PM Micro-Generator Design for Smart Grid Systems

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Abstract: High Speed (Permanent Magnet) PM Generators driven by micro-turbines are widely used in Smart Grid System. So, this paper proposes comparative study between classical, optimized and genetic analytical design cases for 500 kW output power at tip speed 250 m/s. These two designs trials of High Speed Permanent Magnet Synchronous Generators (HSPMSGs) are: Classical Sizing; Constrained optimized maximum efficiency with bounded constraints are introduced in the problem formulation. Then a genetic algorithm is formulated for obtaining maximum efficiency and minimizing machine size. All results are simulated with MATLAB, Optimization Toolbox and its Genetic Algorithm. The sizing method presented gives a step by step method for high speed PM generator design. This paper illustrates the benefits of HSPM generators, compared to the original PM synchronous generators, since it offers significant reductions in both weights and volumes. It discusses the electrical and magnetic sizing of HSPMGs, at 500 kW power and tip speed of 250 m/s. The optimizing variables are rotor length to diameter ratio, rotor radius, and stack length, for optimization and in the genetic algorithm. It should be noted that the large-scale trust-region method does not currently solve this type of problem, but using medium scale line search has provided an acceptable performance. It was found that using the genetic algorithm in HSPMSG sizing will solve both constrained and unconstrained optimization problems. The results of the genetic algorithm are presented with the same optimization variables, as before, but the fitness functions, in which the constraints are varied for both efficiency maximization and genetic sizing. We also used the genetic algorithm to maximize efficiency. We have observed that this will have the benefit of limiting machines losses. In this study, we have found that a noticeable improvement appears in the performance parameters. Finally, analytical design examples comparisons are introduced with study of machines waveforms, Total Harmonics Distortion THD, rotor losses and effect of number of poles changing.