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DESIGN AND CONSTRUCTION OF A PORTABLE THERMOELECTRIC MEDICINE COOLER BOX

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Abstract- *Efficiency and strength of drug or medicine is critically depends on accurate storage at a right temperature. Drug has to be stored in an arid, dried place, avoiding the sunlight and moisture. A number of drugs require some different storage conditions such as in the cooler box or refrigerator. Here we design a portable and rechargeable thermoelectric medicine cooler box at a low cost .Our proposed thermoelectric medicine cooler box working like a refrigerator and it keeps the medicine at temperature about 8 °c-15°c for 10-12 hours. We use a peltier module that helps to get thermoelectric effect. In our system we apply both P and N-type semiconductor where heat is exit from negative terminal and released at positive terminal. Cu and Al alloy are use to construct as heat sink and A CPU cooling fan and Ice pack for cooling. A 12volt battery can also be use to powering up the thermoelectric medicine cooler box. A temperature meter is considered for measuring the temperature. As per our knowledge our prototype cooler box will be helpful for the person who wants to move with their medicine.*

Keywords: Medicine cooler Box, Drug efficiency, Peltier module and Thermoelectric.

1. INTRODUCTION

Medicine is the most essential tool for human health to control and prevent infection or treatment of various diseases as well as saving life. The effectiveness and potency of a medicine depends on how the medicines are manufactured, packaging and the most important is storage. Storage of medicines at a Suitable temperature is mandatory to assure their efficiency, power as well as physical properties. Generally medicines are needed to be keep in a dried place and in absence of heat, sunlight and moisture. Whereas a number of medicines need particular condition specially stored at a specific temperature like some are stored in the room temperature, a variety of drugs need very low temperature at 2-8°c like as refrigerator. Medicines can expire or deteriorate rapidly on improper storage. Due to improper storage medicine are decreasing their effectiveness and also produces poisonous substances. High or improper temperature and moisture are the most important factors involved in drug worsening. [1,2, 3]. Therefore medicine storage is highly regulated and vital issue. Different medication required different storage temperatures. The federal agency; FDA in United States department of health and human services recommend the following temperature categories:

1. Room Temperature 20-25°c(68-77°F)
2. Refrigeration means 2-8°c (36-46°F)

The following table shows the medicine storage condition on the label and their meaning:

Table 1: Medicine storage condition on the label and their meaning [2]

Sl. No.	Storage Condition	Temperature
1	Freezer	- 2° to -18°C
2	Deep freezer	Below -18°C
3	Cool place	Between 8° to 30°C
4	Cold place Do not freeze	Between 2° to 8°C (in the refrigerator, but not in the freezer compartment)
5	Dry place	Do not keep in a place with excess moisture (e.g. kitchen, bathroom). Keep in the original container
6	Away from light	Do not expose to light or sunlight

The World health organization and FDA approved the following storage conditions for various medicines.

Table 2: Types of Medicine and their required storage conditions [2]

Sl. No.	Type of Medicine	Storage condition
1	Tablet, Capsule	Temperature not exceeding 30°C
2	Creams	< 25°C unless specified, Do not freeze.
3	Oral powder	Protect from moisture
4	Ointment, Gel	< 30°C unless specified, Do not freeze.
5	Nasal powder	Protect from light & moisture
6	Oral liquid, Pessaries, Suppositories	Well closed contained
7	Insulin Preparation	Unless specific, store at 2° to 8°C, should not be frozen, protect from light.
8	Inhalations	Avoid extremes of temp & large variation in temperature

In 1951 an American scientist Richard C Laramy invented a cooler box and got successfully patented the idea of a "Portable chest", which is known as "cooler" in the USA, a"chilly bin" in New Zealand and an "esky" in Australia. Later his idea was used to the design an ice boxes for medical purposes. Traditional refrigerator that are currently use for medicine storage commercially consist of compressor, pump and condenser which consume a lot of energy as well as those are not echo friendly , costly and non- portable. The objectives of our research are to make a portable and rechargeable medicine cooler box by using thermoelectric effect instead of compressor or CFC gas at a low cost, maintain the efficacy of medicine during storage and travelling.
Our proposed model of a portable and rechargeable thermoelectric medicine cooler box will provide the storage environment for the drugs those are need to be transfer or carry during take a trip.

2. Methodology and Materials

In our proposed model we used the thermoelectric effects which reveal the existence of combination between electrical and thermal phenomenon. In thermoelectric effects electric voltage is created due to temperature difference on both side and reverse phenomenon is occur if voltage is applied on it. When the temperature gradient occurs that causes charge carries in the material to diffuse from the hot side to the cold side [4, 5]. The cooling system of our proposed cooler box model used thermoelectric devices as temperature controllers. The fundamental parts of a thermoelectric cooling system which are applicable for our design process are as follows:
1. Peltier module
2. DC cooling Fan
3. Heat sink.

