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Design and thermal analysis of an HTS module coil for a 12 MW wind power generator

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High temperature superconducting (HTS) generator is attractively researched with the advantages of high efficiency, and small size compared with conventional generator. One of the big challenge is cooling down the temperature of HTS magnet to ensure the superconducting state. It can take a long time to reach a vacuum because of bulky cooling system. In order to improve the cooling performance of generator, the HTS module coil is designed with the estimation of total heat losses. This paper deals with the design and thermal analysis of an HTS module coil for a 12 MW wind power generator. Heat losses of the HTS module coil include radiation loss, eddy current loss of the structures of the coil bobbins, ac loss of the HTS magnet, conduction loss of the current leads and supports of the magnet, and Joule loss of the current leads and joint with the HTS magnets. The two-stage cryo-cooler of RDK-415D was used to achieve the operating temperature of 20 K. Current leads were designed optimally for reducing the conduction and Joule heat losses. The total heat losses of the HTS magnet module were analyzed using 3D finite elements program. The supports were located in the 1^{st} stage area and 2^{nd} stage area of the HTS module coil. The size of all of supports was calculated to estimate the conduction heat loss from outside to the 1^{st} stage area and from the 1^{st} stage area to the 2^{nd} stage area. The results of heat losses and temperature distribution were confirmed by using FEM program. As a result, the temperature of the magnet was achieved under operating temperature of 20 K, and total heat loss was less than the cooling capacity of the cryo-cooler. The results will be utilized for structure design of large-scale superconducting generator module coil.

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