SOLAR POWERED VACCINATION BOX

A Review

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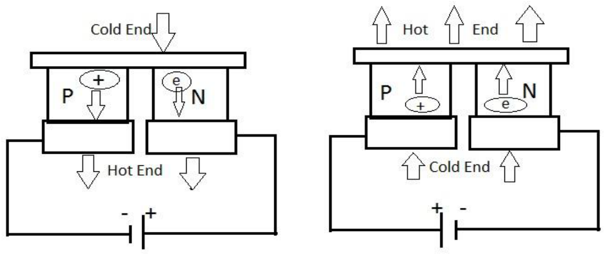
ABSTRACT

Conventional cooling systems such as those used in refrigerators utilize a compressor and a working fluid to transfer heat. Thermal energy is absorbed and released as the working Fluid undergoes expansion and compression and changes phase from liquid to vapor and back, respectively. Semiconductor thermoelectric coolers (also known as Peltier coolers) offer several advantages over conventional systems. They are entirely solid-state devices, with no moving parts; this makes them rugged, reliable, and quiet. They use no ozone depleting chlorofluorocarbons, potentially offering a more environmentally responsible alternative to conventional refrigeration. They can be extremely compact, much more so than compressor-based systems. Precise temperature control (< ± 0.1 °C) can be achieved with Peltier coolers. However, their efficiency is low compared to conventional refrigerators. Thus, they are used in niche applications where their unique advantages outweigh their low efficiency. Although some large-scale applications have been considered (on submarines and surface vessels), Peltier coolers are generally used in applications where small size is needed and the cooling demands are not too great, such as for cooling electronic components (Astrain and Vian, 2005). Objective of this project is to design thermoelectric Refrigerator Utilize Peltier effect to refrigerate and maintain a specified temperature, perform temperature control in the range 5 °C to 25 °C. Interior cooled volume of 1Litre and Retention for next half hour

INTRODUCTION

Thermoelectric cooling uses the Peltier effect to create a heat flux between the junction of two different types of materials. A Peltier cooler, heater, or thermoelectric 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. This technology is far less commonly applied to refrigeration than vapor compression refrigeration is. The primary advantages of a



Peltier cooler compared to a vapor-compression refrigerator are its lack of moving parts or circulating liquid, very long life, invulnerability to leaks, small size, and flexible shape. Its main disadvantages are high cost and poor power efficiency. Many researchers and companies are trying to develop Peltier coolers that are cheap and efficient. 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 Seeback effect). However, a well-designed Peltier cooler will be a mediocre thermoelectric generator and vice versa, due to different design and packaging requirements.

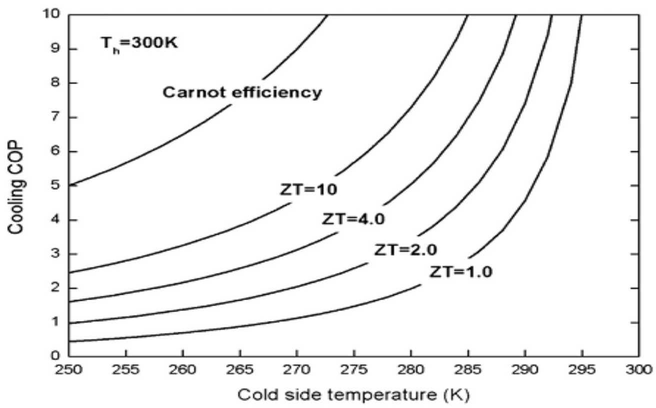
Thermoelectric cooler (TEC) is sort of cooler or heater which is a combination of two different material to get hot and cold junction at its end by use of electric potential or voltage. TEC works on the principal of Peltier effect which is conversion of electrical applied voltage into thermal gradient. Thermoelectric effect can be observed when direct current is applied across the P and N type semiconductor materials. Heating and cooling effect depends on direction of current flow; electron carries energy from cold to hot junction. TEC is a versatile compact component which is very reliable, long life and silent as it does not contain any moving parts. Despite having so many advantages TEC have low COP, as heat absorb at cold junction is less than energy supplied. Performance of a TEC depends on material's thermal conductivity, electrical conductivity,Seeback coefficient,Peliter coefficient,

Because of the performance limit of thermoelectric (TE) materials, a commercial one-stage TE cooler can provide about, at most, 70 K maximum temperature difference, when its hot end remains at room temperature. When a large temperature difference is required for some special applications, the single-stage TEC will not be qualified. Two options to enlarge the maximum temperature difference of TECs are one through transient cooling and the other by using two- or multi-stage TECs .The bulk two-stage TECs are commercially arranged in cascade, and the colder stage is attached to the heat source and the hotter stage pumps total heat to the environment. The cascade TECs also have been developed as micro coolers to cool the high power electronic and opto-electronic devices Therefore, two-stage, or even more, TE coolers should be applied to obtain larger temperature differences at better coefficient of performance (COP).

