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AC Loss Issue in Power Applications of a High Temperature Superconductor

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There has been considerable progress in fabrication of a long and practical high temperature superconducting wire for industry applications since superconducting materials with a relatively high critical temperature were discovered in 1986. The high temperature superconducting wire is presently developed for use in large-scale power engineering devices such as power transmission cables, fault current limiters, transformers, and electric motors. However, they have not become commercially available from any makers yet. The alternating magnetic field in these devices causes electromagnetic energy dissipation (AC loss) despite zero resistance of the superconductor. The dissipated heat must be removed from the low temperature vessel by a refrigerator. The refrigerator has two intrinsic disadvantages; it is too expensive and has extremely low efficiency. For example, the refrigerator consumes about 10 times larger than the actual AC loss around liquid nitrogen temperature and 1000 times around liquid helium temperature. This means that AC loss is crucial in commercialization of the high temperature superconducting power devices. For their realization, we must reduce the AC loss level low enough to compete with a conventional copper wire in both economic and technical point of view.

In this talk, we first introduce commercial DC superconducting products briefly, e.g. superconducting magnetic energy storage (SMES) systems, magnetic resonance imaging (MRI) devices, and silicon crystal growing devices which have recently been developed successfully in domestic company of Duksung. Secondly, we will talk about two typical power applications of the high temperature superconductor in AC loss point of view, for example, the 22.9 kV/ 1250 A superconducting cable and the 22.9 kV/ 630 A superconducting fault current limiter, which are being worked in Korea Electric Power Research Institute (KEPRI) and LS Industrial Systems Co. (LSIS) respectively. General things of AC loss including technical importance and several types of AC loss, its evaluation method and so on will also be presented. We report self-field loss, dynamic resistance loss, and magnetization loss characteristics of a technical high temperature superconducting wire, which have experimentally and theoretically been investigated in our laboratory since 1996. Finally, we will discuss outlook for decreasing AC loss of the high temperature superconducting wire.

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