International Journal of Research
Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

Conversion Systems of Wind Energy Using DFIG

P V Samrat & G.Isaac
M.E., College of Engineering,Osmania University
M.Tech(Power Electronics and Industrial Drives), JNTU College Of Engg, Hyd

ABSTRACT: *Doubly-fed induction generator (DFIG) are extensively used for variable velocity wind energy conversion structures(WECS). This paper offers a detailed evaluation on diverse topologies, configuration, energy converters and control schemes used with the operation of the DFIG. The main involvement of this work fabrication in thecontrol of GSC for supplying harmonics. Similarly to its slip power transfer. The rotor-aspect converter (RSC) is used for reaching most strength extraction and to deliver required reactive electricity to DFIG. Wind energyconversion machine (WECS) works as a static compensator (STATCOM) for supplying harmonics even if the wind turbine is in shutdown situation. Of each GSC and RSC manipulate algorithms are provided in detail. DFIG-primarily based WECS is applied using MATLAB/Simulink. A prototype of the proposed DFIG based WECS is developed the usage of a digital sign processor (DSP). The wind power is the preferred for all renewable energysources.*

KEYWORDS-Variable speed DFIG, MPPT, windenergy, power quality, active filtering, GSC

I. INTRODUCTION

Now-a-days, the intake of traditional power belongings has elevated, So efforts had been made togenerate power from renewable energy sources together with wind, sun and so on., Wind power has end up definitely one in every of themost crucial and promising property of renewable energy. This needs more transmission capability andbetter method of keeping gadget reliability. In recent times the wind power capability of the area is approximately50gw and it's far anticipated to achieve 160GW through using 2012. In cutting-edge Wind Turbine generation system (WTGS), thewind mills are subjected to model of load and effect of sudden wind tempo versions.With expanded penetration of wind strength into electric powered grids, Doubly-Fed Induction Generator (DFIG) windturbines are in large part deployed due to their variable pace characteristic and for that reason influencing gadget dynamics. This hascreated an hobby in growing appropriate fashions for DFIG to be incorporated into power gadget research. Thecontinuous style of having high penetration of wind power, in state-of-the-art years, has made it necessary to introducenew practices. Furthermore, so that it will model power virtual converters, in the high-quality state of affairs, it's miles assumedthat the converters are exceptional and the DC-link voltage some of the converters is constant. Consequently, dependingon the converter manipulate, a controllable voltage (modern) deliver may be carried out to symbolize the operation ofthe rotor-side of the converter within the version.

Within the literature, manasipattnaik, “have a have a look at of Doubly-Fed Induction Generator for variable pace windenergy Conversion structures”, offers brief concept about the operation and working of DFIG.[1].F. Poitiers, M.Machmoum,R. Le Doeuff and M.E. Zaim, “manage Of A Doubly-Fed Induction Generator For Wind energyconversion system”, offers information about the modeling of the DFIG and the manipulate operation used.[2].R.Pena, J.C Clare and G.M Asher (1996), “Doubly Fed Induction Generator the use of again-to-again PWM converter andits software to variable-velocity wind-strength technology”, describes the rotor facet converter manipulate of dfigwhich offers the reference waveform for rotor facet converter and the pulses for RSC were received withthis the real and reactive strength may be managed.[3].

T.Thiringer, A.Petersson, and T.Petru (2003), “griddisturbance reaction Of Wind Turbine organized With Induction Generator and Doubly-Fed inductiongenerator”, offers brief concept approximately the grid disturbance reaction to fixed velocity wind turbines and wind turbineswith DFIG are provided.[4].A.Petersson, L.Harnefors, and T.Thiringer (2005), “assessment OF contemporary

International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

controlmethods For Wind mills the use of Doubly-Fed Induction device," gives brief concept about the assessment of thestator-flux orientated modern-day manage of the DFIG.[5].carlesbatlle,arnaud`oria-Cerezo ,Romeo Ortega (2006) , "arobustly stable PI Controller for The Doubly-Fed Induction gadget", this paper offers the short concept about theclosed loop of the device the use of the PI controller.