2.1 Peltire Module

In our proposed model a peltier TEC1 – 12706 modules is used. Jean Charle Athance Piltier a French physicist in1834 revealed that an electric current is produce heat cool at the junction of two dissimilar metals, Depending on the direction of current flow. It helps to get thermoelectric effect. The peltier module is consisting of two dissimilar conductors. The two dissimilar conductor junctions will absorb or release heat that depends on the electric current flow direction. and thus peltire effect occurs. In peltire device most commonly used thermocouple semiconductor are bismuth and telluride [6]. Fig. 1 (a) showing the N and P-type semiconductor Energy band diagram and (b) and (c) showing the piltier cooling system.

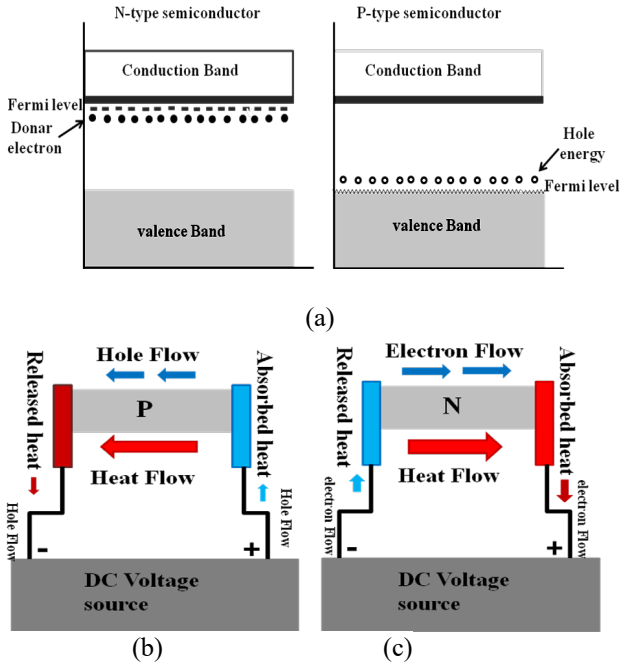

Fig. 1: N and P-type semiconductor Energy band diagram (a) peltier cooling System (b, c).

In our system we arranged the N and P -type pellets in a combine semiconductor Energy band that produce piltier effect showing in the Fig. 2[10] Thereby we develop a circuit by forming a junction between the two conductor with a plated copper tab. According to this setting of cooler box there is temperature difference directly converted into electric voltage and vice versa thereby can keep all of the heat moving in the same direction. As show in the fig 1 the positive terminal of P and negative terminal of N connected to each other. In our system we assemble the circuit appropriately so that there is discharge of heat to one side and take up another side.

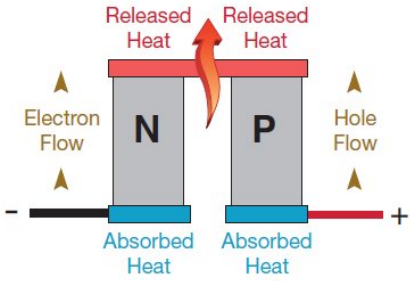

Fig. 2: Peltier cooling by couple of N & P [10]

2.2 Heat Sink

Heat sink is heat carrier or transferor so that it can carry heat away from hot end .We arrange a heat ink on the hot side of the peltier module in our thermoelectric medicine cooler box that incorporates a Dc cooling fan to keep a hot component cooled down .

2. 3 DC Colling Fan

A CPU cooling fan is used in this project. As one side of the peltier get cold and other side gets hot, it needs to cool the hot side to get more cooling effect. A DC fan with heat sink is used to cool down the hot side and another fan is used to circulate the air inside the Medicine cooler box.

(a) b)

Fig. 3: (a) Dc cooling fan with Heat sink (b) 12v rechargeable battery

2.4 Insulation Material

Insulation material is used to insulate the air flow and also heat flow inside the refrigerator. In our project we used thermocool sheet as a insulation material. Because, the thermocool sheet is lightweight, easily affordable and cost effective then the polyurethane rigid foam. The thermocool insulator has high insulation value.

2.5 Rechargeable battery:

The peltier module and all the cooling fans are run in 12volt power supply. A 12volt battery can also be used to powering up the refrigerator. But here a 12v power supply is used which converts 220v AC current to 12v DC current.

2.6 Ice Pack

In this project we used high-quality Dry Ice Pack for cooling. An ice pack or gel pack is one kind of plastic portable bag filled with salt water or refrigerator gel.

