European Association for the Development of Renewable Energies, Environment and Power Quality (EA4EPQ)

International Conference on Renewable Energies and Power Quality (ICREPQ'10)
Granada (Spain), 23th to 25th March, 2010

Integrated Design and Optimization of a Direct Drive Axial Flux Permanent Magnet Generator for a Tidal Turbine

O. Keysan[1], A. S. McDonald[2] and M. Mueller[3]

[1-3] School of Engineering, Institute for Energy Systems
University of Edinburgh
King's Buildings, Edinburgh EH9 3JL United Kingdom
Phone: +44 (0)131 6505629 e-mail: **o.keysan@ed.ac.uk**, **markus.mueller@ed.ac.uk**

Abstract:

The C-GEN is a novel topology of direct drive air-core permanent magnet generator being developed at University of Edinburgh [1]. The topology has many benefits such as; absence of cogging torque, reduced mass and ease of manufacturing. A 20 kW prototype test rig and 15kW machine for a wind turbine has been manufactured and tested previously. Initial sizing studies for wind turbines indicate that the C-GEN concept will be up to 50% lighter than conventional iron cored PM direct drive generators [1]. In addition to the applications wind turbines, C-GEN technology can also be implemented for marine energy power take-off systems. To investigate that, a feasibility study –funded by npower juice- is being undertaken in collaboration with two wave and two tidal energy companies.

In this paper, design and optimization method of an axial flux permanent magnet generator for a tidal energy converter device (SRTT - Scotrenewables Tidal Turbine) has been investigated. An analytical optimization tool is designed that combines electromagnetic, structural and thermal aspects of the machine design. Without integrated design method the design process takes iterative steps which is very time consuming and costly. More over, when these design aspects are not well coupled, it is very difficult to achieve the most optimum solution for the specific application.

A genetic algorithm optimization method has been utilized based on the operation conditions of generator and pre-defined constraints on dimensions and material limitations. The cost function is defined in detail that includes economical features as well as the technical features. Also all operation points of the device are included in the optimization process which is very important in variable speed power take-off systems. The output of the optimization is a 550 kW generator with a total mass of 13 tonnes which is comparable to current hydraulic or gearbox systems. The output of the analytical design tool is compared with electromagnetic and structural FEA simulation results. It is found that the analytical design tool has a good agreement with FEA results. To conclude, C-GEN generator is a promising technology for marine renewable direct drive power take-off systems. The contribution of the proposed integrated design and optimization method is very large in that conclusion.