Evaluation of Realizability of High-T_c SMES

Background

Recently, development of high-T_c superconducting wires and tapes is progressing. In particular, it is expected that YBCO-coated conductors are applied to SMES due to an advantage of wide operation temperatures. Therefore, feasibility study of High-T_c SMES including some experiments using model coils and some numerical simulations have been carried out in a national project of "Technology Development of SMES System" from 1999 to 2003. This work is supported by METI and conducted by NEDO as a feasibility study of High-T_c SMES as a part of development of SMES system.

Objectives

Clarification of technical realization of high-T_c SMES and more cost reduction than that of low-T_c SMES

Principal Results

a) Technical realization of high-T_c SMES

・Investigation of high current conductors for high-T_c SMES

The world record of critical current (I_c) for the one turn model coil using the Bi2212 Rutherford conductor conductively cooled using a cryocooler is achieved 4 kA at 26 K, which is satisfied to develop high-T_c SMES. Fig. 1 shows the equipment of critical current measurement for Bi2212 Rutherford conductor and the results of critical current measurement. It is also indicated that possibility of high-current superconducting conductors using a displacement of 6 Bi2223 superconducting tapes as a result from the examinations of trial conductors and trial model coils.

・Magnet technology

In the magnet technology, the conductive cryocooling technology and the current leads are indicated to be important issues to realize high-T_c SMES using model coils. In the current leads, the new current leads with the pulse tube cryocooler are developed, whose insulation characteristics are independent on vacuum pressures. Fig, 2 shows the photo of the developed current leads.

b) Cost estimation of high-Tc SMES

One of the advantages of high-T_c SMES is the wide operation temperature due to use of the cryocooling system. Initial costs of high-T_c SMES on the basis of the results from the conceptual design for the troidal coil system are estimated at each operation temperature. According to the comparison with the cases using high-T_c superconductors and low-T_c superconductors, it is found that the cost reduction using the YBCO-coated conductors at all of the temperature range is more expected than that of the low-T_c superconductors due to use at relatively high magnetic fields. Fig. 3 shows the results of the cost estimation and the coil shape of high-T_c SMES designed at 20 K.

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Reference

A. Ichinose, et al., "Research and Development of High-T_c SMES", submitted to *IEEE Transaction of Applied Superconductivity*.

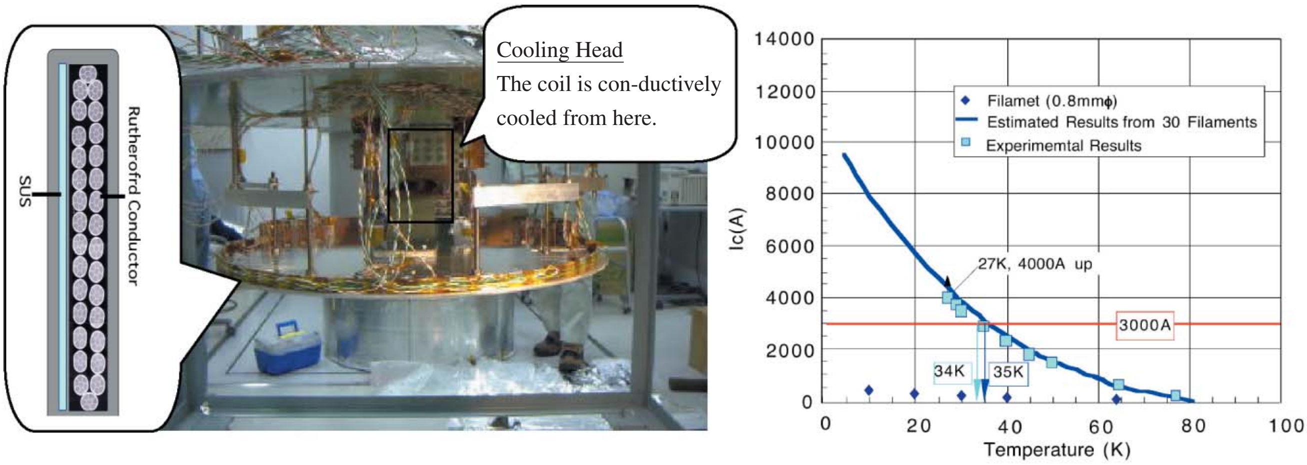

Fig.1 Critical measurement equipment of Bi2212 Rutherford conductor carried 4 kA under conductive cooling conditions and critical current measurement results

