Recent Progress in High Temperature Superconductor Magnet Technology and Its Applications

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Over three decades have passed since the first discovery of high temperature superconductor (HTS) back in 1986. Despite the early expectation on strong potential of HTS for various industries with the benefit of advancement of HTS materials science and technology, its application has been quite limited to laboratory research magnets until the early 2010s, mainly due to the well-known technical challenge of "quench protection" of high-performance HTS magnets. In 2009, the so-called no-insulation (NI) HTS winding technique was reported for the first time by MIT, which provides an alternative approach to protect HTS magnets. The key idea of the NI technique is to allow current sharing among adjacent turns upon a quench, which essentially enables the "electric-burn-out-free" operation even at an extremely high operating current density of >1000 A/mm^2. Nowadays, the NI technique and its variations have been widely applied to various applications beyond laboratory magnets, which include fusion, accelerator, wind turbine, electric propulsion, MRI/NMR, energy storage and more. This seminar presents a summary of the recent progress on the HTS magnet technology in general and introduces selected applications with a focus on the nuclear engineering (such as the recently developing compact fusion reactor magnets). Also, key challenges and potential solutions for the next-generation high field HTS magnets and their applications are also discussed, not limited to NI.

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