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Design of 10MJ toroidal field D-type superconducting energy storage magnet

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Abstract—Superconducting magnetic energy storage system (SMES) has the advantages of fast response, four quadrant adjustable active and reactive power. It can improve the stability of power system, improve power quality, be used as distributed power system and energy management in power system. The research and development of large capacity energy storage magnet is an important development direction of SMES. SMES can be divided into low temperature SMES and high temperature SMES according to different superconducting materials. Because cryogenic magnets need to be cooled by soaking in liquid helium, its application is limited to a certain extent, so it is difficult to be widely used. With the development of high temperature superconducting tape preparation technology and the improvement of tape performance, high temperature superconducting magnets have broad application prospects in SMES and other electromagnetic devices. The components of SMES include superconducting magnet, refrigeration system, power regulating system and monitoring system. The high temperature superconducting magnet is the core component of SMES. In this paper, the toroidal field D-type magnet is selected as the energy storage magnet of 10MJ SMES. Based on the electromagnetic optimization design, the thermal analysis and force analysis of the magnet are completed, and the performance parameters of the magnet and the toroidal magnet are compared.

Index Terms—SMES, high temperature superconducting magnet, toroidal field D-type magnet, thermal analysis, force analysis

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