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Control of Speed and Torque of Two Quadrant DC Motor Drive Using Active Buck Boost Invertor

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ABSTRACT

In This Paper Wind Systems, A/S which is one of the leading manufacturers of wind turbine systems in the world. The proposal deals with DC-DC connected offshore wind system. This is a promising technical solution regarding the increasing demand of electrical power and the long distances between on- and offshore sites. The main goal is the development of steady state models of an entire wind turbine system with selected AC-DC converters between the generator output and DC-DC connection of the wind turbines. The Buck-boost with a high frequency transformer and a three phase rectifier are selected for modeling this thesis. The models are used as a basis for the simulations of the two different wind turbine systems with a wind speed ramp as input. Relying on these simulations two performance factors are investigated, torque and speed, relating to which performance of DC drive is analyzed.
Keywords : DCdrive, MATLAB-Simulink invertor,PI controller

I. INTRODUCTION

Wind turbines must be controlled depending on the available wind power and the required power output. There are two control strategies, stall and pitch control. The stall control mechanism is a passive regulation of the wind turbine. Its main duty is to reduce the power extraction from the wind at too high wind speeds, which are dangerous for the wind turbine. It is used in fixed speed wind turbines. Nowadays a pitch control is used in variable speed turbines [1].

A. Pitch control

In contrast to the stall control, the pitch control mechanism is an active regulation of the power extracted from the wind. It changes the pitch angle by turning the blades. The pitch angle is zero at maximum power extraction. It is increased at too high wind speeds or if the demand of power is less than the possible extracted power. Both is done in order to decrease the output power and to reduce the rotational speed of the wind turbine. But in this thesis the main focus is on the maximum power extraction of the wind. So the pitch control is only used to avoid too high rotational speeds at wind speeds above nominal speed [1].

B. Power Control

The power harnessed from the wind by the turbine is converted in electrical power by the generator. As mentioned above a maximum power extraction of the wind is considered in this report. Figure 2.2 shows the output power of the generator as function of the wind speed v. At cut-in speed of the wind the turbine starts working. The power coefficient cp is kept constant at its maximum value. When reaching rated speed, the tip speed is at its maximum. If the wind speed is still increasing the tip speed has to be constrained in order to avoid damage of the wind turbine. Keeping the tip speed constant, means decreasing the power coefficient and so the output power of the generator is kept constant at its maximum. At cut-out speed of the wind the wind turbine is shut down to prevent damage to rotor and generator [4].

The Buck-boost converter is a cascade of a buck (step down) and a boost (step up) converter. It can have a higher or lower output voltage compared with the input voltage depending on the duty ratio. But the voltage at its output has a negative polarity. During the on state of the switch the inductor receives energy form the input voltage and the diode is reversed biased. When the switch is turned off the stored energy in the inductor is transferred to the output. The input voltage is disconnected and so does not transfer energy to circuit. The current of the inductor rises during the on-state and decreases while the switch is turned off.

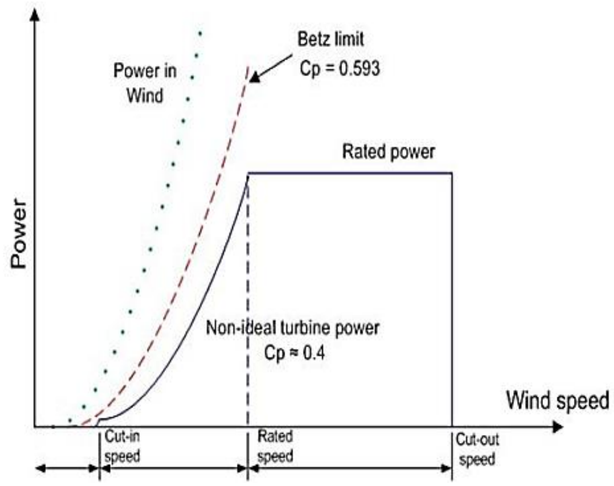


Figure 1. Power versus wind speed [4]

II. METHODS AND MATERIAL

Related Work

The table below shows all different wind turbine concepts in direct comparison. The three mentioned groups of wind turbine systems are colored differently.

The fixed speed solutions *(dark grey)* show a not dynamic behavior as part of the grid. The control of active power is slow and limited. These applications do not provide a reactive power control. In case of a short circuit the generator is disconnected and cannot be used to build grid voltage up again [6]. But the investments for these systems and the costs for maintenance are low [5].

The wind turbine with a limited speed concept *(grey)* has a better dynamic behavior according to active and reactive power control and the control bandwidth. On the other hand investment and maintenance costs increase[5].

wind speed turbines *(white)* show the best dynamic behavior with a positive impact on the grid regarding reactive power. These types of turbines are able to stay connected to the grid during and after a fault if they are equipped with power converter protection, so they can improve the stability of the grid [6]. Nevertheless, the investment and maintenance costs have the highest value of all WPSs mentioned here [1].