The Objective of this project is to design thermoelectric Refrigerator which utilizes Peltier effect to refrigerate and maintain a specified temperature, perform temperature control in the range 5 °C to 25 °C for interior cooled volume of 1 L The Main advantage of this project is that this chiller is very compact and one can carry easily in a small bag and the cost is much cheaper than currently available portable chillers in market, which is affordable

LITERATURE REVIEW

The papers proposes different types of system to utilize solar energy for refrigeration. Papers summarized progress on thermoelectric cooler starting from the discovery, thermoelectric material and various parameters ie material's thermal conductivity, electrical conductivity, Seeback coefficient. Finding shows that a good thermoelectric material should have high Seeback coefficient, high electrical conductivity (or high power factor), and low thermal conductivity. For a specific module and fixed hot/cold side temperatures, there exists an optimum current for maximum coefficient of performance (COP) as shown in figure 2.1.



G. Jeffrey et al worked on enhancement of figure of merit. The advances in ZT factor came from two primary approaches:

1) bulk samples containing Nano scale constitutes, and
2) Nano scale materials themselves.

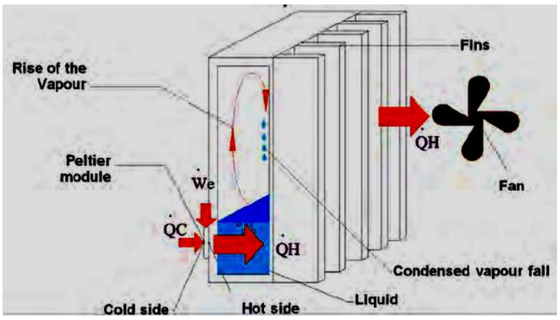
Regard to the approach of bulk samples containing Nano-scale constitutes, researchers have figured out that good thermoelectric materials are the so called "phonon-glass electron-crystal (PGEC)" material, where high mobility electrons are free to transport. charge and heat but the phonons are disrupted at the atomic scale from transporting heat. Some primary bulk thermoelectric materials are skutterudites, clathrates and half-Heusler alloys, which are principally produced through doping method.

Xiao-DongWang et all found optimization of two-stage thermoelectric (TE) coolers arranged in two practical design configurations, and the optimization methods can be extended to other multi-stage designs. The first arrangement is the conventional pyramid-styled multi-stage TE cooler, in which the supplied electric current is unidirectional with the top stage of the unit being the coldest. A second design configuration comprises the cuboid-styled multi-stage cooler, in which the supplied current can be alternated, and thus, the top and bottom stages can be switched between heating and cooling modes. In the first design of the TE cooler, the optimization goal is geared towards determining the optimum ratio of the number of TE modules between stages when the total number of modules is kept constant, while in the second design configuration, it is to solve for the optimum ratio of electric current between stages. Optimum design parameters for the two types of two stage TE coolers are compared on given conditions. For practical purposes, all properties of TEs are based on commercial TE materials.

Shumin Lin et al present a trapezoid-type two-stage Peltier couples (TTPC) for applications in two-stage thermoelectric cooling. By using the TTPC units without intermediate ceramic plates, the TTPC based thermoelectric module may reduce the interstage thermal resistance that could provide better performance. The simulation result indicates that the Peltier couple leg length allocation ratio between the cold stage and hot stage as well as the shape ratio of trapezoid-type Peltier couple leg at hot stage affect the maximum cooling capacity and coefficient of performance (COP) of TTPC.

shows three methods leading the enhancement of thermoelectric cooling system performance. The first one is through thermoelectric module design and optimization, such as the thermo element length, number of thermocouples, thermo element length to cross sectional area ratio, slenderness ratio and thermo element with non-constant cross section area. The second approach relates to cooling system thermal design and optimization , which includes investigation of heat sinks geometry allocation of the heat transfer area and heat transfer coefficients of hot and cold side heat sinks, thermal and electrical contact resistances and interface layer analysis , more effective heat sinks (i.e. heat sink integrated with thermo syphon and phase change material) .

The third approach relates to the thermoelectric cooling system working condition (i.e. electric current input), heat sink coolant, and coolant's mass flow rate.



RESULTS

For the results of our project, after assembling all the parts, we had taken trials for No load (Air Cooling), medium load (normal water) and cold water. The readings were noted and then 3 plots of time versus temperature drop, time versus heat rejected and time versus COP were plotted for each case.

