UNIVERSITY OF ENGINEERING & TECHNOLOGY,

M.SC. THESIS TOPIC PROPOSAL

Transient Analysis of Salient-Pole SG WECS based on MTPA and Rotor Speed Feedback Control

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Research Title

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Problem statement

Wind energy has seen exponential rise in global energy share over the past decade. Climate change and greenhouse effect issue has pushed the global leaders towards use of renewable energy systems. Wind energy is an efficient way to convert inexhaustible natural resource into electric power. Moreover, it is pollution free, reduce hydrocarbons imports and supports sustainable development. However, wind energy conversion systems (WECS) comes with a number of challenges, from fluctuating wind supply to complicated conversion and control systems.

Different generator schemes that are used in WECS are, SCIG, DFIG, WRIG and PMSG. PM synchronous generators are widely used these days as they are reliable, cost efficient, high grid supportability and high energy yield. As the wind speed varies continuously, it becomes necessary to use control systems for efficient conversion. The aim is to analyze the transient and steady-state performance of the PMSG based WECS using rotor speed feedback control.

Objectives and Aims

- The main objective is to analyze performance of ***Salient-pole SG*** wind energy system with the ***Maximum Torque per Ampere (MTPA)*** and ***Rotor speed feedback control.*** The dynamic performance of the system in the transient state operation is to be analyzed rigorously.

- The experimental simulations will be conducted on the MATLAB SIMULINK platform to demonstrate the variations in the state trajectories of the system in time-domain.

- Furthermore, the a comprehensive comparison will be made based on advantages of the MTPA and rotor speed feedback control over other control system based on PM Synchronous generator.

Literature survey

The different generator topologies are reviewed by Zuher Alnasir & Mehrdad Kazerani [1] in which they have highlighted the advantages of the PMSG based systems over other systems.

PM synchronous generators are highly reliable, cheap to construction and maintenance, grid supportable and has high energy yield as indicated by [2] NS Patil, YN Bhosle. As far as different control systems are concerned [3] the different control scheme, as MPPT and UPFC were compared by Wu B., Lang Y., Zargari N., Kouro S.

In 2015, Guenoune, Ibrahim, Alain Glumineau, Franck Plestan, and Ali Chermitti [4] worked on MTPA control system for PMSG driving in partial and full load for maximum power extraction. Their research further supported by Zahari Zarkov, Boris Demirkov [5] who analyzed the torque and speed of a variable wind profile PMSG system using MTPA control.

Methodology

In Synchronous Generator based WECS, the active control system is responsible for handling the following three state variables.

- The maximum active power that can be produced by the wind turbine at a given wind speed.
- The reactive power injected to the grid as dispatched by the supervisory controller or grid operator.
- The DC link voltage of the power converters.

Generally, the generator-side converter controls the active power of the generator sing any practicable maximum power point tracking control algorithm, whereas the grid-side converter controls the DC voltage and reactive power to the grid. The following aspects of this research will distinguish it from previous works.

1. A salient-pole synchronous generator is employed instead of a non-salient generator.
2. The MTPA control is used for the salient-pole generator versus the ZDC scheme for the non-salient generator.
3. A rotor speed feedback control is employed with optimal power control for MPPT.

The maximum torque per ampere control generates a given torque with a minimum stator current. For a given rotor flux linkage, the generator torque is a function of d and q axis current. Through this control the maximum torque is to be achieved at any given value of the flux.

Experimentation

The experimental analysis of the transient as well as steady-state response of the SG-based WECS will be studied. The behavior of different variables such D-axis Q-axis currents, stator and rotor voltages, power factor, torque vs. speed and torque vs. current waveforms will be analyzed. MATLAB-Simulink platform will be used to model the experimental tests to analyze transient and steady state operation.

Experimental setup
TO model and simulate the PMSG WECS system, MATLAB/SIMULINK will be used.

Results expected and method of the analysis

All previous studied were based on just MTPA based control on PMSG wind energy systems.

- This research will employ two control strategies i-e Maximum torque per ampere and Rotor speed feedback control.

- After analyzing the outcomes of experiments, the aim is to enhance the performance of conventional PM synchronous generator based WESC and increase the robustness of system to tackle power quality challenges by improving the transient and steady state behavior.

References

[1] Alnasir, Z., & Kazerani, M. “An analytical literature review of stand-alone wind energy conversion systems from generator viewpoint”. *Renewable and Sustainable Energy Reviews*, 28, 597-615.

[2] Patil, N. S., and Y. N. Bhosle. "A review on wind turbine generator topologies." In *2013 International Conference on Power, Energy and Control (ICPEC)*, pp. 625-629. IEEE, 2013.

[3] Wu B., Lang Y., Zargari N., Kouro S., “Power Conversion and Control of Wind Energy Systems,” pp. 109-113, Wiley & Sons: NJ, USA, 2011.
with Superior Harmonic Performance”, IEEE Transactions on Power Electronics, 2009, 24(11), pp. 2436-2445.

[4] Guenoune, Ibrahim, Alain Glumineau, Franck Plestan, and Ali Chermitti. "Control of wind turbine driven a permanent magnet synchronous generator using backstepping-MTPA strategy control.", In 2015 4th International Conference on Electrical Engineering (ICEE), pp. 1-6. IEEE, 2015.

[5] Zahari Zarkov, Boris Demirkov, "Power control of PMSG for wind turbine using maximum torque per ampere strategy", Electrical Machines Drives and Power Systems (ELMA) 2017 15th International Conference on, pp. 292-297, 2017.

Comments of the Supervisor

I certify that this is my own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged. If this statement is untrue I acknowledge that I will have committed an assessment offence and should be penalized accordingly.

Ahmed Abbas

Signature of Student Signature of Supervisor

Endst. No. Unive/ _____

Date_____

This proposal duly recommended by the Postgraduate Committee of The Department of Electrical Engineering in its meeting held on _____ is hereby forwarded to the Director ORIC for obtaining the approval of the Vice-Chancellor.

Chairman,
Department of Electrical Engineering
Engineering

Dean,
Faculty of Electrical