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Analysis of current distribution and AC losses in a RW2 prototype cable for the European DEMO TF coils

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Several design proposals have been envisaged for the Toroidal Field (TF) coils of the future European DEMO fusion reactor, which are based on a Nb3Sn conductor cable made with the react&wind (RW) or wind&react technologies.
Among them, Swiss Plasma Center (SPC) is proposing a RW solution combined with a layer winding technique for the coil, which is expected to permit the conductor grading as a function of the magnetic field, with a consequent remarkable saving of superconducting (SC) material.
To prevent the degradation due to bending of the fragile Nb3Sn, the proposed RW conductor cross-section has a high aspect ratio, with the SC strands located as close as possible to the section neutral axis.
The conductor cabling starts with the production of small circular SC strand bundles, which are in turn wound to form a composite Rutherford-like structure.
The conductor stability is provided by two layers of segregated stabilising copper located on the two wide sides of the SC Rutherford bundle.
A set of different solutions have been investigated as regards the two stabilising layers which, so far, basically consisted of a solid mixed matrix obtained from small rolled Cu-based assemblies.
Quite different experimental AC losses test results have been obtained from samples made of the same type of SC Rutherford bundle and different types of stabilizers, showing that further analysis and development of this cable component have to be carried out.
Recently, the use of a Rutherford bundle of clad copper strands has been considered, in order to comply with the required anisotropic properties of the stabiliser as regards both the longitudinal and transverse conductivity, to reduce the stabiliser eddy currents loss, while providing good stabilising performances.
In this work, the THELMA code is used to model short SULTAN samples of this type of RW cable, in order to analyse the effect of the new stabiliser design parameters on the total AC losses and the induced currents distribution.
To this purpose, the new geometrical model is adopted, which reproduces in a verisimilar way both the SC and stabilisers strands trajectories and reduces as much as possible their geometrical interferences, getting reasonable interstrand contact areas.
The model interstrand contact conductances are tuned using available experimental results of contact resistances measurements. Then the behaviour of different design alternatives is investigated and discussed in the paper through a parametric analysis.

Category

Electromagnetics modelling of LTS and HTS magnets

Keywords

DEMO, TF coils, Nb3Sn, AC losses

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