Prospect of Liquid Hydrogen Cooled Superconducting Power Apparatus and Carbon Free Energy System

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***Abstract*— HTS (YBCO and BSCCO) superconducting wires are generally cooled by liquid nitrogen (77K). However, it is considered that excellent electro-magnetic properties of such materials are achieved with temperature of 20–40 K. Additionally, MgB_2 wire ,which is suitable for LH_2 cooling (critical temperature is 39 K), is now developing in critical current and critical magnetic field property. LH2 is expected as a coolant for a HTS superconducting magnet because of its excellent cooling properties, such as large latent heat, low viscosity coefficient and so on. On the other hand, hydrogen technology is one of the important solutions for innovative carbon free energy infrastructure. In Japan, hydrogen energy distribution infrastructure for FCV (Fuel Cell Vehicle) is accelerating in urban area. Cryogenic energy of LH_2 is expected to use effectively for superconductor cooling and have a synergy effect of hybrid energy system with electricity and hydrogen using LH_2 cooled superconducting power apparatus as key components. In order to design HTC superconducting devices cooled by LH_2, it is necessary to make heat transfer characteristic of LH_2, and electro-magnetic feature of LH_2 cooled superconductors clear. Our research group have been investigating on Liquid hydrogen (LH_2:20K) cooled superconductors and its cooling properties supported by Japan Science and Technology Agency (JST). We have designed and fabricated an experimental setup, which can be used for investigating heat transfer characteristics of LH_2 in a pool and also in forced flow for wide range of sub-cooling and forced flow velocity, and for evaluation of electro-magnetic properties of superconductors cooled by LH_2. A Fundamental database of heat transfer in LH_2 has been preparing for pool-cooling and also for forced-flow-cooling. Critical current under external magnetic field of MgB_2 wires cooled by LH_2 were investigated using the experimental facility.**

***Keywords (Index Terms)*— Liquid hydrogen, heat transfer characteristics, superconducting power device, HTS superconductor, carbon-free energy system.**

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