REFRIGERANTLESS REFRIGERATION

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AFFILIATION:

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ABSTRACT:

The aim of this presentation is to bring an innovative mode of refrigeration onboard. By using the **"PELTIER EFFECT"** we can reduce the risk of operation in this. A simple thermocouple module is used to cool liquid in compartment. When DC current is supplied, on one side of the module gives the cooling effect then the other side heat is generated. In hot side an exhaust type fan with heat sink is placed to remove the heat continuously. Then the amount of temperature difference is varied according to the current supplied. Then the system can be controlled by varying current supply. This method is "ECO FRIENDLY" because no refrigeration gas or compressor used in this method. Then the cost of refrigerator is less than the compressor refrigerator. This Peltier module consists of a semiconductor. In this semi conductor it forms p-n and n-p junctions. Each junction has thermal contact with heat sinks. When switching on the current of the defined polarity, there forms a temperature difference between the heat sinks: one of them warms up and works as heat sink, the other works as a cooler. By using this

"REFRIGERANTLESS REFRIGERATION" method we could reduce the pollution, cost of the device compared to other device. It could be made more compact and maintenance is less required. In this device electrical components are only required to be given care.

KEYWORDS:

1. PELTIER EFFECT
2. THERMOCOUPLE
3. REFRIGERATION
4. TON OF REFRIGERATION

CONTENT

- OUTPUT CALCULATION
- CONCLUSION

INTRODUCTION:

The aim of this presentation is to reduce the risk of operation of refrigerator work onboard. By using the “COMPRESSORLESS REFRIGERATOR” method working on the principle of “PELTIER EFFECT” we can reduce the risk of operation in this a simple thermocouple module is used to cool liquid in compartment. This method is “ECO FRIENDLY” because no refrigeration gas or compressor is used in this method. The cost of such a refrigerator is less than the compressor refrigerator.

BASIC PRINCIPLE:

The basic principle of “Compressorless Refrigerator” is “Peltier Effect”. This Peltier Effect was named after a French watchmaker Jean Charles Athanase Peltier (1785-1845), who discovered it in 1834.The Peltier Effect takes place when an electrical current is sent through two dissimilar materials that have been connected to one another at two junctions. One junction between the two materials is made to become warm while the other becomes cool, in what amounts to an electric current is given.

EXISTING SYSTEM:

In a conventional refrigeration system, the main working parts are evaporator, condenser and compressor. The evaporator surface is where the liquid refrigerant boils, changes to vapor, and absorbs heat energy. The compressor circulates the refrigerant and applies enough pressure to increase the temperature of the refrigerant above ambient level. The condenser helps discharge the absorbed heat to the surroundings.

PROPOSED SYSTEM:

The main working parts in a thermo electric refrigeration system are a cold junction, a heat sink and AC/DC power supply. Two dissimilar conductors replace the refrigerant. The cold sink (evaporator surface) becomes cold through absorption of energy by the electrons as they pass from semiconductor to another, instead of energy absorption

by the refrigerant as it changes from liquid to vapor. The AC/DC power source pumps the electrons from one semiconductor to another, and the heat sink (condenser) discharges the accumulated heat energy from the system. Therefore, the thermoelectric cooling system refrigerates without refrigerant and without the use of mechanical devices.

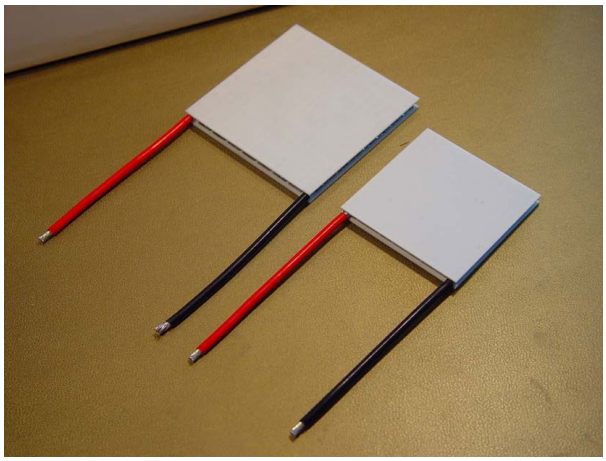
COMPONENTS REQUIRED:

