Investigation of AC inductive excitation phenomena through current distribution simulation within REBCO wire using n-value model

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Abstract

The objective of the research and development is the realization of a 600 MW-class high-temperature superconducting (HTS) generator with liquid hydrogen serving as the coolant. The application of HTS assembled conductors to the field winding of the generator is currently under consideration. The development of a 600 MW-class HTS generator necessitates assembled conductors capable of conducting large currents of 6 kA-class under liquid hydrogen cooling. The verification of their transport current characteristics is essential· However, the current capacity of the liquid hydrogen test apparatus constructed at JAXA's Noshiro Rocket Testing Center is 500A, making it difficult to apply currents of several-kA directly.[1)]

Consequently, the current induction method employed for large current application to low-temperature superconducting conductors is being considered. The conventional current induction method uses a direct current (DC) sweeping through a primary coil to induce high currents in a secondary coil[2)]. However, this method has been known to exhibit issues with measurement inaccuracy in the secondary current due to noise and drift of the Rogowski coil voltage signal. Consequently, a new current induction method employing alternating current (AC) has been proposed and is currently under investigaion.[3)]

A secondary coil was fabricated using a single HTS wire and integrated within the primary coil to conduct fundamental verification tests (Figure 1). The present study aims to challenge the detecting the critical current (*Ic*) of the secondary coil by monitoring the phase difference between the Rogowski coil voltage and the primary current, as well as the distortion rate of the Rogowski coil voltage waveform.

In order to enhance our comprehension of this induction phenomenon, numerical simulation has been performed to simulated the phenomenon. A previous calculation of the electric field within the REBCO wire using Norris's AC loss model below the *Ic* and the n-value model above the *Ic* resulted in the discontinuity of the secondary current waveforms. Therefore, the REBCO wire was divided into fifty sections in the width direction using a thin-film approximation. The current distribution within the wire was calculated by solving the differential form of Maxwell's equations, which incorporated the n-value model. The calculation was then combined with a lumped-parameter circuit model to reproduce the induction phenomenon. The results of the numerical simulation and comparisons with the AC induction current test results will be discussed (Figure 2).

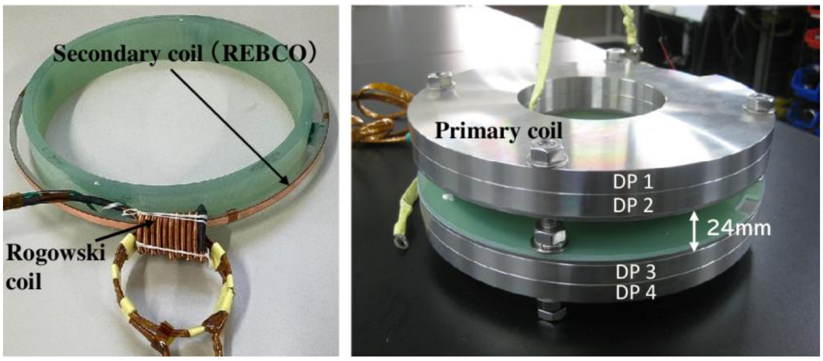

Figure 1 Test Sample

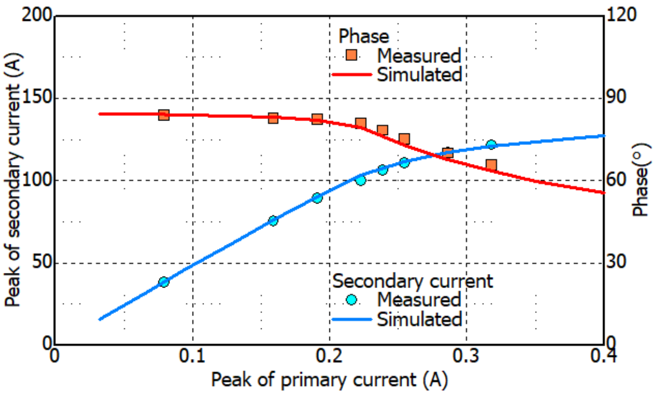

Figure 2 Comparison of measured and simulated results (0.5 Hz)

References
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2)G. B. J. Mulder et al. Proceedings of the 11th International Conference on Magnet Technology pp479-484, 1990
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Keywaords: High-temperature superconductor, REBCO, Inductive energization, n-value model

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