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Numerical Study of Magnet Stability in the Superconducting Armature Winding for a Superconducting Generator

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Full superconducting generator uses superconducting magnets wound with HTS tapes to replace copper wires to form a strong magnetic field. As far as superconducting magnets are concerned, stabilization is the guarantee of reliable operation of superconducting magnets, because in the operation of superconducting magnets, small changes in temperature, magnetic field or current will cause magnetic flux jump, even lead to quenching phenomenon. In order to maintain a good working performance of armature windings, it is necessary to analyze the stability of superconducting magnets. Therefore, the armature winding structure of 1MW synchronous generator is designed in this paper, and YBCO superconducting magnet is used to form concentrated windings.Then, the electromagnetic-thermal-mechanical coupled problem in superconducting magnets is aimed to be solved by using a commercial software which is based on the finite element method. Firstly, for electromagnetic stability of superconducting magnets, flux density and AC loss of the armature winding with different stator groove shapes are calculated based on the given critical current. Secondly, for mechanical stability of superconducting magnets, the dynamic balance of superconducting magnets in the mechanical properties is analyzed. Thirdly, for heat transfer stability of superconducting magnets, heat dissipation capacity of armature windings is improved by analyzing two different kinds of heat pipes attached to the surface of superconducting magnets.Results show that semi-open slot is the most beneficial to improve electromagnetic stability of superconducting magnets.And a appropriate balance center of magnets can enhance mechanical stability of superconducting magnets. Meanwhile, the optimized cooling structure of armature windings greatly improves heat transfer stability of magnets. The model provides an effective tool for the optimization of working stability in superconducting magnets of the full superconducting generator.

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