Preliminary AC inductive excitation tests of 1-turn high-temperature superconducting assembled conductor coil under liquid nitrogen and liquid hydrogen cooling

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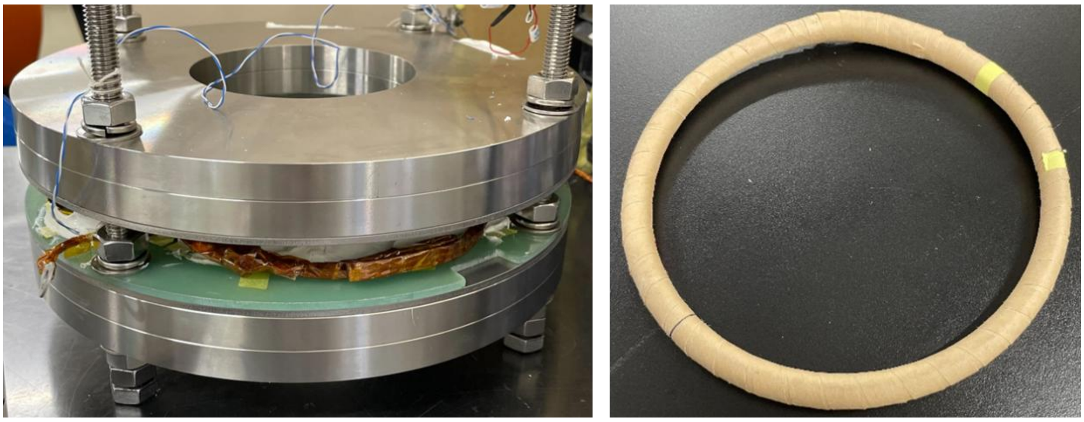
Abstract

The present project entails the development of a 600 MW-class high-temperature superconducting (HTS) generator that utilizes liquid hydrogen as a coolant. To superconduct the field winding of a generator, it is imperative to develop a HTS assembled conductor that is capable of conducting 6 kA at 20 K and 5 T. The development of the assembled conductor is underway, comprising twelve REBCO wires that are wound in a four-layer structure on a 5-mm diameter former.

The implementation of 6 kA-class energization tests on assembled conductors under liquid hydrogen cooling is imperative. However, conducting several kA-class energization testing using the liquid hydrogen testing equipment[1)] that have been constructed at the Noshiro Rocket Testing Centre of the Japan Aerospace Exploration Agency (JAXA) presents a significant challenge. Consequently, the sweep inductive excitation method[2)], which is employed as an energization technique for large-scale low-temperature superconducting conductors, was considered. However, concerns regarding the accuracy of the induced current measurement due to drift in the Rogowski coil voltage and zero-resetting methods utilizing the normal-conducting transition of HTS coils have emerged. To address these challenges, a research study has been launched to examine a novel AC inductive energization method that employs alternating current (AC) to the primary coil.

The objective of this study is to conduct a 6 kA-class energization test on the assembled conductor under liquid hydrogen cooling and an external magnetic field. The preliminary study has entailed the AC inductive excitation experiments on a one-turn short-circuit coil composed of a single REBCO wire[3)]. The primary coil consists of four double pancake coils with an inner diameter of 130 mm and an outer diameter of 206 mm, comprising approximately 444 turns of REBCO wires. These experiments have yielded the confirmation of the induction phenomenon as predicted by the numerical analysis. Subsequent to this confirmation, the fabrication of a one-turn short-circuit secondary coil with an inner diameter of 144 mm was initiated. This coil composed of an assembled conductor with three REBCO wires and was subjected to an AC inductive energization test under liquid nitrogen cooling. In the context of a primary current frequency ranging from 0.5 to 4 Hz, the induction ratio was found to be consistent with the designed specifications. It was observed that the phase difference between the Rogowski coil voltage and the primary current underwent decline when the peak value of the secondary current exceeded the assembled conductor Ic. Furthermore, it was determined that

measuring the secondary coil *Ic* with greater precision can be achieved by establishing the distortion rate of the Rogowski coil voltage waveform as an index. In addition, the results of AC inductive excitation tests conducted under liquid hydrogen cooling are presented.



(a) (b)

Figure 1 a) REBCO primary coil, b) One-turn secondary coil with assembled conductor

References

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Keywaords: High-temperature superconductor, Assembled conductor, Inductive energization, Liquid hydrogen

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