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GRID SIDE CONTROL BY USING STATCOM AND FUZZY CONTROLLER

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ABSTRACT:
Now-a-days technology for generating electricity from renewable energy sources such as wind energy, has greatly increased. Because of its non-polluting and economically variable nature, wind energy is considered one of the most important and promising source of renewable energy all over the world. In this paper the STATCOM is used to quickly sense the voltage sag and overcome it. The STATCOM control scheme for the grid connected wind energy. generation system for power quality improvement is simulated using MATLAB/SIMULINK in power system block set.DFIG consist of common induction generator with slip ring partial scale power converter. In this paper presents the total concept is controlling the grid side converter by using STATCOM with fuzzy. thestatcom controller is activated under fault condition and de-activated under normal condition. The method of a three phase grid system with different fault condition is simulated by using MATLAB.

KEYWORDS:- STATCOM, grid side controller, DFIG, wind turbine, fuzzy.

INTRUDUCTION

The conventional energy source such as oil, natural gas, coal, or nuclear are finite and generate pollution. Alternatively, the renewable energy sources like wind, fuel cell, solar, biogas/biomas, tidal, geothermal, etc. Are clean and abundantly available in nature. Among those the wind energy has the huge potential of becoming a major of renewable energy for this modern world.

Wind power is clean, emissions-free power generation technology. Wind energy systems employ various installations to exploit wind energy such as synchronous or squirrel-cage and doubly fed asynchronous machines (DFIG). The changing of wind speed has an effect on the considered power transfer. In general, the efficiency of variable speed systems is higher compared to the one of fix speed systems. DFIG wind turbines are nowadays more widely Especially in large wind farms. The main reason for their popularity when connected to the electrical network is their ability to supply power at constant voltage and frequency while the rotor speed varies, which makes it suitable for applications with variable speed. Additionally when a bidirectional AC-AC converted is used in the rotor circuit, the speed range can be extended above its synchronous value recovering power in the regenerative operating mode of the machine.aspect. Currently the growth of wind power generation is very fast throughout the world. Voltage flicker is one of the most important power quality aspects that should be reduced enable the quality of electric power. The reason behind voltage flicker is fluctuations, which are developed by load variations in the grid system. The incorporation of doubly feed induction generators (DFIG generators) in wind turbines, improves stability and frequency of the voltage through their decoupled control of active and reactive power. Or absorbs reactive power to or from the grid to compensate small in order to promote the integration of wind farms into the electrical network, Flexible AC transmission system, FACTS, are widely used. The FACTS STATCOM system is one of them. STATCOM has some advantages, such as better performance, quick response, smaller in size, less cost, and capable of satisfying both active and reactive power requirements. This method is suitable for the applications with frequently fluctuating loads and power flow. By using high frequency switching PWM, the high speed switching converter will generate smooth current with low harmonic content. STATCOM provides voltage variations at the connection point of the wind farm with the grid.

POTENTIAL &WIND CONVERSION:

In recent years, the environmental pollution has become a major concern in people daily life and a possible energy crisis has led people to develop new technologies for generating clean and renewable energy. Wind power along with solar energy, hydro power and tidal energy production. Among these renewable energy sources, wind power has the fastest growing speed (approximately 20% annually) in the power industry. With the concern of environmental pollution, wind power is being established in many countries by way of government level policy. It is reported that by 2020, Europe will achieve 20% of power consumed in there supplying by large scale offshore wind farms. Besides, Europe is now planning for enlarging the capacity of the large scale offshore wind farms to more than 30 GW power by 2015. Besides Europe, other countries such as China and USA also have promising offshore wind power resource and similar plans for wind farm installation. The development of wind power in India began in the 1990's, and has progressed steadily in the last few years. As per February 2013, India has 18634 MW of installed capacity of wind power. The main requirement for wind power installation is land and grid infrastructure availability. There are reports which indicates India have total wind power access of around 45,000 MW assuming 1% land availability for wind farms requiring @12 ha/MW in sites

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having wind power density in excess of 200W/sq.m. at 50 hub-height. India is targeting to add 15000MW in the 12th Five Year plan period.

