms .there are two types of turbines used in the wind energy generation system. One is the vertical axis wind turbine and other horizontal axis wind turbine. The output power of the wind energy generation system depends on the wind velocity and physical dimension of wind turbine. Output power of wind turbine is expressed in given equation.

$$P = \frac{1}{2} \rho A V^3 \text{ (Watts)}$$

P = output power

V = wind speed (m/s)

A= cross section area of blade.

ρ = air density (kg/m3)

International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 2 Issue 6, June-2013, pp: (69-71), Available online at: **www.erpublications.com**

II. Doubly Fed Induction Generator

Doubly fed induction generator is the main part of the wind energy generation system. It is important that the generator can function at variable speed but the presence of converters between the generator and the network harms the global efficiency of the installation. The DFIG proposes a good compromise between the variation speed range which it authorizes and the converters size compared to the machine nominal power.

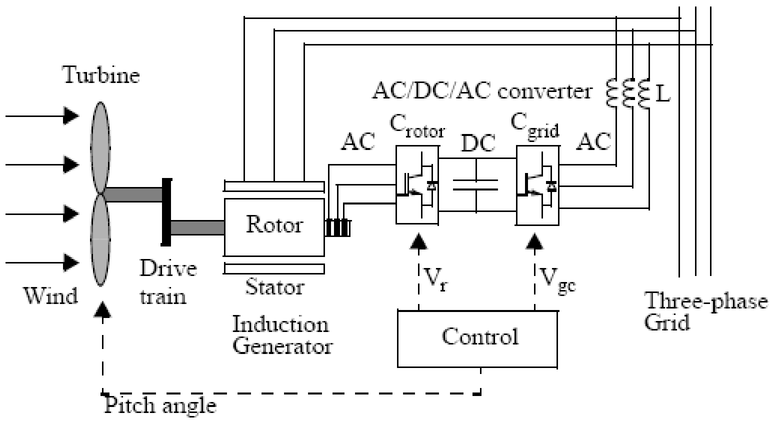

Fig. 1: DFIG wind turbine system

Figure 1 is shown in the basic arrangement of doubly fed induction generator. The stator of DFIG is directly connected to the grid while the rotor is indirectly to the grid through back-to-back converters. Which are capable of providing 10-40% of the generators rated power the back-to-back converters are controlled by pulse width modulation (PWM). Doubly-fed electric machines are basically electric machines that are fed with ac currents into both the stator and the rotor windings. Most doubly-fed electric machines in industry today are three phase wound-rotor induction machines. Although their principles of operation have been known for decades, doubly-fed electric machines have only recently entered into common use. The rotor side converter control is derived from the DFIG equations.

$$V_s = R_s I_s + \psi_s + j\omega\psi_s$$
$$V_r = R_r I_r + \psi_r + j(\omega - \omega_r)\psi_r$$
$$\Psi_s = L_s I_s + L_m I_r \quad \psi_r = L_r I_r + L_m I_s$$

Where Vs, is stator voltage, Vr is rotor voltage, Is is stator current, Ir is rotor current vector. ψ_s, ψ_r both are the Stator and rotor flux linkage vector, ω_s, ω_r both are the Stator and rotor angular frequency. Lm is Mutual inductance, $L_{\sigma s}$, $L_{\sigma r}$ are Stator and rotor leakage inductances, Ls, Lr both are the Stator and rotor self-inductance, Rs, Rr both are the Stator, rotor resistance.

III. Back-To-Back Ac/Dc/Ac Converter

The AC-DC-AC converter used on the rotor which consists of two voltage-sourced converters, i.e., rotor-side converter (RSC) and grid-side converter (GSC), which are connected "back-to-back." Between the two converters a dc-link capacitor is placed, as energy storage, in order to keep the voltage variations or ripple in the dc-link voltage small. With the rotor-side converter it is possible to control the torque or the speed of the DFIG and also the power factor at the stator terminals, while the main objective for the grid-side converter is to keep the dc-link voltage constant regardless of the magnitude and direction of the rotor power. The grid-side converter works at the grid frequency. A transformer may be connected between the grid-side inverter or the stator, and the grid. The rotor-side converter works at different frequencies, depending on the wind speed. The back-to-back arrangement of the converters provides a mechanism of converting the variable voltage, variable frequency output of the generator (as its speed changes) into a fixed frequency, fixed voltage output compliant with the grid. The DC link capacitance is an energy storage element that provides the energy buffer required between the generator and the grid.

