MITIGATION OF HARMONICS IN DOUBLY FED INDUCTION GENERATOR (DFIG) WITH AN ACTIVE FILTER BY UTILISING GRID-SIDE CONVERTER (GSC)

V. VIJAYA BHASKAR[1] G. SAI KUMAR[2]
[1]Assistant Professor, Department of EEE, Holy Mary Institute of Technology& Science, Hyderabad, TS, India.

[2]Pg Scholar, Department of EEE (EPS), Holy Mary Institute of Technology& Science, Hyderabad, TS, India.

ABSTRACT
The standard purpose of this endeavor is assignment of doubly fed inductance generator (DFIG) with a fused powerful channel limits using Grid side converter (GSC). In this proposed DFIG, the reactive power for the enrollment machine has been given from the RSC and the load reactive power has been given from the GSC. The decoupled control of both dynamic and responsive forces has been proficient by RSC control. The proposed DFIG has also been affirmed at wind turbine backing off condition for remunerating sounds and receptive intensity of close-by burdens. The essential duty of this work lies in the control of GSC for giving sounds notwithstanding its slip control trade. The rotor-side converter (RSC) is used for accomplishing most outrageous power extraction and to supply required receptive capacity to DFIG. This wind energy conversion system (WECS) works as a static compensator (STATCOM) for giving sounds notwithstanding when the wind turbine shutdown condition. Control estimations of both GSC and RSC are shown in detail. The proposed DFIG-based WECS is duplicated using MATLAB/Simulink.

Index Terms: *Grid side converter (GSC), rotor side converter (RSC), static synchronous compensator (STATCOM) doubly fed induction generator (DFIG), coordinated dynamic channel, nonlinear load, control quality, wind energy conversion framework (WECS). STATCOM*

I.INTRODUCTION

In the present days, wind turbines have been utilized as fixed speed wind turbines with squirrel cage induction generator and capacitor banks. The greater part of the wind turbines is fixed speed due to their effortlessness and minimal effort [4]. By watching wind turbine attributes, one can obviously recognize that for removing greatest power, the machine should keep running at different rotor speeds at various wind speeds. Utilizing present day control electronic converters, the machine can keep running at movable rates [5]. Consequently, these variable speed wind turbines can enhance the wind energy generation [6]. Out of all factor speed wind turbines, doubly fed induction generators (DFIGs) are used because of their high performance and cheap in cost [7]. Alternate favorable circumstances of this DFIG are the higher energy yield; bring down converter rating, and better usage of generators [8]. These DFIGs likewise give great damping execution to the feeble network [9]. Autonomous control of dynamic and reactive power is accomplished by the decoupled vector control calculation displayed in [10] and [11]. This vector control of such framework is typically acknowledged in synchronously turning reference outline situated in either voltage axis or flux axis. In this process, the control of rotor-side converter (RSC) is actualized in voltage-arranged reference outline. Grid connections need the grid codes and operation of wind farms is explained. Reaction of DFIG-based wind energy conversion system (WECS) to grid faults is associated with the fixed speed WECS.

As the wind passing in the grid became vivid, the utilization of different speed WECS for beneficial employments, for example, harmonic mitigation and power smoothening are necessary for combing to power generation. This power smoothening harmonic is accomplished by including super magnetic energy saving systems projected in [14].

The other auxiliary models for example, transient stability limit and reactive power essential are accomplished by including static compensator (STATCOM) in [15]. A distribution STATCOM (DSTATCOM) combined with fly-wheel energy storage framework is utilized at the wind farm for mitigation of harmonics and frequency disturbances. Be that as it may, for this operation the scholars have utilized another two more additional converters. For the improving of reliability and power quality at DC link a high capacitor energy storage system of Unified power quality conditioner is placed. For controlling the reactive power and also compensating the harmonics separate converters are used by scholars.

In DFIG converters for the improvement of power quality and reactive power compensation the scholars are modified the control algorithms. The reactive power and harmonics mitigation control are accomplished with the assistance of existing RSC.

The RSC rating is improved by these techniques. Reactive power control and harmonic compensation are finished utilizing GSC. Hence, the harmonics will not pass through machine windings in all these cases. However, the scholars have utilized DC control of GSC. According to IEEE-519 standard total harmonic distortion (THD) isn't under 5% given in Table-I, by this, the harmonics compensation isn't so compelling. The scholars have likewise not checked reproduction results experimentally. For eliminating harmonics an indirect current control procedure is basic and shows better execution when compared with direct current control.

