PROJECT

REPORT

DESIGN AND FABRICATION OF PORTABLE MAGNETIC REFRIGERATION UNIT

Toc H INSTITUTE OF SCIENCE & TECHNOLOGY

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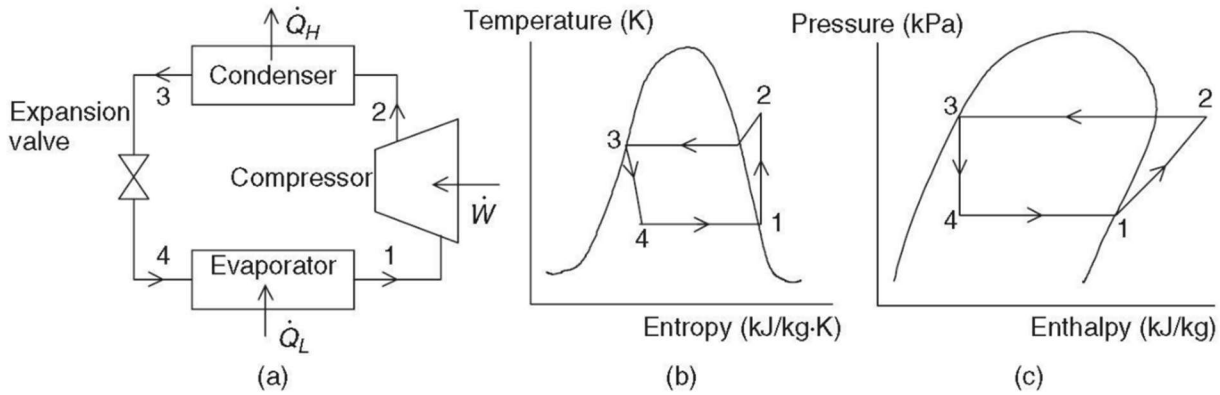
Acknowledgement

First of all we would like to express our sincere gratitude to the ISHRAE society for providing us such an opportunity to express our idea and further helping us to complete the same.

We also thank the members of ISHRAE KOCHI chapter for their support and guidelines.

We also extend our sincere gratitude to our faculty advisor and HOD mechanical dept. Toc H institute of science and technology for their sincere support and guidelines throughout our work

CONVENTIONAL REFRIGERATION SYSTEM



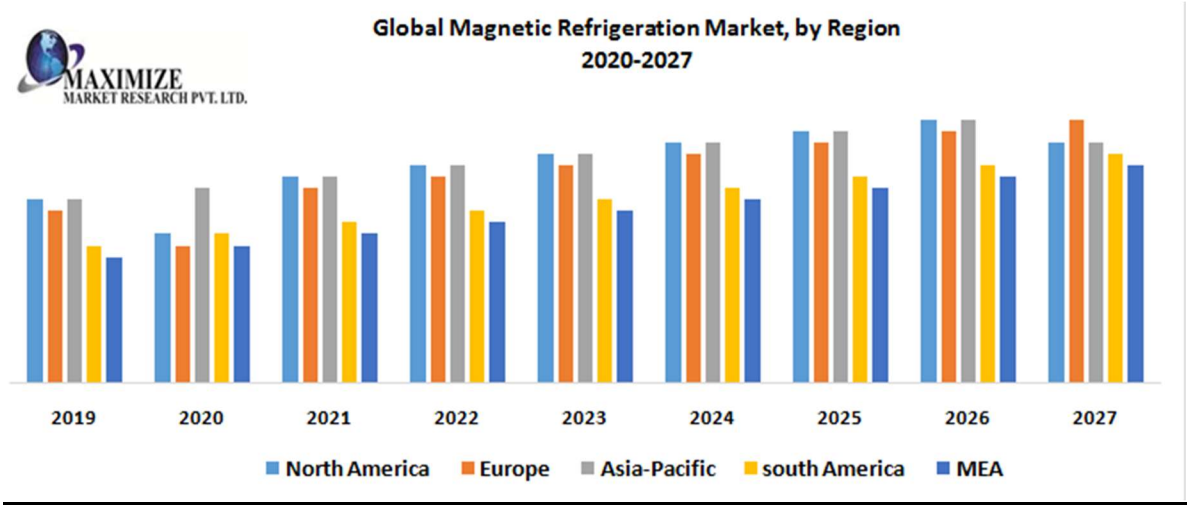
MAGNETIC REFRIGERATION

WHAT IS MAGNETIC REFRIGERATION?

