Received: 17 February 2018 | Revised: 22 May 2018 | Accepted: 22 June 2018

DOI: 10.1002/ese3.215

RESEARCH ARTICLE

Energy Science & Engineering Open Access

Power control of variable speed wind turbine based on doubly fed induction generator using indirect field-oriented control with fuzzy logic controllers for performance optimization

Othmane Zamzoum | **Youness El Mourabit** | **Mustapha Errouha** | **Aziz Derouich** | **Abdelaziz El Ghzizal**

Ecole Superieure de Technologie de Fès, Université Sidi Mohamed Ben Abdellah, Fes, Morocco

Correspondence: Othmane Zamzoum, Ecole Superieure de Technologie de Fès, Université Sidi Mohamed Ben Abdellah, Route d'Imouzzer BP 2427, Fes, Morocco (othmanezamzoum@gmail.com).

Abstract

The main objective of this study is to improve the energy quality extracted by variable speed wind turbine based on doubly fed induction generator. First, the dynamic modeling of different parts of the system is presented. The electrical machine is modeled in PARK reference frame. Thereafter, the control technique is detailed. Indirect field-oriented control with fuzzy logic controllers (FLC) is used to control the rotor currents and consequently the real and reactive powers of the stator generator. Then, the design of FLC is detailed by tuning its most significant parameters, which are scaling factor rules base and membership functions. Finally, a simulation using the MATLAB/SIMULINK environment is carried out to prove the validation of the control strategy using a 2 MW wind turbine. The results show a satisfactory performance in terms of rapidity, stability, and precision under variable wind speed conditions.

KEYWORDS

doubly fed induction generator, field-oriented control, fuzzy logic controller, maximum power point tracking, scaling factor, variable speed wind turbine

1 | INTRODUCTION

In the last decades, increasing consumption of electrical energy and damaging effect on environment and human's health of fossil-fuels oblige the energy researchers to develop renewable energy alternatives.[1,2] Therefore, among of different kinds of available renewable resources, wind power has become more attractive and promising source due to its advantages from a point of view of cost, efficiency, and reliability.[3,4]

Uncertain and unpredictable behavior of wind energy, affected by the daily and seasonal climate change, can have a negative impact on the performance and stability of the system.[5] As a result, using Variable speed technologies of wind turbine allow to extract the maximum amount of wind energy by operating over a wide range of wind speeds.[6]

Thus, in the modern wind energy conversion systems (WECS), doubly fed induction generator (DFIG) have a crucial role in variable speed technology. This machine can offer many advantages: it can operate at variable speed (subsynchronous or super-synchronous speed) by adjusting the phase and frequency of rotor voltages.[7] The power converter can be significantly improved in terms of size. It can be designed to transfer only 30% of the DFIG's rated power. This makes the wind turbine more efficient, lighter, and cheaper.[8] Moreover, The DFIG allows the possibility to control separately the real and reactive power which makes this machine a competitive choice in terms of grid compatibility.[9]

The structure of the control system is very important not only for extracting the maximum wind power with the best performance, but also to prevent the quality degradation of