Validation Test of the Forced-Flow Cooling Concept for the Superconducting Magnet of AMIT Cyclotron

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Abstract:

Advanced Molecular Imaging Techniques cyclotron is a compact device aimed to produce radioisotopes for medical imaging. A uniform 4-T field is created by means of two NbTi coils in a Helmholtz arrangement. Both coils are embedded in a stainless steel casing that holds the Lorentz forces. The cooling scheme is based on a low-pressure forced internal flow of two-phase liquid-vapor helium through a narrow channel machined in the casing. Preliminary thermohydraulic analysis showed that this concept is capable of cooling the coils, removing a heat load of up to 1 W with just a small amount of mass flow (about 0.1 g/s). In the final application, cold helium will be provided by a cryogenic supply system (CSS), which basically consists of a closed circuit recondenser using a single cryocooler. Previous heat loads are inside the CSS specifications. This paper will present the results of a scaled mock-up of the coils, cooled by a controlled flow of helium provided from a helium Dewar, tested to check the thermal loads, quench training, fluid-solid interaction, and the necessary control system to handle the helium mass flow. It will prove the viability of the concept while advising the potential problems that could arise in the real system.

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Contents

I. Introduction

Amit cyclotron includes two low-temperature superconducting coils that must be cooled while accomplishing restrictive boundary conditions [1]. These include a very compact design for the whole magnet, which relies in a challenging design for cooling (heat exchange concept) and insulation. Magnet provides a uniform 4 T field by means of two NbTi coils in a Helmholtz arrangement and warm iron. These coils are fit using an aluminum shrinkage to withstand magnetic pressure. Also, they are supported by a stainless steel casing to withstand repulsive force between them. A helicoidal path is provided in it for liquid helium (LHe) flow. As the whole casing is at helium temperature, it is surrounded by a thermal shield cooled by helium gas at about 60 K to be used as thermal shield. Finally, glass fiber rods are responsible for handling net magnetic forces and positioning the coils inside the casing in a low heat losses approach.

Authors

Figures

References

Citations

Keywords

Metrics

Footnotes