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Wed-Mo-Po3.10-07 [81]: AC loss, contact resistance, and cabling degradation analysis of various Nb3Sn sub-size CICC cable designs

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The superconducting cables for magnet systems in nuclear fusion reactors usually adopt the Cable-in-Conduit conductor (CICC) concept. CICC cables are known for higher thermal stability compared to other cable designs. Selection of a suitable cable design for higher operational performance still remains a challenge. The maximum magnetic field in future fusion reactors like DEMO and CFETR may reach up to 15 T, cable designs that can withstand electromagnetic loads at these higher fields, at the same time minimizing coupling losses, require thorough analysis.

Therefore, six sub-size CICC cables made of Nb3Sn strands are manufactured and tested experimentally on AC coupling loss, interstrand contact resistance, and cabling degradation. The inter-strand coupling loss and contact resistance are analyzed with the numerical code JackPot ACDC, developed at the University of Twente, to find an optimal cable pattern. Transport current degradation is measured on a few selected strands in the cables and strand indentation from cabling and compaction are analyzed as well.

Among six cables, four are design variations of a cable pattern with close-to-one twist-pitch-ratio as earlier found as an optimization for coupling loss and transverse load. For this so-called Twente cable design, variations have been chosen in twist pitch length and void fraction. Remaining cables are CWS-I, based on the Copper Wound Superconducting strands design and the CFETR Central Solenoid Model Coil (CSMC) design, proposed by ASIPP. The CWS design is aimed at reducing superconducting strand pinching causing degradation of transport properties mainly during compaction and possibly also at cyclic loading, by using soft copper strand inclusion. The CSMC cable pattern is close to the ITER CS cable design and is taken as a reference for comparison. The study of coupling loss and mechanical deformation on Nb3Sn cables is also relevant for other strain sensitive materials like MgB2 and BiSSCO round wires, potentially to be used in CICC as well.

Authors: V A, Anvar (University Of Twente); Mr EVERT WILLEM HAMER, Teun (Saxion); BAGNI, Tommaso (University of Twente); Dr YAGOTINTSEV, Konstantin (University of Twente); QIN, Jinggang; WU, Yu (ASIPP); DEVRED, Arnaud (CERN); Dr HOSSAIN, Md Shahriar (University of Wollongong); Prof. ZHOU, Chao (Institute of Plasma Physics, Chinese Academy of Sciences, Hefei, Anhui, China); NIJHUIS, Arend (University of Twente)

Presenter: V A, Anvar (University Of Twente)

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