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Experimental investigation on Medicine box using Peltier effect

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Abstract- *Peltier effect is used to distribute the conditioned air to an occupied space to improve comfort. It describes thermo-electric cooling or Peltier effect; it is designed specifically for medicine field. The design is motivated by the fact that Peltier elements can provide hot and cold flow on demand and they do not necessarily require moving parts. This can be factor for cost and weight reduction. To take the advantage of these features it propose the design of a medicine box cooling unit based on thermo-electric cooling elements and provide its analysis.*

Key words: *Peltier effect, semiconductor, medicine box, thermoelectric, seebeck effect.*

I. INTRODUCTION

This paper aims to demonstrate the developmental stages of the design of medicine box using peltier systems based on thermoelectric elements. A thermoelectric device generates a voltage when there is a temperature difference between its surfaces. Conversely, when a voltage is applied across the terminal of such a device, it creates a temperature difference between its surfaces. At the atomic scale, an applied temperature gradient causes charge carriers in the material to diffuse from the hot side to the cold side. The thermoelectric effect works on two different principles that are known as the “Seebeck Effect” and “Peltier Effect”.

Seebeck Effect: Thermoelectric Generators (TEG) devices are solid-state elements that function according to what is known in physics as the Seebeck effect. These devices generate electrical power when a temperature difference exists across its two sides. The power is generated by the heat flux across the module. Typical efficiencies of Seebeck elements range between 5%–8%. TEGs work on temperature differentials, and the greater difference between the hot side and the cold side, the bigger the amount of power that will be produced within the physical temperature limits. In use of such systems great effort must be placed on the heat management, especially heat removal design of the cold side. Given a constant hot side temperature, the effectiveness of the TEG construction in conducting heat from the hot side to cold side and dissipating this heat flux to the environment usually determines the net power generated. Peltier Effect: This effect is created by applying a voltage between two electrodes connected to a sample of semiconductor material with a resultant cooling of one side and heating of the other side. It is shown in Fig.1.

Thermoelectric Cooling (TEC) or the Peltier effect causes a temperature differential across the module heating one side and simultaneously cooling the other. Thermoelectric cooling was first discovered in 1834 by a scientist named Peltier, but its commercial potential was not realized until semiconductor production methods have been developed in the 20th Century. Peltier effect can be useful when it is necessary to transfer heat from one medium to another. During operation, DC current flows through the TEC to create heat transfer and a temperature differential across the ceramic surfaces, causing one side of the TEM to be cold, while the other side gets hot. A standard single-stage TEC can achieve temperature differentials of up to 70°C. However, modern semiconductor materials and manufacturing methods enable production of TEC elements exceeding this limitation.

TECs have several advantages over alternate cooling technologies. They do not necessarily require moving parts and are also very quiet. The solid state construction TECs results in high reliability in operation. TEMs can cool devices down to well below the ambient temperatures. Colder temperatures

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can be achieved, down to -100°C, by using a multistage thermoelectric cooler in a vacuum environment. Thermoelectric cooler consists of two elements of semiconductors, which are heavily doped to create either an excess number of electrons (n-type) or a deficient number of electrons (p-type) that are arranged on opposing sides. These opposite materials are placed on the cold and hot plates, along with conductive materials like copper

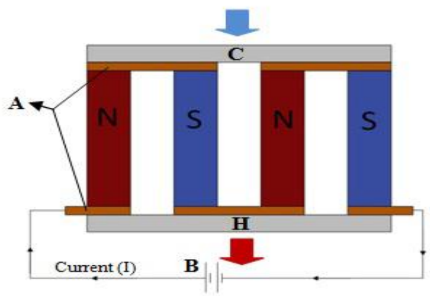

Fig.1 Peltier effect

A Conductive material.
B DC power source.
C Cold plate.
H Hot plate.
N N type semiconductor element.
S P type semiconductor element.