II. A NEW APPROACH FOR UPFC

These dfigs additionally provide correct damping performancefor the weak grid. Unbiased control of active andreactive strength is finished with the aid of the usage of the decoupled vectorcontrol set of policies. This vector manipulate of such systemis generally found out in synchronously rotating referenceframe oriented in each voltage axis or flux axis. Inthis art work, the manage of rotor-aspect converter (rsc) isimplemented in voltage-orientatated reference body.Response of dfig-based wind electricity conversionsystem (wecs) to grid disturbance is in comparison to thefixed pace wecs. Generated power smoothening isachieved by way of the use of enforcing first-rate magnetic energystorage structures.

The other auxiliary offerings together with reactive powerrequirement and short stability limit are achievedby which encompass static compensator (statcom).Adistribution statcom (dstatcom) coupled withfly-wheel energy storage machine is used at the windfarm for mitigating harmonics and frequencydisturbances. A terrific capacitor power storage systemat the dc hyperlink of unified strength splendid conditioner(upqc).Improving electricity wonderful and reliability. Theharmonics compensation and reactive energy controlare carried out with the assist of present rsc. Anindirect contemporary control method is straightforward and showsbetter ordinary performance for doing away with harmonics ascompared to direct modern-day manage.

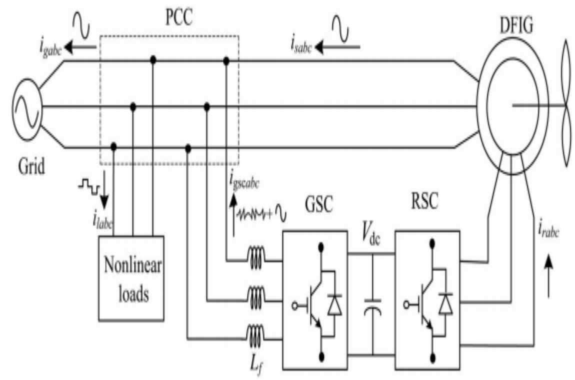


Fig. 1. Proposed system configuration

Working precept:on this paintings, a new manage algorithm for gsc isproposed for compensating harmonics produced bynonlinear loads the use of an indirect modern-day control. Rscis used for controlling the reactive power of dfig.the other principal benefit of proposed dfig is that itworks as an active clear out even if the wind turbine isin shutdown condition. Therefore, it compensates loadreactive strength and harmonics at wind turbine stallingcase. Each simulation and experimental performancesof the proposed incorporated energetic filter out-primarily based dfig arepresented in this work. The dynamic overall performance ofthe proposed dfig is also tested for varyingwind speeds and adjustments in unbalanced nonlinearloads at factor of common place coupling.

In fig.1 shows a schematic diagram of the proposed DFIGbased WECS with integrated activefilter capabilities. DFIG, the stator is directlyconnected to the grid as shown in Figure. Two back-toback connected voltage source converters (VSCs) areplaced between the rotor and the grid. Nonlinear loadsare connected at PCC as shown in Fig. 1. Theproposed DFIG works as an active filter in addition tothe active power generation similar to normal DFIG.Harmonics generated by the nonlinear load connectedat the PCC distort the PCC voltage.

RSC is controlled for achieving maximum power pointtracking (MPPT) and also for making unity powerfactor at the stator side using voltage-

International Journal of Research
Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

orientedreference frame. Synchronous reference frame (SRF) control method is used for extracting the fundamentalcomponent of load currents for the GSC control.

DESIGN OF DFIG-BASED WECS:

Selection of rankings of vscs and dc-hyperlink voltage isvery plenty crucial for the a hit operation ofwecs.

