An Integrated Active Filter Capabilities For Wind Energy Conversion Systems With Doubly Fed Induction Generator

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Abstract- *This project represents the operation of Doubly Fed Induction Generator (DFIG) with an integrated active filter capabilities using Grid Side Converter (GSC). The main contribution of this work lies in the control of GSC for supplying harmonics in addition to its slip power transfer. The Rotor Side Converter (RSC) is used for attaining maximum power extraction and to supply required reactive power to DFIG. This Wind Energy Conversion System (WECS) works as a Static Compensator (STATCOM) for supplying harmonics even when the wind turbine is in shut down condition. Control algorithms of both GSC and RSC are presented in detail. Proposed DFIG based WECS is simulated using MATLAB / Simulink.*

I. LITERATURE SURVEY

[1]. Boutoubat Met Al (2013) explains about how to improve the reactive power compensation and active filtering capability of a Wind Energy Conversion System (WECS). The proposed algorithm is applied to a Doubly Fed Induction Generator (DFIG) with a stator directly connected to the grid and a rotor connected to the grid through a back-to-back AC-DC-AC PWM converter. The control strategy of the Rotor Side Converter (RSC) aims at first, to extract a maximum of power under fluctuating wind speed.

[2] .Ejlali Aet Al(2014) presented a paper for power quality improvement of Wind Energy Conversion System (WECS) by compensation of grid harmonic currents produced by non-linear loads. The proposed method which has been applied to a Doubly Fed Induction Generator (DFIG) through rotor side converter (RSC), provides simultaneous speed control and power quality improvement.

[3]. Hasanien H. M(2014), presented a paper about adaptive control scheme of the superconducting magnetic energy storage (SMES) units with the purpose of smoothing the wind farms' output power. The adaptive control scheme is based on the set-membership affine projection algorithm (SMAPA), which provides a faster convergence and less computational complexity than the normalized least-mean-square algorithm.

[4]. Sharma S et al(2011), explains about a synchronous detection-based control algorithm for voltage and frequency control (VFC) of an isolated asynchronous generator (IAG) is proposed for a stand-alone wind energy conversion system (SWECS). A three-legged voltage source converter (VSC) with an isolated star/polygon transformer is used as an integrated VSC. The integrated VSC with a battery energy storage system is used to control the active and reactive powers of the SWECS.

[5]. Suvire G. O et al(2012), has described about the integration of wind power generation in power systems is steadily increasing around the world. In this work, a distribution static synchronous compensator (DSTATCOM) coupled with a flywheel energy storage system (FESS) is used to mitigate problems introduced by wind generation in the electrical systems. The control technique has two control modes. One control mode mitigates the power fluctuations of wind generators, and it is based on fuzzy logic and a special filter. The other control mode contributes to recover the frequency when significant faults arise in the system.

S.NO	AUTHOR/YEAR	TITLE	DISCRIPTION
1	Boutoubat M/2013	The reactive power compensation and active filtering capability of a wind energy conversion system	To extract a maximum of power under fluctuating wind speed
2	Ejlali A/2014	Power quality improvement of wind energy conversion system by compensation of grid harmonic currents	The DFIG through rotor side converter (RSC),provides simultaneous speed control and power quality improvement.
3	Hasanien H/2014	Adaptive control scheme of the superconducting magnetic energy storage units	The SMES units with the purpose of smoothing the wind farms output power. which provides a faster convergence
4	Suvire G/2012	The integration of wind power generation in power systems	The DSTATCOM coupled with a flywheel energy storage system is used to mitigate the problems
5	Sharma S et al(2011)	a synchronous detection-based control algorithm for voltage and frequency control (VFC) of an isolated asynchronous generator	A three-legged voltage source converter (VSC) with an isolated star/polygon transformer is used as an integrated VSC. The integrated VSC with a battery energy storage system is used to control the active and real of the SWECS.

II. EXISTING SYSTEM

In this project, a wind energy conversion system (WECS) using grid-connected wound rotor induction machine controlled from the rotor side is compared with both fixed speed and variable speed systems using cage rotor induction machine. The comparison is done on the basis of major hardware components required, operating region, and energy output due to a defined wind function using the characteristics of a practical wind turbine.

