Development of a 66/6.9kV-20MVA REBCO Superconducting Transformer with a Current Limiting Function

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Abstract: We developed and tested a 3ϕ-66kV/6.9kV-2MVA power transformer using REBCO superconducting tapes. It was a 1/10 model of a designed 3ϕ-66kV/6.9kV-20MVA one, where the superconducting windings was reduced only in current capacity by reducing the number of constituent tapes in parallel conductors. 1-turn voltage was 41.5 V/turn. *%IZ* was 3%. The windings were cylindrical ones. In the primary winding, a single REBCO tape with a width of 5 mm and a thickness of around 0.2 mm was wound into 8 layers. In the secondary one, an 8-strand parallel conductor was wound into 2 layers, where each strand was transposed 15 times per one layer for even current distribution and no additional ac loss in stacking. In addition, the REBCO tapes for the secondary winding were scribed by laser into a 3-filament structure to reduce the ac loss. The total length of REBCO tapes reached to 10km. The windings for 3 phases were installed into a GFRP cryostat which had an elliptic-cylinder-shape and three cylindroid bore for an iron core at room-temperature. The windings were designed to be cooled with subcooled liquid nitrogen. The Brayton-cycle cryocooler with a cooling capacity of 2kW at 70 K, which was developed together with the REBCO superconducting transformer, was located close to the transformer. Subcooled liquid nitrogen was forced-flowed by a pump unit between the transformer and the cryocooler. The initial cooling time from a room temperature down to 77 K was around 39 hours. The completed transformer was first bath-cooled with liquid nitrogen at 77 K and tested according to the domestic regulation for conventional transformers. The dielectric strength was verified by applying 350 kV impulse voltage and 140 kV ac voltage for 1 minute. However it was difficult to make sudden short circuit tests of the actual 3ϕ-66kV/6.9kV-2MVA transformer itself due to the equipment problem. Therefore, making sudden short circuit tests repeatedly of 6.9/2.3kV-400kVA REBCO superconducting transformers with a short circuit generator with a capacity of 200 MVA, we developed the software program so as to numerically simulate the response of the REBCO superconducting windings against the fault excess current and designed the 20MVA transformer. In this workshop, we will report the details of the development and test of 3ϕ-66kV/6.9kV-2MVA REBCO superconducting transformer.