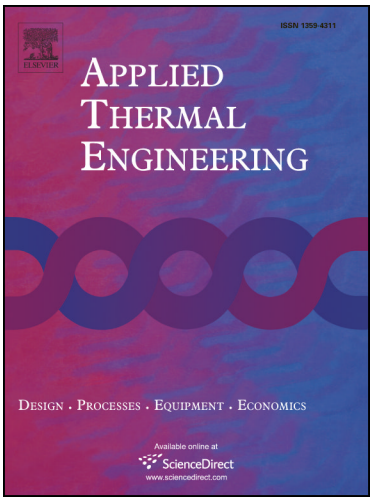

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A novel cascade micro-unit regeneration cycle for solid state magnetic refrigeration

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Abstract

Magnetic refrigeration (MR) is regarded as an alternative solution for vapor-compression refrigeration system to eliminate the usage of hydrofluorocarbons (HFCs). However, better solutions and breakthroughs are urgently needed to promote the commercialization process of MR. In this paper, a novel solid state MR system is proposed based on a new cascade micro-unit regeneration (MUR) cycle, in which heat can be regenerated at the correct time and in the reasonable space through the special cycle design. The heat regeneration in such system is one-way solid-to-solid heat conduction with a small temperature difference, thus avoiding the heat transfer loss that exists in conventional active magnetic regenerators. The cycle design concept and operation mechanism are described in detail. A quasi-two-dimensional numerical simulation model is developed for the proposed system to investigate optimal geometric parameters, operating characteristics and system performance. Using gadolinium as the magnetocaloric material and an applied magnetic field of 1.5 T, a maximum no-load temperature span of 50.9 K and a maximum COP of 4.2 are achieved by a 72-lattice configuration. Moreover, the optimal rotating speed range is determined for maximizing the specific cooling power (SCP) under different configurations and operating conditions. The obtained maximum SCP range is from 2.6 W kg^{-1} to 105.8 W kg^{-1}. The results reveal good potential for practical application.

Keywords: magnetic refrigeration, micro-unit regeneration cycle, solid state, cascade refrigeration.

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