2.7 Temperature Meter

For measurement and display the temperature inide the cooler box we used Infrared temperature meter

(a) (b)

Fig. 3: (a) Ice pack (b) Temperature meter

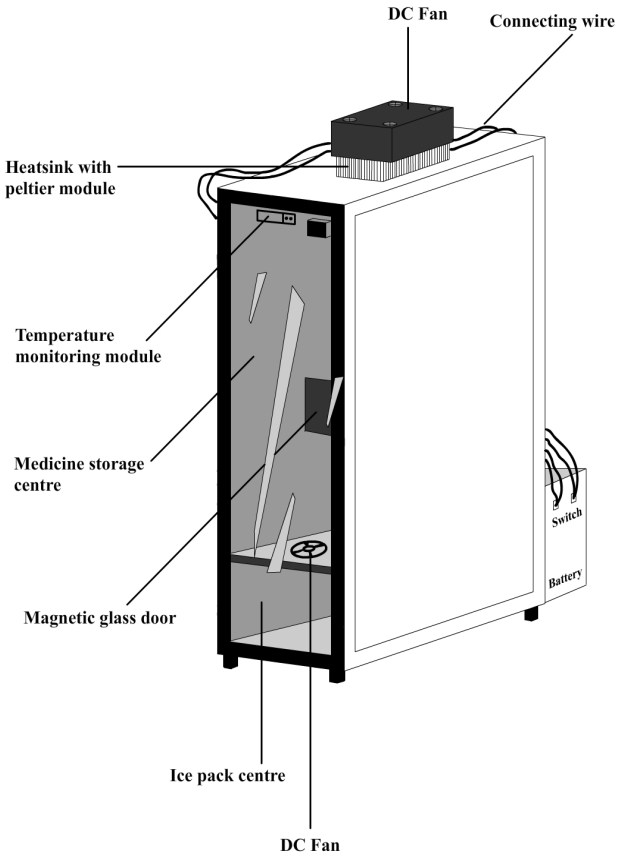

Fig. 4: Schematic view of a portable medicine cooler box

3. DESIGN OF THERMOELECTRIC MEDICINE COOLER BOX

3.1 General Configuration

Although a number of designs were initially proposed to demonstrate the peltier effect, this paper showcases the design and development of a thermoelectric medicine cooler box system for space cooling using a thermoelectric module.

Outer dimension:
Height = 45 cm, Length = 20 cm, Width = 16 cm
Inner dimension:
Height = 35cm, Length = 17 cm, Width = 11 cm
Insulation material thickness: 1.5 cm
Dimension of peltier module: 40 mm * 40mm * 3 mm
Volume of the cooler box: 14400 cubic centimeters.

3.2 Cooling Capacity (QC):

Peltier effect gives the heating and cooling rate of a thermoelectric cooling. The cooling capacity QC obtained from the energy equilibrium at the cold side the Of the thermoelectric cooler.

Energy supplied (P): The power consumed (W) in the thermo element is equal to the joule heating and input power used to create the temperature difference of the Peltier module.

Fig. 4: Constructed portable medicine cooler box

3.3 Temperature difference:

By using "digital temperature sensor" final temperature at the surface of module and the heat sink measured on both hot side and cold side are as follow. The temperature on the hot side is (Th = 38˚C) and the temperature on the cold side is Cold side (Tc = 18˚C) Hence, Temperature difference can be considered as ΔT= (Th − Tc) = (38–18) = 20˚C

4. Result and DISCUSSION

Medicine is the most essential and live saving things for human beings. The pharmaceutical companies where the medicine produced give some instruction for how to store the medicine. Temperature is the most important factor for medicine storage. A quantity of medicine like vaccine, insulin requires special temperature for storage to keep their efficacy intact. We proposed a Portable and Rechargeable Thermoelectric Medicine cooler Box at a Low cost where we use the thermoelectric cooling system. The medicine cooler box working like a refrigerator and it keeps the medicine at temperature about 8°C-15°C for 10-12 hours. The present study shows the promising potential of using thermoelectric cooling system by peltire module with Dc cooling fan with heat sink and a rechargeable 12v battery for medicine cooler box. Though there are some construction problems like desire temperature that is 2-8°C, heavy weight of the finally constructed cooler box but final project working properly and further research will overcome the present problem.

5. CONCLUSION

Since Peltier cooling is not efficient comparatively and due to its small size applications, it is not widely used. It found its application only in electronics cooling etc. And for getting more cooling we use ice pack. But also in that case we did not get our desire temperature. After using ice pack we see that that the temperature is getting down around 8°C to 15°C. But the the required temperature for medicine storage is 2°C to 8°C. For getting exact temperature further research will be done.

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