FUTURE SCOPE

The units of energy production can be developed in the various regions by using thermoelectric modules. In these days the society face the energy crisis but also the harmful effects of pollution. The thermoelectricity is a "Green Technology" to generate electricity without any harmful effect. The educational institutions, furnace regions, metro cities, industrial areas, universities and other locations can be selected for the establishment of such energy centers where the waste heat can be easily available and can be recycled after conversion to the same system.

Energy Generation and its Enhancements:

The present research work is oriented for the generation of thermo emf by utilizing the waste heat contents. This work also implies for the utilization of electric field, magnetic field and stress which can exist already in the operating conditions or can be applied externally for better results. The orientation of the thermoelectric modules (parallel or perpendicular) can also be considered related to the strength of external parameters. In this work not only the classical thermoelectric materials are considered as the thermo generation elements but the well-known Resistive Temperature Detective (RTD) and advanced semiconducting materials (Bi, Pb, Te) are also considered as thermo generator elements. So there is a wide range of energy generation characteristics. In the classical thermocouples the Fe-Constantan, among the RTD materials the type E thermocouples and in the pallets the Pb3Te3 is a good energy converter. Thermo emf generation for each of the pallet in the magnetic field is slightly enhanced than that of their normal mode performance. First rank can be assigned to the pallet Pb3Te3 in which the output thermo power is improved by several orders. Its 121-conversion efficiency also increases with increase in the strength of the applied electric field strength. Hence the research work provides the way to overcome the energy crisis in future without any special production of heat but only by the utilization of the available waste heat by the proper selection of materials and operating parameters; which is free from any type of the pollution or complexities. The reliable thermoelectric equipment/modules can be framed of these materials in the selective orientations of electric or magnetic fields.

Precise Measurements by RTD Materials:

There is a variety of temperature sensing systems in each of the engineering and industrial areas which can be categorized according to the requirements and the range of temperatures to be measured. In high temperature situations (molten state of materials, separation of ores etc.) the Resistive Temperature Detective (RTD) materials are generally used which are basically thermocouples, works on Seebeck Effect. This research work puts a protest for the alteration of these temperature accuracies due to the effect of electric and magnetic fields, which are generally present in such operating conditions and affect the thermoelectric properties. Hence, this research work inspires for the consideration of effect of such external parameters for the precise measurements; to seek the reliability of a system.

Refrigeration:

Thermoelectric devices achieved an importance in recent years as viable solutions for applications such as spot cooling of electronic components, remote power generation in space stations and satellites etc. These solid state thermoelectric devices are free from moving parts, having good reliability however their efficiency depends on the selection of materials. Such devices with higher efficiency can be implemented for refrigeration also. Actually the combination of See beck Effect and Peltier Effect is the absolute advent for such refrigeration. If heat from solar energy is provide as the input to this implementation the cooling will be the output. Surely this research work will be an idea for better refrigeration and becomes an effort to overcome the energy crisis by the means of refrigeration from waste heat. In the instruments like computers, laptops, dynamos and vehicles the low grade waste heat can be utilized for cooling and can also be recycled to improve their performances. To reduce the thermal conductivity the heat resistant membranes can also be used. In a large number of devices metallic blocks are used, which causes eddy currents due to non-uniform magnetic fields. If these magnetic fields are synchronized to the thermo coupled devices then it is observed that the thermo emf will enhanced. This results to more cooling without any extra input. Such thermoelectric cooling devices can be applied to industries, buildings of hot regions and to the houses in summer. However, they require some modifications related to their size and the selection of materials but

their cheapness, ecofriendly nature, no cause to global warming are enough inputs to motivate the engineers for their implementations in almost all the suitable applications of daily life in near future.

(d) Medical and Blood Bank Application:

TEC can be used in medical application if heat sink optimization is done. On an average of 6 to 10 ^{0}C temperature is needed for Human body organ storage and an average about 14 ^{0}C temperature is required for blood storage which can be achieved by TEC container. In today's condition blood is transferred by some type of cooling storage but disadvantages are associated with it like bulky and it has some chloro-flouro carbons so it is not environment friendly.

(e) Milk Industry-

TEC can also be used for milk storage if containers with large volumes sufficiently equipped with TEC module and optimum design. Now-days, use of Thermo-electric Refrigeration has gained large importance as compared to Commercial available Deep freezers.

(f) Solar Operated –

The major another benefit is that Thermoelectric Refrigeration could be powered by Solar energy. Solar Panels receive energy from the sun and the heat store is converted into DC power supply and then supplied to TEC modules. So, the use of Battery can be eliminated which makes TEC more safely, ecofriendly and Cost-effective.

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