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ADVANCED POWER CONTROLLING TECHNIQUES FOR DFIG – BASED WIND TURBINES- A REVIEW

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ABSTRACT:

As we move forward, a lot of changes in the technological field regarding energy production can be witnessed. Renewable energy sources are penetrating the energy production field mainly due to the numerous advantages they offer in contrast with conventional fuels. Moreover, the finite nature of fossil fuels and the dangers faced regarding climate changing are two more factors contributing to the above. The wind energy is considered as one of the most promising alternative of energy with enormous potential. The main problem during the exploitation of wind power as an energy source is that it is not a constantly available one. Furthermore, the fluctuating nature of wind speed and direction can cause many disturbances in the power delivered to the grid or even cause generator tripping, system decoupling, etc.

Fixed speed wind turbines have managed to cope with the fluctuating characteristics of the wind but on the other hand they leave an important amount of wind power unexploited. It is mainly due to this fact that variable speed wind turbines are considered to be not only the present but also the future of wind energy industry applications. Due to this certainty, authors have focused on the analysis of a variable speed generator; in our case a Doubly-Fed Induction Generator (DFIG). In this paper authors have presented the review of advanced power controlling techniques for DFIG, based wind turbines.

Keywords: Wind turbines, doubly fed induction generators, Vector control, direct torque /powercontrol.

I. INTRODUCTION

In the past decades, a great increase in electrical power demand and depletion of natural resources have made environmental and energy crises. These have led to an increased need for production of energy from renewable sources so that the world wind energy production has grown significantly due to cleanness and renewability. Wind power generation is estimated to be 10% of the world's total electricity by the year 2020 and is expected to be double or more by the year 2040. Wind turbines (WTs), which play a main role in wind energy, are basically divided into fixed and variable-speed technologies. [1]

Variable-speed WTs have been increasingly employed recently due to several advantages compared with the fixed speed technologies, including maximized power capture, decreased mechanical stresses imposed on the turbine, improved power quality, and decreased acoustical noise. The variable speed technologies can be further subdivided into two types: synchronous generators with full-scale converters and doubly fed induction generators (DFIGs) with partial-scale converters. The DFIG is particularly employed for high-power applications, due to the lower converters cost and lower power losses. The DFIG control comprises both the rotor side converter (RSC) and grid side converter (GSC) controllers so that the RSC controls stator active and reactive powers and the GSC regulates dc-link voltage as well as generates an independent reactive power that is injected into the grid. [2]

Vector control (VC) is the most popular method used in the DFIG-based WTs .This method has some of the advantages and disadvantages, such as its dependence on the machine parameters variation. In order to overcome the aforementioned problems, different nonlinear control methods such as direct torque control/direct power control (DTC/DPC) have been proposed. This method has also some advantages and disadvantages although many modified methods have been presented to overcome these problems, their drawback is complex online computation.[3]

In order to enjoy the benefits of VC and DTC, the combined VC and DTC (CVDPC) method has been applied successfully to induction motor and permanent magnet synchronous motors. However, the CVDPC method has not been studied appropriately for the DFIG. In this paper, it is focused on comparison of VC and DPC by looking for similarities between their principles and searching for a fundamental common basis. From this common basis, in order to enjoy the benefits of VC and DPC and to avoid some of the implementation difficulties of either of two methods, the CVDPC method is proposed for the RSC of the DFIG. The proposed CVDPC has several advantages in comparison with VC, including fast dynamic response, robustness against the machine parameter variations, lower computation, and simple implementation. On the other hand, it has benefits in comparison with DPC, including less harmonic distortion and lower power ripple. The rest of this paper is organized as follows. In Section II, the VC and DPC methods are described and the common basis of them is investigated. In Section III, the proposed control system and its basic idea are discussed. In Section IV, simulation results are shown, and finally, in Section V, the conclusion is presented. [4]

II. LITERATURE REVIEW:

Below is a literature review of works carried out in last few years controlling for DFIG-based wind turbines.

1) **Jafar Mohammadi, Sadegh Vaez-Zadeh, Saeed Afsharnia, Ehsan Daryabeigi** have proposed the combined vector and direct power control (CVDPC) for rotor side converter (RSC) and doubly fed induction generator. (DFIG's). The proposed system in this paper is having the benefits of Vector Control (CV) and direct power control (DPC) in compacted control system. The proposed system by authors included fast dynamic response, robustness against the machine parameters variation, lower computation, and simple implementation. It is also beneficial as it has less harmonic distortion and lower power ripple. In this paper authors have proved the superiority of the CVDPC over either VC or DPC by means of the MATLAB/ Simulink under steady state and transient conditions.