Power generation in general will contain more wind power in the near future. Wind turbines must be reliable and dynamically controllable depending on the demand of active and reactive power. Another important aspect is the negative impact on the grid; it should be as less as possible. Wind turbines relying on fixed or limited fixed speed concepts are developments of a time in which semiconductors with a high performance were not available or too cost intensive. These concepts are not able to fulfill the mentioned requirements. Only variable speed wind turbines are able to fulfill these requirements. That is the reason why only concepts based on variable speed will be investigated in this paper.

System comparison of wind turbines [5]

System	I	II	III	IV	V	VI	VII	IIX	IX	X
Variable speed	No	No	No	No	limited	Yes	Yes	Yes	Yes	Yes
Control active	limited	No	limited	limited	Yes	Yes	Yes	Yes	Yes	Yes
Control reactive power	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Short circuit	No	No	No	No	No /Yes	Yes	Yes	Yes	Yes	Yes
Control bandwidth	1-10s	1-10s	1-10s	100ms	1ms	0,5-1ms	0,5-1ms	0,5-1ms	0,5-1ms	0,5-1ms
Flicker	Yes	Ye	Yes	Yes	No	No	No	No	No	No
Softstarter needed	Yes	Yes	Yes	Yes	No	No	No	No	No	No
Reactive power compensato	Yes	Yes	Yes	Yes	No	No	No	No	No	No
Investment	++	++	++	++	+	0	0	0	0	0
Maintenanc	++	++	++	++	0	+	+	+	+	+

III. RESULTS AND DISCUSSION

The results obtained from power flow method and continuation power flow method are discussed which are performed at the 6 bus system by using MATLAB toolbox Power system analysis toolbox (PSAT).

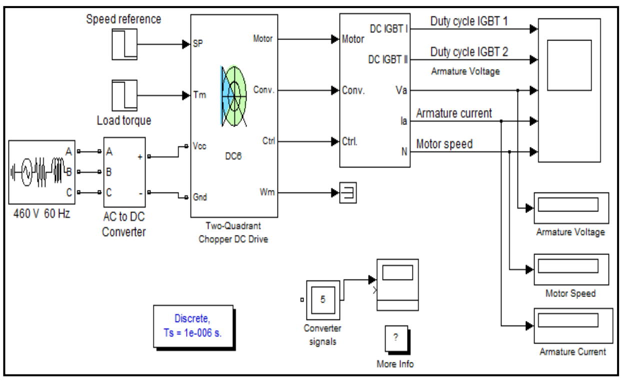
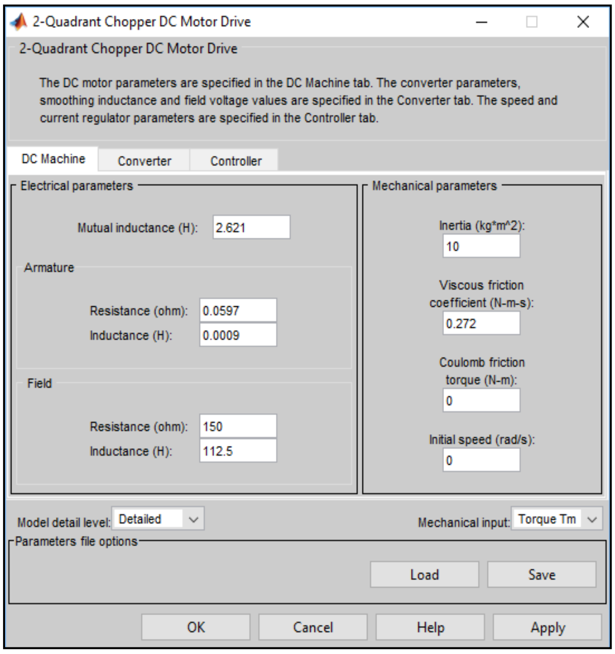


