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Development of static magnetic refrigeration system using multiple high-temperature superconducting coils

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It is expected to build a sustainable social system that uses “hydrogen” as a fuel to generate electricity without emitting CO2. To realize this, technology for storing a large amount of hydrogen is indispensable, and storage as liquid hydrogen is ideal. However, the efficiency of the cooling device in the temperature range around 20 K required for long-term storage with liquid hydrogen is low, and the equipment is huge and expensive, so it has not been established as a widely used technology.
Magnetic refrigeration is expected to be a highly efficient refrigerator in the temperature range of around 20 K because it can realize an ideal refrigeration cycle. However, in magnetic refrigeration, it is necessary to give a magnetic field change to the magnetic material. Further, in order to perform cooling with a large capacity and extremely low temperature by magnetic refrigeration, the magnetic field strength of a permanent magnet is insufficient, and it is indispensable to use a superconducting coil capable of generating a strong magnetic field with low power consumption.
This study aims to develop a static magnetic refrigeration system using multiple high-temperature superconducting coils. By utilizing the energy storage characteristics of the superconducting coil, we are considering a magnetic refrigeration system that can repeatedly generate magnetic field changes to save energy without the need for large amounts of energy to be taken in and out of the outside. The results of analyzing the behavior of magnetic field changes due to coil arrangement, such as reversing the magnetic poles of multiple coils next to each other, and the trial design of coils using FAIR conductors, which are under development, and the loss evaluation due to magnetic field changes were performed. We report on the technical feasibility of a static magnetic refrigeration system using multiple HTS coils.

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