

Review on Solar Powered Thermoelectric Cooler

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Abstract - An Thermoelectricity describes the mutual impact of temperature and electricity in a material and is primarily based on three fundamental effects: the Seebeck-effect, the Peltier-effect and the Thomson-effect. This paper makes use of the thermoelectric (Peltier) module for refrigeration powered through the solar panel is going to be one of the most cost effective, clean and environment friendly machine for refrigeration. Thermoelectric refrigeration makes use of a precept known as the "PELTIER" effect to pump heat electronically. Refrigeration means elimination of heat from a body so that it will convey it to a temperature decrease than the ones of the atmospheric temperature. There are numerous techniques of refrigeration. All having their personal blessings and disadvantages, so that it will make use of their blessings A few researchers attempted to mix those techniques with every different and finished experimentation on it to get a few worth results. This paper presents a top level view on one of the refrigeration method that is thermoelectric refrigeration system applied to produce the cooling effect. In our proposed refrigeration system. We now no longer want any type of refrigerant, mechanical tools like compressor, prime mover, etc. for its operation. We are managing with Peltier module and solar panel and some accessories. Thermoelectric modules are constructed by a sequence of tiny steel cubes of varied wonderful metals that are bodily bonded collectively and related electrically, heat is transferred from one metal to the other. The fundamental motive of this mission is to offer refrigeration to the far off regions wherein power supply is not possible.

Key Words: solar panel, thermoelectric refrigeration, peltier unit, COP . Thomson Effect, Motor, LDR Sensors

1.INTRODUCTION

There are four widely known cooling systems, Vapour Compression, absorption, thermoelectric and newly recognised Thermo-acoustic refrigeration system. The cooling effect produced by the refrigeration system is primarily based totally on easy precepts of operation, that a heat flux is absorbed from a room, and evacuated to the exterior. In most of the domestic refrigerators, the most used cooling system is vapour compression, because it provides good COP. Refrigeration systems extract heat from a closed container and leaves into surroundings. Main additives of a refrigeration system are condenser, an evaporator, a

compressor, and an enlargement valve. In a cyclic phenomenon of a refrigeration system, the refrigerant vapour leaves the evaporator and enters the compressor as a saturated vapour at the vaporizing temperature and pressure and the liquid leaves the condenser and enters the expansion valve as a saturated liquid at the condensing temperature and pressure. The development with inside the generation is the non-stop manner to fulfil the requirement of the swiftly converting world. People often ask themselves 'Why is solar energy good?' and, as a result, fail to realise the importance of solar technology. Solar power has evidently become the trend in renewable energy. What other reasons should you consider when going solar? Here are 3 compelling reasons

1. Solar Power Is Good for the Environment:

Solar power is a great way to reduce your carbon footprint. There's nothing about solar power that pollutes mother nature. Solar power doesn't release any greenhouse gasses, and except for needing a source of Clean water to function, it uses absolutely no other resources. Solar Electricity Makes Your

2. Home Go Off-the-Grid:

The decrease in the cost of solar panels serves as a great example of why there should be an increase in the use of solar energy. Traditional electricity relies heavily on fossil fuels such as coal and natural gas Not only are they bad for the environment, but they are also limited resources .This translates into a volatile market, in which energy prices alter throughout the day.

3. Solar Power Is a Free Source of Energy:

The sun provides us with more energy than we could ever use, and no one can monopolise the sunlight.

2. What is Thermoelectric refrigeration?

Thermoelectric refrigeration is one of the methods of producing low temperature and it is based on the reverse Seebeck effect. The theories behind the operation of thermoelectric refrigeration can be traced back to the early 1800s. Jean Peltier discovered there is a heating or cooling effect when electric current passes through two conductors of dissimilar metals. Thomas Seebeck found that, when two dissimilar conductors at different temperatures would create an electromotive force or voltage. William Thomson

showed that, over a temperature gradient a single conductor with current flow will have reversible heating and cooling effect. With these principles in mind and the introduction of semiconductor materials in the late 1950s, many researchers studied and tried to develop a better thermoelectric refrigeration system to utilize this technique in industry and domestic appliances. A Thermoelectric Refrigeration module is a small heat pump, which has the advantage of no moving parts. The Thermoelectric module operates on direct current and used for heating or cooling by reversing the direction of current flow. This is achieved by moving heat from one side of the module to the other with current flow. The elements of semiconductor material are connected electrically in series and thermally in parallel. When a positive DC current is applied to the n-type thermo-element, electrons pass from the p- to the n-type thermo-element and the cold side temperature decreases as heat is absorbed. This heat is transferred to the hot side, where it is dissipated into the heat sink and surrounding environment. The heat absorption (cooling) is proportional to the current and the number of thermoelectric couples. Thermoelectric cooling has become a viable technology for small cooling applications. The performances of Thermo-electric cooler are expressed as follows:

