STUDY ON MAGNETIC REFRIGERATION SYSTEM AS AN ALTERNATIVE TO CONVENTIONAL REFRIGERATION SYSTEM

Kaushal Tare¹

¹(Department Mechanical Engineering, V.C.E.T Vasai, kaushal.tare@gmail.com)

Abstract—Taking into consideration the degradation of environment and the increasing power consumption of the conventional refrigeration systems we intended to discuss the colossal project which is indeed the need of an hour and a disguised boon to the cosmos. Curtaining off to the exemplary invention, a next stage to the sterling refrigeration technology- MAGNETIC REFRIGERATION. In this study light will be shed on new refrigeration technology, Magnetic Refrigeration based on the unique property Magneto-Caloric Effect (MCE) which has become a promising competitive technology for the conventional gas-compression/expansion technique that contributed climate change and empowered negative environmental effect due to increasing energy consumption.

Keywords—Magneto Caloric Effect, Magnetic Refrigeration, Gadolinium, Ozone Layer, Power Consumption

1. INTRODUCTION

The conventional refrigeration system is based on the vapour compression cycle. In vapour compression cycle a lot of work is done on the system by means of compression of the working fluid. Thus the compressor consumes ample of power supply. In this system the use of Compressor is totally neglected. Also, the refrigerant used in convention refrigeration system are gases like CFC’s, HFC’s etc. which are having a hazardous effect on the environment contributing to ozone layer depletion. The new alternative claims to design a eco-friendly refrigeration system which would serve the purpose without affecting the environment.

Magnetic refrigeration is a method of refrigeration based on the magnetocaloric effect. This effect, discovered in 1881, is defined as the response of a solid to an applied magnetic field which is apparent as a change in its temperature. This effect is obeyed by all transition metals and lanthanide-series elements. At curie temperature, the dipole moment of the magnetic substances get aligned, and in this process they dissipate heat. The Curie temperatures of various lanthanide elements and their alloys have yielded MCEs across a broad range of temperatures between ~0 - 300 K. When a magnetic field is applied, these metals, known as Ferro magnets, tend to heat up. As heat is applied, the magnetic moments align. When the field is removed, the ferromagnet cools down as the magnetic moments become randomly oriented. Gadolinium, a rare-earth metal, exhibits one of the largest known magnetocaloric effects. It was used as the refrigerant for many of the early magnetic refrigeration designs. Gadolinium is one such element which shows MCE at room temperature.

It is a physical process that exploits the magnetic properties of certain solid materials to produce refrigeration. At the same time; it does not emit any CFC or HCFC compounds, hence it never affects our environment specially ozone layer. Also, due to absence of compressor there are no reciprocating parts, hence, the process is noise free and damping is also not needed as there is no unbalance created. The feather in the cap is that “Magnetic Refrigeration” technique considerably reduces the power consumption. Also, the system would be maintenance free.

2. DETAILS EXPERIMENTAL

2.1 Materials and Procedures

Curie temperature is the temperature at which the magnetic properties of material changes. Very few elements have curie temperature at around room temperature. Gadolinium is one such example. When gadolinium is subjected to a strong magnetic field its atomic dipoles get arranged in one particular direction and thus become aligned. In this process heat is liberated to surrounding. After removal magnetic field the atomic dipoles again get randomly oriented and in this process they absorb heat from surrounding thus cooling it. This principle is known as “Magneto Caloric Effect” and can thus be used for refrigeration. Thus Magneto Caloric Effect serves as the base for Magnetic Refrigeration. A lot of research on this technique has resulted into fabrication of
alloy of Gd Si and Ge giving the satisfactory results of temperature difference when used in Magnetic Refrigeration system.

2.2 Gadolinium

Gadolinium is one such magnetic solid which has curie temperature at around room temperature. Alloys of gadolinium produce 3 to 4K per tesla of change in magnetic field, hence used for magnetic refrigeration or power generation purposes.

![Magnetic Material](image1)

![Fig.2. Basic Principle of Working](image2)

2.3 Magnet

In order to get reasonable cooling effect very strong magnetic field is required. Such field can be obtained using electromagnet or neodymium magnets which are strongest available permanent magnets. Element Material: Neodymium, Atomic number: 60 Phase: Solid, Melting Point: 1297 K, Thermal conductivity: 16.5 W/(m-K), Grade: N52, Dimensions: 50mm*50mm*25mm.

![Fig.3. Neodymium Magnet](image3)

![Fig.4. Magnetic Field Visualization](image4)

When two such magnets are kept facing each other with faces having opposite polarities, a very high magnetic field is generated between which is close to 10000gauss. Such high magnitude is enough to produce 2 to 3 degree Kelvin cooling effect.

3. RESULTS AND DISCUSSION

From the above discussions we can conclude that, higher the order of magnetic field generated coupled with use of new fabricated alloys of Gd in laboratories greater will be the cooling effect produced. It is by use of this technique that temperatures of order of 0K have been reached. Though magnetic refrigeration is used for cryogenic applications, we should intend to apply this knowledge in creating a refrigeration system which could serve better for domestic purpose. Besides these the other applications in which magnetic refrigeration system would find space would involve industrial storage of food, replacing air conditioning system in locomotives. It may also find applications of cooling in a noiseless environment. This system would also prove efficient in medical refrigeration like in storage of blood plasma, chromatography and other laboratory refrigerators. Cooling of electronics by the magnetic refrigeration technology may be provided by eg. central cooling systems and not by local devices.

4. CONCLUSIONS

1. Power consumption reduces by 30-40%.
3. The important aspect is that the setup avoids use of harmful refrigerants like CFC’s, HCFC’s, and Freon thereby being environmental friendly by avoiding depletion of ozone layer.

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REFERENCES