Choice of DC-link Voltage: The dc-hyperlink voltage of VSC must be greater than twicethe peak of most phase voltage. Whileconsidering from the rotor aspect, the rotor voltage is sliptimes the stator voltage. So, the layout criteria for theselection of dc-link voltage may be done byconsidering handiest percent voltage. Even as thinking about fromthe GSC aspect, the percent line voltage (vab) is 230 V, as the system is hooked up in delta mode.consequently, the dc-link voltage is anticipated as

$$V_{dc} \geq \frac{\sqrt[2]{2}}{\sqrt{3} * m} V_{ab}$$

where

Vab is the line voltage at the PCC.

Maximum modulation index is selected as 1for linear range.

The value of dc-link voltage (Vdc) by (1) isestimated as 375 V.

Hence, it is selected as 375 V

Selection of VSC Rating: The DFIG draws a lagging volt-ampere reactive(VAR) for its excitation to build the rated air gapvoltage. , the rating of the VSC used as RSC Srated isgiven as

$$S_{rated} = \sqrt{P_{r\,max}^2 + Q_{r\,max}^2}$$

Design of Interfacing Inductor: The design of interfacing inductors between GSC andPCC depends upon allowable GSC current limit(igscpp), dc-link voltage, and switching frequency ofGSC. Maximum possible GSC line currents are usedfor the calculation. Maximum line current dependsupon the maximum power and the line voltage at GSC.The maximum possible power in the GSC is the slippower.Interfacing inductor between PCC and GSC isselected as 4 mH.

$$L_i = \frac{\sqrt{3} m v_{dc}}{12 a f_m \Delta i_{gsc}}$$

$$= \frac{\sqrt{3} \times 1 \times 375}{12 \times 1.5 \times 10\,000 \times 0.25 \times 3.76} = 3.8mH$$

CONTROL STRATEGY:

Control algorithms for both GSC and RSC arepresented in this section. The control algorithm for emulating wind turbine characteristics using dcmachine and Type A chopper is also shown in Fig. 2.

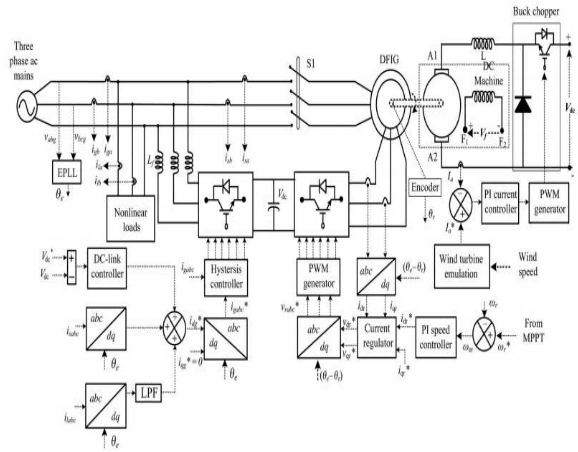


Fig. 2. Control algorithm of the proposed WECS.

Control of RSC: The main purpose of RSC is to extract maximumpower with independent control of active and reactivepowers. Here, the RSC is controlled in oltageoriented reference frame., the active andreactivepowers are controlled by controlling direct andquadrature axis rotor currents (idr and iqr).

$$i_{dr}^*(k) = i_{dr}^*(k-1) + k_{pd}\{\omega_{er}(k) - \omega_{er}(k-1)\} + k_{id}\omega_{er}(k)$$

Where:

The speed error (ωer) is obtained by subtractingsensed speed (ωr) from the reference speed (ω∗r).

International Journal of Research
Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

kpd and kid are the proportional and integralconstants of the speed controller.
ωer(k) and ωer(k − 1) are the speed errors at kth and (k−1)th instants.
i * dr(k) and i * dr(k − 1) are the direct axis rotor reference current at kth and (k−1)th instants.
Reference rotor speed (ω∗r).

In general, the quadrature axis reference rotor current (i∗qr) is selected such that the stator reactive power (Qs) is made zero. In this DFIG, quadrature axisreference rotor current (i ∗qr) is selected for injecting
the required reactive power. Inner current controlloops are taken for control of actual direct andquadrature axis rotor currents (idr and iqr) close to thedirect and quadrature axis reference rotor currents (i∗dr and i ∗qr). The rotor currents idr and iqr arecalculated from the sensed rotor currents (ira, irb, and
irc).

