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Modelling and Power Control of Wind Turbine Driving DFIG connected to the Utility Grid

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Abstract. In this paper, the modelling and power transfer control of the variable speed wind energy system are presented. Firstly, a Maximum Power Point Tracking (MPPT) method is developed in order to maximize the energy generation of wind system based on doubly fed induction generator (DFIG). Then, the control of both Rotor Side Converter (RSC) and Grid Side Converter (GSC) is studied and the design of a multivariable selective filter is presented. Finally, simulation of a 850 kW doubly fed induction generator wind system was performed in the Matlab / Simulink / SimPowerSystems environment.

Key words

DFIG, Active Power, Reactive Power, Wind turbine, MPPT.

1. Introduction

Currently, wind energy has become a viable solution for energy production, in addition to other renewable energy sources. While most wind turbines are fixed speed, the number of variable speed wind turbines is increasing [1]. The DFIG with a vector control strategy delivers good performance and is commonly used in wind turbine industry [2]. There are many reasons for using a DFIG for a variable wind speed, such as reducing strain on mechanical parts, noise and the possibility for control active and reactive power [3].

The wind system using a DFIG and the back-to-back Pulse Width Modulation (PWM) converter which connects the rotor of the generator and the network has many advantages. One of them is the power converters used that are sized to pass a fraction of the total power of the system [4]-[5], thereby reducing losses in power electronic components.

The performance and output power do not depend only on the DFIG, but also the way the back-to-back converter is controlled. The back-to-back converter consists of two parts: the machine side converter called Rotor Side Converter (RSC) and the network side converter called Grid Side Converter (GSC). The RSC controls the active power and reactive power produced by the machine. The GSC controls the DC bus voltage and power factor. In this study, a technique to control the two power converters is presented and the wind system dynamic performance is analyzed by simulations in Matlab / Simulink / SimPowerSystems. Firstly, the wind turbine is modeled then a MPPT technique for extracting the maximum power is presented. Subsequently, a model of the DFIG is derived in *dq* reference frame. Finally, simulation results and their interpretation are provided.

2. Modelling of the Wind Turbine

The power extracted by a turbine depends on the power factor and it is given by the following equation [6] :

$$P_{extracted} = \frac{1}{2}.\rho.S.C_p(\lambda,\beta).v^3 \qquad (1)$$

Where :

ρ : mass density of air [kg/m^3]; v : speed of the wind [m/s]; S : area swept by the blades [m^2]; C_p : power coefficient; λ : represents the ratio between the speed at the blade tip and wind speed; β : is the blade angle.

The turbine is typically coupled to the generator shaft through a gearbox with a ratio G, which is determined to maintain the generator speed within a desired range.

The wind turbine can produce only part of the power due to the kinetic energy of wind.

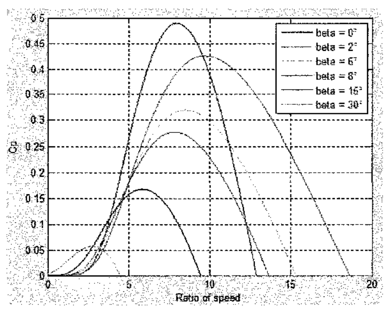

Figure -1- Power coefficient versus λ and β