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A performance study on the flux pump based modularized exciter for a large-scale HTS wind power generator

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Recently, a high-temperature superconducting (HTS) generator module with brushless HTS exciter for large-scale wind turbines is suggested for improving the stability of the generator. The brushless HTS exciter is used for inducing the field current to the HTS module coil without power supply, current lead, and slip ring, and hence reduces total power loss. However, unbalanced field current may occur due to the physical mismatch of major parameters of each module such as inductance and resistance, and it causes output degradation after all. In this paper, the authors performed a performance study on the flux pump based modularized exciter for a 12 MW class HTS wind power generator and suggested allowable range of the unbalanced field current of each modularized exciter. The value of the field current of the brushless HTS exciter was determined by some parameters of the brushless HTS exciter. Unbalanced rate of the field current was calculated by the difference between field currents of modules. Based on the calculated unbalanced rate, the electromagnetic characteristics of the unbalanced field condition were analyzed using finite element method. The results were compared to the results of the conventional HTS exciter, and the magnetic field distributions and output characteristics of the generator considering the conventional and brushless HTS exciters were presented. Compared to the conventional HTS exciter, the output characteristics were almost the same until 3% of the unbalanced rate. However, when the rate was over 3%, the output power decreased and the torque ripple increased exponentially. These phenomena are likely to cause serious mechanical problems such as noise, and stress of the generator. Therefore, the authors strongly recommend to apply a control algorithm in the brushless HTS exciters for maintaining the unbalanced rate under allowable range. The results can effectively be utilized to design a modularized large-scale wind power generator.

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