ICE-MAKING MACHINE ON THE PRINCIPLE OF PELTIER EFFECT

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ABSTRACT

Now days use of refrigeration unit by using refrigerants increases rapidly. But using these units ozone layer depletion problems also increases. So it is necessary to overcome this problem. Therefore our aim is to design and manufacture the refrigeration unit without use of any refrigerants. So we are going to manufacturing a compact thermoelectric based refrigeration system, which is portable and eco-friendly.

Although there are a variety of applications that use thermoelectric devices, all of them are based on the thermoelectric principle. When designing a thermoelectric application, it is important that all of the relevant electrical and thermal parameters be incorporated into the design process. Once these factors are considered, a suitable thermoelectric device can be selected based on the guidelines presented in this article. We have studied the ice cube production in function of the thermal resistance of the hot side heat dissipater and the voltage supplied to the Peltier module, using a computational model and experimental data.

Keyword: Peltier Module, Refrigerants, Refrigeration System, Thermoelectric Principle, Voltage

I INTRODUCTION

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

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.

From above we have concluded that it is possible to create system using Peltier effect for making ice with minimum time.

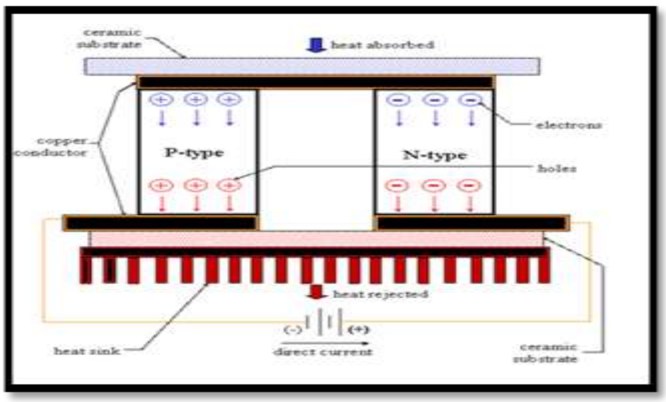

Fig. 1: Peltier Effect

II OUTLINE OF PROPOSED WORK

2.1 Scope

The scope for this study would focus all necessary activities for benchmarking the existing application with the current performance level and performance standards to be set for arriving at the objectives of the dissertation work. Recommendation of best alternative use for refrigerant refrigeration systems.

2.2 Methodology

2.2.1 Objectives

1. To design the system.
2. To select material as per design.
3. To analyze the efficiency and power consumption of system theoretically.
4. To make assemble the system practically as shown in Fig.2.
5. To find out what is actual time for making ice in our system.

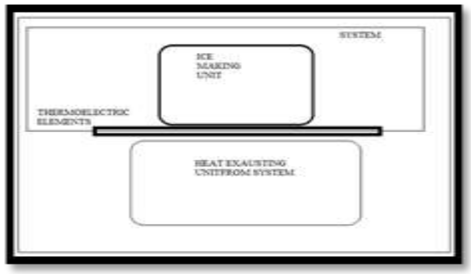

Fig. 2: Proposed experimental setup

2.3 Thermoelectric Principle of Operation

The typical thermoelectric module is manufactured using two thin ceramic wafers with a series of P and N doped bismuth-telluride semiconductor material sandwiched between them as shown in Figure (2.3.1). The ceramic material on both sides of the thermoelectric adds rigidity and the necessary electrical insulation. The N type material has an excess of electrons, while the P type material has a deficit of electrons. One P and one N make up a couple, as shown in Figure (2.3.2). The thermoelectric couples are electrically in series and thermally in parallel. A thermoelectric module can contain one to several hundred couples.

As the electrons move from the P type material to the N type material through an electrical connector, the electrons jump to a higher energy state absorbing thermal energy (cold side). Continuing through the lattice of material; the electrons flow from the N type material to the P type material through an electrical connector dropping to a lower energy state and releasing energy as heat to the heat sink (hot side). Thermoelectric can be used to heat and to cool, depending on the direction of the current. In an application requiring both heating and cooling, the design should focus on the cooling mode. Using a thermoelectric in the heating mode is very efficient because all the internal heating (Joulian heat) and the load from the cold side is pumped to the hot side. This reduces the power needed to achieve the desired heating.

