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Separate Powers Control Structure of Doubly fed Induction Machine Based on Fractional Regulator

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Abstract

This paper shows that we can improve the performance of the auto-adjustable electric machines if a fractional dynamic is considered in the algorithm of the controlling order. This structure is particularly interested in the separate control of active and reactive power of the double-fed induction generator (DFIG) of wind power conversion chain. Fractional regulators are used in the regulation of chain of powers. Knowing that, usually, the source of DFIG is provided by converters through controlled rectifiers, all this system makes the currents of lines strongly polluted that can have a harmful effect for the connected loads and sensitive equipment nearby. The solution to remedy these problems is to replace the power of the rotor DFIG by a matrix converter which represents a THD less important. The structure of the adopted adjustment is tested using Matlab/Simulink and the results are presented and analyzed for a variable wind.

Keywords : DFIG, wind, matrix convertor, fractional, regulator.

1. Introduction

The rapid development of industrial activity is only possible with an important production of energy. However, to meet this demand, the installation of production lines for energy is widely encouraged. The great interest shown today in the doubly fed induction generator (DFIG) in the chain of energy production, has prompted us to analyze the performance of the separate control of active and reactive power when fractional regulators are seen in the control chain and power ratings of DFIG rotor is provided by a matrix converter (MC), see Fig 1.

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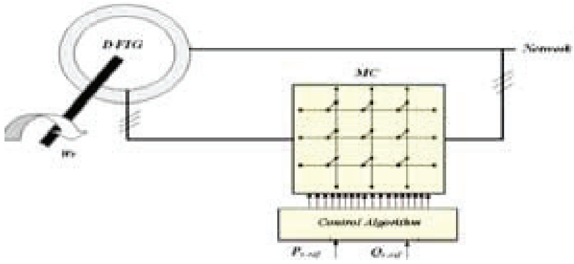

Fig. 1 Schematic of the conversion

2. Separate control of powers

In this section, we present a study on the control of active and reactive powers of DFIG. The objective is to separately control these two powers to control the production of wind [1]. Depending on the structure of Fig 1, the stator pulsation is imposed by the network, however it can be assumed constant. Thus, the speed control is possible by adjusting the apparent power of the rotor via the slip. The model we have developed takes into account the simplifying assumptions [2]: constant air gap, effect of notches neglected, sinusoidal spatial distribution of magnetomotive forces in the gap, the influences of skin effect and the heating are taken into account, the magnetic circuit is unsaturated and the permeability is constant and the neutral is not connected therefore no zero-sequence system. Thus, the equations of the stator voltages and rotor voltages of the DFIG in the Park are:

$$\begin{cases} V_{sd} = R_s.I_{sd} + \dfrac{d\phi_{sd}}{dt} - \dot{\theta}_s.\phi_{sq} \\ V_{sq} = R_s.I_{sq} + \dfrac{d\phi_{sq}}{dt} + \dot{\theta}_s.\phi_{sd} \\ V_{rd} = R_r.I_{rd} + \dfrac{d\phi_{rd}}{dt} - \dot{\theta}_r.\phi_{rq} \\ V_{rq} = R_r.I_{rq} + \dfrac{d\phi_{rq}}{dt} + \dot{\theta}_r.\phi_{rd} \end{cases} \tag{1}$$

The stator and the rotor flux can be expressed as:

$$\begin{cases} \phi_{sd} = L_s.I_{sd} + M.I_{rd} \\ \phi_{sq} = L_s.I_{sq} + M.I_{rq} \\ \phi_{rd} = L_r.I_{rd} + M.I_{sd} \\ \phi_{rq} = L_r.I_{rq} + M.I_{sq} \end{cases} \tag{2}$$

Where ,

V_{sd} , V_{sq} , V_{rd} , V_{rq} are respectively the direct and quadrate components of the space phasors of the stator and rotor voltages ; I_{sd} , I_{sq} , I_{rd} , I_{rq} are respectively the direct and quadrate components of the space phasors of the stator and rotor currents, Φ_{sd} , Φ_{sq} ,Φ_{rd} ,Φ_{rq} are respectively the direct and quadrate components of the space phasors of the stator and rotor currents , R_s , R_r , L_s and L_r are respectively the resistances and inductances of the stator and rotor windings and M is the main inductance.

The dynamic equation is:

$$J\frac{d\Omega}{dt} = T_{em} - T_l - K_f.\Omega \tag{3}$$

With the electromagnetic torque (T_{em}) is defined by:

$$T_{em} = p\frac{M}{L_s}(I_{rd}.\phi_{sq} - I_{rq}.\phi_{sd}) \tag{4}$$