II. DOUBLY FED INDUCTION GENERATOR (DFIG)

DFIG is a shortened form for Doubly Fed Induction Generator; this generation principle is wider utilizing in wind turbines. It depends on an induction generator with a multiphase wound rotor and a multiphase slip ring get together with brushes for access to the rotor windings. It is conceivable to maintain a strategic distance from the multiphase slip ring get together (see brushless doubly-bolstered electric machines), however there are issues with productivity, cost and size. A superior option is a brushless wound rotor doubly-fed electric machine.

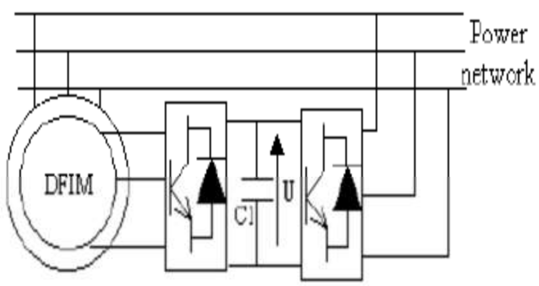

Fig. 1 Doubly-fed induction generator

To controls both the rotor and the grid currents the principle of the DFIG is used. In this rotor windings are connected to the grid via slip rings and back-to-back voltage source converter. In this rotor frequency recurrence can unreservedly contrast from the gird frequency (50 or 60 Hz). The speed of the generator's turning speed is independent from the stator of the grid and the active and reactive power fed of the grid by controlling the rotor currents. Either the two-axis current vector control or direct torque control (DTC) is used for control principle. DTC has ended up having preferred steadiness over current vector control particularly when high responsive flows are required from the generator.

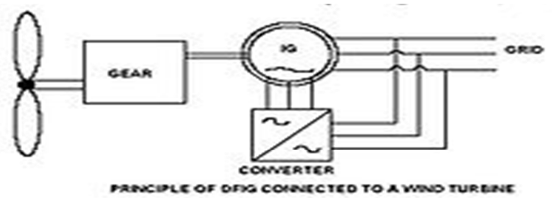

Fig 2. Standard of DFIG associated with a wind turbine

The number of turns of the stator is typically wound with 2 to 3 times in doubly-fed generator rotors. This implies the rotor voltages will be higher and currents gradually lower. In this way in the average ± 30 % operational speed go around the synchronous speed, the rated current of the converter is as needs be bring down which prompts a lower cost of the converter. The downside is that controlled task outside the operational speed go is unimaginable on account of the higher than rated rotor voltage. For more, the voltage transients cause due to the grid disturbances (three-and two-stage voltage plunges, particularly) will be also magnified. With the end goal to avert high rotor voltages - and high current resulting about because of these voltages - from pulverizing the IGBTs and diodes of the converter, an assurance circuit (called crowbar) is utilized.

When excessive voltages or currents are detected then the crowbar will be short-circuited the rotor windings through a small resistance. With an order to have the capacity to proceed with the task as fast as conceivable a functioning crowbar should be utilized. The active crowbar in a controlled manner rotor short will be remove by the active crowbar and thus by the start of the grid disturbance after 20-60 ms the rotor side converter can be started.

Along these lines it is conceivable to generate reactive current to the grid during whatever is left of the voltage dip and thusly assist the matrix with recovering from the fault. A doubly fed induction machine is an wound rotor doubly-fed electric machine and has a few focal points over a conventional induction machine in wind power applications. To start with, as the rotor circuit is controlled by a power electronics converter, the induction generator can both import and fare reactive power. This has vital ramifications for power system dependability and enables the machine to help the grid during the serious voltage disturbances (low voltage ride through, LVRT).

III. OPERATING PRINCIPLE OF PROPOSED SYSTEM

Fig.3 It demonstrates a schematic graph of the proposed DFIG based WECS with integrated active filter capabilities. In DFIG, the stator is directly associated with the grid as appeared in Fig3. Two series connected voltage source converters (VSCs) are set between the rotor and the grid. Nonlinear loads are connected at PCC as appeared in Fig3. The proposed DFIG functions as an activate filter notwithstanding the active power generation like ordinary DFIG. Harmonics produced by the nonlinear load connected at the PCC contort the PCC voltage. These nonlinear loads are harmonic currents relieved by GSC control, so the stator currents and grid currents are harmonics free. To making unity power factor and to achieve maximum power RSC is controlled.

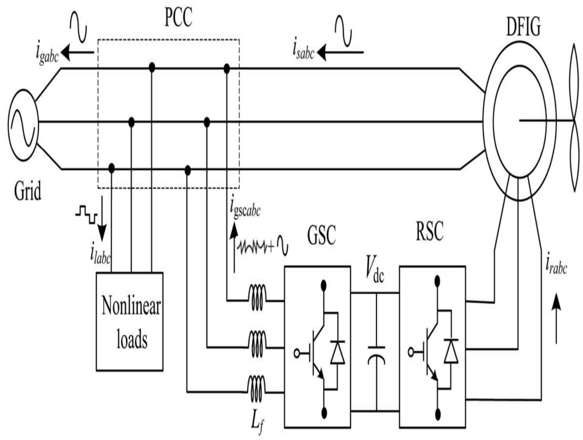

Fig. 3. Proposed framework setup.