Control of GSC:
The novelty of this work lies in the control of this GSCfor mitigating the harmonics produced by the nonlinearloads. The control block diagram of GSC is shown inFig. 2. Here, an indirect current control is applied onthe grid currents for making them sinusoidal andbalanced. Therefore, this GSC supplies the harmonicsfor making grid currents sinusoidal and balanced.These grid currents are calculated by subtracting theload currents from the summation of stator currentsand GSC currents. Active power component of GSCcurrent is obtained by processing the dc-link voltageerror (vdce) between reference and estimated dc-linkvoltage (V ∗ dc and Vdc) through PI controller as

$$i^*_{gsc}(k) = i^*_{gsc}(k-1) + k_{pdc}\{v_{dce}(k) - v_{dce}(k-1)\} + k_{idc}v_{dce}(k)$$

Where kpdc and kidc are proportional and integral gains of dc-link voltage controller.Vdce(k) and Vdce(k− 1) are dclink voltage errors at kth and (k−1)thinstants. i∗gsc(k) and i ∗gsc(k − 1) are active powercomponent of GSC current at kth and (k−1)th instants.

II. SIMULATION RESULTS

The DFIG machine modes of operation namely sub-synchronous generating, super-synchronous generating aresimulated and the waveforms for speed and stator, rotor power and torque in each of the above modes of operationare presented. The rotor speed is controlled by using v/f control and grid-side reactive power &Vdc are controlledby using voltage oriented control techniques. The grid-side current is controlled by using reference current controltechniques under p-q theory.

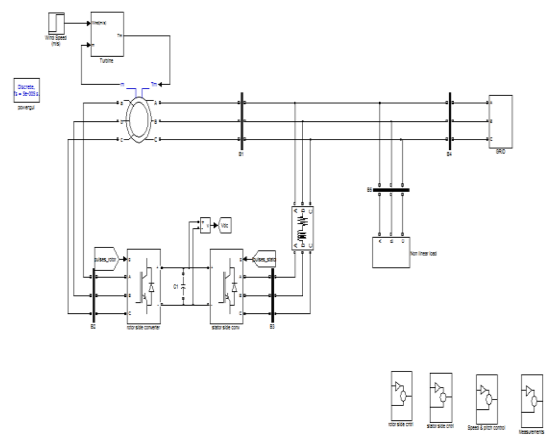
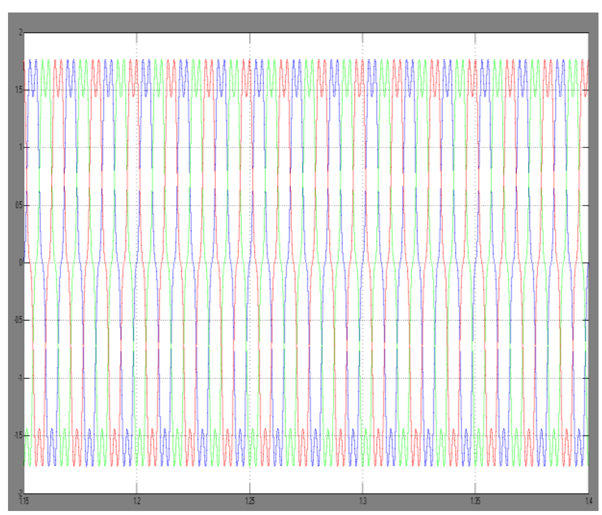
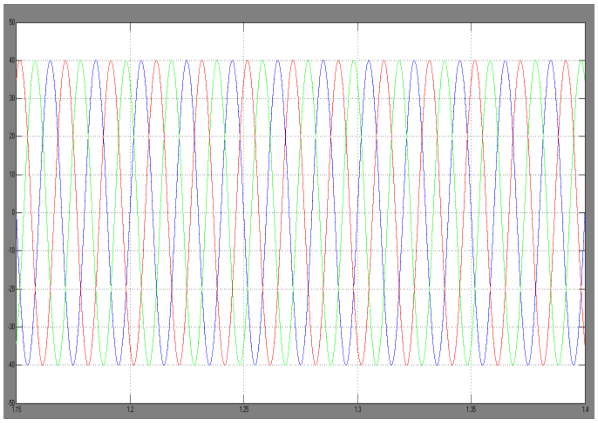


