Modeling, Control and Simulation of a Variable Speed Wind Turbine Connected to Networks

Merabet Hichem[1*], Bahi Tahar[2], Drici Djalal[1], Bedoud Khouloud[1], Boukadoum Aziz[3]

[1] Research Center in Industrial Technologies (CRTI) P.O. Box 64, Cheraga, Algeria.

[2]Department of Electrical Engineering, University of Annaba, Algeria

[3]Department of Electrical Engineering, Echahid Cheikh Larbi Tebessi University, Algeria

*Corresponding author's e-mail: h.merabet@crti.dz

ABSTRACT

The development of technologies and conversion structures related to the use of renewable energy for power generation by wind turbines poses significant research challenges. This paper examines the properties and performance of the control application of a wind power system associated with an induction generator via power converters connected to a distribution network. However, in order to evaluate the performance of such a conversion structure a simulation program taking into account the specificities and models of each element of the chain has been developed using Matlab/Simulink.

Keywords: Wind Turbine, Induction generator, Variable speed.

1 Introduction

In the field of power generation, fuels (raw materials) are the world's most important energy resources and are at the heart of energy demand. However, the unfortunate fact of the undeniable depletion of fossil fuels and their undesirable effects on the atmosphere has prompted decision makers in countries around the world to ensure an energy transition from fossil fuels to renewable sources which was seen at the time have been forced to meet existing energy needs. For this purpose, the development of wind turbine (WT) systems has become very powerful and interesting [1], [2], mainly in terms of control and energy quality. However, their potential is important worldwide [3], [4].

2 Methodology

This work presents a study on the control and performance analysis of the conversion system of distribution grid connected to induction generator (IG) based wind power system. The applied control approach aims to improve the efficiency and reliability of the conversion system. The entire model is simulated in Matlab/Simulink software and the simulation results obtained under various tests and operating conditions are displayed and interpreted.

3 Modeling of wind turbine

The wind power conversion chain structure considered in this work as shown in Figure 1, it consists of an induction generator connected to the distribution network through two power electronic converters separated by a capacitor.

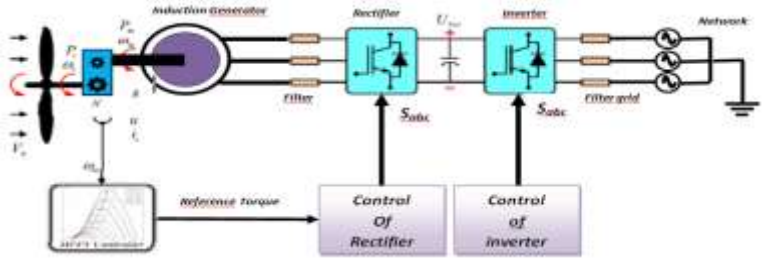

Figure 1: *Configuration of wind turbine with Induction generator*

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4 Simulation of Results

Following on from the above, this section is devoted to present the simulation results obtained under a variable wind profile consisting of steps of 4 m/s and 5.5 m/s, as shown in the top panel of Figure 2. In this wind profile we can see that the specific speed, pitch angle and power factor are correctly following the reference values. Figure 3 presents the torque produced by the turbine and the torque of the generator that ensure the motion of the generator. After transition regimes related to wind profile levels, we find that they overlap. Moreover, the same figure shows that the speed of the generator perfectly follows the reference speed imposed on it.

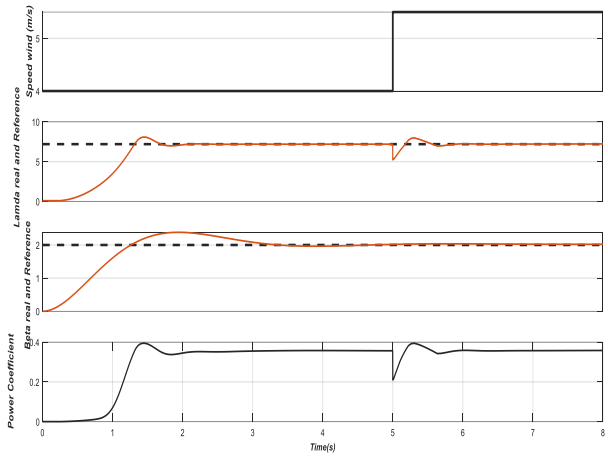

Figure 2: *Wind speed profile and wind turbine characteristics*

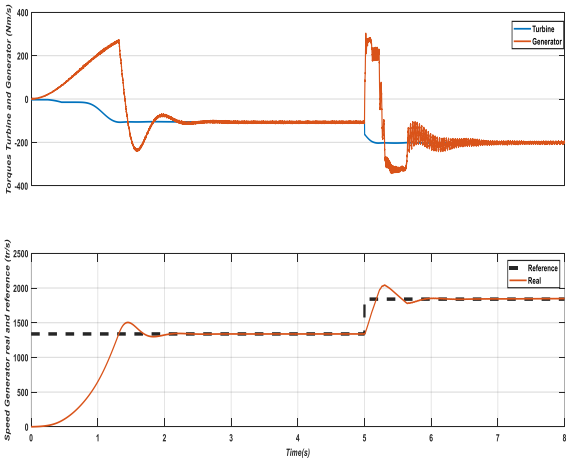

Figure 3: *Torques and speeds of the turbine and generator*

5 Conclusion

This work is part of our contribution to the design and development of structures for wind energy conversion systems aimed at meeting international standards, facilitating their implementation and ensuring the quality of the energy produced. An analysis of the structural and control simulation results used in this work highlights the interest of such installations and confirms their feasibility.

In the future work will be a basis for studying:

- The faults inverter of the conversion system and their impact on the operating of the wind energy conversion chain.
- Study the robustness of the control strategy applied in the case of the presence of converter faults installed in wind energy conversion chain.
- This system contains two power inverter back to back type, where the study of fault is necessary in order to know the damaged inverter.

How to Cite

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