Contribution ID: **100** Type: **Poster Presentation**

Development of a cooling system for 66/6.9kV-20MVA REBCO superconducting transformers with a Ne turbo-Brayton refrigerator and subcooled liquid nitrogen

Monday 29 June 2015 09:00 (2 hours)

In Japan, we have developed 3φ-66/6.9kV-20MVA RE1Ba2Cu3O7-δ(RE:Rare Earth, Y, Gd and so on, REBCO) superconducting transformers with a current limiting function as a national project. First we made a basic research on the ac loss reduction and the enhancement of current capacity of REBCO superconducting tapes, the dielectric strength of liquid nitrogen, a current limiting function of REBCO superconducting windings and so on. The subcooling of liquid nitrogen was required from the viewpoint of dielectric strength. We have finished the design of a 20MVA transformer and fabricated a 1/10 model, i.e. 3φ-66/6.9kV-2MVA one. The superconducting windings were installed in a GFRP cryostat and cooled with subcooled liquid nitrogen at 65 to 77 K. The iron core was located at room temperature. For the sake of a long maintenance interval and a high cooling efficiency, we developed a turbo-Brayton refrigerator with neon gas as a working fluid. The cooling capacity was 2kW at 65K. Here an expansion turbine and a two-stage turbine compressor with non-contact magnetic bearings were adopted. In the 2MVA model, liquid nitrogen was forced-flowed between the GFRP cryostat and an additional cryostat in which a pumping system and a heat exchanger between the neon gas and the liquid nitrogen were installed. In addition, for the future system, we are making a research and development of a new cooling system in which a radiator-type heat exchanger was directly installed into the GFRP cryostat. In this paper we will report the progress of the research and development.

This work was supported in part by New Energy and Industrial Technology Development Organization (NEDO) as Technological Development of Yttrium-based Superconducting Power Equipment.

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Session Classification: C1PoA - Cryogenics for Power Applications, Energy, Fuels and Transportation I

Track Classification: CEC-02 - Large-Scale Systems, Facilities, and Testing