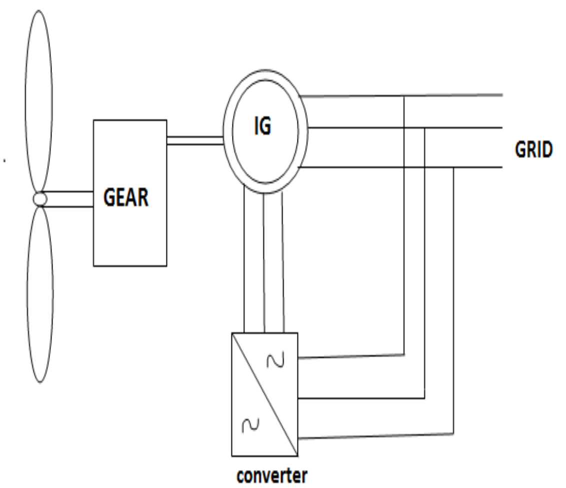


Fig 1 Block diagram of SGIG WECS

Fig 3.1 shows the block diagram of the wound rotor induction machine. Although a fixed speed system is more simple and reliable, it severely limits the energy output of a wind turbine. In case of variable speed systems, comparison shows that using a wound rotor induction machine of similar rating can significantly enhance energy capture.

Disadvantage

- High inrush current.
- Speed control is not possible.
- More sensitive to the supply voltage fluctuations.
- Low starting torque and high starting currents.

III. PROPOSED SYSTEM

The increase in population and industrialization, the energy demand has increased significantly. However, the conventional energy sources such as coal, oil and gas are limited in nature. Now there is a need for renewable energy sources for the future energy demand. The other main advantages of these renewable sources are eco-friendliness and unlimited in nature. Due to the technical advancements, the cost of the wind power produced is comparable with that of conventional power plants. So the wind energy is the most preferred out of all renewable energy sources.

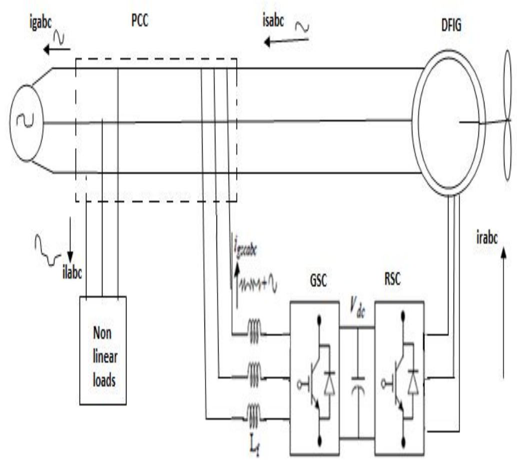


Fig 2 Block diagram of DFIG WECS

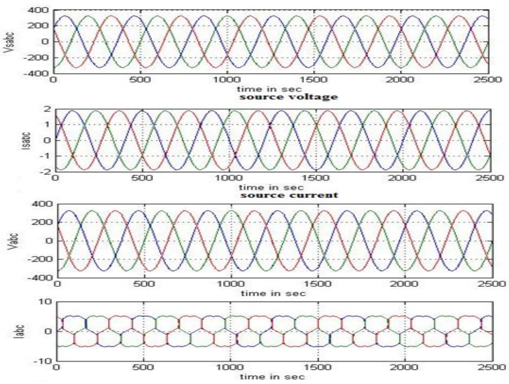
Fig 3.2 shows the block diagram of doubly fed induction generator. In the initial days, wind turbines have been used as fixed speed wind turbines with squirrel cage induction generator and capacitor banks. Most of the wind turbines are fixed speed because of their simplicity and low cost. By observing wind turbine characteristics, one can clearly identify that for extracting maximum power, the machine should run at varying rotor speeds at different wind speeds. By using modern power electronic converters, the machine is able to run at adjustable speeds. So these variable speed wind turbines are able to improve the wind energy production.