IV. CONTROL STRATEGY

Control algorithms for both GSC and RSC are exhibited in this section. Total control schematic is given in Fig.4. The control algorithm for emulating wind turbine attributes utilizing dc machine and Type A chopper is likewise given in Fig.4.

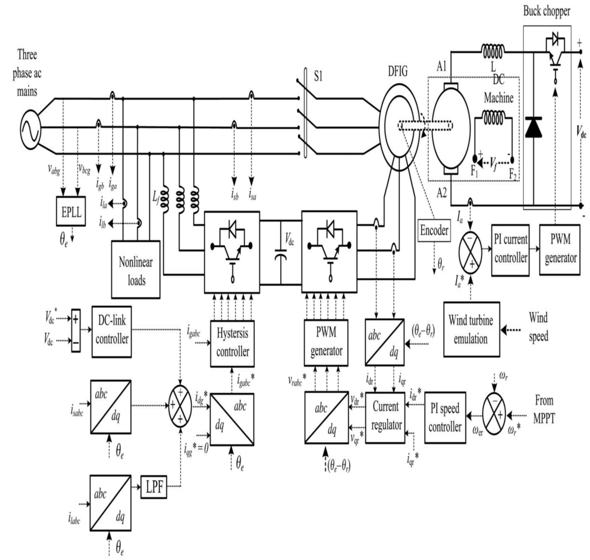

Fig. 4. Control algorithm of the proposed WECS.

Control of RSC

The primary motivation behind RSC is to extricate maximum power with free control of reactive power and active power. Here, the RSC is controlled in voltage-drawn reference outline. Thusly, the reactive power and active powers are controlled by controlling direct and quadrature axis rotor currents (idr and iqr), separately. Coordinate pivot reference rotor current is chosen with the end goal that maximum power is separated for a specific wind speed. This can be accomplished by running the DFIG at a rotor speed for a specific wind speed.

Control of GSC

The curiosity of this work lies in the control of this GSC for mitigating the harmonics created by the nonlinear loads. The control GSC block diagram is appeared in Fig. In this, an indirect current control is connected on the grid currents for making them sinusoidal and adjusted. Along these lines, this GSC supplies the harmonics for making grid currents sinusoidal and adjusted. These grid currents are figured by subtracting the load currents from the summation of stator currents and GSC currents. Active power segment of GSC current is gotten by preparing the dc-link voltage fault (vdce) among reference and evaluated dc-connect voltage (Vd∗c and Vdc) through PI controller as

$$i^*gsc\,(k) = i^*gsc\,(k-1) + kpdc\ \{Vdce\,(k) - Vdce(k-1)\} \quad ..(16)$$

Where kpdc and kidc are corresponding and essential additions of dc-connect voltage controller. Vdce(k) and Vdce(k − 1) are dclink voltage blunders at kth and (k−1)th moments. I*gsc(k) and i*gsc(k − 1) are dynamic power segment of GSC current at kth and (k−1)th moments. Dynamic power segment of stator current (ids) is acquired from the detected stator flows (isa, isb, and isc) utilizing abc to dq change as

$$ids = \frac{2}{3}\left[isa \sin\theta e + isb \sin(\theta e - {}^{2\pi}/_{3}) + isc \sin(\theta e + {}^{2\pi}/_{3})\right] \quad ....(17)$$

Essential dynamic load current (ild) is acquired utilizing SRF hypothesis [33].

Instantaneous load currents (ilabc) and the estimation of phase angle from EPLL are utilized for changing over the heap flows in to synchronously rotating frames dq (_ild). In synchronously rotating frames, fundamental frequency currents are changed over into dc amounts and every single other harmonics are changed over into non-dc amounts with a recurrence move of 50 Hz. DC estimations of load currents in synchronously rotating dq outline (ild) are removed utilizing low-pass filter (LPF).

