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Superconductivity and Hydrogen – The Perfect Wedding

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***Abstract*— High-temperature superconducting wires are appropriate to be operated at temperatures between 15 and 40 K from the viewpoint of electro-magnetic characteristics and stability. In this temperature range, liquid hydrogen (LH2) can be used as the so-called refrigerant especially for large magnets, due to its significant features such as high latent heat and low viscosity coefficient. However, because of its wide explosion range and low ignition energy, LH2 has rarely been studied as a refrigerant.**

On the other hand, research and development toward carbon-free energy infrastructure is in progress, and LH2 is one of the most important energy carriers. Therefore, we propose an energy infrastructure that links electricity and hydrogen by effectively utilizing the cryogenic heat of LH2 and using LH2-cooled superconducting power equipment as a key component. To this end, we will: 1) understand the heat transfer characteristics (immersion and forced convection cooling) as a refrigerant for superconducting equipment and build a database for design and fabrication, 2) measure the electromagnetic characteristics of superconducting wires and magnets cooled by LH2, 3) design and fabricate an experimental apparatus that will enable these measurements, and 4) provide safety design guidelines for LH2 cooling systems.

This research project has been conducted since 2008 with support from JSPS and JST, Japan. Currently, a project to develop a LH2-cooled superconducting generator is underway with support from NEDO, Japan. This presentation shows an overview of the experimental apparatus we have developed, the results of measurements of the heat transfer characteristics of LH2, and the electrical and magnetic properties of superconducting materials under LH2 cooling.

***Keywords (Index Terms)*— Liquid hydrogen, heat transfer, electro-magnetic properties**

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