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# Use of Peltier Effect in Medical Device

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**Abstract -** Freeze is an electronic device which can reduce the inside temperature of the container to a required temperature according to the requirement of the customer. It consists of an BMS (Battery Management system) which help in proper supply to the container.

It has been designed in such a way that it can be used in the transportation of the medical items such as insulins, medicines and can be design in order for the transplantation of the organs.

Freeze has a capability to reduce the inside temperature up to certain degree in minutes and can even freeze the water within 15-17 minutes.

Freeze consist of the following subsystem which help in efficient working of the device, they are as follows: -

BMS - Battery Management system, Li-ion battery, Container, Heat sink, Peltier.

## 1. INTRODUCTION

This is a biomedical device capable of storing insulins while transporting from one place to another. It works on the basic principle of Peltier effect. Peltier effect can be used to generate electricity, measure temperature or change the temperature of objects. Because the direction of heating and cooling is determined by the polarity of the applied voltage, thermoelectric devices can be used as temperature controllers.

The term "thermoelectric effect" encompasses three separately identified effects: the Seebeck effect, Peltier effect, and Thomson effect. The Seebeck and Peltier effects are different manifestations of the same physical process.

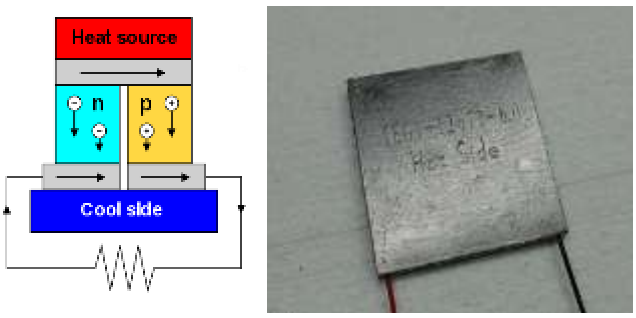


Fig1.1: Peltier Working diagram

### 1.1 BATTERY CONNECTION TO LOAD CIRCUIT

A BMS may also feature a pre-charge system allowing a safe way to connect the battery to different loads and eliminating the excessive inrush of current to load capacitors.

In our designed device which is capable of working for up to 10 hours without being online to the system, it necessarily requires a smooth charging and discharging system to bring our system in active situation, we are using Peltier BMS already available working with the output power of 12V 6A which is supplied to Peltier. BMS is powered through a rectifier attached to the power bank.

The connection to loads is normally controlled through electromagnetic relays called contactors. The pre-charge circuit can be either power resistors connected in series with the loads until the capacitors are charged. Alternatively, a switched mode power supply connected in parallel to loads can be used to charge, the voltage of the load circuit up to a level close enough to battery voltage in order to allow closing the contactors between battery and load circuit. A BMS may have a circuit that can check whether a relay is already closed before pre-charging (due to welding for example) to prevent inrush of current to occur.

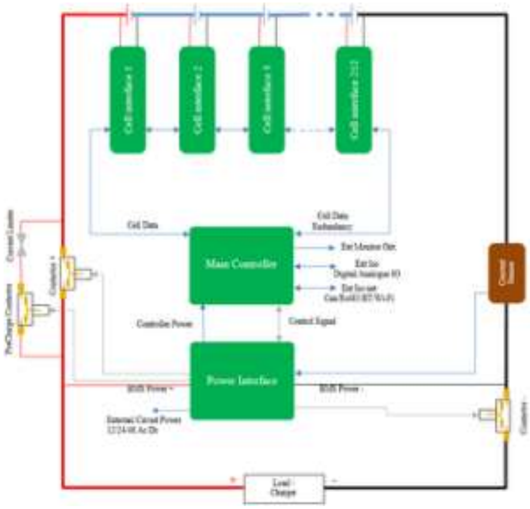

Fig1.2: Peltier BMS

### 1.2 HEAT SINK

A heat sink is designed to maximize its surface area in contact with the cooling medium surrounding it, such as the air. Air velocity, choice of material, protrusion design and surface treatment are factors that affect the performance of a heat sink. Heat sink attachment methods and thermal interface materials also affect the die temperature of the integrated circuit. Thermal adhesive or Thermal grease improve the heat sink's performance by filling air gaps between the heat sink and the heat spreader on the device. A heat sink is usually made out of copper or *aluminum*. Copper is used because it has many desirable properties for thermally efficient and durable heat exchangers. First and foremost, copper is an excellent conductor of heat. This means that copper's high thermal conductivity allows heat to pass through it quickly. *Aluminum* heat sinks are also used as a low-cost, lightweight alternative to copper heat sinks.

