Performance of a 10 kJ SMES Model Cooled by Liquid Hydrogen Thermo-Siphon Flow for ASPCS Study


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To effectively use renewable energy sources such as wind and photovoltaic power generations, we propose a new electrical power storage and stabilisation system, called an Advanced Superconducting Power Conditioning System (ASPCS), that consists of superconducting magnetic energy storage (SMES), a fuel cell-electrolyser (FC-EL), hydrogen storage, direct-current-to-direct current (DC/DC) and direct-current-to-alternating-current (DC/AC) converters, and a controller. The ASPCS compensates for fluctuating electrical power generation by combining the SMES with quick response and hydrogen energy storage with unlimited capacity.

The ASPCS compensates for fluctuating electrical power generation by combining the SMES and FC-ELs for ASPCS operation and (2) confirmation of the feasibility of the liquid hydrogen-based cooling scheme—is presented.

Many engineering studies and development efforts are required to produce an ASPCS. The most important topics are (1) establishment of combined input/output power control loops and sequences of both SMES and FC-ELs for ASPCS operation and (2) confirmation of the feasibility of the liquid hydrogen-based cooling scheme. A small model of the ASPCS was developed to demonstrate the ASPCS’s effects and to study these topics. The ASPCS model, which handles 1 kW power generated by a solar cell system, consists of a 10-kJ SMES, an FC unit, an EL unit, a hydrogen storage tank, and a control system.

To prevent from large AC loss in the thermal conductors themselves due to SMES operation, many slits and one-turn-cuts are devised. The coil has been successfully cooled down and charged up to a nominal current of 200 A.

AC loss of 10 W induced in the pure aluminium sheet is rather larger than predicted value of 0.16 W, because one turn loops still left in the coil. But temperature rise is low enough to continue AC excitation.

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