MAGNETIC COOLING

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Abstract

The effort of this project is to perform and examine the Magnetic Refrigeration which uses solid materials as the refrigerant. These materials demonstrate the unique property known as magneto caloric effect, which means that they increase and decrease in temperature when magnetized/demagnetized. This effect has been observed for many years and was used for cooling near absolute zero. Recently materials are being developed which have sufficient temperature and entropy change to make them useful for a wide range temperature applications.

Magnetic refrigeration is an emerging technology that exploits the magneto caloric effect found in solid state refrigerants. The combination of solid-state refrigerants, water based heat transfer fluids and efficiency leads to environmentally desirable products with minimal contribution to global warming. Among the numerous application of refrigeration technology air conditioning applications provide the largest aggregate cooling power and use of the greatest quantity of electric energy.

Key Words: - *Magnetization, Caloric Effect, Air conditioning, Entropy, Refrigerants.*

1.INTRODUCTION

Modern society largely depends on traditional refrigeration methods like vapor compression cycles and vapor absorption cycle. Furthermore, its operation more or less makes use of ozone depleting refrigerants whose use has lately not been desired for environmental reasons. For this reason, researchers and engineers working in refrigeration have started to investigate new technologies for refrigeration among which the most promising is magnetic refrigeration. [1]

Magnetic Refrigeration is a technology which is used to produce cooling based on magneto caloric effect.

Magneto Caloric effect defined as magnetic materials changing its temperature when magnetic field applied on the material changes i.e. they increase and decrease their temperature when magnetized and demagnetized. The temperature change by magnetization and demagnetization are used to generate cooling. [2]

The presence of a magnetic field makes ferromagnetic material become more ordered. This is accompanied by disorder within the atomic lattice, which causes an increase in the material's temperature and the absence of a magnetic field means that the atomic lattice is more ordered and results in a temperature decrease. [3]

The discovery of the magneto caloric effect in the early 1900's can be attributed to Weiss and Piccard (Smith, 2013), but the research on magnetic refrigeration for near room temperature applications started only with the first magnetic cooler prototype developed by Brown (1976). Two decades later, a breakthrough paper on the discovery of the giant magneto caloric effect of Gd5Si2Ge2 was published by Pecharsky and Gschneidner (1997). Since then, a number of laboratory demonstration prototypes have been reported in the literature (Gschneidner and Pecharsky, 2008; Yu et al., 2010). [4]

The ultimate goal of this technology would be to develop a standard refrigerator for home use. The use of magnetic refrigeration has the potential to reduce operating and maintenance costs when compared to the conventional method of compressor-based refrigeration. By eliminating the high capital cost of the compressor and the high cost of electricity to operate the compressor, magnetic refrigeration can efficiently (and economically) replace compressor-based refrigeration technology. [5]

2. EXPERIMENTAL SETUP

We made a magnetic cooling device which work on the magneto caloric effect.

For this purpose we require a device which can generate magnetic field, so we used a solenoid which generated magnetic field of about 0.1T and these magnetic field lines passes through the material that is to be cooled. The material here used are Mild steel, Cobalt and Nickel.

The solenoid is 6 inch in length and 3 inch in diameter on which 5 layers of copper wire are winded. The copper wire is of 24 gauge and number of turns over the solenoid is 6065. The material length is 4 inch and diameter is 0.5 inch.

The material is inserted in the solenoid on which magnetic lines passes and temperature sensor is connected with the material i.e. Mild Steel and is further connected to our Arduino chip which shows the temperature on the display. The material is put inside the solenoid with the help of wooden stands and holes are made on the wooden stands so that maximum of magnetic lines gets passed from the material. On the material the copper tube is winded. Here Copper tube are used because they are a good heat conductor and when water flow in the copper tube the water take excess heat from the material and cools it. To flow the water in, water pump is used. The reservoir is used where water is stored and water circulate from here to copper tubes and return back here.

Air pump which create a vacuum in our chamber. The chamber is made up of fiber sheet and a layer of thermacol is placed inside the chamber for insulating the surface of the chamber.

The temperature sensor used here is LM35 whose programming is done on the Arduino software. All the connections are done and the temperature sensor is connected to our material which send the signal to Arduino and Arduino display the temperature in our display.

1. Length of solenoid = 6inch
2. Diameter of solenoid= 3inch
3. Diameter of copper wire= 24gauge
4. Length of material=4inch
5. Diameter of Material= 3 inch

3. RESULT

Following Result were obtained after the successful testing of the device:

Material	Before magnetization (in degree Celsius)	After magnetization for 5 seconds (in degree Celsius)	After cooling with water for 10 seconds (in degree Celsius)	After demagnetization (in degree Celsius)	Temperature difference (in degree Celsius)
Mild Steel	36	58	41	35.52	.48

4.CONCLUSION

In this paper the author talks about the magnetic refrigeration which is environmental friendly technology and a substitute to the conventional refrigeration system which produces harmful gases which are responsible for global warming. Magnetic refrigeration do not uses any refrigerants. It promises to be a promising technology in future. In order to make the magnetic refrigerator commercially viable, scientists need to know how to achieve larger temperature swings and also permanent magnets which can produce strong magnetic fields of the 8-10- tesla order. There are still some thermal and magnetic hysteresis problems to be solved for the materials that exhibit the MCE to become useful.

5. REFERENCES

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