- Thermoelectric Module
- SMPS
- Heat Sink
- Cooling Fan

THERMOELECTRIC MODULE:

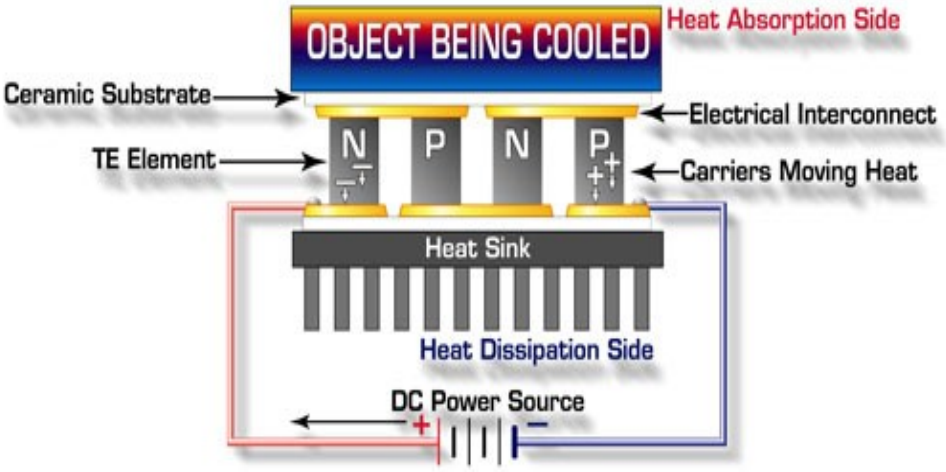
A Semiconductor-based electronic component that functions as a small heat pump. By applying a low voltage DC power source to a TE module, heat will be moved through the module from one side to the other. Therefore, one side will be cooled while the opposite side will be heated. Consequently, a TE module can be used for both heating and cooling.

Thermoelectric modules are solid-state heat pumps that operate on the peltier effect. A thermoelectric module consists of an array of p- and n-type semiconductor elements are heavily doped with electrical carriers. The elements are arranged into array that is electrically connected in series but thermally connected in parallel. This array is then affixed to two ceramic substrates, one on each side of the elements. Let's examine how the heat transfer occurs as electrons flow through one pair of p- and n- type elements within the thermocouple module.



The p-type semiconductor is doped with certain atoms that have fewer electrons that necessary to complete the atomic bonds within the crystal lattice. When a voltage is applied, there is a tendency for conduction electrons to complete the atomic bonds. When conduction electrons do this, they leave “holes” which essentially are atoms within the crystal lattice that now have local positive charges. Electrons are then continually dropping in and being bumped out of the holes and moving on to the next available hole. In effect, it is the holes that are acting as the electrical carries.

Now, electrons move much more easily in the copper conductors but no so easily in the semiconductors. When electrons leave the p-type and enter into the copper on the cold side, holes are created in the p-type as the electrons jump out to a higher energy level to match the energy level of the electrons already moving in the copper. The extra energy to create these holes comes by absorbing heat. Meanwhile, the newly created holes travel downwards to the copper on the hot side. Electrons from the hot side copper move into the p-type and drop into the holes, releasing the excess energy in the form of heat. **THERMOELECTRIC MODULE**



The n-type semiconductor is doped with atoms that provide more electrons than necessary to complete the atomic bonds within the crystal lattice. **WORKING OF THERMOELECTRIC COUPLE**

When a voltage is applied, these extra electrons are easily moved into the conduction band. However, additional energy is required to get the n-type electron to match the energy level of the incoming electrons from the cold copper. The extra energy comes by absorbing heat. Finally, when the electrons leave the hot side of the n-type, they once again can move freely in the copper. They drop down to lower energy level, and release heat in the process.