MAGNETIC REFRIGERATION IS A CCOOLING TECHNIQUE BASED ON MAGNETO-CALORIC EFFECT. IT IS A METHOD OF COOLING A SPACE WITH THE HELP OF MAGNETS AND MAGNETICCALORIFIC MATERIAL INSTEAD OF USING COMPRESSOR, CONDENSOR AND REFRIGERANT.

THE REFRIGERANTS USED IN CONVENTIONAL REFREGERANTS ARE KNOWN TO BE POLLUTANTS CAUSING OZONE LAYER DEPLETION, WHICH INTURN INCREASE THE EXPOSURE OF LIVING THINGS TO THE HARMFUL ULTRAVIOLET RADIATION. BY THE ELIMINATION OF THE SAME, OZONE LAYER DEPLETION CAN BE REDUCED UPTO AN EXTEND.

INSTEAD OF USING THOSE HARMFUL REFRIGERANTS MAGNECTIC REFRIGERATION SYSTEMS USE MAGNETS AND MATERIALS WITH MAGNETO-CALORIC EFFECT FOR THE PURPOSE OF COOLING OR REDUCTION OF TEMPERATURE

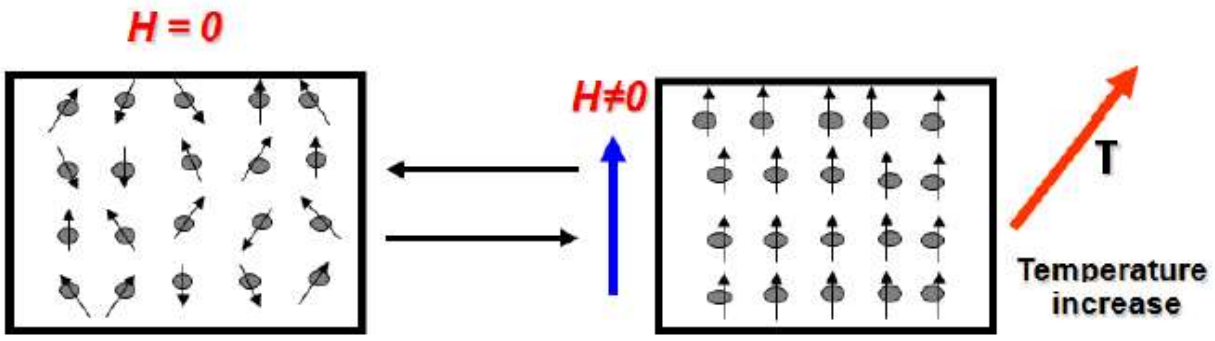


The graph above clearly depicts the growth of magnetic refrigeration over few years and also depicts the growth which it would achieve in the near future.

Magneto caloric effect

Basic principle behind magneto-caloric effect is that when a material is magnetized it heats up and cools down when demagnetized.

An increase or decrease in the strength of an external magnetic field modifies the ordering of the magnetic moments of the atoms that form the material, thus altering magnetic entropy



On the application of magnetic field particles get aligned to minimize the magneto static energy developed in each particle, particles orient and assemble along an axis parallel to applied magnetic field.

MEC can be defined as the response of a magnetic material to applied magnetic field, which manifests as change in temperature.