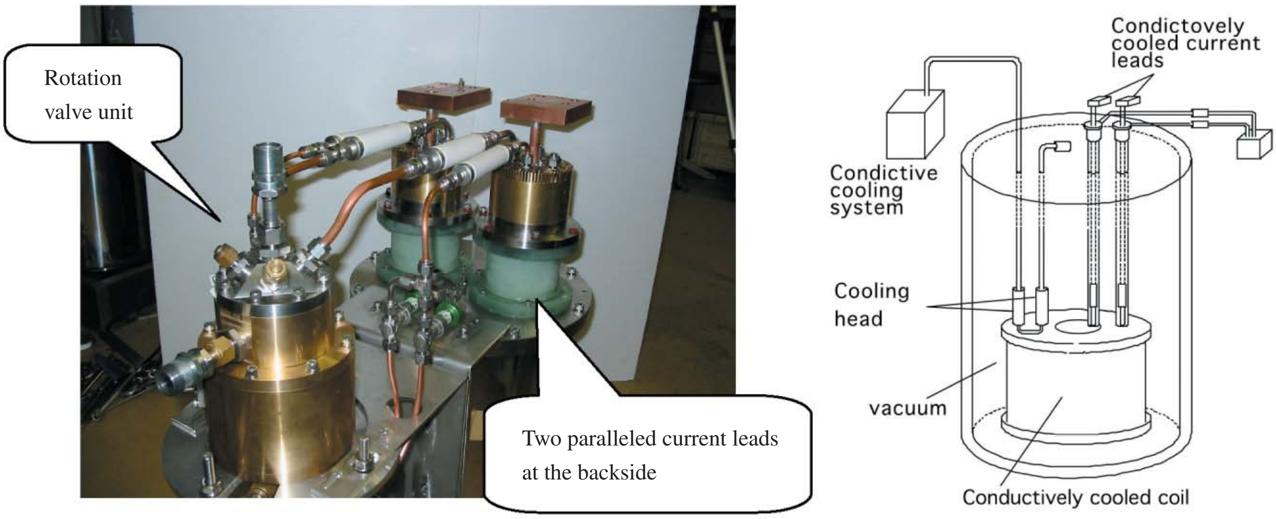

Fig.2 A photo of developed current leads with the GM pulse refrigerator and a construction of the high-T_c coil and the current leads

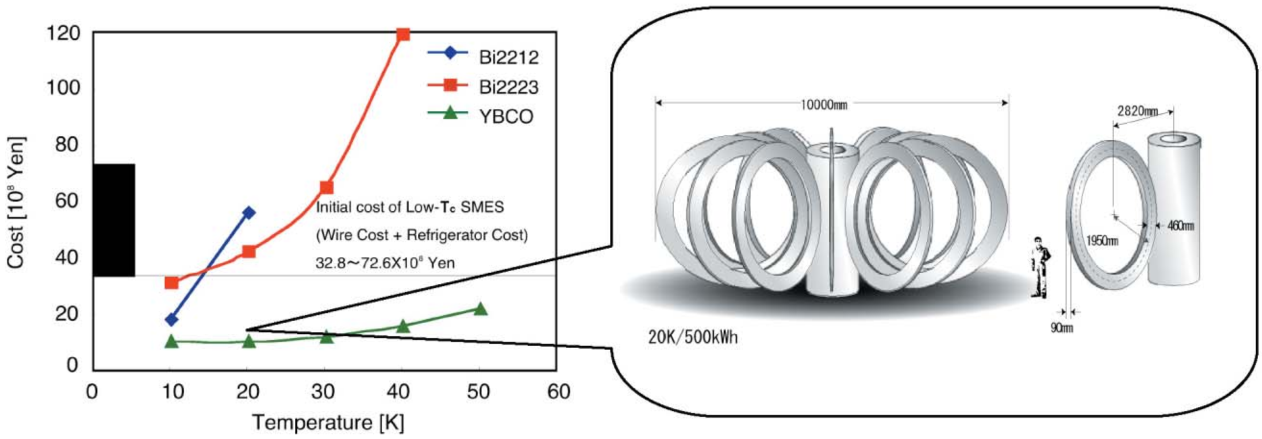

Fig.3 Summation of wire cost and refrigerator cost of power system stabilization of 500 kW/h (1.8GJ) at each operation temperature and the conceptual design of high-T_c SMES using YBCO coated conductors at 20 K.