Fig 3 Matlab/simulinkdiagram of DFIG connected to WECS

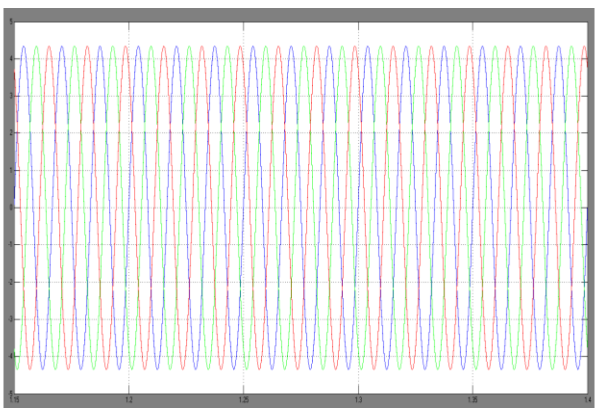


(a)

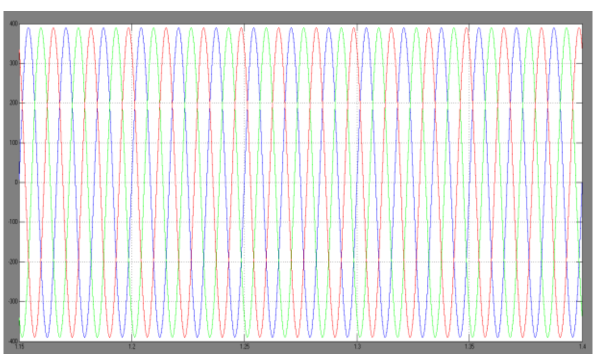


(b)

Fig 4 (a)Load current (Iabc1) (b) Load voltage (Vabc1)

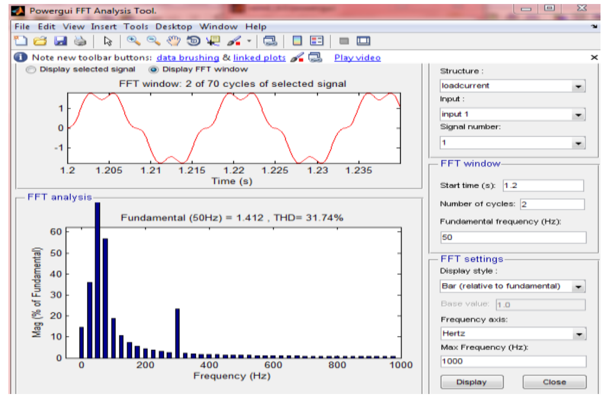


(a)

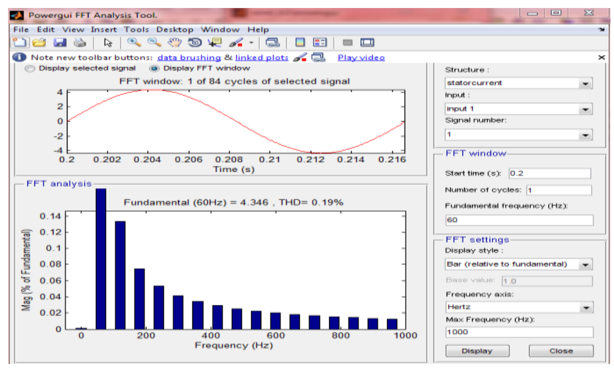


(b)

