Seminar

Institute for Plasma Research

Title : High Ampacity High Temperature Superconducting (HTS) Bi-directional Cable Thermal Characteristics in Practical Utility Applications

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Venue : Seminar Hall, IPR

Abstract :

High Temperature Superconducting (HTS) bi-directional cables are excellent candidates towards next generation all electric ships and aircrafts, as they make feasible significantly lighter and compact power equipment. The new Voltage Source Converter topologies including HTS have enhanced the controllability and bi-directional power transfer capabilities which are just mandatory for all electric systems applications. Scepticism with HTS solutions remains with its complexity, low damping and initial capital cost coupled with reliable and cost-efficient cryogenics system. Given rarity of experimental installations and prototypes (since these are the emerging solutions for next generation devices), numerical models have gained ground as popular tools to examine electromagnetic, thermal and coupled behaviour of superconducting equipment in such applications. HTS cable are easy to design and even to fabricate. The design of HTS largely focus on its electromagnetic behaviour optimizing its performance under variable operating conditions and geometrical constraints. However, in all these applications, the thermal analyses and performance is of critical importance and consequences; as it is vital to keep the operating temperature within the critical limits, in order to maintain superconductivity and eliminate quenching and related accidents.

In this work, we have addressed the critical issues adopting the volume-element-method (VEM) employing flexible parabolic-elliptic-partial differential equations on a numerical software platform. This method is a useful tool towards identifying the critical cable lengths that ensures a safe operation of the HTS cable in a given all-electric applications. Given a HTS cable design, such tools are capable of addressing the sizing of the cryogenic system parameters and the cryogenic system itself with its required flexibilities. It also addresses the essential thermodynamic measures including tuning the critical mass flow rates for a given length of the laid HTS cable in a given operational scenario that would ensure the fail safe operation. Additionally, the transport currents, the cooling conditions, the pressure drops, associated heat generation over long duration operation and their management etc can also be effectively addressed. Appropriate counter measures towards off-normal events can also be predicted. We shall present the methodology as well as a case study to validate the above formalisms and claims made.