Test Results of a NbTi Wire for the ITER Poloidal Field Magnets: A Validation of the 2-pinning Components Model

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Abstract - A two-components model has been recently developed, for describing the normalized bulk pinning force curves and the critical current density of NbTi strands over a wider B-T range with respect to conventional single-component models. The model was previously successfully applied to data collected on several NbTi commercial strands, with different size, Cu:nonCu ratio, filament diameter and layout, thus confirming the presence of two different pinning mechanisms in conventionally processed NbTi wires. For a further validation, we have extensively tested a strand recently produced by the Chinese Company Western Superconducting Technologies for the ITER Poloidal Field (PF) magnets PF2 to PF5, and applied the model to these data. In order to take into account the observed non-scaling with temperature of the reduced pinning force curves, the model has been updated, including the observed difference in the temperature dependences of the two components contributing to the overall bulk pinning force. The importance of testing wires over very wide temperature ranges is evidenced, and the good agreement between experimental and fit results validate the proposed formulation, which can be regarded as a reliable tool for the description of NbTi performances, to be used in the design of superconducting magnets. From the phenomenological point of view, it is shown that at low temperatures, the two pinning mechanisms contribute to the bulk pinning force, resulting in a pinning force peaking at a reduced field $B/B_{irr} \cong 0.5$. As the temperature increases, the pinning force peak moves to lower fields, indicating that the low field component pinning mechanism becomes dominant.

Index Terms - ITER, critical current density, magnetic characterization, transport measurements, superconducting NbTi strands.

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