The Rotor-Side Converter (RSC)

The rotor-side converter (RSC) applies the voltage to the rotor windings of the doubly-fed induction generator. The purpose of the rotor-side converter is to control the rotor currents such that the rotor flux position is optimally oriented with respect to the stator flux in order that the desired torque is developed at the shaft of the machine. The rotor-side converter uses a torque controller to regulate the wind turbine output power and the voltage measured at the machine stator terminals. The power is controlled in order to follow a pre-defined turbine power-speed characteristic to track the maximum power point. The actual electrical output power from the generator terminals, added to the total power losses (mechanical and electrical).

The Grid-Side Converter (GSC)

The grid-side converter aims to regulate the voltage of the dc bus capacitor. Moreover, it is allowed to generate or absorb reactive power for voltage support requirements. The function is realized with two control loops as well an outer regulation loop consisting of a dc voltage regulator. The grid-side converter controls the flow of real and reactive power to the grid, through the grid interfacing inductance. The objective of the grid-side converter is to keep the dc-link voltage constant regardless of the magnitude and direction of the rotor power.

Conclusion

The wind energy system is more useful for the generation of electrical power but the amount of generated power is less by compare to other electrical energy generating source. The presented study presents a DFIG based wind turbine literature and different wind turbine topology. The main issue of grid is discussed and analytical survey has been introduced for the grid problems. The different topology of wind turbine has been explained with their corresponding application and advantages. The study includes grid problem, grid code operation and grid connection of wind form.

References

[1]. "Global wind Report: Annual market update," Global Wind Energy Council, pp.18-19, 2010.
[2]. A. D. Hansen, L. H. Hansen, "Market penetration of wind turbine concepts over the years," European Wind Energy, EWEA, vol. 10, pp. 81-97, 2007.
[3]. T. Ackermann, "Wind power in power systems," John Wiley and sons, England, 2005.
[4]. R. Pena, J. C. Clare, G. M. Asher, "Doubly fed induction generator using back-to-back PWM converters and its application to variable-speed wind-energy generation," IEE Proc. Elect. Power Appl., vol. 143, no. 3, pp. 231-241, 1996.
[5]. S. Soter, R. Wegener, "Development of induction machines in wind power technology," Proc. IEEE Int. Electric Mach. Drives Conf., vol. 2, pp. 1490-1495, 2007.
[6]. W. Leonard, "Control of Electrical Drives," Springer, New York, 2001.
[7]. P. W. Carlin et all ," The History and State of the Art of Variable-Speed wind Turbine Technology" National Renewable Energy Laboratory/National Wind Technology Center, 1617 Cole Boulevard, Golden, CO 80401, USA.
[8]. Rishabh Dev Shukla et all," Dynamic Performance Of DFIG Based WECS Under Different Voltage Sag'' International Journal of Chem Tech Research CODEN(USA): IJCRGG ISSN : 0974-4290 Vol.5, No.2, pp 980-992, April-June 2013.
[9]. M. G. Simoes, B. K. Bose, R .J. Spiegel, "Fuzzy logic based intelligent control of a variable speed cage machine wind generation system," IEEE Trans. Power Electron., vol. 12, no. 1, pp. 87-95, 1997.
[10]. N. Mohan, T. M. Undeland, W. P. Robbins, "Power Electronics: Converters, Applications and Design," Clarendon Press, Oxford, UK, 1989.
[11]. S. R. Jones, R. Jones, "Control strategy for sinusoidal supply side convertors," IEE Colloq. Developments in real time control for induction motor drives, vol. 24, 1993.
[12]. A. Nicastri, A. Nagliero, "Comparison and evaluation of the PLL techniques for the design of the grid connected inverter systems," Proc. IEEE Int. Symp. Ind. Electron. pp. 3865-3870, 2010.
[13]. T. Sun, Z. Chen, F. Blabejerg, "Flicker study on variable speed wind turbines with doubly fed Induction Generators," IEEE Trans. Energy Convers., vol. 20, no. 4, pp.896-905, 2005.