## APP2-1

# Heat Leak and Pressure Drop Measurements of the 1000 m Class Superconducting DC Power Transmission System in Ishikari

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500 m class and 1000 m class superconducting DC power transmission systems were constructed in Ishikari, Japan (Ishikari project). The 500 m system connects a photovoltaic power plant to an internet data center. On the other hand, the 1000 m system has been used to obtain data for construction of future longer transmission lines. In the summer of 2016, the second cooling and circulation test of the 1000 m system was performed, which was followed by the first cooling test performed in the winter of 2015. In these tests, characteristics of the cryogenic system, including a heat leak and a pressure drop, were measured. The heat leak of the system was estimated from the temperature rise and the flow rate of the liquid nitrogen. The measured values were 1.746kW and 2.091kW at the outer pipe temperature of -2.4°C and 17.4°C, respectively, for the cable including the terminals. The pressure drops were measured with pressure gauges for the liquid nitrogen. The pressure drop at 36.03L/min was 42.80kPa for the circulation distance of 2000m.
This work was supported in part by the Japanese Ministry of Economy, Trade and Industry (METI) and by the New Energy and Industrial Technology Development Organization (NEDO).

Keywords: DC power transmission, Heat leak, Pressure drop

# APP2-2

## Fluid characteristic of liquid nitrogen flowing in HTS cable

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For long distance design and operation of High-temperature superconducting (HTS) cables, evaluations of heat transfer and fluid flow dynamics of liquid nitrogen (LN2) flowing in the HTS cable is important. However, the LN2 flow is complicated when the cable core is housed in a double corrugated stainless steel cryostat-pipe and positioned at an eccentric position to the center of the cryostat-pipe. In this paper, the fluid characteristic, such as the pressure drop and the temperature, of liquid nitrogen flowing HTS cable will be discussed by comparing the measured values of the HTS cable system, which was constructed in NEDO project, with the simulated values of computer simulation analysis.

Keywords: High-temperature superconductors, Power transmission cable, Liquid nitrogen, Fluid flow

## APP2-3

# Hydraulic Evaluation of Pressure Drops and Temperature Profiles in Liquid Nitrogen Circulation Coolings for HTS Power Transmission Cables

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The research and development of power transmission cables using high temperature superconducting (HTS) wires have been in progress all over the world. Although a liquid nitrogen circulation pump for the cooling of HTS cable with long length is needed, a pump with discharge pressure, maintenance interval and high efficiency required for its realization has not been developed yet. Our group is now developing a maintenance-free circulation pump composed of magnetic bearings and superconducting motor. In this study, the pressure drops and temperature profiles along typical types of HTS cable systems circulating the subcooled liquid nitrogen are preliminarily evaluated for optimal design of the circulation pump.
The target of circulation pump for liquid nitrogen to be developed by our group is the discharge pressure of 1 MPa, volumetric flow rate of 100 L/min and temperature of 65 K at the outlet of pump (or the inlet of HTS cable). In order to estimate the pressure drops and temperature profiles of subcooled liquid nitrogen, it is necessary to determine the structures and sizes of HTS cables in advance. Therefore, two types of HTS cables are focused here on the basis of the existing projects for HTS cable developments. One is a three-in-one AC cable located inside a corrugated pipe [1], whereas the other is a DC cable inside a straight pipe [2]. The pressure losses and temperature profiles in two types of HTS cable systems under the assumption of constant mass flow rate are estimated using a commercial package for cryogen properties [3] and some expressions for Reynolds number, friction factors, pressure drop, temperature rise, and so on.
This work was supported by the Advanced Low Carbon Technology Research and Development Program (ALCA) from the Japan Science and Technology Agency (JST).
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Keywords: Circulation pump, Friction factor, Liquid nitrogen, Superconducting power transmission cable