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Experimental investigation of 20 K two-stage layered active magnetic regenerative refrigerator

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An active magnetic regenerative refrigerator (AMRR) is one of the useful technologies to improve the efficiency of hydrogen liquefaction process. The AMRR utilizes magnetocaloric effect to reduce the cold end temperature of the active magnetic regenerator (AMR). Since the magnetocaloric effect is a reversible process, it facilitates high thermodynamic efficiency of AMRR. However, the magnetocaloric effect only appears near the transition temperature. Therefore, in order to achieve a wide temperature span of the AMR, the layered AMR with four kinds of magnetic refrigerants (GdNi2, Gd0.1Dy0.9Ni2, Dy0.85Er0.15Al2, Dy0.5Er0.5Al2) has been considered. Because each magnetic refrigerant has different heat capacity, it is very important to determine the proper mass flow rate of the helium gas which is used as a heat transfer medium. In this paper, the performance of the two-stage layered AMRR is experimentally investigated. The test apparatus includes two-stage layered AMRs, low temperature superconducting (LTS) magnet which generates maximum magnetic field of 4 T, and the helium gas oscillating flow system. The mass flow rate of working fluid is controlled separately at the first and second stages of the AMR. Each mass flow rate at the cold end is measured by two hot-film sensors (1260A-10, TSI) calibrated at the cryogenic temperature (20 K ~ 80 K). The temperature span of the AMR is recorded 60 K and the performance of the AMR with the variation of the mass flow rate is analyzed. The results show that the mass flow rate of working fluid is a crucial factor in the AMR performance.

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