Contribution ID: **58** Type: **Poster presentation (105min)**

Structural Design and Analysis of a 150 kJ HTS SMES Cryogenic System

Thursday, 10 July 2014 10:30 (2h 15m)

A 150 kJ high temperature superconducting magnetic energy storage (HTS-SMES) system is under manufacturing in China. This paper focuses on the structural design and analysis of the SMES cryogenic system. The cryogenic system is designed and manufactured to maintain the operating temperature. The system includes a vacuum vessel, its thermal radiation shield, its supporting devices, conduction plates, and current leads. Two G-M cryocoolers are used for the system cooling, the main one is connected to the HTS coils and the other is connected to the thermal shield and the lower ends of the current leads. In this study, the 3D models of the SMES cryogenic system were created with CATIA, a 3D model design software, and the analysis of the SMES cryogenic system was done by ANSYS. The mechanical analysis results on the vacuum vessel, suspension devices and supporting devices are presented, particularly the analyses on suspenders and shelf supports are of vital importance since the finished SMES system should meet vehicle-mounted requirements in long time transport. The heat load and the temperature distribution of the thermal shield were analyzed. A cooling experiment of the cryogenic system was trialed and the thermal shield was cooled down to about 50 K.

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Session Classification: Thu-Mo-Posters Session 3.2

Track Classification: C-05: Cryostat technology