V. RESULTS AND DISCUSSION

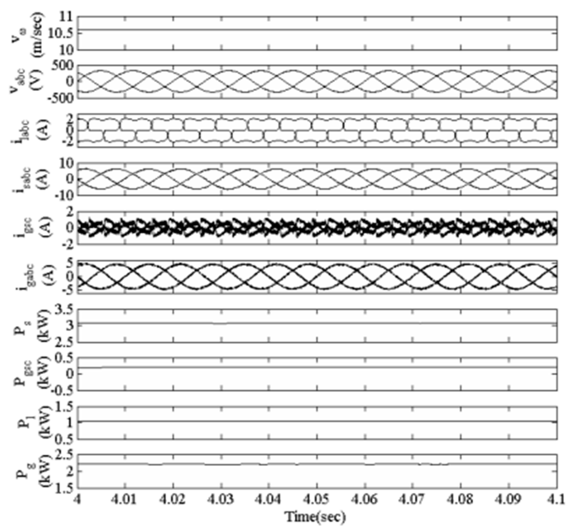

Fig.5 . Simulated execution of the proposed DFIG based WECS at fixed wind speed of 10.6 m/sec (rotor speed of 1750 rpm).

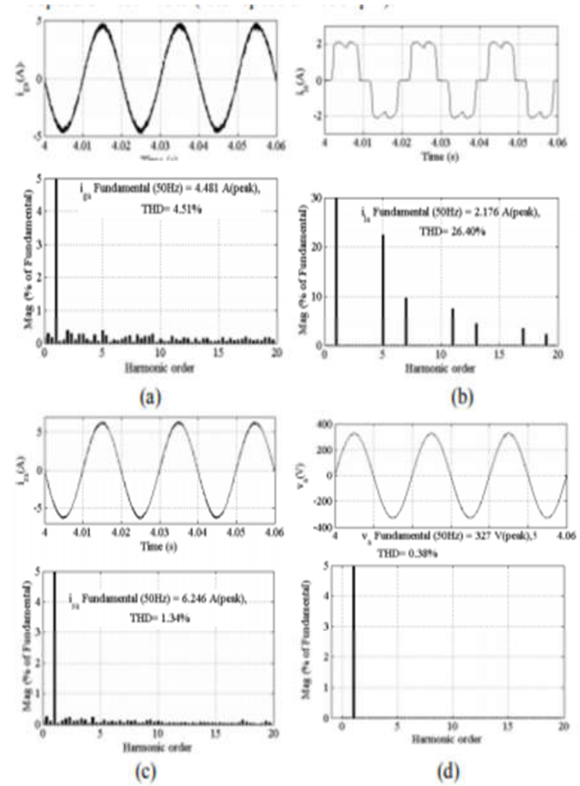

Fig.6 . Simulated waveform and harmonics spectra of (a) matrix current (iga), (b) stack current (ila), (c) stator current (isa) and (d) network voltage for stage 'a' (vga) at fixed wind speed of 10.6 m/sec (rotor speed of 1750 rpm).

CONCLUSION

The GSC control calculation of the proposed DFIG has been changed for providing the reactive power and harmonics of the gird loads. In this proposed DFIG, the reactive power for the induction machine has been provided from the RSC and the load reactive power has been provided from the GSC. The decoupled control of both reactive and active powers has been accomplished by RSC control. The proposed DFIG has likewise been checked at wind turbine slowing down condition for reactive power and compensating harmonics of grid loads. This proposed DFIG-based WECS with an integrated active filter has been mimicked utilizing MATLAB/Simulink condition, and the reproduced outcomes are checked with test aftereffects of the created prototype of this WECS.

Consistent state execution of the proposed DFIG has been exhibited for a wind speed. Dynamic execution of this proposed GSC control calculation has additionally been confirmed for the variety in the wind speeds and for nearby nonlinear load.

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AUTHOR'S BIOGRAPHY

V. VIJAYA BHASKAR completed Pre-Ph.D in Saveetha University, Chennai. He completed his M.Tech (Power Electronics) in the year of 2013 from JNTU Hyderabad. Completed B.Tech in Electrical and Electronics Engineering from JNTU Hyderabad in 2011. He has 5 years of experience in teaching field and Examination branch. Presently working as Assistant Professor in Holy Mary Institute of Technology & Sciences, Bogaram, R.R.District, Hyderabad, and Telangana, India. He has published 22 research papers in reputed National and International Journals and Attended International and National Conferences, attended 10 workshops. His areas of interest are, Power Electronics, Power Electronics & Drives, Power Systems & FACTS, etc.

G. SAI KUMAR received the **B.Tech**. Degree in **EEE** from JNIT ENGG College, Ibrahim Patnam, Ranga Reddy(Dt), Andhra Pradesh, India, in the year 2015 from JNTUH University. **Pursuing M.Tech** in **Electrical Power Systems** in Holy Mary Institute of Technology & Sciences, Bogaram, R.R.District, Hyderabad, and Telangana, India. His favorite topics include Renewable energy resources, DFIG, industrial drives, power systems, power systems, control systems, HVDC and Reactive power compensation techniques.