

DESIGN OF PORTABLE HOT AND COOLING SYSTEM USED IN KITCHEN APPLICATION USING PELTIER EFFECT

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ABSTRACT

Energy consumption has been rising globally in recent years, which is a major source of concern owing to its impact on climate change. Climate change has resulted in stronger hurricanes, more droughts and heat waves, rising sea levels, and predictions that the arctic will be ice-free by mid-century, according to NASA. The heating and cooling of buildings is one of the most noticeable energy consumption methods that have a detrimental impact on the climate. As a result, reducing the amount of energy used in buildings for heating and cooling has become a popular research topic. While energy efficiency has improved dramatically in recent years, the usage of hazardous refrigerants like R-410a has already had a significant negative impact on the environment. Solar, wind, and thermal power plants are the most common sources of electricity nowadays. However, because more space can be utilised as a result of this, fuel costs are rising every day, and power consumption in commercial sectors is at an all-time high. As a result, use a Thermo electric power generator to avoid these issues. Peltier coolers and Thermo electric generators are examples. The thermo electric generator converts waste heat into electrical energy.

Keywords Peltier coolers, TE generators, SPST switch

2. INTRODUCTION

The Peltier effect is used in thermoelectric cooling TEC1-12706 to establish a heat flow between two different types of materials. A Peltier chiller, heater, or thermoelectric heat pump is an active solid-state heat pump that uses electrical energy to move heat from one side of the appliance to the other, depending on the direction of the current. A Peltier device, Peltier heat pump, solid state refrigerator, or thermoelectric cooler are all names for the same thing. They can be used for either heating or cooling (refrigeration), however cooling is the most common application. It can also be used as a heat or cool temperature regulator. Temperature differentials are created via thermoelectric coolers. One side heats up, while the other cools down. As a result, depending on which side you utilise, they can be used to heat or cool something. You can also create electricity by taking advantage of a temperature difference. Thermoelectric Peltier coolers, such as the TEC1-12706, are made up mostly of semiconductor material sandwiched between two ceramic plates and are utilized in a wide range of applications, including CPU coolers and other power sources. A thermoelectric cooling module is a tiny heat pump that is made up of electronic semiconductor components. Heat is transported from one side of the module to the other when a direct current power source is applied to a TEC. As a result, a cold and warm side is created. Computer CPUs, CCDs, portable refrigerators, medical devices, and other industrial applications use them extensively.

[1] Make it as portable as can and to be eco-friendly as well as low cost. An effort to develop the refrigeration system using thermo-electric peltier module in which the user can be able to maintain as well as can control the temperature of the cooling system. [2] attempts to perform an experimental study on one of the applications of Thermo Electric Generators under the benefit of the army. Even as a well-developed technology, the efficiency of TEG hasn't reached the standard in order for it to be used in Energy Production. But with different ways of approaching this technology, we could benefit other needs like a Portable cooling

bottle.[3]This paper presents a near accurate model of thermoelectric generator with realistic conditions with a user-friendly approach. The inputs of the considered model are temperature dependent parameters, temperature of hot source and ambient temperature to which cold junction is exposed. The results are computed to evaluate the performance of TEM for generated voltage, power and efficiency. [4]the performance of these systems is evaluated in the research and also commercialization point of view, reliability of this device and life of this device is discussed in the paper. The output graph of cooling and heating according to time is shown in figures 8, 9, and 10. From these graph we can calculate the approximation of the performance and use this Peltier Module in our daily life to save power consumption.

[5]developed a new air conditioning system and completely eco-friendly air-condition. Where, the principle of operation of the current air conditioning system depends on refrigerant gas like Freon, Ammonia, etc., by using these refrigerant gases the air conditioning system can get maximum output. One of the major disadvantages for these refrigerant gases is global warming and harmful gas emission. To protect the environment, these problems can be solved by using thermoelectric modules. [6] presents a standby solution for supplying electricity to lighting loads of remote areas using Peltier based thermos-electric generators. The Peltier modules use the heat from a solar water heater to generate the required DC voltage, which is converted into AC using a simple single phase inverter to feed the lamp load.

3. METHODOLOGY

3.1 COOLING MECHANISIM

A cooling system based on Peltier Effect uses very less power and is portable. It uses a very thin thermoelectric module through which the required heat transfer can be achieved. Thermoelectric coolers operate according to the Peltier effect. The effect creates a temperature difference by transferring heat between two electrical junctions. When the current flows through the junctions of the two conductors, heat is removed at one junction and cooling occurs. The goal was to supply power to the thermoelectric modules using an ac source by converting it into direct current. The modules in turn will cool a container wherein water will be filled and tests be done. The modules are connected to the terminals of the transformer circuit. Switches are introduced in between the path to enable controlled cooling.

3.2 HEATING MECHANISIM

A heating element converts electrical energy into heat through the process of resistive. The electric current passing through the element encounters resistance, which produces heat. Typically, heating elements are made from a coil, ribbon or strip of wire that provides heat. Heating elements contain an electric current, which flows through the coil or ribbon or wire and becomes very hot. The element converts the electrical energy passing through it into heat, which spawns outward in every direction.