Magnetic materials undergo isothermal magnetic entropy changes (ΔS m) or adiabatic temperature changes (ΔT adiabatic) upon the application or removal of an external magnetic field. This phenomenon is known as the magneto-caloric effect. Magnetic refrigeration based on the magneto-caloric effect is considered to be a promising energy-efficient and environmentally benign refrigeration technology

Magneto-caloric effect are mostly exhibited by rear earth metals and elements belonging to lanthanide series.

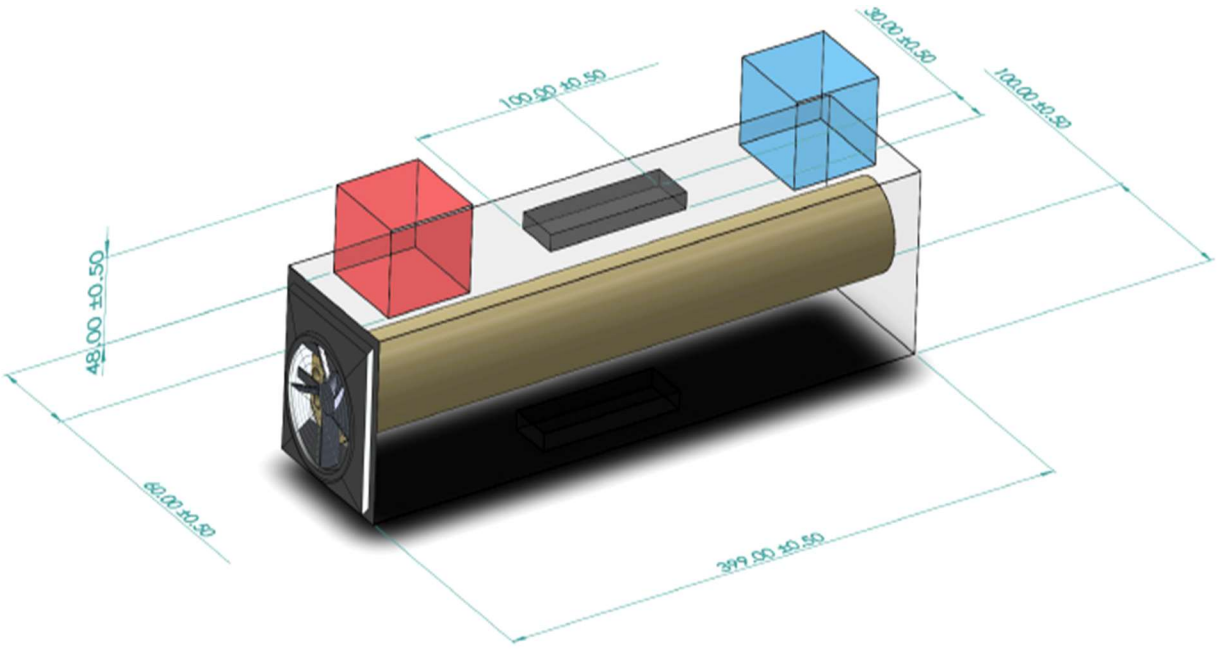
Outcome of the project

1. Designed and fabricated a portable magnetic refrigerator that runs using materials that exhibit magneto-caloric effect.

2. A platform to test magneto-caloric effect of various materials.

3. Can be used for comparative studies for regenerator geometries and magneto-caloric materials.

Design of the refrigeration unit



The figure above depicts the exploded 3 dimensional view of the unit.