## 2. STORAGE GUIDELINES OF INSULIN

Keep your insulin away from heat and light. Any insulin that you don't store in the refrigerator should be kept as cool as possible (between 56°F and 80°F.) (Clinical review by Dan Kent, 2019) Keep unused bottles, cartridges, and pens of insulin in the refrigerator (between 36°F and 46°F). If stored properly, these will be good until the expiration date listed on the insulin. Keep insulin cartridges and pens that you're currently using at room temperature (between 56°F and 80°F.) (Clinical review by Dan Kent, 2019)

The following terms relate to temperature and medical supplies. It is important to follow the manufacturer's recommended storage conditions for all products.

Store frozen: Some products, such as certain vaccines, need to be transported within a cold chain and stored at -20°C (4°F). Frozen storage is normally for longer-term storage at higher-level facilities.

Store at 2°-8°C (36°-46°F): Some products are very heat sensitive but must not be frozen. These are usually kept in the first and second part of the refrigerator (never the freezer). This temperature is appropriate for storing vaccines for a short period of time.

Keep cool: Store between 8°-15°C (45°-59°F). Store at room temperature: Store at 15°-25°C (59°-77°F). Store at ambient temperature: Store at the surrounding temperature. This term is not widely used due to significant variation in ambient temperatures. It means "room temperature" or normal storage conditions, which means storage in a dry, clean, well ventilated area at room temperatures between 15° to 25°C (59°-77°F) or up to 30°C, depending on climatic conditions. (Managing Drug Supply, 1997)

## 3. CONCLUSIONS

On the basis of guidelines of storing certain medicine in low temperature we made certain modification on the design through which we can change temperature of inside container using voltage regulator. We are using voltage sensor, temperature sensor, moisture sensor, temperature regulator which are all attached to a 2.4inch Tft LCD display which will provide current operating conditions of inside container.

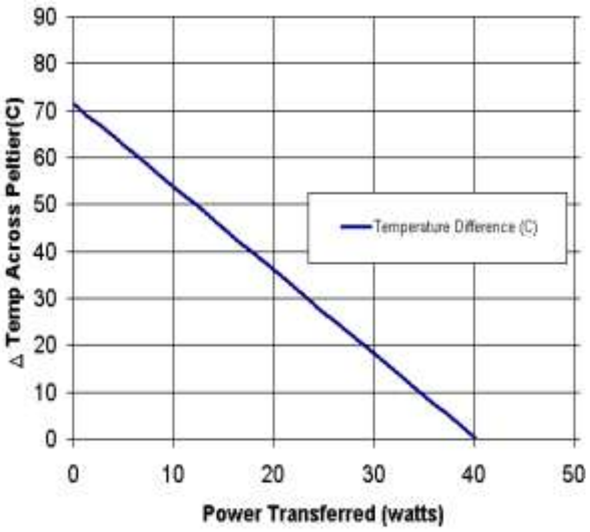


Fig1.3: Peltier Temperature characteristics with power supply

Looking at the graph, you can see that, for example, if the Peltier element will have a delta T of 55°C if it has to move 10W of power (in the form of heat). You will also see that at one point - at 40 Watts in the case of this example - delta T becomes zero. This occurs when the TEC has reached its maximum thermal transfer capability ($Q_{max}$). So, our example Peltier element cannot transport more than 40W. I admit that this graph is a bit oversimplified. (Steinbrecher, 2019)

After constructing a model of final product, we observed certain characteristics of Peltier which differs from theoretical characteristics.

Fig : 1.3 final product

Minimum temperature observed after applying defined supply was 3 degree, we also observer that initially Peltier attain higher efficiency than later on it comes to a constant temperature as shown in the graph.

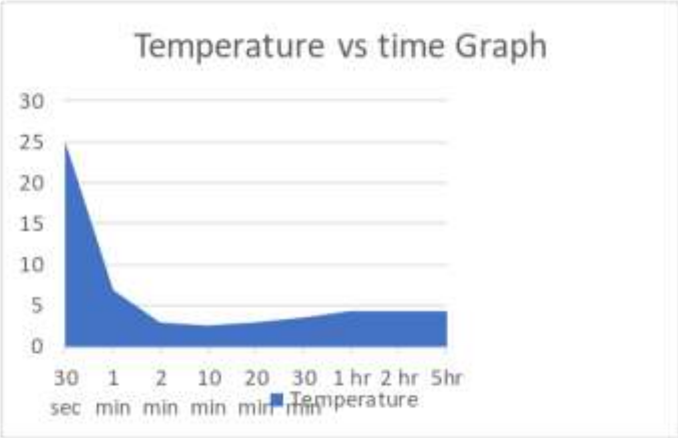


Fig 1.4 : Temperature v/s time Graph

**Future Scope-** Freeze can be used as a medicine carrier/storing device (for medicines which require low temperature for storing for longer utility) in remote area like villages, rescue operation etc.

On further modification of freeze by installing pressure modulator we can use it for storing tissues and organs to transport in remote areas for transplantation purpose.

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