

Peltier based Ice Maker

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Abstract: -

The Portable Ice Maker system is based on Peltier module and its effect. The Peltier or thermoelectric cooler (TEC), can be used either for heating or for cooling application. As it works on principle of thermodynamics the module itself can be used as a generator or as a source of thermal dissipater of heat and cold. The system consist of two Peltiers (12V- 6A). The Peltier causing temperature difference at two different junction, the hot junction temperature is reduced by water cooling due to this the temperature at opposite cold junction drops drastically at lower degree's to form ice cube's. The container holding water to form ice at cold junction is built from pure aluminum to obtain maximum results. The key components of Portable Ice Maker is housed in an enclosed insulated cabinet to achieve maximum efficiency. The thermoelectric cooling of Peltier module features longevity with less maintenance due to its solid state design. The advantage of Peltier technology is that it is location independent, vibration free as well as its operation is noise less as compared to conventional compressor which contains harmful gases which are harmful to environment. The Ice Maker machine is a light weight, compact and rigid.

Keywords: Ice maker, Peltier effect, seebeck effect, thermoelectric module.

1. INTRODUCTION

Now days mostly refrigerating and air conditioning devices uses refrigerants such as R-22, R-134a etc.

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These refrigerants produce very hazardous effects on environment. Due to leakage of these gases ozone layer depletion, global is warming such environmental problems going to increase. Also the cost of these gases is relatively high. So we are going to produce refrigeration effect without these gases i.e. by using Peltier effect. The reverse of the Seebeck effect is also possible: by passing a current through two junctions, you can create a temperature difference. This process was discovered in 1834 by scientist named Peltier, and thus it is called the Peltier effect. This may sound similar to Joule heating described above, but in fact it is not. In Joule heating the current is only increasing the temperature in the material in which it flows. In Peltier effect devices, a temperature difference is created: one junction becomes cooler and one junction becomes hotter.[6] Although Peltier coolers are not as efficient as some other types of cooling devices, they are accurate, easy to control, and easy to adjust. Peltier effect devices are used coolers for microelectronic devices such as microcontrollers and computer CPUs. This use is very common among computer hobbyists to help them in over-clocking the microprocessors for more speed without causing the CPU to overheat and break in the process.[3] A single Peltier element can be used to produce electrical power (via the Seebeck effect) or to pump heat (via the Peltier effect). In either application, the

power output of a single Peltier element is generally not sufficient for realistic situations. To increase their power, commercial Peltier devices are composed of many n-type and p-type semiconductor Peltier elements. The individual elements are connected in series using metallic junctions. As a result of this, the junctions between the semiconductors do not form a barrier potential, as they would do in a p-n diode, and charge carriers flow freely in both directions. In a Peltier device, the individual elements are arranged so that the n- and p-type heat flow in the same direction.[1] From above we have concluded that it is possible to create system using Peltier effect for making ice with minimum time.[5]

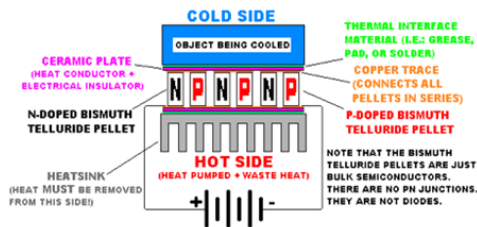


Fig. 1: Peltier Effect

2. Working of block diagram-

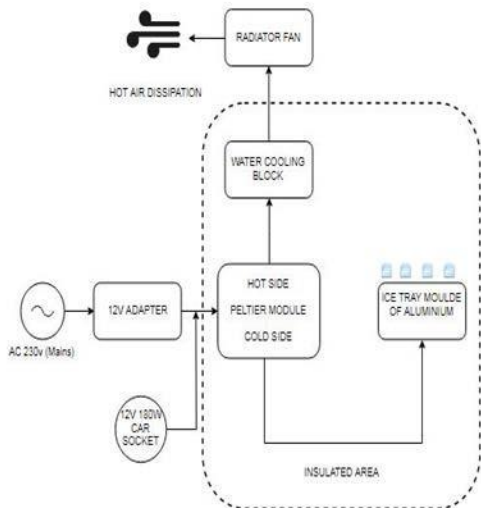


Fig. 2: Block Diagram of Portable Ice Maker
 The key components used in Portable Ice Maker are as follows:

- Peltier Module
- Water Cooling Unit
- Radiator Fan
- Power Supply Unit
- Aluminum Module (Ice Tray)

2.1 PELTIER MODULE- The thermoelectric coolers work on the peltier effect. The module has two sides when a DC electric current passes through device one side gets hot whereas the other gets cold by using appropriate way to dissipate out the heat, cold side goes below the room temperature. Depending on the required area number of peltiers can be added or removed.