CONCEPT OF DFIG:

The basic layout of a DFIG is shown in fig.1, Doubly fed induction generator is basically a wound rotor induction machine with multi phase wound rotor with multiphase slip rings assembly and brushes enabling access to the rotor. The rotor windings are connected to the grid through an AC-DC-AC converter. The rotor and the grid currents are controlled by controlling the converter.

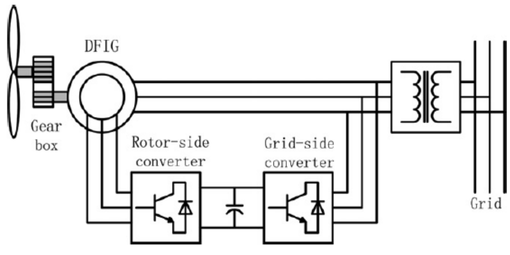

Fig. 1. Schematic of DFIG wind power generation system.

This enables the control of the active power and reactive power flow to the grid from the stator independent of the generator's speed. The number of turns on the rotor of a doubly fed induction generator is 2 to 3 times that of the stator. This means that the rotor voltages are higher and the currents are lower. Therefore in the typical operational speed range of + 30% of the synchronous speed the converter has to handle lower currents thus reducing the cost of the converter. A doubly fed induction generator has the advantage that power can be imported from or exported to the grid through the power electronics converter. This allows the system to support the grid during severe voltage disturbances thus improving the system stability. By controlling the rotor voltages and currents the synchronization of the machine with the grid is maintained even when the wind speed varies. Under light load conditions, the wind energy is utilized more efficiently than a fixed speed wind turbine. Only 25-30 % of the power is fed to the grid through the converter while the remaining is fed directly to the grid. Due to this reason, the cost of the converter is low and the efficiency of the doubly fed induction generator is good.

DFIG WIT STATCOM:

A STATCOM, also known as an advanced static VAR compensator, is a shunt connected FACTS device. It generates a set of balanced three phase sinusoidal voltage at fundamental frequency, with rapidly controllable amplitude and phase angle. In this paper, STATCOM is modeled in MATLAB/SIMULINK using an IGBT PWM converter with a dc-link capacitor. The objective of STATCOM is to ride through voltage dip quickly

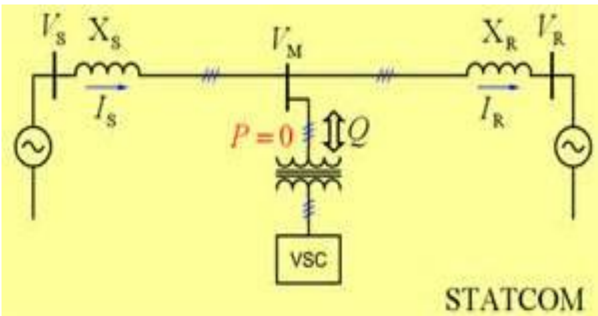

Fig2: block diagram of statcom

Grid side converter control:

The object of the grid side converter is to keep the dc like voltage constant irrespective of the direction of the rotor power flow. Decoupled control of active and reactive power flowing between rotor and grid is done by using supply voltage vector oriented control. In such a scheme, current i_X is controlled to keep the dc link voltage constant current $i_y$is used to obtain the desired value of reactive power flow between the supply side converter and the supply.

All voltage and current quantities are transformed to a special reference frame that rotates at the same speed as the supply voltage space phasor with the read axis (x-axis) of the reference fame speed equal the synchronous speed.

The schems make use of the supply voltage , the converter terminals voltage, and the phase currents onto the new reference frame. First the supply voltage angle (θs) has to be determined by definition, the supply voltage angle is

$$\theta_s = \tan^{-1}\left(\frac{V_{SQ}}{V_{SD}}\right)$$

The real axis(x)is aligned with the supply voltage phasor. Thus, Vy=0 hence the powers between the grid side converter and the grid are

$$P = \frac{3}{2}(v_x i_x + v_y i_y) = \frac{3}{2} v_x i_x$$

$$Q = \frac{3}{2}(v_y i_x - v_x i_y) = -\frac{3}{2} v_x i_y$$

The dc power has to be equal to the active power flowing between the grid and the grid side converter. Thus

$$E i_{0s} = \frac{3}{2} v_x i_x$$

$$C\frac{dE}{dt} = i_{0s} - i_{0r}$$

Where i0s is the current between the dc link and the rotor and i0r is the current between the dc link and the stator. Thus, the dc link voltage can be controller by controlling ix.

