Abstract

Experiment of the 200-meter DC superconducting power cable and Perspectives of DC superconducting power transmission and distribution

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The experiment of DC superconducting power cable had been started in 2006 by the aid of Japanese government in Chubu University, and the 20-meter cable facility was constructed and named CASER-1. Several ideas of the system were tested such as the Peltier current lead to reduce the heat leak from the terminal, the straight cryogenic pipe to reduce heat leak and circulation power, the individual connection of the copper cable and the high temperature superconductor (HTS) tape to measure the current of each HTS tape after the cable installation into the cryogenic pipe and to watch and avoid the current imbalance of HTS tapes. We also constructed the test bench to measure the heat leak of the cryogenic pipe precisely, and the circulation loss of the liquid nitrogen (LN2) was estimated by the numerical calculation and the semi-empirical formula for a long distance cable system. The experimental results and the analysis showed that these ideas are correct principally, and therefore we decided to construct the 200-meter cable test facility in 2008 by the financial aid of Nano-Optonics Energy Inc. The facility was completed in March 2010 and called CASER-2. The current and voltage of the cable are 2 kA and ±10kV, and the Bi-2223 HTS tape is used and the cable is composed of 39 tapes, and co-axial type. We performed the experiments three times until March 2011. The objects of the experiment are as follows,
1) to obtain the experimental circulation loss of the LN2 and the comparison of the experimental data and calculation results, 2) to use the zinc coated iron pipe as the outer pipe of the cryogenic pipe to reduce the cost and to enhance the magnetic energy of the cable system,
3) to measure the vacuum pumping time of the cryogenic pipe and its structure, 4) to keep the soundness of the long cable for thermal contraction and expansion in the thermal cycle, 5) to measure over all heat leak of the cryogenic pipe of the system, 6) to test the performance of the thermal siphon to enhance the circulation power by the heat leak and so on. The experiment is continued now, and we will show the test facility, the experimental results and their analysis. We will discuss the development scenario of the DC superconducting power transmission and distribution system, and mention the future applications of the cable system. Finally, we discuss with the various aspects of the DC superconducting power transmission line to connect the renewable energy sources.