Components used:
Power Source
Transformer/Battery (12V)
Controlling Switch
Semiconductor
Heat Sink
Blower

II. EXPERIMENTATION

Thermoelectric cooling system uses the peltier effect to create a heat flux between the junctions of two different types of materials. A Peltier cooler, heater, or thermo electric heat pump is a solid-state active heat pump which transfers heat from one side of the device to the other, with consumption of electrical energy, depending on the direction of the current. Such an instrument is also called a Peltier device, Peltier heat pump, solid state refrigerator, or thermoelectric cooler (TEC). It can be used either for heating or for cooling, although in practice the main application is cooling. It can also be used as a temperature controller that either heats or cools. It is shown in Fig.2.

A Peltier cooler can also be used as a thermoelectric generator. When operated as a cooler, a voltage is applied across the device, and as a result, a difference in temperature will build up between the two sides. When operated as a generator, one side of the device is heated to a temperature greater than the other side, and as a result, a difference in voltage will build up between the two sides (the seebeck effect). However, a well-designed Peltier cooler will be a mediocre thermoelectric generator and vice versa, due to different design and packaging requirements. Fig.3 shows Peltier effect in series connection, when it gives more output.

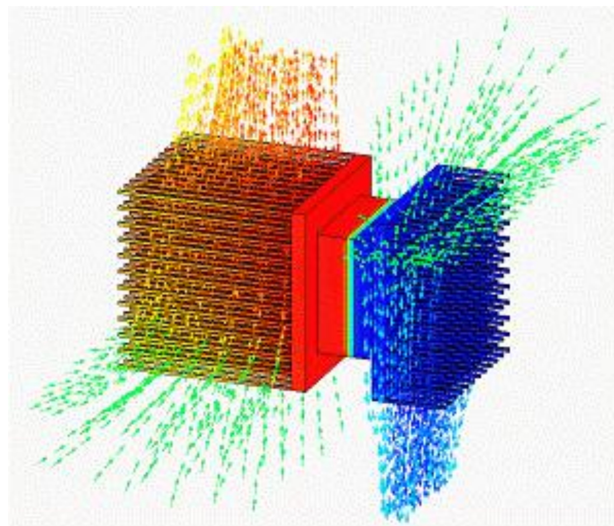

Fig.2 heat flux between the junctions

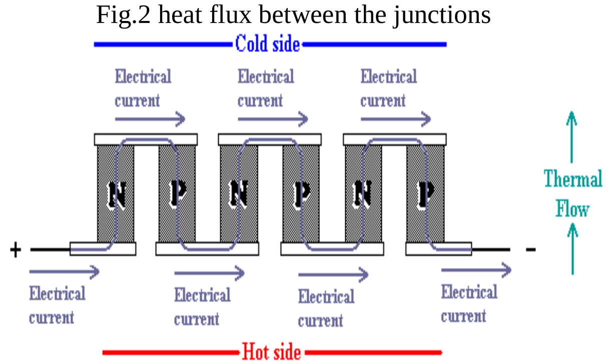

Fig.3 Peltier effect in series connection

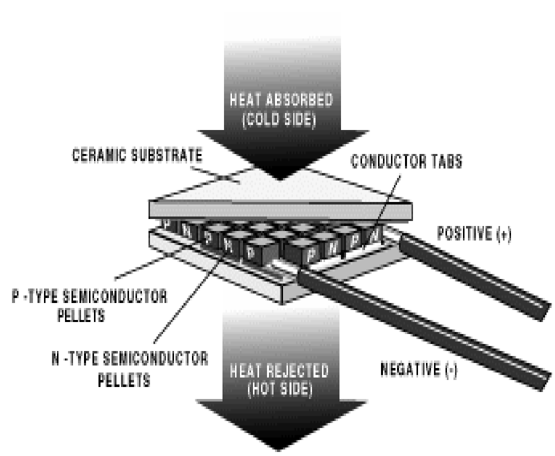

Fig.4 Seebeck effect

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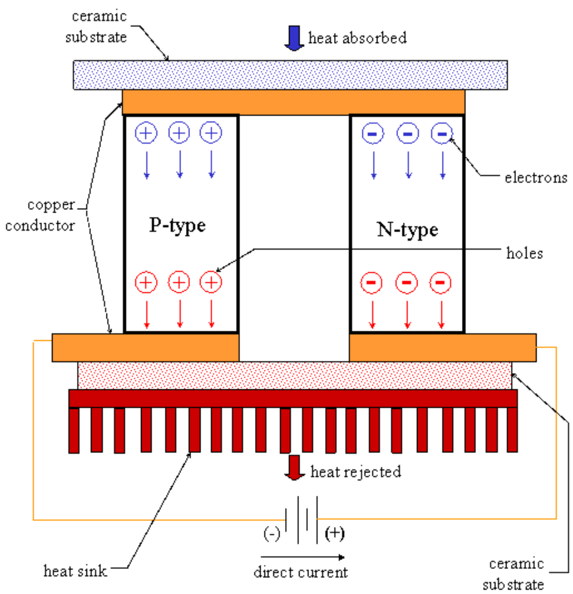

Fig.5 Thermo electric circuit

These devices generate electrical power when a temperature difference exists across its two sides.

III. DESIGN AND CALCULATIONS

In this section we provide the design of medicine box using thermo electric system utilizing Peltier elements. First thermodynamics calculations are presented the sizing computations are provided a commercially available TEC module is selected and its parameters were used for the design. Fig.4 shows Seebeck effect and Fig.5 shows Thermo electric circuit. Table.1 shows performance Specifications of TEC1-12730.