2) **Heng Nian and Yipeng Song,** have proposed a direct power control scheme for doubly-fed induction generator for variable speed wind power generation. The motive of this study is to reduce the errors from active and reactive power in order to achieve high accuracy and fast dynamic power response based on the estimated stator flux.

3) **S. Li, T. A. Haskew, K. A. Williams, and R. P. Swatloski** has discussed DFIG wind turbines on the basis of direct current vector control method. Authors have compared and demonstrated and proposed the DFIG wind turbine control structure for better control and superior performance within steady state as well as transient state. The analysis performed under certain physical constraints, beyond which, the proposed control approaches operates the system by regulating the RSC for maximum wind power extraction as the first priority and by controlling the GSC to stabilize the dc-link voltage as the main concern. The proposed method was authenticated with Sim Power system for effectiveness.

4) **L. Xu and P. Cartwright,** have presented the novel strategy of direct power control for a doubly fed induction generator (DFIG)-based wind energy generation system. The selection of proper voltage and vectors of rotor side plays vital role in the method. Initially rotor flux of generator does not affect the stator active and reactive power. Authors have proposed to use the stator flux in order to minimize the problems related to rotor flux. The stator resistance which does not affect the system performance is used in this method.

5) **S. Vaez-Zadeh and E. Jalali**, have proposed the control method. This method is implemented in the three phase induction motor drive. The proposed control system in this paper, includes current vector in connection with a switching a switching table. The proposed method is useful to reduce the losses.

III. PROBLEM STATEMENT:

Vector control (VC) is the most popular method used in the DFIG-based WTs. Some of the advantages are precise steady-state performance, less power ripple, and lower converter switching frequency. However, it has some disadvantages, such as its dependence on the machine parameters variation due to the decoupling terms and high online computation owing to the pulse width modulation (PWM) procedure. Moreover, the coefficients of proportional–integral (PI) controllers, in the conventional VC, must be optimally tuned to ensure the system stability within the whole operating range and attain sufficient dynamic response during the transient conditions. In order to overcome the aforementioned problems, different nonlinear control methods such as direct torque control/direct power control (DTC/DPC) have been proposed. The main advantages of DTC/DPC methods include fast dynamic response, robustness against the machine parameters variation, reduction in computation, and simple implementation. However, they have some disadvantages including significant torque/power ripples due to the high bandwidth of the hysteresis controllers, variable switching frequency of the converters, and deterioration of the controller performance during the machine starting and low-speed operations. Although many modified methods have been presented to overcome these problems, their drawback is complex online computation.

In order to enjoy the benefits of VC and DTC, the combined VC and DTC (CVDPC) method has been applied successfully to induction motor and permanent magnet synchronous motors. However, the CVDPC method has not been studied appropriately for the DFIG.

A. OBJECTIVE:

The main objective of this proposed project is to design “A Combined Vector and Direct Power Control for DFIG-Based Wind Turbines” which will use a combined vector and direct power control (CVDPC) for the rotor side converter (RSC) of doubly fed induction generators (DFIGs). The performance of the proposed CVDPC method is compared with both VC and DPC under steady-state and transient conditions. Simulation results confirm the superiority of the CVDPC over either VC or DPC.

B. SUB OBJECTIVES:

Below are the sub objectives to complete project in modular form-

1. Study of basic structure of DFIG: - This section will includes study of basic structure of DFIG

2. Study of Vector Control Technique:- This section includes **Study of Vector Control Technique** for the DFIG system.

3. Study of Direct power Control Technique:- This section includes **Study of Direct power Control Technique** for the DFIG system.

4. Study of Combine Direct and vector power Control Technique:- This section includes **Study of combine Direct and vector power Control Technique** for the DFIG system.

5. MATLAB/Simulink Simulation:- This part includes the simulation of DFIG fed power system which will be controlled by combine direct and vector control technique.

C. SCOPE OF THE PROPOSED PROJECT:

The developments in wind energy systems and the advances in power electronics have enabled efficient wind energy capture. They also describe, briefly, the proposed simulation study of control schemes used in wind energy systems. The modeling of the various SIMULINK implementations has been investigated.

