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Comprehensive Approach to Enhance the Output Power of DFIG-Based Wind Energy Conversion Systems

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Abstract. This paper presents a method for measuring a wind turbine's MPP (Maximum Power Point) with a three-bladed VSWT that is driven by a DFIG (Double-Fed Induction Generator) (Variable Speed Wind Turbine). The rotor incorporates a DFIG with successive PWM voltage-source converters within its integrated rotor integrated circuit. Grid-side converters generate and establish sinusoidal currents while independently managing the active and reactive power drawn from the grid supply using vector control techniques. The rotor-side converter needs to be vector controlled in order for the speed range to function. The vector approach manages the permit circuit optimally to maximize the amount of wind energy gathered. The control needs of the permit circuit take this into account. Such a system is analyzed using MATLAB software

1. Introduction

In response to the increasing demand for electricity and the important environmental impact of conventional energy systems, society is looking to alternative energy sources for energy generation. Due to their environmental friendliness, renewable energy sources often renew themselves according to nature's cycle, and they are regarded as virtually limitless [1]. There are numerous wind energy systems (WGS) available in the world, they are environmentally friendly, amicable, and efficient enough to generate power for a neighborhood due to their ease of accessibility and topological suitability. In the past few years, Doubly Fed Induction Generators (DFIGs) have become a more favorable option when compared to Permanent Magnet Synchronous Generators (PMSGs) or DC generators. This paper delves into one wind energy conversion method that utilizes DFIGs. Wound Rotor Induction Machines (WRM) or Doubly Fed Induction Machines (DFIM) (WRIM), often in the megawatt power range, have been used in countless applications for decades. It is a term commonly used to characterize electrical machines that have been developed. range of many kilowatts. Figure 1 displays an illustration of a DFIM supply configuration. To create the magnetic field inside the stator, a three-phase voltage is applied straight from the network with consistent amplitude and frequency. A three-phase voltage is also provided to the rotor. with unequal frequencies to meet the machine's varied working circumstances (speed, torque, etc.). A three-phase back-to- back three-phase converter is used to do this, as can be seen in the straightforward schematic in the image. This converter is powerful in producing the necessary voltage of the rotor AC power to manage the DFIM's overall operating point and achieve power trading by the rotor in the grid when used in conjunction with a successful control strategy. Several layouts or converter topologies can be utilized, even if a voltage source converter is illustrated

2. Materials And Methods

Dynamic modeling is suitable for rotor-side inverter control signals because it simplifies the control strategy compared to that of a three- phase inverter. The creation of the dynamic and dq models for DFIM incorporates space vector theory into the machine's fundamental electrical equations and assumes that the machine is ideal and linear. As in the stationary example, which is considered. Figure 2 depicts three various rotating reference frames that are frequently employed when creating space vector-based DFIM models. The system's rotor frame (DQ) revolves about the stator frame (-), which is fixed. ωm, and the synchronous frame (dq) rotates ωs. The lowercase 's', 'r', and 'a mean that the space vector is a statement of the stator, rotor, and sync. An implied frame or spatial vector can be described in each of these frames by direct and inverse rotation transformations [7].

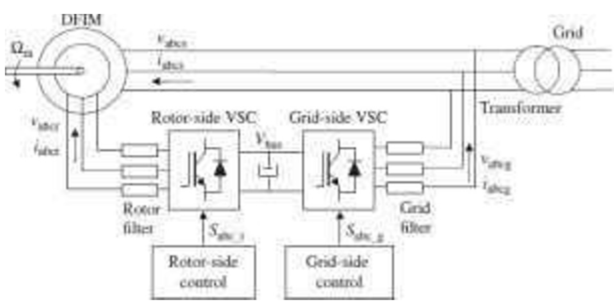

Fig. (1). The DFIM's general supply setup

3. Maximum Power Point Tracking

The commonly used approach to wind turbine control isshown in Fig. 3 and includes four working modes: Limit the minimum working speed. Accompany the maximum power curve resulting from thefluctuating speed operating with the preloaded load. When operating with the preloaded load, restrict theMaximum speed The calculated power should be the maximum Operating speed. speed for a specific wind speed and uses this as a benchmark for turbine speed. This controller is known as an indirect speed controller (ISC). The controller (governor) then controls the turbine's speed. The name of it is Direct Speed Control (DSC). location on the Zone 2 maximum power curve where theWT is dynamically stable can be demonstrated using ISC. This implies that at a specific location on the maximum power curve, the VSWT typically returns to its operational point whenthe speed varies. In Figure 4, the ISC is displayed.

4. Vector Control

This section describes DFIM control. It is important to distinguish between two different criteria: grid-connected functionality and steady-state operation. There are slight differences in the control of the two configurations, which areexplained below**.** Among the various possible control techniques for the further development of DFIM, We solely take vector control methods into account. DQ coordinates can beused for control. Thus, it is necessary to calculate the rotor voltage and current in DQ coordinates. First, determine the space vector stator voltage angle, thensubtract 90° from that nominal angle to determine θs. Synchronize the stator voltage network using an intelligent phase-locked loop (PLL) for more robust determination and immunity to small disturbances and harmonics. The rotor side converter's overall vector control (RSC) is shown in Figure 5 [6]. Control is an important aspect of line-sidesystems. Without a technique to properly control some of thevariable sizes of the parts on the grid side, this becomes difficult. This control technique is generally preferred for various grid-tied converter control techniques. Well-thought-out and clear requirements promise better utility characteristics. The Vector control strategies follow the ideology of encoding the structure of the system to be controlled (in this case the grid-side system) in terms of spatial vectorsLine- side converters regulate the DFIM's power flow components. The rotors of the DFIM carry some of the power produced by the wind turbines. This power flow passes through a grid-side converter, the rotor, and the DC connector before reaching the grid. Figure 1 depicts complete control of the line side converter (GSC).

References

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