3.3 PROPOSED SYSTEM

The input heat energy is recovered from heat source of Heat Sink Processor Fan. The heat side of the TEG module is assembled in heat observer aluminum plate. This heat observer plate is transfer the heat to TEG module by conduction method. Opposite side of the TEG module (cold side) is placed on the cooling system. The system is use to reducing the heat in the cold side of the TEG by conviction method. Hence the TEG module converts heat energy to cooling. Thermoelectric technology provides an alternative to traditional methods of solar power generation, generation from waste heat, heating and cooling. Thermoelectric module can convert heat energy to electrical power directly. Compared with other methods

TEG possesses the salient features of being compact, light-weighted, noiseless in operation, highly reliable, maintenance free, and involving no moving or complex parts. It is environment friendly operation, free of carbon dioxide emission and radioactive substances and does not contribute to the depletion of natural resources.

4. RESULT AND DISCUSSION

As alternative to commonly used passive cooling techniques, thermoelectric cooling can offer numerous advantages. These include accurate temperature control and faster response, the opportunity for fanless operation reduced noise, space savings, reduced power consumption and the ability to cool components to sub-ambient temperatures.

4.1 PRODUCT DESCRIPTION

A Peltier thermoelectric module consists of an array of Bismuth Telluride semiconductor pellets that have been “doped” so that one type of charge carrier either positive or negative carries the majority of current. The pairs of P/N pellets are configured so that they are connected electrically in series, but thermally in parallel. Metalized ceramic substrates provide the platform for the pellets and the small conductive tabs that connect them. When DC voltage is applied to the module, the positive and negative charge carriers in the pellet array absorb heat energy from one substrate surface and release it to the substrate at the opposite side. The surface where heat energy is absorbed becomes cold, the opposite surface where heat energy is released, becomes hot. Reversing the polarity will result in reversed hot and cold sides.

4.2 TO DETERMINE THE OPERATING CURRENT AND THERMAL ABSORPTION

Find ΔT :

$$\Delta T = T_h - T_c = 50^\circ\text{C} - 10^\circ\text{C} = 40^\circ\text{C}$$

Use the function diagram for $T_h = 50^\circ\text{C}$ to find the current to maintain $\Delta T = 40^\circ\text{C}$, at the supplied voltage:

From the diagram, $I = 3.77 \text{ A}$

Find the heat pumped from the function diagram, at $I = 3.77 \text{ A}$ and $\Delta T = 40^\circ\text{C}$:

From the diagram, $Q_c = 20.75 \text{ W}$

Thermoelectric coolers can be susceptible to thermal fatigue. Conventionally manufactured units contain ordinary solder bonds between the electrical interconnect (copper) and the P/N semiconductor elements, as well as solder or sinter bonds between the interconnect and ceramic substrate. While these bonding techniques normally create strong mechanical, thermal and electrical bonds, they are inflexible, and can degrade and eventually fail when subjected to the repeated heating and cooling cycles that are typical of normal Peltier module operation.

4.3 SPST SWITCH (SINGLE POLE SINGLE THROW (SPST) SWITCH)

A Single Pole Single Throw (SPST) switch is a switch that only has a single input and can connect only to one output. This means it only has one input terminal and only one output terminal. A Single Pole Single Throw switch serves in circuits as on-off switches was shown in figure 1. When the switch is closed, the circuit is on. When the switch is open, the circuit is off. SPST switches are, thus, very simple in nature.



Single Pole Single Throw Switch

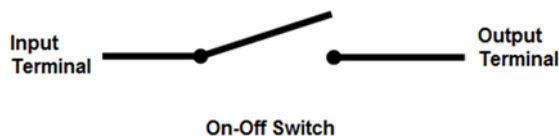


Figure 1 SPST Switch circuit diagram

Figure 2 SPST Switch

4.4 SINGLE POLE SINGLE THROW (SPST) SWITCH CIRCUIT

Below is an example of a circuit which utilizes a single pole single throw switch. When the SPST is closed, the circuit is closed and light from the lamp switches on as shown in figure 2. When the SPST is then opened, the light from the lamp goes out and the circuit is off. This shows the basic nature and function of a SPST. The working model is shown in figure 3.

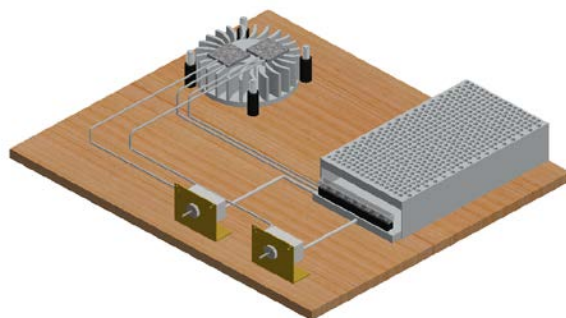


Figure3. 3D view of the mode

5. CONCLUSION

The model of Peltier module has been used and experimentally verify the temperature performance according to the time when we supply 12 V, 2A DC. The cooling and heating from Peltier module is totally depend upon the stress and contacting terminal of the Ceramic plate which is acting like two electrodes. Power supply is one of the important factors in case of heating. Without controlled power supply and switching, its performance will be down and device will stop working.

This Peltier module is very important electronics component for better power saving. This has very low power and high output. So in general life we can use this device. It will be better to use it except other heating element which is available in the market.

Through Evaporative cooler pad and this thermoelectric module our cooler can perform very low temperature task. And if we use desiccant wheel then it will much effective because we can get low temperature air with dry air. So it can slightly remove air-conditioners availability with low power consumption.

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