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Design and development of magnetic refrigeration prototype for the performance analysis of magnetocaloric materials

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Magnetic refrigeration (MR) has been receiving an attention as an alternative system to conventional refrigeration based on vapor compression. Normally, the vapor compression uses hydrofluorocarbons (HFC) and Chlorofluorocarbons (CFC) as refrigerant fluids which damage ozone layers causing global warming. Consequently, the magnetic system has been developed to replace the traditional system to reduce global warming potential (GWP). The alternative cooling technology is based on the magnetocaloric effect (MCE) of magnetocaloric materials (MCM) which are able to change their temperature following magnetic flux density under magnetic field generator. The refrigeration is operated via an active magnetic regeneration (AMR) cycle with rotating magnets. In this work, the magnet assembly has been designed and studied with the aspiration for compact and efficiency. Based on extensive reviews, the magnet assembly model of Okamura *et al.*¹ provides the conceptual design with optimal compactness and efficiency. Hence, in this study, the magnet assembly design has been developed based on the model by Okamura *et al.* The magnetic system consists of a soft magnetic composite stator and four neodymium (NdFeB) permanent magnets rotated by motor. The magnetic field performance of the assembly is analyzed using the COMSOL Multiphysics software. The generated magnetic field is 0.65 T provided by only 0.9 L of permanent magnets. In addition, the efficiency of the magnet design is represented by a figure of merit parameter, Λ_{cool}. Among others, the proposed design exhibit a high Λ_{cool} value of 0.17, which is as high as five times better than the magnet assembly designs by prior work.

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