Contribution ID: **407** Type: **Poster**

Development of Indigenous Electrical Insulation Breaks for Superconducting Magnets of Fusion Devices

Friday, October 26, 2018 2:00 PM (20 minutes)

Electrical insulation breaks are very critical component of large-scale fusion devices employing superconducting magnets. The electrical insulation breaks developed for the requirement of up gradation of hydraulics for the superconducting polodial field coils (SC) of SST-1 fusion machine. The electrical insulation breaks have been installed in the hydraulic, validated and sustained the operational required temperature. It has performed in rigorous environment of many thermal cycling from 300 K to 4. 2K of pressure 1-12 bar which induced more thermal stress in electrical insulation breaks. Main function of such insulation break is to supply cold helium to SC magnets and to isolate the magnets electrically from ground potential during the quench. The salient design features include bigger dimension of ½"size, break-down voltage to 5 kV, helium leak tightness ≤ 1 x 10-8 mbar-l/s at 4.5 K and needless to mention the cryogenic compatibility and flexibility issues. Success rate is about 75 % as it is new attempt with indigenous epoxy resin system. The basic structural materials are SS 316L feed tube separated by a cryogenic grade G10 GFRP insulation material which bonded with cryogenic epoxy resin. The failures causes have been identified, analyses that considered and rectified during indigenous development of electrical insulation breaks.The failure was observed after the repeated 4.2 K cryogenic cycles which doubts the reliability of component and epoxy resin system. The real research & development as well as challenge are to define and develop an adequate cryo compatible epoxy. The electrical insulation breaks and cryogenic epoxy resin are not commercially available items, not reliable, cost factor and failure was noticed after cold thermal cycles. The In-house indigenous developed electrical insulation breaks can be used for future indigenous superconducting magnet fusion machines, electrical isolation and for low temperature experiments purpose (up to 15 kV applications), bonding and sealing of dissimilar materials at cryo temperature with very much cost effective. In this paper, the design, development, fabrication, performance test at 300 K, 77 K and 4.2 K of electrical insulation breaks and highlight on development of indigenous cryogenic epoxy resin system will be presented.

Country or International Organization

India

Paper Number

FIP/P8-12

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Session Classification: P8 Posters

Track Classification: FIP - Fusion Engineering, Integration and Power Plant Design