CONTROLLING OF DOUBLY FED INDUCTION GENERATOR USING DIRECT TORQUE CONTROL

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ABSTRACT:

In this paper, direct torque control (DTC) technology of doubly fed induction generator (DFIG) is applied to variable speed wind power generation systems.The DTC is mostly used in the objective to improve the reduction of the undulations or the flux's distortion, and to have good dynamic performances. It's essentially based on a localization table which allows selecting the vector tension to apply to the inverter according to the position of the stator flux vector and of the direct control of the stator flux and the electromagnetic torque.The modeling of the complete system is done in MATLAB-SIMULINK.Simulation results shows the proposed DTC control strategy.

KEY WORDS: Doubly fed induction generator, Rotor side control, Direct torque control, Switching table, Torque and flux calculator, Magnetization control,

I. INTRODUCTION:

With the industrial and population growth, energy consumption has increased significantly over the last three decades. The serious issue of depletion of resource like coal, gas and petroleum at a very fast rate has motivate countries around the globe to think about alternative natural resources which are inexhaustible, sustainable and environmentally friendly. Among non-conventional resources for electricity wind power has attracted great interest in the past few decades and has undoubtedly been the most rapidly growing renewable energy source. Though the wind energy industry is young from a power generation system point of view it has benefitted significantly from the steady advances in technology made in the components dealing with grid integration, the electrical machine, power converters and control capability. The days of the simple squirrel cage induction machine are long gone. We are now able to control the real and reactive power of the machine, limit power output and control voltage and speed. Meanwhile doubly fed electrical machines have entered into common use only recently with the advancement of wind power technologies for power generation. They are variable speed 3phase wound rotor induction machines with advantages over other types of generators when used in wind turbines. In Doubly fed induction generator both rotating and stationary part consist of winding. Both winding transfer power to the electrical system.

In Doubly Fed Induction Generator the rotor side converter can be controlled by using direct control technique in which torque and flux of generator are directly controlled by converter voltage space vector selection through a look up table.

II: DIRECT TORQUE CONTROL:

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Fig.1. and fig.2. explains the control strategy of Direct torque controller. The flux Ψ_s and torque T_e magnitudes are compared with the estimated values, and the errors are operate through hysteresis-band controllers. The flux loop controller has two levels of digital output:

$$H_\Psi=1 \text{ for } E_\Psi \ \ +HB_\Psi$$

$$H_\Psi= -1 \text{ for } E_\Psi \ \ - HB_\Psi$$

2 HB_Ψ = total hysteresis- band width of the flux controller. The circular trajectory of the command flux vector Ψ_s with the hysteresis band rotates in an anticlockwise direction as shown in figure 8.58(A). The actual stator flux Ψ_s tracks the command flux in zigzag path. The torque control loop has three levels of digital output which have the following relations.

$$H_{Te} = 1 \text{ for } \ E_{Te} \ \ +HB_{Te}$$

$$H_{Te} = -1 \text{ for } \ E_{Te} \ \ -HB_{Te}$$

V_{abc} abc αβ

I_{ab} abc αβ

Flux

Torque

Fig1: Block diagram of Direct Torque Controller

III: INVERTER VOLTAGE VECTORS SWITCHING TABLE:

H_Ψ	H_{Te}	V_1	V_2	V_3	V_4	V_5	V_6
1	1	010	100	111	100	111	011
	0	110	100	101	001	011	010
	-1	100	101	001	011	010	110
-1	1	101	101	001	101	100	110
	0	001	111	101	111	110	111
	-1	011	001	101	100	110	010

IV: MATHEMATICAL MODELLING :

The stator voltage equation is given by:

$V_S^S = R_S\, i_s^s + d\Psi_s^s/dt$

The stator flux evolution can be approximated by the addition of a sinusoidal and an exponential term.

$\Psi\alpha s = K_1 e^{-k_2 t} + K_3\cos(\omega t + K_4)$

$\Psi\beta s = K_5 e^{-k_2 t} + K_3\cos(\omega t + K_4)$

During the fault the sinusoidal current exchange with the grid will be always preffered. So the rotor and stator current should be sinusoidal.

$I_s^s = L_h /\sigma L_r L_s\, (L_r/L_s\, \Psi_s^s - \Psi_r^s)$

$I_r^s = L_h / \sigma L_r L_s (L_s/L_h \Psi_r^s - \Psi_s^s)$

But from the expression it is seen that it is tough to achieve sinusoidal current exchange as Direct Torque Control technique controlled only rotor flux amplitude. Hence a solution is suggested for this problem. Exponential terms should be cancel by generating equal oscillation in the rotor flux amplitude and in the stator flux amplitude. As a result quality of the current is improved with the oscillatory rotor flux than the constant flux.

V:BLOCK DIAGRAM OF DFIG USING DTC:

VI: SIMULATION RESULTS

Fig.2: Current in the rotor

Fig.3: Current in the stator

Fig.4: Rotor speed, Electromagnetic torque, Rotor angle

Fig.5: Voltage and current across load.

VII: CONCLUSION:

Direct torque control strategy for doubly fed induction machine was proposed for variable speed wind power generation system .At t =.03,.05,.08, 1 we have change the speed of turbine, but due to direct torque controller the output frequency of the generator remain constant.

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