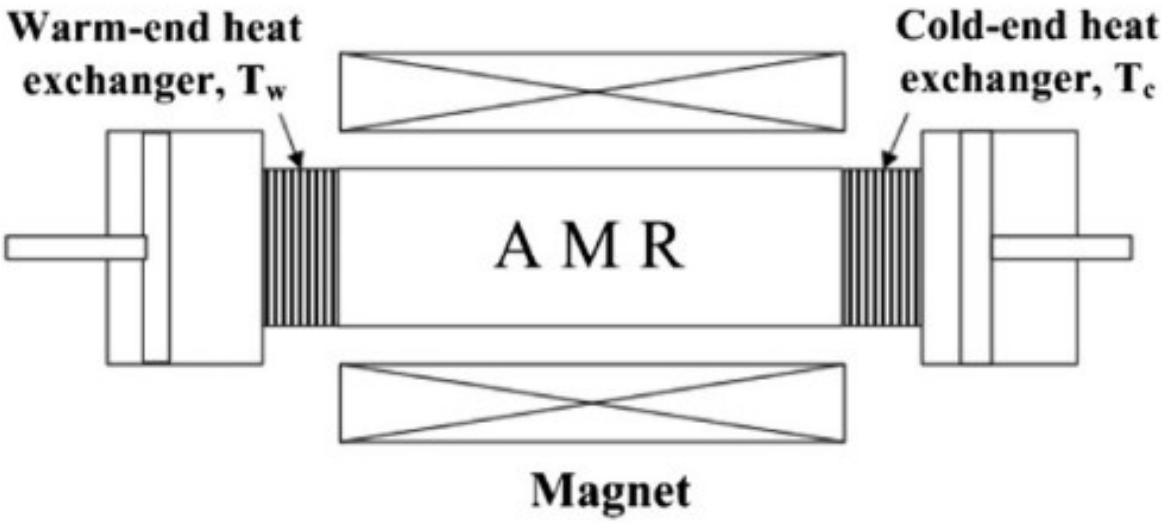
Working of magnetic refrigerator

Once the material has been heated up by the applied magnetic field the water from the cold-end reservoir is pumped and passed through the active magnetic regenerator which in turn heats up the water and the heated water is collected at the hot-end reservoir provided at the other end, and the hot water is cooled using a fan provided. The same water from the hot-end reservoir is pumped back to cold end side once the material has demagnetized which results in the lowering of temperature of the water collected at the-cold end side.

The reduction in temperature of water from ambient/initial temperature after collecting the water back at cold-end side would be same as the temperature rise in water that had occurred during the initial pass from cold-end to hot end when the material was magnetized.

The temperature of water collected at cold can be measured and can be subjected to multiple pass through the active magnetic regenerator to obtain the required reduction in temperature.

This cold water can be then passed to the refrigeration compartment through evaporator coil which would absorb the heat and this heated up liquid can be passed back to the magnetic refrigeration unit and then subsequently cooled and then supplied back. And the cycle continues.


Warm-end heat exchanger, T_w
Cold-end heat exchanger, T_c
A M R
Magnet

COMPONENTS USED FOR THE CONSTRUCTION

COMPONENTS	*QUANTITY*
Active magnetic regenerator	1
Electromagnets	2
Hot-end heat exchanger and cold-end heat exchanger	1 EACH
Water pump	2
Fan similar arrangement at hot end	1
Temperature sensors	1

MAGNETO-CALORIC MATERIAL USED

Gadolinium

Gadolinium is one among the rare earth material with atomic number 64 capable of exhibiting magneto caloric effect.

Its appears like a silvery white material when the oxidized layer is removed from its surface. It's not available in its pure state naturally, however it is obtained as gadolinium oxide from the nature and further necessary processes are carried out to obtain pure gadolinium.