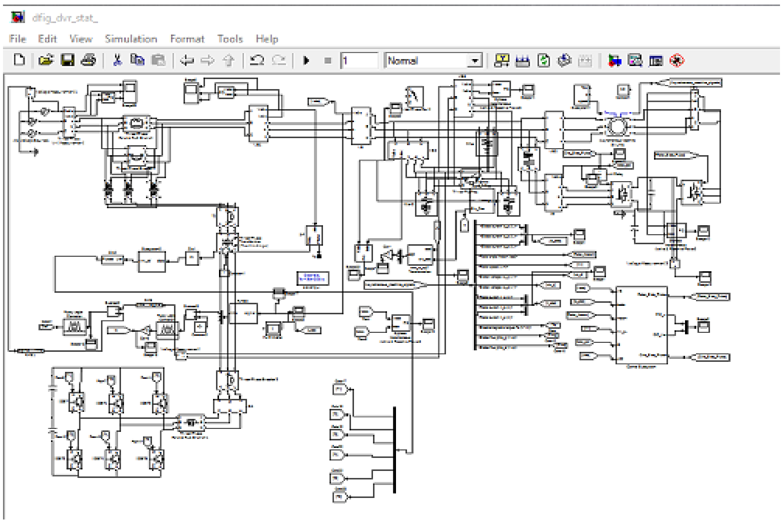

Fig3:DFIG with statcom structure

Power transmission contingencies:

The best known disturbances of the voltage wave form are voltages sags and swells.harmonics, and voltage imbalances. these can be through the figure 4 as shown in below. The type of contingencies occur when they are subjected to sensitive load changes towards the distribution side

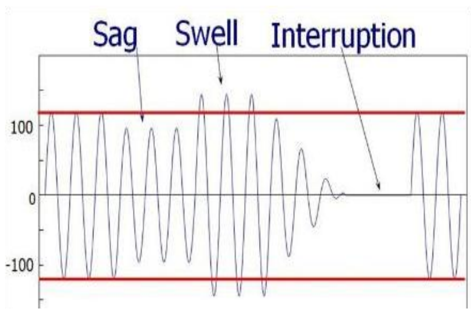

Fig4.

FUZZY LOGIC CONTROLLER:

The control system is based on fuzzy logic controller is one type of non linear controller and automatic.

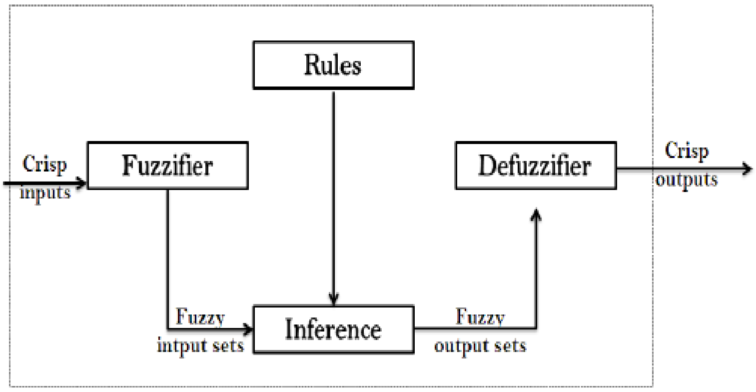

Fig4: Block diagram of fuzzy controller

The fuzzy logic controller system consist of four main parts. first, by using the membership functions, inputs are fuzified the based on rule based and the inferencing system ,outputs are produced and finally the fuzzy outputs are defuzzifiedand they are applied to the main control system.
Error of inputs from their references and error deviations in any time interval are chosen as MATLAB. The output of fuzzy controller is the value that should be added to the prior output to produce new reference output.

