

技术及应用

绕制预应力对MICE超导耦合磁体冷质量应力状态的影响

潘衡¹; 刘孝坤¹; 吴红¹; 郭兴龙¹; 徐风雨¹; 王莉¹; M. A. Green²

1.哈尔滨工业大学 低温与超导技术研究所, 黑龙江 哈尔滨150080 2.美国劳伦兹伯克利国家实验室, 伯克利 加利福尼亚州94720

收稿日期 修回日期 网络版发布日期:

摘要 超导耦合螺线管磁体为μ介子离子化冷却实验装置(MICE)中的关键设备,其线圈内径1 500 mm,长度285 mm,采用截面1.65 mm×1.00 mm的NbTi复合超导线,励磁到210 A时,峰值磁场可达7.4 T。在降温和励磁过程中,为减小导线窜动而导致失超,线圈绕制过程中需对导线和紧固带施加预应力。本文根据组合筒理论,得出了绕制过程中线圈和紧固带的预应力与冷质量内部应力分量的关系。采用有限元方法对线圈绕制、冷却和励磁3个连续过程进行动态仿真,分别分析了导线和紧固带绕制预应力的变化对冷质量内部各主要应力峰值的影响,得出线圈和紧固带绕制时满足磁体稳定性和结构安全的预应力优化结果,为MICE超导耦合磁体的研制及其他类似大直径、多层的超导螺线管磁体绕制提供理论依据。

关键词 [MICE超导螺线管磁体](#) [预应力](#) [有限元](#) [应力分析](#)

分类号

Effect of Conductor Winding Pre-stress on Stresses in Cold Mass Assembly of MICE Coupling Magnet

PAN Heng¹; LIU Xiao-kun¹; WU Hong¹; GUO Xing-long¹; XU Feng-yu¹; WANG Li¹; M. A. Green²

1. Institute of Cryogenics and Superconductivity Technology, Harbin Institute of Technology, Harbin 150080, China; 2. Lawrence Berkeley National Laboratory, Berkeley CA 94720, USA

Abstract The superconducting solenoid magnet is one of the key equipment in the muon ionization cooling experiment (MICE). The coil has an inner diameter of 1 500 mm, length of 285 mm, and is made from copper matrix NbTi conductors with the insulated cross area of 1.65 mm×1.00 mm. The peak magnetic field is up to 7.4 T at a full current of 210 A. In order to reduce mechanical motion of conductors and avoid magnet quench during cooling and charging, the pre-stress is applied to conductor and banding during coil winding process. To solve the confirmation problem of winding pre-stress, the relationship between pre-stress and stress components in cold mass assembly was proposed according to composed cylinder theory. By dynamic simulation of whole processes including winding, cooling and charging by finite element model, the analyses on the stress in cold mass assembly with different pre-stresses on conductor and banding were carried out, and the optimized results of winding pre-stresses for winding the MICE coupling magnet were got.

Key words [MICE](#) [superconducting](#) [solenoid](#) [magnet](#) [pre-stress](#) [finite element](#) [stress analysis](#)

DOI

通讯作者

扩展功能	
本文信息	
▶ Supporting info	
▶ [PDF全文](917KB)	
▶ [HTML全文](0KB)	
▶ 参考文献	
服务与反馈	
▶ 把本文推荐给朋友	
▶ 文章反馈	
▶ 浏览反馈信息	
相关信息	
▶ 本刊中 包含“MICE超导螺线管磁体”的相关文章	
▶ 本文作者相关文章	
· 潘衡	
· 刘孝坤	
· 吴红	
· 郭兴龙	
· 徐风雨	
· 王莉	
· Mnbsp	
· Anbsp	
· Green	