2.2 WATER COOLING UNIT- To dissipate out the heat of peltier we are using water cooling technique. It consist of a Radiator fan, Water pump and Coupling Aluminum Block. The peltier hot side is coupled with aluminum block which runs coolant through radiator driven by water pump and a fan is mounted over the radiator to dissipate heat.

2.3 RADIATOR FAN- The cooling fan consist of Aluminum Heat sink attached to blower fan. This unit is mounted over the cold side of peltier module, as the heat is dissipated through the hot junction the condensation process is started at aluminum heat sink which is attached to the cold side of peltier module. By using a blower fan the condensed air is blown to the projected area.

2.4 POWER SUPPLY UNIT- The power supply unit consists of a 12V adapter which helps in converting a 230V AC signal to 12V DC signal. An arrangement of a car socket is made for using this module in cars, bikes etc.

3. DESIGNING & IMPLEMENTATION

By building compression free platform with the help of peltier module which is cost-effective and opening a wide area o portability to portable ice-maker.

The core of our system lies on peltier module which coupled to aluminum mold of length consisting of 15 cm, width 7cm and height 3 cm which can create

eight solid ice cubes. This whole area is insulated with an insulating material box which does not allow to leak the cold air out of it.[2]

The water cooling block coupled to hot side of peltier draws all the heat from it and constant water flow ensuring that no heat is occurred at one area. The heat from water/coolant is exhausted out from radiator fan setup. This allows minimum temperature at opposite side which helps rapid cooling of water to form ice cubes. Design of this whole system is an approach to flexibility, portability and low cost with negligible maintenance.



Fig. 3: Prototype Model

By building small prototype we have created a single

ice cube with a temperature of -7°C in Figure 3.

4. CONCLUSION

The Peltier module used is TEC1-12706. From Figure 4 graph we can state that by using normal technique of heat dissipation from aluminum heat sink where room temperature is 30°C . The temperature drop was slow in which the system was drawing 3.20A at 30°C and at 9°C it was drawing 2.99A.

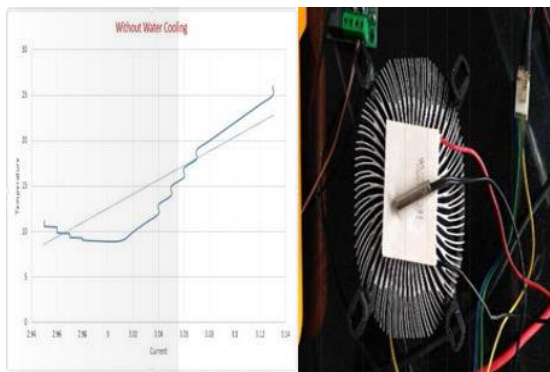


Figure 4: Graph Without Water Cooling

From Figure 5 graph by using water cooling technique the results were exceptional at room temperature of 30°C starting with 3.50A of current attained was -6°C at a current draw of 3.25A.

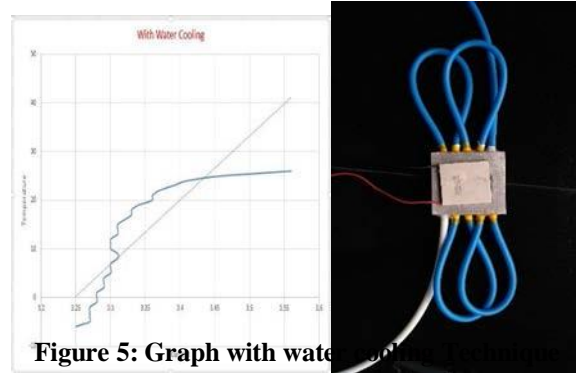


Figure 5: Graph with water cooling

By Comparing both the results we came into conclusion that the water cooling technique is best and suitable technique as it gives optimum efficiency of the peltier module. By harnessing the water cooling technique with peltier module we have developed a unibody structure of a Portable ICE Maker which can create eight solid ice cubes. If the purity of the semiconductor of the metal inside peltier is at purest form it will result in a higher efficiency than the market Peltier device. The Figure 6 shows the final product of Ice Maker where we can make 8 cubes of Ice in one go and it takes around 35 mins to get the Final product.



Figure 6: Ice Maker Unit

5. FUTURE SCOPE

As low efficiency of Peltier it cannot be a total replacement of compressor but it is a viable solution for applications as a spot cooling of electronic components, cold water dispenser units, soda machines, portable refrigeration. However, they require some modifications related to their size and application but their cheap, eco-friendly to nature, no cause to global warming are enough inputs to motivate the engineers for their implementations in almost all the suitable applications of daily life in near future.

6. APPLICATIONS

- In pharmaceutical industries, refrigeration is needed and to control many types of chemical reactions.
- In the medical sector, ice maker based refrigeration is used while transporting vaccine, organs and stem cells from one place to another.
- Outdoor kitchen is a remarkable place to have a portable ice maker.

7. REFERENCES

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