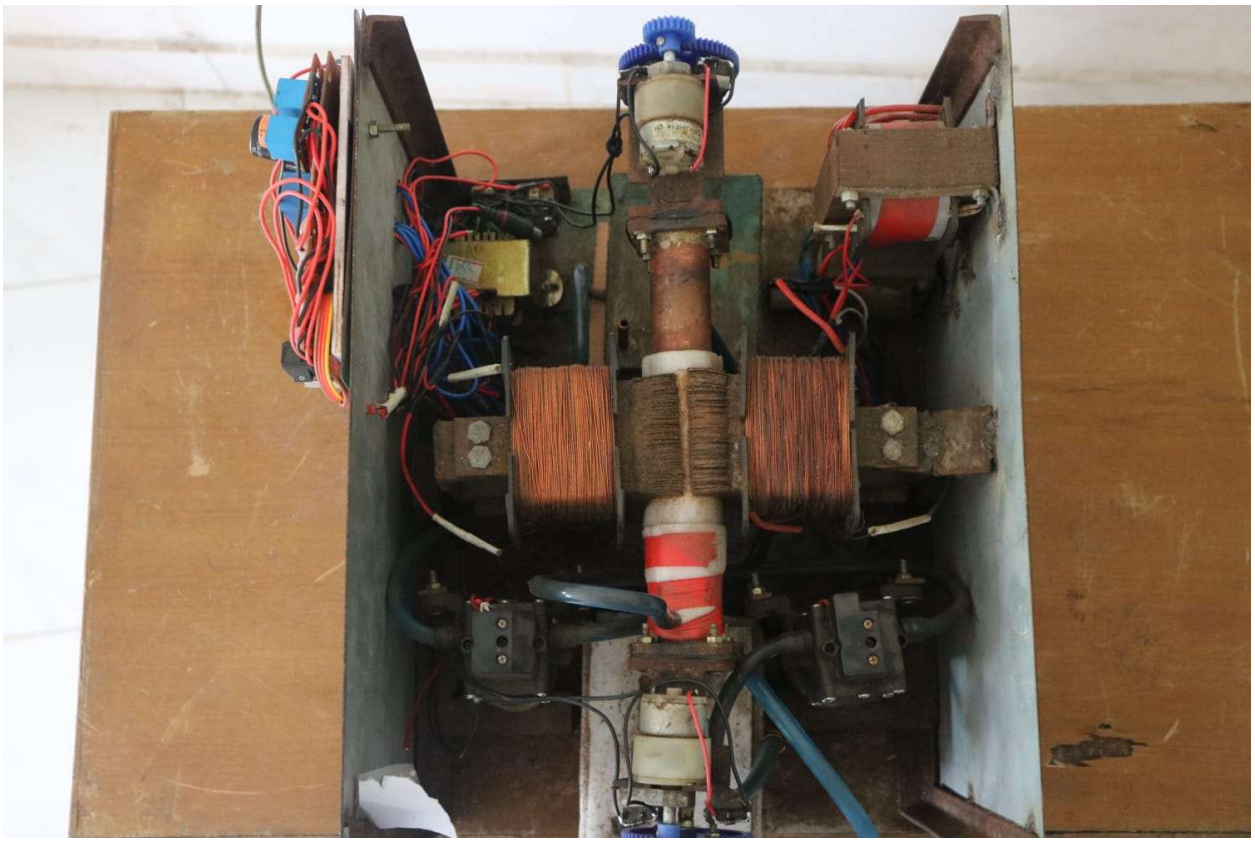
We had chosen gadolinium because it was comparably easy to acquire and even though its costly, it was cheaper among the available materials.

MATERIAL CONSTRAIN

Due to high cost of acquiring pure gadolinium in smaller quantity the use of material was limited thus the temperature reduction obtained was within the range of 3-3.5 degrees, temperature reduction can be further obtained by the usage of more gadolinium.

Temperature reduction on a further scale can be achieved by using other magneto caloric-effect or working on the material side.

Pictures



CONCLUSION

This opportunity provided by ISHRAE is very much helpful for students for converting their ideas into reality. Such students research grant opportunities encourage students to to think outside their syllabus in developing newer innovative ideas.

Once again we thank ISHRAE for this excellent opportunity which would definitely help us in our future

Video link

https://drive.google.com/file/d/1bq61cMXnWmLKObBFiCXhvHTtPssiGbVJ/view?usp=sharing

Expenditure

1. Material (gadolinium) -- 10500
2. Fabrication --25000
3. Electronic components and programing --13000
4. Transport -4000

Total expense -- 52500

THANK YOU