# Design and instrumentation of an experimental system for magnetic refrigeration

**Auteur :** Parmentier, Justine
**Promoteur(s) :** Vanderbemden, Philippe; Lemort, Vincent
**Faculté :** Faculté des Sciences appliquées
**Diplôme :** Master en ingénieur civil physicien, à finalité approfondie
**Année académique :** 2016-2017
**URI/URL :** http://hdl.handle.net/2268.2/3248

# ABSTRACT

Nowadays climate change has become an important concern for people around the world. The refrigeration industry is a highly polluting sector that represents alone around 15 % of the overall electric consumption. Typical coolants used in domestic and industrial refrigeration still involve nocive gases, such as the chlorofluoro-carbons which are associated to a high ozone depletion and global warming potential.

The search for more environmentally-friendly alternative has thus been rising greatly these past few years. Among them, a noteworthy candidate of replacement for the most widely used, steam-compression refrigeration technology, is the magnetocaloric effect-based refrigeration. This one depends not on the thermal response of a gas to a change of pressure but on the one a magnetocaloric material exhibits when subjected to a magnetic field variation. Many prototypes based on the magnetocaloric effect arose recently, and the magnetic refrigeration shows promises for the future of the industry. However it is still an active field of research.

In this work, the design and the instrumentation related to a magnetocaloric effect-based, room-temperature refrigeration demonstrator are explored. A Halbach, cylindrical, 1.05 T-field magnet will be utilized for building it. After having reviewed in details the underlying theory of the magnetocaloric effect and surveyed some already existing devices, a preliminary thermal study is performed numerically in order to help designing the prototype.

The material of choice for magnetic refrigeration is gadolinium, a rare earth whose magnetocaloric effect appears close to the ambient temperature. Thin sheets of this material will be used for the actual prototype, but first the force acting on them as they enter the field of the magnet is experimentally studied. The influence of the distance between the middle of the plates and the center of the magnet gap as well as other parameters are investigated, such as the thickness or the weight of the sheets.

Examples of curves derived when measuring the force for one, two and eight plates at a time inside the magnet and as a function of the distance to its center are visible in appendix. The results observed show that this force is either maximum or minimum as the center of the plates is at the exact level of the edge of the magnet yoke, whereas it cancels out once both the magnet and the plates center align on each other. The force also increases linearly with the number of plates. One sees in appendix a comparison between twice the force obtained for one plate and the one measured for two plates. Both forces have very similar values, showing the proportionality of this force to the number of sheets used.

At the end of this work the instrumentation needed to asses the performances of the prototype is also characterized and tested. Finally, all the pieces required for making the actual prototype are summarized and the possible future openings described. Along with the magnetic part of the prototype, there is still need for a hydraulic circuit to be designed and constructed in order for the device to be fully operating.