Abstract

Magnetic Refrigeration is based on the *magnetocaloric effect*, an intrinsic property of certain magnetic materials which manifests it, describes its behavior when exposed to a changing magnetic field. These *Magnetocalori*c materials act as heat storage medium and participate in the cycle like a regenerator, as the temperature change is associated with a sudden variation, by imposing and removing an applied magnetic field.

Thus, a room-temperature magnetic refrigeration, achieved in this work, includes two parts; the first part is the theoretical study. In which, a heat transfer performance analysis is done for a flat plate for the *reciprocating active magnetic regenerative refrigerator* with time and space variation. The second part includes the construction and the test of the reciprocating active magnetic regenerator (AMR), which consists of high-purity *Gadolinium* plates, used in most magnetic refrigeration prototypes. It is associated with, a *Permanent Halbach* magnet of an alloy of *Neodymium*, *Iron* and *Boron*. This gives a maximum magnetic flux density of 1.5*Tesla*, and be ideal for household refrigerator applications generates strong magnetic fields.

This reciprocating AMR apparatus is used to measure the no-load temperature span, represents the maximum temperature difference, and is obtained between the two heat ends for a range of operating conditions. Two types of working fluids, namely distillate pure water and water/ethylene glycol mixture are tested at the same operating conditions. The water was found the best due to an overestimated the large thermal conduction.

The maximum no-load temperature span was found to be about 11*K*, in which the regenerator operated temperature differences between the two

outermost ends are 15℃ and 26℃, respectively. Thus, for Utilization factor of 0.5 associated with an ambient temperature of 296*K*, (23℃) for 13 plates of *Gadolinium* seems suitable as the regenerator. Many other parameters have been studied for this temperatures span, as the volumetric flow rate dependence and found, 600mm^3/sec. Also, the cooling power is 3W, for the ambient temperature 296*K*, associated with a piston stroke and total cycle time are 1*cm and* 8*s*, respectively.

All obtained results were analyzed and discussed compared with one dimensional theoretical model of a reciprocating AMR which developed using *FORTRAN* program. They were then verified numerically and experimentally, against similar AMRR models in one and two dimensions and fairly good agreements were achieved.