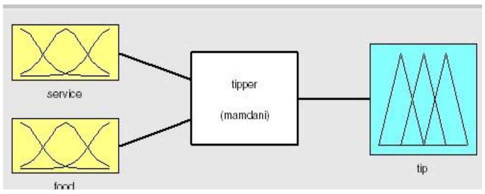

Fig5: selection of input and output variables

SIMULATION RESULTS:

The output of wind power.energy system is shown below in which the phase voltages, line current, active power, reactive power and rotor speed is shown below.

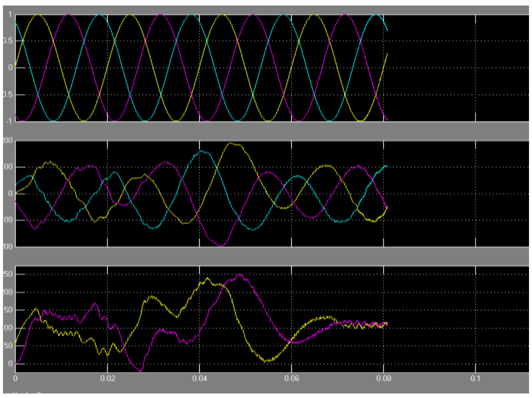

Fig6:grid side input wave form of active and reactive power

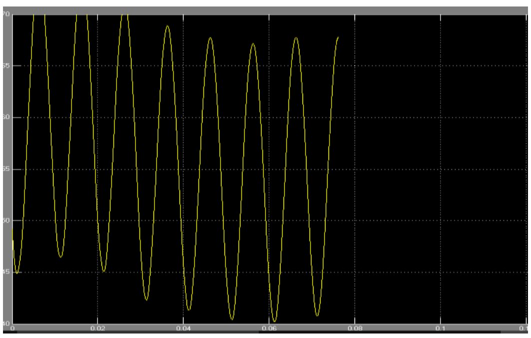

Fig7: fuzzy wave form

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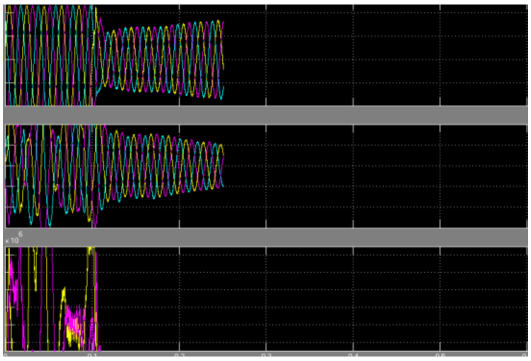
Fig8:wave form after fault

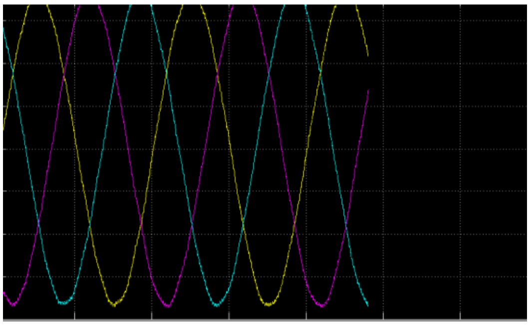
Fig9: DFIG wave form

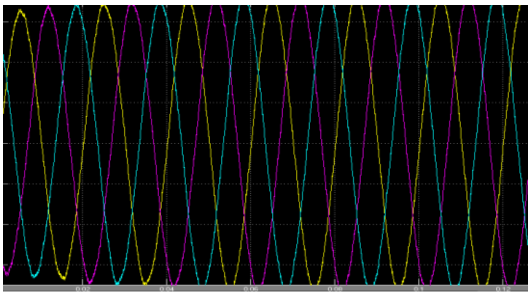
Fig10:statcom wave form

CONCLUSION

This paper explores the possibility of connecting a STATCOM to the wind power system in order to provide efficient control. In this paper, the wind turbine modeled is a DFIG that is an induction machine which requires reactive power compensation during grid side disturbance. An appropriately sized STATCOM can provide the necessary reactive power compensation when connected to a weak system. In this paper the total concept is to control the grid side power in DFIG system with help of statcom controller and fuzzy controller by using this two controller maintain the voltage and current constant.

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