ANALYSIS OF NOVEL STRATEGIES FOR CONTROL OF AN AUTONOMOUS WIND-DIESEL GENERATING UNIT

by

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CERTIFICATE

Certified that the thesis entitled **"Analysis of Novel Strategies for Control of an Autonomous Wind-Diesel Generating Unit"** which is being submitted by **Mr. Khamis Aly Nabwy Allam** for the award of the Degree of Doctor of Philosophy in the Department of Electrical Engineering of the Indian Institute of Technology, Delhi is a record of the student's own work carried out by him under our joint supervision and guidance. The matter embodied in this thesis has not been submitted for the award of any other degree or diploma.

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ABSTRACT

The popularity of wind diesel power generation systems (WDPGS) stems from a reliable combination of continuously available diesel power and pollution-free wind power. Important problems in the current state of art for autonomous wind diesel power generation systems relate to operation and on line control of these units, particularly in case of weak systems with large penetration of wind power. Suitable control strategies are therefore required to take full advantage of wind energy during periods of its availability. These strategies must work to maintain power quality in terms of regulated voltage and frequency.

The unit configuration under consideration in this work consists of a diesel driven synchronous generator in parallel operation with a wind driven induction generator. This type of generation system is known to suffer from two problems:

(i) Voltage dynamics due to the interaction between the induction generator and the automatic voltage regulator operating on the alternator field,

(ii) Active power dynamics in presence of severe wind gusts.

The focus of this work is to develop prime mover and excitation control strategies that aim at improvement of system operation with reference to the problems (i) and (ii) listed above. A simple lag lead compensator is designed for the excitation system which regulates the terminal voltage of the unit to a desired set point, while mitigating voltage instabilities. Further, an improved wind turbine pitch angle controller is developed so as to regulate the energy extracted by the asynchronous generator in presence of wind

variations and gusts. Design for both controllers is based on suitable linear models of the entire generation system.

The entire control system is tested through simulation of large number of study cases using both static (resistive-inductive) and dynamic (induction motor) loads. System frequency variation, power output of the diesel unit, and load voltage variation are some of the dynamic conditions used to evaluate the effectiveness of the control algorithms.

Note:- The names MATLAB and SIMULINK as used in this thesis refer to software products that are manufactured by the Math Works Inc. The names are registered trade marks of this company.

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