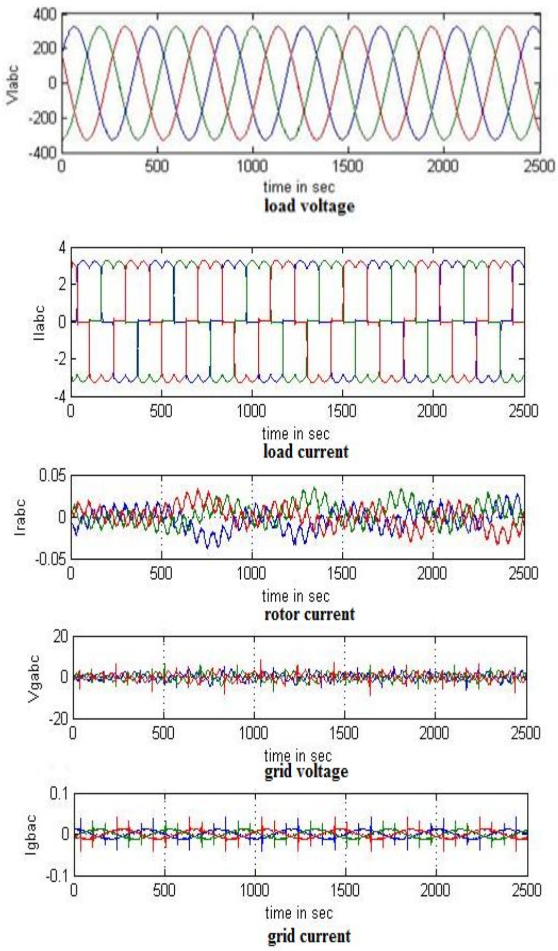
Out of all variable speed wind turbines, Doubly Fed Induction Generators (DFIGs) are preferred because of their low cost. This comes about due to the ability to operate with rated torque even at super synchronous speeds; power is then generated out of the rotor as well as the stator. Moreover, with rotor side control, the voltage rating of the power devices and dc bus capacitor bank is reduced. The size of the line side inductor also decreased. These DFIGs also provide good damping performance for the weak grid. Independent control of active and reactive power is achieved by the decoupled vector control algorithm presented in. This vector control of such system is usually realized in synchronously rotating reference frame oriented in either voltage axis or flux axis. In this work, the control of Rotor Side Converter (RSC) is implemented in voltage oriented reference frame.

ADVANTAGES

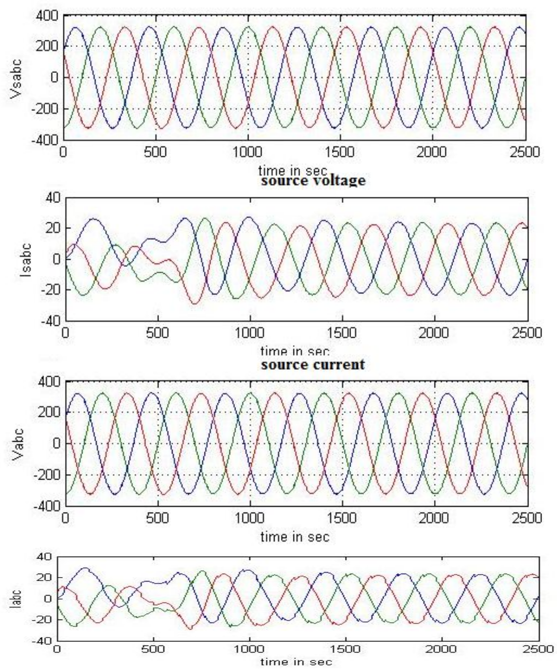
- Low cost
- Higher energy output
- Lower converting rating
- Better utilization of generators
- High energy demand
- Draw continuous dc current from the renewable energy.
- Features a lower capacitor voltage rating.
- Reduces the switching for renewable energy and inverter.

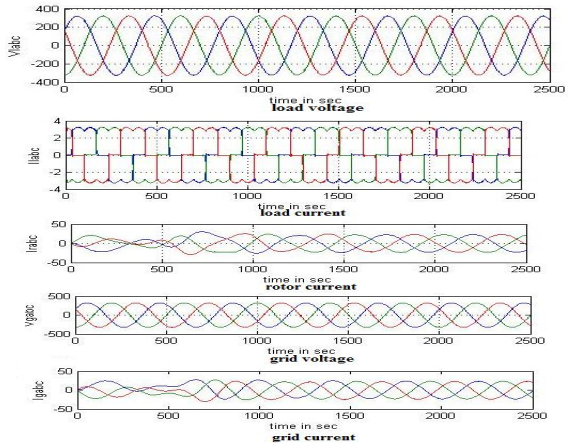
SIMULATION RESULTS OF WITHOUT DFIG





SIMULATION RESULTS OF WITH DFIG





IV. CONCLUSION AND FUTURE SCOPE

The proposed DFIG has also been verified at wind turbine stalling condition for compensating harmonics and reactive power of local loads. This proposed DFIG based WECS with an integrated active filter has been simulated using MATLAB/Simulink. The controller is modified and implemented in Fuzzy Logic Controller (FLC). The simulation output of FLC is most steady state and fast response.

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