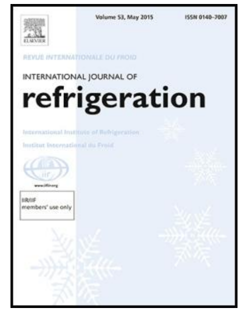

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Adapting an Active Magnetic Regenerator to a continuous fluid flow application

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Highlights

- A concept to suit a continuous fluid flow application has been tested
- The performance gain has been investigated both numerically and experimentally
- This concept applied to Magnetic Refrigeration showed a cooling power gain up to 22%

Abstract

This paper presents a concept adapted to magnetocaloric refrigeration in order to better suit an application of a continuous fluid flow such as an industrial process. The concept, called the by-pass flow, consists in a derivation in the fluid flow from the Active Magnetic Regenerator (AMR) in order to take a part of the heat transfer fluid from the cold side of the regenerator and after passing it through a counter-current heat exchanger to reinject it into the hot side. The value of the by-pass fluid flow rate has been studied by two theoretical methods (qualitative and quantitative approaches) being then validated by numerical simulations and experimental measurements. Numerical simulation shows an increase of 27 % in the value of cooling power when the by-pass method is implemented. In the case of experimental measurements, the cooling power with the by-pass solution shows values between 8 and 22 % more than the classic solution, depending on the frequency values. The main operations are described and the results are presented, analyzed and discussed.

Keywords: magnetic refrigeration, active magnetic regeneration, by-pass flow, industrial process

Nomenclature

MR	Magnetic refrigeration	*[-]*
MCE	Magnetocaloric effect	*[-]*
ΔT	Temperature difference	*[K*
CHEX	Cold heat exchanger	*[-]*
COP	Coefficient of performance	*[-]*
AMR	Active Magnetic Regenerator	*[-]*
CSR	Coefficient of sub-relaxation of by-pass flow	*[-]*
T_{in}	Entering temperature	*[°C]*
T_{out}	Exit temperature	*[°C]*
η	Efficiency of the heat exchanger	*[-]*
m	Mass flow rate	*[kg/s]*
c_p	Specific heat	*[J/kg K]*
q_c	Heat capacity rate of the fluid	*[J/kg K]*
Φ_{max}	Maximum efficiency of a heat exchanger, with infinite length	*[-]*
L	Heat exchanger length	*[mm]*
η_c	Cooling effectiveness of the heat exchanger	*[-]*
η_h	Heating effectiveness of the heat exchanger	*[-]*
ρ	Density of the fluid	*[kg/m³]*