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Power Control System of Warped Grid Voltage for Slip Ring Induction Generator: A Review

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Abstract

Wind energy is one of the most reliable, efficient, and developed renewable sources of energy. The most extensively utilised concept nowadays is a slip ring induction generator (SRIG) based on a wind farm. The dynamic modelling and control of a slip ring induction generator (SRIG) based on wind turbine systems were reviewed and investigated in this study. Many authors and researchers work on various projects and analyses based on the power control of warped grid voltage for slip ring induction generators. The dynamic performance of a doubly fed induction generator is investigated under a variety of operating situations, including stability, grid voltage distortion, and no distortion. This research examines the direct power control (DPC) technique for a doubly fed induction generator (DFIG)-based wind power generation system with and without warped grid voltage. Different literature surveys are also used to look into the harmonic component analysis of the electrical grid.

Keywords*: - Warped grid voltage, power electronics, DFIG, Slip Ring Induction Generator*

INTRODUCTION

Due to the low rating of power-electronics circuits required to separately regulate active and reactive powers provided to the grid, the doubly fed induction generator (DFIG) has been widely utilised in wind power production [1]. For a long time, the underlying theory and principles of self excitation in induction devices have been understood [2]. The DFIG is an induction generator with windings on both the stator and the rotor. With a static converter attached between the stator and rotor, the DFIG is now commonly utilised in variable-speed wind energy applications [3]. DFIG is widely used due to a number of advantages, including a simple converter rating of about 35% of the generator rating, irregular speed, and reactive power operation characteristics. When compared to fixed-speed induction generators or alternators with full-sized converters, converter costs are also lower and power losses are lower [4].

DOUBLY FED INDUCTION GENERATOR

In India, the utilisation of doubly fed induction generators is increasing as the country's wind power production capacity grows [5]. When the rotor of an induction generator spins faster than the synchronous speed, it generates electricity. The stator flux rotation is quicker than the rotor rotation in typical motor operation [6]. The rotor and stator windings of a doubly fed induction generator, commonly known as a three-phase induction generator, are fed with three-phase AC power [7]. A multiphase slip ring assembly is also used to deliver power to the rotor. The DFIG is used in conjunction with a power electronic system that consists of two three-phase Graetz Bridges that are linked back to back and share a common DC connection. It is commonly utilised in wind turbine generators to create energy [8]. In a wind turbine system, a doubly fed induction generator features a rotor with strong overspeed withstand, insulation against converter voltage peaks, slip ring design for extended service intervals, and bearing design to minimise circulating currents [9].

DIRECT POWER CONTROL

The power penetration of DFIG-based wind turbines into the grid is constantly growing, and the management and functioning of DFIG in the face of grid disruptions has been a hot topic of research in recent years [10]. Direct control (DTC and Direct power control) has various limitations, the most noteworthy of which are significant torque/flux (active/reactive power) waves and variable switching frequency [11]. Under warped grid voltage circumstances, several forms of resonant current regulators for a doubly fed induction generator (DFIG) are: 1: conventional resonant section of a proportional integral resonant (PIR) regulator, 2: VPI resonant part of a vector proportional integral (VPI) regulator [12]. Electrically vector control [13], active and reactive power control [14], direct torque control [15], direct power control [16], variable structure or sliding mode control [17], passivity control, and mechanical (pitch, stall, and active stall control, yaw control, flywheel storage) [18] are some of the methods used to control induction. [19] The DPC method enhances system performance. These enhancements have an impact on system responsiveness on the DC side capacitor voltage, power-factor correction, sinusoidal line current, and power quality [20].

CONCLUSION

These setups are based on a power control approach that uses a rotating reference frame that is fixed to the generator's air-gap flux. The generator's active and reactive power may be adjusted separately and consistently [22]. The analysis of fundamental items such as power and current regulation has been carried out. The survey examines a VPI-based DPC method for a wind turbine-driven DFIG system operating under harmonically distorted grid voltage, which suppresses the power pulsation component and successfully implements the smooth active and reactive power output of DFIG under harmonic voltage. Control and automated power electronic equipment, protection systems, and other electrical loads are all negatively affected.

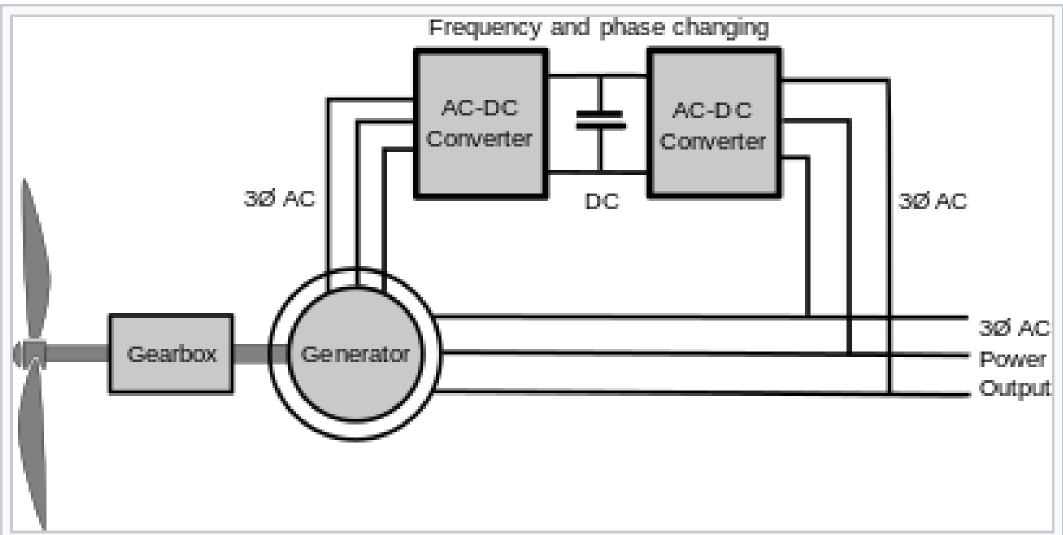

Figure: 1 Doubly-fed generator for wind turbine

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