The main point is that heat is always absorbed at the cold side of the n-type and p-type elements, and heat is always released at the hot side of the thermoelectric element. The heat pumping capacity of the body is proportional to the current and is dependent on the element geometry, number of couples and material properties.

Switched-Mode Power Supply (SMPS):

A switched-mode power supply (switching-mode power supply, SMPS, or simply switcher) is an electronic power supply that incorporates a switching regulator in order to be highly efficient in the conversion of electrical power. Like other types of power supplies, an SMPS transfer's power from a source like the electrical power grid to a load (e.g., a personal computer) while converting voltage and current characteristics. An SMPS is usually employed to efficiently provide a regulated output voltage, typically at a level different from the input voltage. Unlike a linear power supply, the pass

transistor of a switching mode supply switches very quickly (typically between 50 kHz and 1 MHz) between full-on and full-off states, which minimizes wasted energy. Voltage regulation is provided by varying the ratio of on to off time. In contrast, a linear power supply must dissipate the excess voltage to regulate the output. This higher efficiency is the chief advantage of a switched-mode power supply.

Switching regulators are used as replacements for the linear regulators when higher efficiency, smaller size or lighter weights are required. They are, however, more complicated, their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor. This SMPS help us to regulate the 230volts of a/c to the voltage of our desire.

HEAT SINK/COLD SINK:

A Heat Sink/Cold Sink is a term for a component or assembly that transfers heat/cold generated within a solid material to a fluid medium, such as air or a liquid. The heat sink is attached to the hot side of the module to the ambient. A cold sink is attached to the cold of module. It is used to facilitate heat transfer from whatever being cooled to the cold side of the module. The most commonly used heat sink/cold sink is the aluminum plate that has fins attached to them. A fan is to remove the ambient air through the heat sink to remove heat from the module

COOLING FAN:

A fan is a device used to create a flow of air. A fan consists of vanes or blades which act on the air. Usually it contained within some forms of housing or case. Fan produces air flows with high volume and low pressure; it is just the opposite of compressors which produce high pressures at a comparatively low volume. In this system we are using fan to remove the heat produced at the hot side of the module. This is the only moving part present in the device.

DISADVANTAGES OF CONVENTIONAL REFRIGERATION:

- It handles refrigerants which are ozone depleting gases.
- They need more space.
- Compressor is a wear part.

- Conventional compressors are very costly and need higher maintenance cost.
- The piping system of the compressor is subject to leak if not well maintained.

ADVANTAGES OF PROPOSED SYSTEM:

- Thermoelectric refrigerators are more environmentally friendly because they do not use ozone depleting gas.
- Thermoelectric coolers solid state design allows them to take up less floor space and they are light weight.
- Lesser maintenance.
- Thermoelectric coolers have high reliability with test showing lives greater than 200,000 hours (almost 23 years).
- No complicated piping system is required.
- No moving parts to wear.

OUTPUT:

A project done on the proposed system yielded the results as follows:

Quantity of water used	: 150ml
Initial Temperature of water	: 34°C
Voltage Supplied	: 12v dc
Maximum ampere	: 10amp
Final Temperature of water	: 18°C
Time taken for cooling	: 8 min

CALCULATION:

COP_{actual} = Heat Removed / Work Done

Heat Removed (Q) = $M_{water} \times Cp_{water} \times \Delta T$ in KJ

Mass of water (M_{water}) = 150ml = 0.15Kg/sec

Specific Heat Capacity of water (Cp) = 4.18KJ/Kg

Work Done = V×I in Watts

$\Delta T = T_{initial} - T_{final} =$ 307-291 = 16k

Q = 0.15×4.18×16 = 10.032KJ

Voltage (v) = 12v; Current (I) = 10amp

Work Done = 12×10 = 120W = 432KJ/hr = 0.12KJ/sec

COP_{actual} = 10.032 / 0.12 = 83.6

CONCLUSION:

Hence this system can be used onboard ships instead of conventional refrigeration systems in which compressors are used. This can revolutionize the concept of refrigeration in ships. Refrigeration could be done at a lower cost and with lower use of electricity.

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