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Preliminary design and analysis of 20 K helium cooled MgB2 based superconducting current feeder system for Tokamak application

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Superconducting (SC) current feeder system is an integral part of a large-scale superconducting magnets based machines like a tokamak or accelerator. One end of the SC feeder is connected to SC feeder of magnet and another end is connected to the power supply via current leads for powering the magnet. So far, low temperature superconductor (LTS) is the popular choice for such applications. Magnesium diboride (MgB2) considering its lower cost, superconducting transition temperature of 39 K, ductile nature and ease of availability, is now gaining wide attention for SC feeders system. To assess its suitability, we report 1-D thermo-hydraulic study of 10 kA rated MgB2 current feeders system cooled with 20 K helium for SST-1 tokamak as a case study. The temperature margin and corresponding pressure drop along this feeder are calculated for mass flow rates ranging from 0.3 g/s to 1.0 g/s helium at 20 K, 4 bar (a) with a cooling inlet from magnet side. It yields a temperature margin of 6 −16 K across the entire length of feeder depending up on mass flow rate of helium. There is a possibility of cooling the binary current lead (HTS + MgB2) from cold helium coming out from the feeder. From our study, MgB2 current feeder system provides benefits of higher temperature margin, lower mass flow requirement and cryogenic savings by use of 20 K helium as coolant compared to existing NbTi based feeders. In future, it could provide a safe, reliable and cryogenic operational cost saving solution for SC current feeders for Tokamak applications.

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