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

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In Japan, we have developed 3 $\phi$ -66/6.9kV-20MVA RE1Ba2Cu3O7- $\delta$ (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. 3 $\phi$ -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.

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