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M3Or4P-01: [Invited] AC Loss simulation and system-wide analysis on a Single-Phase 6.5 MVA HTS Traction Transformer for Chinese High-Speed Trains

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Electrification of transport is a growing trend. Traction transformers are critical components of Chinese high-speed-trains. Traditional oil-based single-phase 25 kV/1.9 kV traction transformers have a weight of 6 tones, the efficiency less than 94%, and fire risk. The use of HTS has been proposed for compact and light weight traction transformers for Chinese high-speed-trains. The transformers consist of four single-phase HTS windings, operating at 65 K, each of which drives a motor. AC loss in the HTS windings is one of key parameters for the traction transformer application, and in order to achieve the targets of less than 3 tons of transformer system weight, better than 99% efficiency, and 43% short-circuit impedance, AC loss from the transformer windings cannot exceed 2 kW.

In this presentation we show the AC loss FEM modelling results on the traction transformer windings carried out based on both H-formulation and T-A formulation. We investigate the influence of the winding length, asymmetric field –and field-angle-dependent critical current of HTS wires, hybrid winding structure, flux diverters placed near the end part of the windings, the harmonic current components in the low voltage windings on AC loss. With optimized design for AC loss reduction, we discuss the cooling options, total system weight, system component arrangement, and efficiency.

Keywords: Traction transformers, AC loss, H-formulation, T-A formulation, flux diverters, harmonic current components

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Author: Dr JIANG, Zhenan (Victoria University of Wellington)

Co-authors: Dr SONG, Wenjuan (University of Glasgow); Dr STAINES, Mike (Victoria University of Wellington); Ms WU, Yue (Victoria University of Wellington); Prof. FANG, Jin (Beijing Jiaotong University); Prof. BADCOCK, Rodney (Victoria University of Wellington)

Presenter: Dr JIANG, Zhenan (Victoria University of Wellington)

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