Fig 5 (a)grid current(Iabc) (b) grid voltage(Vabc)



(a)



(b)

Fig 6 FFT Analysis tool

III. CONCLUSION

Proposed dfig, thereactive electricity for the induction machine has beensupplied from the rsc and therefore the load reactive energy hasbeen stocked with from the gsc. Decoupled manage ofboth active and reactive powers has dispensed by rsccontrol. Dfig has additionally been tried at wind turbinestalling condition for compensating harmonics andreactive electricity of neighborhood a whole lot. Projected dfig-basedwecs with AN integrated spirited filter out has beensimulated the usage of matlab/simulink surroundings, andthe simulated results ar verified with take a look at results of thedeveloped epitome of this wecs.

REFERENCES

1]. ManasiPattnaik, "Study Of Doubly Fed Induction Generator For Variable Speed Wind Energy Conversion Systems", Special Issue OfInternational

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

Journal Of Power System Operation and Energy Management, ISSN (PRINT):2231–4407,Vol – 1,Issue – 3.

[2]. F. Poitiers, M. Machmoum, R. Le Doeuff and M.E. Zaim, "Control Of A Doubly-Fed Induction Generator For Wind Energy ConversionSystem",GE44-LARGE ,Ecoleploytechnique de l`universite`de Nantes, Saint Nazaire, France.

[3]. R. Pena, J.C Clare and G.M Asher, "Doubly Fed Induction Generator Using Back -to-Back PWM Converter and Its Application ToVariable-Speed Wind Energy Generation", IEEE Proceeding Electrical Power Application., Vol.143, NO.3, May1996, ISSN.,PP. 231-241.

[4]. T. Thiringer, A. Petersson, and T. Petru ,"Grid Disturbance Response Of Wind Turbine Equipped With Induction Generator and DoublyFed Induction Generator", in Proceeding IEEE Power Engineering Society General Meeting, Vol.3, Toronto, Canada, July 2003,pp.1542-47.

[5]. A. Petersson, L. Harnefors, and T.Thiringer, "Evaluation Of Current Control Methods For Wind Turbines Using Doubly-Fed InductionMachine", IEEE Transaction on Power Electrnoics.,Vol 20,No.1,Jan 2005,PP.227-235, July 2000.

[6] D. S. Zinger and E. Muljadi, "Annualized windenergy improvement using variable speeds," IEEETrans. Ind. Appl., vol. 33, no. 6, pp. 1444–1447,Nov./Dec. 1997.

[7] H. Polinder, F. F. A. van der Pijl, G. J. de Vilder,and P. J. Tavner, "Comparison of direct-drive andgeared generator concepts for wind turbines," IEEETrans. Energy Convers., vol. 21, no. 3, pp. 725–733,Sep. 2006.

[8] R. Datta and V. T. Ranganathan, "Variable-speedwind power generation using doubly fed wound rotorinduction machine—A comparison with alternativeschemes," IEEE Trans. Energy Convers., vol. 17, no.3, pp. 414–421, Sep. 2002.

[9] E. Muljadi, C. P. Butterfield, B. Parsons, and AEllis, "Effect of variable speed wind turbine generatoron stability of a weak grid," IEEE Trans. EnergyConvers., vol. 22, no. 1, pp. 29–36, Mar. 2007.

Authors Details:

P V Samrat completed M.E. from College of Engineering,Osmania University in the year 2013. My areas of Interests are Power Electronics,Power Quality,Grids.

G.Isaac Having 9+ Years Of Exp As Asst Professor In The Dept Of Electrical And Electronics Engg, Presently Working As Asst Professor In Global Institute Of Engg And Technology, Jntu, Hyderabad. I Did B.Tech From Royal College Of Engg (Presently Hyderabad Inst Of Engg And Technology And Management In The Year 2005 And M.Tech (Power Electronics And Industrial Drives) From Jntu College Of Engg Hyd In Year 2010.