$$Q_c = \alpha n \times T_c I - \frac{1}{2} (I^2 R) - K (T_h - T_c) .$$

2. LITERATURE SURVEY

Priti Debarma , B.B.Bhowmik in their research presented a review of many researchers on different tracking systems which makes the solar panel perpendicular to the sun for obtaining maximum solar energy. Different types of tracking systems namely single axis trackers. Along with that, dual axis trackers have also been discussed here by them. However they concluded that the cost, maintenance and flexibility of single axis trackers is more preferable than the dual axis trackers.

They also concluded that for capturing more energy, tracking the sun (Solar energy) is the best way because it results in efficient, profitable and clean energy production. Overviewing the cost, maintenance & flexibility single axis trackers is more preferable than dual axis trackers[4] .

Khyati Vyas, Dr. Sudhir Jain In their paper, they presented a brief review over solar tracking systems based on microcontrollers. Alongside this, they also explored various types and methods of operations. Their paper describes the simple and attractive features of a tracking system. They stated that the solar tracker also provides a lucrative solution for third world countries to integrate it into their solar system with a comparatively low cost through software based solutions. Their study revealed that the use of stepper motors enables accurate tracking of the sun. One more

proven point is that LDR resistors are used to determine the solar light intensity.

Their paper concludes that embedding the tracking system with solar panels can be accurate and applicable to meet power demands at different operational conditions.

Stepper motors in solar trackers enable accurate tracking of the sun & light dependent resistor is used to determine the solar light intensity.[3]

Suneetha Racharla, K Rajan in their research performed various surveyed and stated that -"The innovative designs in sun tracking systems have enabled the development of many solar, thermal and photovoltaic systems for a diverse variety of applications in recent years compared to the traditional fixed panels. Solar systems which track the changes in the sun's trajectory over the course of the day collect a far greater amount of solar energy, and therefore generate a significantly higher output power". Their paper has presented a review of the major types of sun tracking systems developed over the past 20 years. They also stated that these sun tracking systems can be broadly classified as single axis and dual axis, depending on their mode of rotation and classified as active and passive tracker depending on the actuator. The sub division and their basic principles of each method have been reviewed in their research. Overall, the results presented in their review confirms that the dual axis tracking system is more efficient compared to other tracking systems. However they noted that in cost and flexibility point of view single axis tracking system is more feasible than dual axis.[2]

Deekshith K , Dhruva Aravind , Nagaraju H , Bhaskar Reddy in their research paper, they gave a brief overview of solar tracking system based on microcontroller and also have described about the simple and attractive features of the tracking system. They stated that the operation cost and maintenance cost of solar tracker are comparatively low. They conducted several experiments and noted that the use of stepper motors in solar trackers enables accurate tracking of the sun and light dependent resistor are used to determine the solar light intensity. Their paper concludes that solar tracking system provides more effective method to track the solar insolation and provide economic consistency for generation of electric power and solar power technology is constantly advancing and improvements will intensify in future. Solar tracking system provides a more effective method to track the solar insolation & provide economic consistency for generation of electric power.[1]

Günther Seliger, Jörg Stephan, Stephan Lange (2000) they mention that When water is sprayed on the textile surface in a thin, evenly distributed layer, the resulting small water droplets dampen and enclose the protruding textile filaments. When the gripper touches down on the textile, the filaments and the water droplets come into contact with the

cooled down. PELTIER-Module's surface, building up an evenly formed water/ice zone between the dry textile region and the ceramic. PELTIER- Module surface. They also mention that due to the cooling capacity, the water starts to freeze, forming a bond between the ceramic surface and the textile filaments, as a result of the adhesive effect. The water between Ceramic and textile surfaces is cooled with the peltier-effect thus forming an Ice-bond between Ceramic & textile surfaces, & are pressed against each other, working as an adhesive.[5]

Pranav Bairagi¹, Lakhan Meghani (2018) in their paper mentioned that the Peltier modules are arranged in such a way that heating and cooling inside the vehicle is conducted as per needed. This Peltier modules are arranged in alternate manner. Some modules are used to cooling while some are used as a heater as per weather conditions. Proper ventilation is been provided to control relative humidity and fresh atmosphere inside the passenger area. This can be done by providing a blower used to discharge the heat. Portable Air Conditioning System can be used in dual mode operation, heating and cooling also able to generate electricity using heat transfer occurs in the system. It achieves minimum temperature 16°C and maximum around 40°C and maximum voltage occurs in about 30 minutes. Replacing this can be harmless to humans.[6]

Prasad Agivale, Prashant Kamble, Vinay Nikam(2018) These Researchers conducted their experiments and have mentioned that the study compares the thermodynamic performance of four small capacity portable coolers that employ different cooling technologies: thermoelectric, Stirling, and vapour compression using two different compressors. The refrigeration systems were experimentally evaluated in a climatized chamber with controlled temperature and humidity. Tests were carried out at two different ambient temperatures in order to obtain key performance parameters of the systems. These performance parameters were compared using a thermodynamic approach [7].