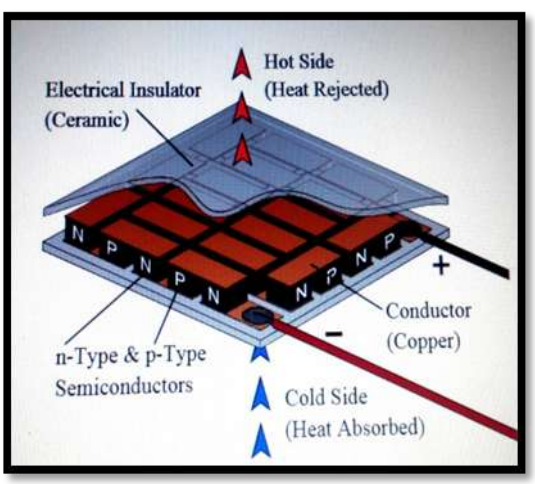

Fig. 2.3.1: TEC Principle of operation

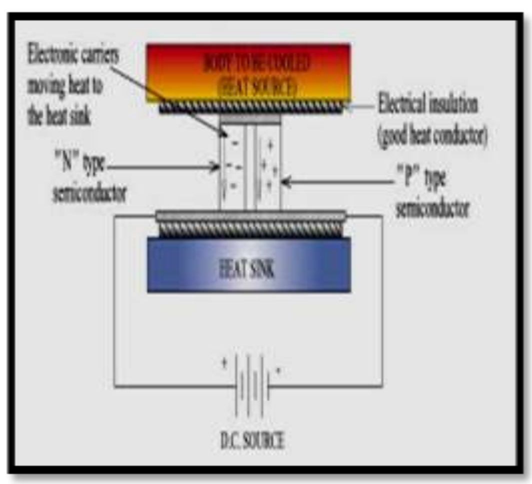

Fig. 2.3.2: Cross section of a thermoelectric cooler

III DESIGN AND DEVELOPMENT OF SYSTEM

According to specification of TEC1-12706 from Hebei I.T. (Shanghai) Co., Ltd.

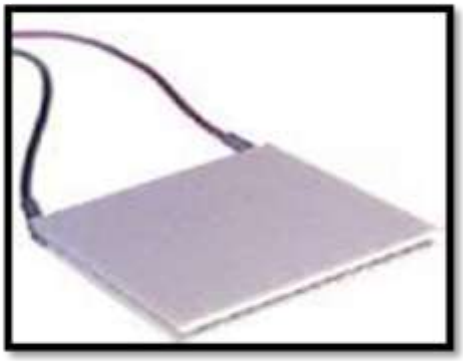

Fig (3.1):- Peltier Element

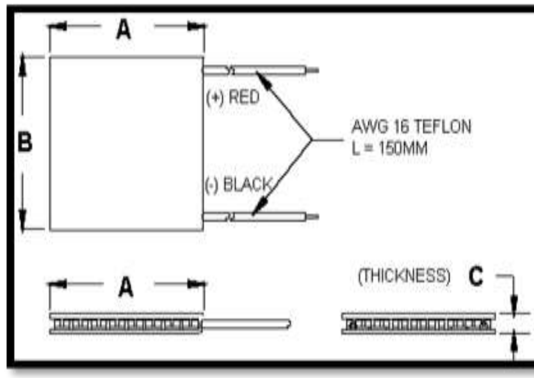

Fig (3.2):- Peltier Dimensions

Ceramic Material: Alumina (Al_2O_3)

Solder Construction: 138ºC, Bismuth Tin (BiSn)

3.1 Size table

Table 3.1

A	B	C
40	40	3.9

3.2 Performance Specifications

Table 3.2

Hot Side Temperature (ºC)	**25ºC**	**50ºC**
Qmax (Watts)	50	57
Delta Tmax (ºC)	66	75
Imax (Amps)	6.4	6.4
Vmax (Volts)	14.4	16.4
Module Resistance (Ohms)	1.98	2.30

3.3 Dimensions of copper cube used to make ice from water

L=30mm = 0.03m, W=30mm = 0.03m , H=10mm = 0.01m

Volume available for freezing = 30 × 30 ×10= 9000 mm^3 = 0.009 lit=$9\times10^{-6}m^3$

Area of freezing = 0.03× 0.03=0.0009m^2

Mass of Water= $\rho\times V=1000\times9\times10^{-6}m^3$=0.009Kg

3.4 Data

Mass of water=m= 0.009Kg

Specific heat of water=4.18 kJ/kg. K

Required Temperature difference from Performance curves.

We get ΔT (ºC) = 50^0C

Hot side Temperature of element= **50ºC**

Cold side Temperature of element = 1**0^0C**

Water Temperature = **30^0C**

3.4.1 Heat required removing from system

$Q = m\times C_p \times \Delta T$

Q = 0.009×4.18× (30-10)

Q =0.075kJ

Q=0.075/60=0.0012 kW

$Q = h\times A \times \Delta T$

h=0.069 kW/m^2K

3.4.2 How to find time required making ice?

Area of surface=30×30=900mm^2

Volume of copper cube = 9×10^{-6} m^3

1) Checking system is lumped accepted or not.

Now,

Biot no. = Bi = h× L_c /k

Where,

h= heat transfer coefficient = 0.069 kW/m^2K

L_c = Characteristic length =Volume/ Area =0.01 m.

K =Thermal conductivity = 0.7×10^{-2} kW/m. K

Bi = 0.099

Hence Biot no. is less than 0.1 hence lumped systems is accepted

Now, T=15ºC T(S) = 9ºC T (∞) = 30^0C

$$\frac{\theta}{\theta i} = \frac{T - T(\infty)}{T(S) - T(\infty)} = \exp(-Bi\ t)$$

From above equation we get time, t= 4.1min

IV CONCLUSION

The process of making ice on the principle of peltier effect is fully depend on the supplied current and voltage proportion. from that project we will concluded that it is possible to make ice without use of refrigerant that means by using peltier module with refrigeration unit and electrical circuit of proper current and voltage by absorbing heat from water at cold side and this heat is rejected by hot side in heat sink making ice at cold side (peltier module). Generally for making ice we must need refrigerant but this refrigerant produce very hazardous effects on environment. cost of this refrigerants are also high so we are going to produce refrigeration effect without these gases i.e. by using Peltier effect which is environment friendly and compact. It require less space and having effect of cooling rate is more as compare to other systems. For making ice it requires just four minutes and this is less time as compared to other system.

V ACKNOWLEDGMENT

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