Front. Energy
DOI 10.1007/s11708-015-0363-9

RESEARCH ARTICLE

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Doubly-fed induction generator drive based WECS using fuzzy logic controller

Abstract The purpose of this paper is to improve the control performance of the variable speed, constant frequency doubly-fed induction generator in the wind turbine generation system by using fuzzy logic controllers. The control of the rotor-side converter is realized by stator flux oriented control, whereas the control of the grid-side converter is performed by a control strategy based on grid voltage orientation to maintain the DC-link voltage stability. An intelligent fuzzy inference system is proposed as an alternative of the conventional proportional and integral (PI) controller to overcome any disturbance, such as fast wind speed variation, short grid voltage fault, parameter variations and so on. Five fuzzy logic controllers are used in the rotor side converter (RSC) for maximum power point tracking (MPPT) algorithm, active and reactive power control loops, and another two fuzzy logic controllers for direct and quadratic rotor currents components control loops. The performances have been tested on 1.5 MW doubly-fed induction generator (DFIG) in a Matlab/Simulink software environment.

Keywords fuzzy logic, wind turbine, vector control, doubly-fed induction generator (DFIG)

1 Introduction

Wind energy is one of the most important and promising sources of renewable energy all over the world, mainly because it is considered to be non-polluting and economically viable. At the same time, there has been a rapid development of related wind turbine technology [1,2]. The global scheme for a grid-connected wind turbine is presented in Fig. 1.

Variable speed operation of wind turbine is usually used to provide energy with the best efficiency. The wind energy conversion system (WECS) based on doubly-fed induction generator (DFIG) has several advantages [3]. It reduces the stresses of the mechanical structure and the acoustic noise, and regulates both active and reactive power [4]. Its back-to-back PWM converters, connected between the grid and the rotor circuit are sized only for 30% of the full power of the generator [5]. The wind turbine generators (WTGs) can achieve the maximum wind power provided at various wind speeds by correctly adjusting the shaft speed [6]. As far as variable-speed generation is concerned, it is necessary to produce constant frequency electrical power from a variable speed source [2,7]. This can be achieved by means of wound-rotor induction generator fed with variable frequency rotor voltage. This allows fixed-frequency electrical power to be extracted from the generator stator. Consequently, the use of DFIGs is receiving increasing attention for wind generation purposes [8,9].

The vector control of the DFIG gives very good performances because it can achieve a decoupling control of the active and reactive power. In recent years, many researches of vector control take the following manner to track the largest wind energy under the rated wind speed. However, when wind speed becomes greater than the rated speed, the output power can remain stable only by adjusting the pitch angle. Compared with the fixed pitch, the variable pitch has many characteristics, such as the smooth output power within the point of rated power, the maintenance of rated power in high-speed section and the stronger performance of gear brake. At a low wind speed, the electromagnetic torque of DFIG is controlled to achieve speed control of wind turbine [10,11]. So far, several researches concentrate on stator active and reactive power controllers. The typical PI controller is used most which can satisfy the control requirement under normal

Received August 17, 2014; accepted January 6, 2015

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