The doubly fed induction generator is vectorically found to be the best power control method with low losses, good performance operation.

IV. METHODOLOGY:

Below is the modular approach for the proposed project-

- Collection and study of relevant literature to arrive at central idea of the proposed work.
- Study of history and developments in wind energy system technology.
- Study of basic controlling technique of DFIG: Pitch controlling and rotor resistance controlling
- Study of vector power control technique with MATLAB/ Simulink.
- Study of direct power control technique with MATLAB/ Simulink.
- To carryout analysis of combined vector and direct power control with MATLAB/Simulink.
- Comparison of result obtained through vector power control, direct power control and combined vector and direct power control.

V. CONCLUSION:

In this work, with considering the structure of VC and DPC, an innovative combined control structure based on the common basis of both methods has been presented for the RSC of the DFIG. The combined system enjoys the current VC approach, which generates the rotor current components and uses the DPC based switching table. The proposed CVDPC method has been compared with both the VC-based optimized PI controllers and DPC in terms of simple implementation, acceptable power ripples, and suitable dynamic response. As a result, the proposed CVDPC method provides a compromise of the advantages of two methods.

In the steady-state conditions, the CVDPC has power ripple as low as that of VC. The ripple is significantly lower in comparison with that of DPC. Furthermore, an FFT analysis shows that CVDPC has a suitable THD as low as that of VC, which is less than that of DPC. In the transient conditions, the CVDPC responds to the wind speed variations approximately as fast as DPC, which outperform VC in terms of dynamic response. Moreover, the CVDPC-like DPC outperforms VC in providing proper decoupling and robustness against the machine parameters variation. Consequently, the proposed CVDPC not only enjoys lower power ripple as good as VC but also keeps high dynamic response as fast as DPC.

VI. REFERENCES:

1) Jafar Mohammadi, Sadegh Vaez-Zadeh, Senior Member, IEEE, Saeed Afsharnia, Ehsan Daryabeigi "*A Combined Vector and Direct Power Control for DFIG-Based Wind Turbines"*
2) Heng Nian and Yipeng Song *"Direct Power Control of Doubly Fed Induction Generator Under Distorted Grid Voltage"*
3) Shuhui Li, Timothy A. Haskew, Keith A. Williams, and Richard P. Swatloski, "*Control of DFIG Wind Turbine With Direct-Current Vector Control Configuration"*, IEEE Transactions On Sustainable Energy, VOL. 3, NO. 1, JANUARY 2012, pp 1-11
4) L. Xu and P. Cartwright, *"Direct active and reactive power control of DFIG for wind energy generation,"* IEEE Trans. Energy Convers., vol. 21, no. 3,pp. 750–758, Sep. 2006.
5) S. Vaez-Zadeh and E. Jalali, *"Combined vector control and direct torque control method for high performance induction motor drives,"* Energy Convers. Manage., Elsevier, vol. 48, no. 12, pp. 3095–3101, Dec. 2007.
6) P. Vas, "*Vector Control of AC Machines".* New York: Oxford Univ. Press, 1990.
7) Jones S.R., Jones R. 1993, Vol. Developments in real time control for induction motor drives, *"Control strategy for sinusoidal supply side convertors"* Published in Developments in Real-Time Control for Induction Motor Drives, IEE Colloquium, pp.1-9...
8) Lie Xu, Senior Member, IEEE, "*Enhanced Control and Operation of DFIG-Based Wind Farms during Network Unbalance"*, IEEE Transactions On Energy Conversion, VOL. 23, NO. 4, DECEMBER 2008, pp 1073 - 1081.
9) Lie Xu *"Coordinated Control of DFIG's Rotor and Grid Side Converters during Network Unbalance*", IEEE Transaction On Power Electronics, VOL. 23, NO. 3, MAY 2008, pp 1041-1049.
10) Ruben Pena, Member, Roberto Cardenas, Enrique Escobar, Jon Clare, and Pat Wheeler, "*Control System for Unbalanced Operation of Stand-Alone Doubly Fed Induction Generators"*, IEEE Transactions' on Energy Conversion, VOL. 22, NO. 2, JUNE 2007, pp 544-545.
11) Guided tour on wind energy, Danish wind industry associates, www.windpower.org/en/tour.html.
12) American Wind Energy Association website (www.awea.org).