Contribution ID: **1053** Type: **Regular 15 minutes Oral Presentation**

Effect of strand diameter, magnetic field and injection length on the current entrance length of internal tin strand

Thursday 31 August 2017 09:15 (15 minutes)

The current entrance and current transfer length (CTL) of prototype DEMO superconducting Nb3Sn internal-tin strands has been investigated in terms of strand diameter, magnetic field and current injection joint length. Knowledge of the current entrance effect of Nb3Sn strands provides insight on current distribution among strands in cables. In particular for large cable-in-conduit conductors (CICC) the strands are subjected to electromagnetic and thermal loading causing strand deformations like bending. Since bending causes a current redistribution between filaments, the current transfer length is essential for CICC performance and stability. Strands subjected to periodic bending will degrade more when having a longer CTL.
Voltage-current measurements were performed on strands having identical internal layout produced by Western Superconducting Technologies Co., Ltd., China (WST) with diameters of 0.83, 1.00 and 1.50 mm. Various current injection lengths and magnetic fields were used at 4.2 K. The results have been analyzed with analytical formulae and also with the 3D numerical strand model developed at the University of Twente. The measured entrance effects were compared with the determined CTL of the strands. As a result, the entrance effect is stronger in strands with a larger diameter due to their higher transverse resistance. The transfer length is also longer for lower magnetic fields due to higher absolute currents and for samples with shorter current injection length. The measurement method, the experimental results and analysis are presented.

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Session Classification: Thu-Mo-Or30

Track Classification: F1 - Low-Tc Wires and Cables