Figure 2. Proposed Model of 2 Quadrant D.C. Drive



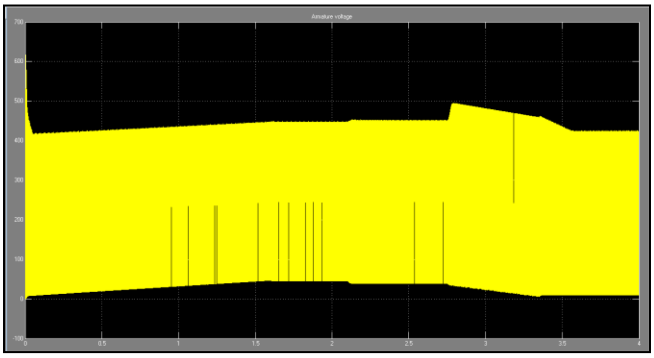


Figure 3. Armature Voltage Waveform

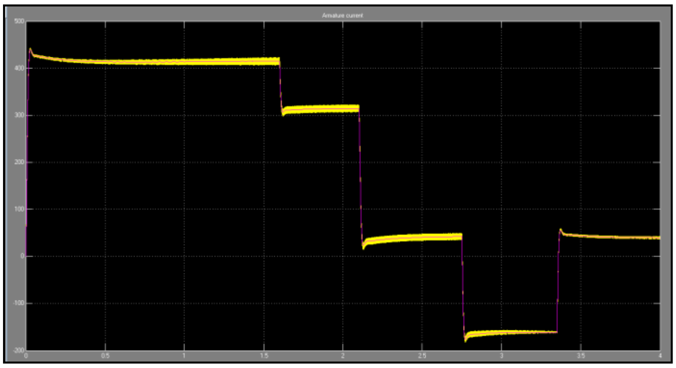


Figure 4. Armature Current Waveform

IV. CONCLUSION

In this paper, focus is set on the AC-DC converter models. Based on all models two wind power systems are simulated in Matlab. According to the performance factors efficiency and annual energy production which are the results of the simulation, both converters are compared. The comparison relying on the factor efficiency is not possible. The results of the simulation are not clear in this case. The Buck-boost converter shows a slightly higher annual energy production.

But the comparison of both converters is not the main goal of this paper. It is the development of AC- DC-converter models in the steady state theory and this goal is reached in this paper and Relying on these simulations two performance factors are investigated, torque and speed, relating to which performance of DC drive is analyzed. The result of the comparison depends on the wind distribution and the values of parasitic elements. If they change the result could be different. That is the reason why the simulation tool made of the models is more important than the result of the comparison.

V. REFERENCES

[1]. Quaschning, Volker. Regenerative Energiesysteme. München : Hanser, 2014.

[2]. Lewald, Norbert. Umweltvertragliche Erzeugung elektrischer Energie - Windkraftanlagen.

[3]. Marques, André Madeira. Design, Control, Simulation and Energy Evaluation of a DC Offshore Wind Park. Instiuto Superior Téchnico, Universidade Ténica de Lisboa : s.n., 2015.

[4]. Lei Shuai, Ana - Irina Stan, Tiberiu Mihai Stanciu, Daniel Ioan Stroe. Variable speed wind turbine equipped with synchronous generator. Aalborg University : s.n.

[5]. F. Blaabjerg, Z. Chen, R. Teodorescu, F.Iov. Power Electronics in Wind Turbine Systems. Aalborg University, Institute of Energy Technology : s.n., 2016.

[6]. Anca D. Hansen, Lars H. Hansen. Market penetration of wind turbine concepts over the years. Force Technology, Lyngby, Denmark; Risø National Laboratory, Wind Energy Department; Roskilde, Denmark : s.n., 2014.

[7]. Paola Bresesti, Wil L. Kling, Ralph L. Hendriks, Riccardo Vailati. HVDC Connection of Offshore Wind Farms to the Transmission System. University of Eindhoven : s.n., March 2013.

[8]. Jorge Varela Barreras, Fernando Valderrey Sánchez. A fast method to evaluate annual energy production of different off-shore wind farm configurations connected to a VSC-HVDC line transmission including evaluation of a new variable speed wind turbine concept based on

RCC-Wrig. Aalborg University, Institute of EnergyTechnology, Denmark : s.n., 2015.
[9]. D. Jovcic, N. Strachan. Offshore wind farm with centralised power conversion and DC interconnection. University of Aberdeen : s.n.
[10]. Lundberg, Stefan. Configuration studies of large wind parks. Chalmers University of Technology, Department of Electric Power Engineering, Göteborg Sweden : s.n., 2013.
[11]. Lazaridis, Lazaros P. Economic Comparison of HVAC and HVDC Solutions for Large Offshore Wind Farms under Special Consideration of Reliability. Royal Institute of Technology, Department of Electrical Engineering, Stockholm : s.n., 2015.
[12]. D. Jovcic, J.V. Milanovic. Offshore Wind Farm Based on Variable Frequency Mini-Grids with Multiterminal DC Interconncection. University of Aberdeen,Universtiy of Manchester : s.n.
[13]. F. Iov, M. Ciobotaru, F. Blaabjerg. Power Electronics Control of Wind Energy in Distributed Power Systems. DK-9220 Aalborg East, Denmark : s.n.
[14]. Dr-Ing, Leibfried Porf. Energieübertragung und Netzregelung. Universität Karlsruhe : s.n. 15Ned Mohan, Tore M. Undeland, William P. Robbins. Power electronics. USA : s.n., 2013.