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Conceptual Design of a Toroidal Field Coil using HTS CrossConductor

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The potential of High Temperature Superconductor (HTS) for a Toroidal Field Coil (TFC) of a future fusion power plant has already been demonstrated in a conceptual design within EUROfusion [1]. One of the candidates of a high current HTS conductor for use in a fusion magnet is the so-called HTS CrossConductor (HTS CroCo) where REBCO tapes are arranged in a cross sectional optimized way.

The basic TFC dimensions have been taken from the PROCESS system code as the starting point for the design of a winding pack, consisting of six CroCos around a copper core, embedded in a stainless steel jacket and cooled by 4.5 K supercritical helium. With this cable geometry, the electromagnetic, structural mechanics, cooling, and thermo-hydraulic performance of an HTS-TFC were investigated. It could be shown that the conductor and winding pack design fulfills the requirements with respect to structure mechanics and hot spot in case of a quench. The current sharing temperature is large enough that it is possible to handle the nuclear heat load on the coil with still sufficient margin.

[1] R. Heller, P. V. Gade, W. H. Fietz, T. Vogel, K. P. Weiss, "Conceptual Design Improvement of a Toroidal Field Coil for EU DEMO using High Temperature Superconductors", IEEE Trans. Appl. Supercond. 26(4) (2016) 4201105

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