Marzieh Siahmargoi, Nader Rahbar (2019) together followed procedure in which the apparatus consists of a thermoelectric module, two heat sinks were designed, tested, and used to validate the results of mathematical modelling and nonlinear equations. System first case, the heatsinks are directly placed in the ambient air, and similarly in the latter cases, two fans were used on both sides of the heatsinks operated at 5V and 12V to cool down the system. In a fixed heat sinks thermal resistance, the optimum voltage in which the cooling power of the system is in its max value. Thus using two heat sinks increases the efficiency in heat dissipation.[9]

Lee M and Kim.T.W, in their researcher used a system which considered the thermoelectric heat pump as the main device

for producing cool air known as Peltier Effect. This led to the generating system theoretically recycling the heat loss to produce additional electricity for other usage. The efficiency of this system tested using two types of experimental using Peltier and Seebeck Effect. They also acknowledged both experiments which were conducted using 3 specific volumes; 1) 1000cm³; 2) 4000cm³; and 3) 9000cm³. Portable Air Conditioning System can be used in dual mode operation, heating and cooling also able to generate electricity using heat transfer occurs in the system. It achieves minimum temperature 16°C and maximum around 40°C and maximum voltage occur in about 30 minutes. Replacing this can be harmless to humans Generally cooling systems are only around 5-15% eff. Wrt to that of 40-65% for conv. Systems but mainly researchers try to improve COP using different materials, as thermoelectric modules are compact in size, no frictional elements, low weight has added a new dimension towards these systems [8].

Shyam Patidar carried out his research for the solar module, And mentions that as long as sunlight is available, the solar module will generate power. It implies that for indoor design applications TEGs are effective candidates to generate power. For the space required, TEGs are good modules when compared with solar panels. TEGs are better than a single solar module in terms of weight. Depending on the application, one of the two types may be preferred. In some applications, the size of the energy generation module may be a concern; TEG may be considered if there is sufficient input available to generate power output. For the solar module, as long as sunlight is available, the solar module will generate power. It implies that for indoor design applications TEGs are effective candidates to generate power. However, it is not easy to reach an appreciable amount of temperature difference such as 150°F-300°F. Costs of solar modules have been rapidly dropping, making them good candidates for energy generation in appropriate climates. For the space required, TEGs are good modules when compared with solar panels. TEGs are better than a single solar module in terms of weight. For comparable power output of a single solar module there may be multiple TEGs connected together which increases the cost of TEGs. This can become a disadvantage of TEGs when compared with solar panels. However, weight and size (area) are still advantages of TEG modules for the appropriate application, environment and power requirement. For the solar module, as long as sunlight is available, the solar module will generate power. It implies that for indoor design applications TEGs are effective candidates to generate power. . For the space required, TEGs are good modules when compared with solar panels. TEGs are better than a single solar module in terms of weight [10].

3. CONCLUSIONS

The cost, maintenance and flexibility of single axis trackers is more preferable than the dual axis trackers[4]. The solar tracker also provides a lucrative solution for third world countries to integrate it into their solar system with a comparatively low cost through software based solutions[3]. Portable Air Conditioning System can be used in dual mode operation, heating and cooling also able to generate electricity using heat transfer[6]. For the space required, TEGs are good modules when compared with solar panels [10]. From this review, By using solar power and with the aid of the peltier plate arranged systematically in a device in a regular working environment, cooling effect can be generated by using minimal amount of energy giving out optimum cooling for domestic, corporate and automobile user evidence., it is clear that thermoelectric refrigeration system utilized to produce the cooling effect is emerging field.

The energy efficiency of thermoelectric refrigerator is still lower than vapour compression refrigeration system (VCRS). More over, further improvement is possible in COP of thermoelectric refrigerator by the use of semiconductor material and also increase in heat exchange capability of heat exchanger to bring down the temperature difference between two faces of peltier plate. However, continuous research is required on the thermoelectric refrigeration method to make it compatible with conventional refrigeration techniques.

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