Dynamic and Steady-State Operational Performance of Induction and Synchronous Reluctance Motors Powered by PV Generator with MPPT

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Abstract

In this paper, detailed operational performance of synchronous generator connected to infinite bus hybrid excited by Permanent-Magnet DC (PMDC) and Photovoltaic (PV) generators is presented. The PV generator is interfaced to the PMDC generator via DC-DC buck-boost switch mode converter which is used to control the voltage injected at all solar irradiance levels via adjusting its duty ratio. The PV generator is designed such that to meet the demands of the synchronous generator excitation at full solar irradiance. The PMDC generator is conventionally powered by fuel engine. Power control unit is used to automatically adjust the PMDC generator driving torque in order to compensate the power need once the output power from the PV generator decreases as a result of reduction in the solar irradiance. To have an idea about the stability of the system operating point, eigenvalues of the linearized system at different running conditions are discussed. The robustness of the system is checked by observing its response based on the complete nonlinear dynamical model after successive step changes in the solar irradiance levels and successive step changes in the set value of the desired excitation voltage particularly used for controlling both the terminal voltage and the output reactive power of the synchronous generator. It is concluded that the proposed hybrid excitation system is technically possible, reliable, can effectively control the output reactive power of the synchronous generator, reduces the total fuel consumption and robust enough to withstand step changes in the system input parameters.