Table.1 Performance Specifications of TEC1-12730

Hot Side Temperature (°C)	25°C	50°c
Qmax (Watts)	257	282
Delta Tmax (°C)	68	79
Imax (Amps)	30.5	30.5
Vmax (Volts)	15.6	17.8
Module Resistance (Ohms)	0.27	0.31

Constant values

ρ_{air} = 1.164 kg/m^3 for atmospheric air

c_p = 1.005 kj/kg k of air

T_{hot} = 45°c for Tec12730

T_{cold} = -23°c for Tec12730

Area of peltier plate (A_p) = l×t

Where,
l = 0.06 m
t = 0.004 m
A_p = 0.6×0.004

A_p = 0.00024 m^2

Area of the box (A_r)= l×b

Where,
b = 0.135m
l = 0.255m
A_r = 0.255×0.135

A_r = 0.0034425 m^2

Volume of the room (V_r) = l×b×h

Where,
h = 0.165m
V_r = 0.255×0.135×0.165

V_r = 0,00568 m^3

Mass flow rate (m) = $\rho \times V_r$

Where,
ρ = 1.164 $kg/_{m^3}$

m = 1.164 × 0.00568
m = 0.00661 $kg/_s$

Heat absorbed by the cold side (Q_c)= $m_{c_p}\Delta t$

Specific heat of air (C_p)=1005 $j/_{kg\,k}$

Temperature difference (ΔT)=T_c - T_h

Temperature of cold side (T_c)=23°c

Temperature of hot side (T_h)=45°c

ΔT=45-23

ΔT=22°c

Q_c=0.00661×1005×22

Q_c=146.14watts

Amount of heat dissipated at the hot side Q_h=Q_c+P_e

Where, Q_c= 146.14 watt

Electrical power (P_e)= V×I

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Voltage(v)=12volts
Current (I)=5amps

P_e = 12×5

P_e=60 watts

Q_h=146.14+ 60

Q_h=206.14 watts

Co-efficient of performance

$$(COP)=\frac{\text{heat transfer from cold side}}{\text{electric power input}}$$

$$COP = \frac{146.14}{60}$$

COP = 2.436

Application

This type of thermo electric system are very useful due to their versatile characteristics as they can be used both for heating and cooling purposes as well as they completely utilize the waste heat which is being rejected at time of cooling of refrigerant.

IV. CONCLUSION

According to this experimental work is conclude that the following;

Peltier effect is incorporated in the medicine box instead of ice bag in thermo coal casing.

Peltier effect semiconductor model gives better required efficiency for the medicine box over the traditional method.

The life time of the cooling system is more by using Peltier effect over the ice bag. So the medicine is kept in safe as long time.

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