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Wed-Mo-Po3.02-05 [15]: HTS-WISE conductor and magnet impregnated with low-melting point metal

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The FFHR Design Team has been investigating several types of High-Temperature Superconducting (HTS) large-current capacity conductors to be applied to the LHD-type helical fusion reactor FFHR-d1 (major radius R = 15.6 m). Presently, before realizing this commercial fusion reactor for electricity production, smaller reactors FFHR-c1 (R = 10.92 m) for DEMO and b1 for volumetric neutron source are being designed. For FFHR-b1, the target values of the current and current density are 10 kA and 120 A/mm^2, respectively, at the magnetic field of >16 T and temperature of ˜20 K on the conductor. A new manufacturing method called "Wound and Impregnated Stacked Elastic tapes, WISE", has been invented as one of the candidate conductors. In this concept, stacked HTS tapes are inserted into a flexible metal tube to form a conductor, and wound onto a coil frame, and then impregnated with low-melting metal. In the flexible metal tube, each tape naturally deforms so as to minimize the strain forces. The low-melting metal stabilizes the conductor from two points of view: good cooling efficiency and uniform current distribution among tapes and windings by utilizing the no-insulation (NI) technique.
A sample coil using the HTS-WISE conductor was fabricated to prove the feasibility of the WISE concept. Ten REBCO tapes of 4-mm width were inserted into a stainless-steel tube and wound to shape a solenoid coil. The major specifications of the coil are 21.5 turns with a minimum winding radius of 40 mm, and 30 μH of inductance. The coil achieved a central magnetic field of 0.16 T at 77 K, having an 800 A current (15 A/mm^2) in steady-state. Despite the appearance of an electric field of ˜1 mV/m along the conductor, quench did not occur. In the presentation, the details of the NI-HTS-WISE magnet concept is discussed.

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