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Conceptual Design and Thermal Analysis of a modular Cryostat for one single coil of a 10 MW Offshore Superconducting Wind Turbine

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The needs for high power offshore wind turbine are increasing continuously together with the rapid development of the wind power market. Superconductivity may be the only technology to scale wind turbines up to 10 MW and beyond by reduction of the nacelle mass. Accordingly, a superconducting 10 MW wind turbine concept for offshore applications is currently under development within the SUPRAPOWER project supported by EU FP7. The objective of this work is to provide an important breakthrough in offshore wind industrial solutions by designing an innovative, lightweight, robust and reliable 10 MW class offshore wind turbine.
The superconducting coils based on MgB2 are supposed to work at about 20 K. Due to the requirements of handling, maintenance, reliability of long term and offshore operation, a concept of semi-modular cryostat was proposed. A cryogen-free cooling method was selected in the design of the cryostat using two stage Gifford-McMahon cryocoolers. The required low temperature difference between the coldest point at the cryocooler cold head and the warmest point at the coil part farthest from the cryocooler requires a special design for a support structure of the coil inside the cryostat and a very good thermal insulation.
The support structures of the cryostat were thermally optimized in aim of reducing the heat load. With careful consideration of AC loss, heat transfer by radiation and conduction through support structure together with current leads, the thermal performance of superconducting coil were analyzed analytical and for comparison by the use of AnsysTM. In this paper, the concept of the cryostat and thermal analysis results will be given in detail.

Primary author: Dr SUN, Jiuce (Karlsruhe Institute of Technology)

Co-author: Dr NEUMANN, Holger (Karlsruhe Institute of Technology)

Presenter: Dr SUN, Jiuce (Karlsruhe Institute of Technology)

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