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SOLAR POWERED AIR CONDITIONING

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ABSTRACT

Rising concern for global warming, energy shortage, environment degradation and oil shortage, have led many nations to adopt renewable energy. Solar energy is the most promising renewable energy as it is inexhaustible and non-polluting. Due to its high potential, solar energy has found its application in air-conditioning. With significant rise in temperature due to global warming, has compelled us to be more dependent on air-conditioners. Increase in the usage of air-conditioners comes up with the problem of increase in the consumption of energy. So, the implementation of solar powered air-conditioning system could reduce such energy consumption and will also reduce the emission of greenhouse gasses. This paper presents a prototype of solar powered air-conditioning system which uses the principle of thermoelectric cooling with the help of peltier devices. It is revealed that the proposed prototype consumes less amount of energy and has a working efficiency of 45.39%.

Keywords: Peltier Cooling, Solar Energy, Air Conditioner, Thermoelectric Cooling.

I.INTRODUCTION

Now days, due to change in climatic conditions and rising temperature due to global warming there is a significant increase in the of air conditioners and demand of air conditioning is increasing rapidly. If we still depend on these conventional electricity air conditioners and electricity generation can be done from the fossil fuel, the global warming becoming worst because of continuously emissions of greenhouse gases in the atmosphere; however the market demand of air conditioning would have been be further enlarge .there is air conditioning a standard provision for buildings in sub-tropical towns and cities. However, building electricity consumption would be more consume by the air conditioning systems [1]. Air conditioning is the phenomenon of simultaneous process of purification, humidity, temperature, and expansion of the fresh air current in acquiescence with the required of spaces needs for the air conditioning [2]. Air conditioning is defined as any process of heat removal and it is also known as refrigeration. The process harvesting could be done when there is easily available of resources so it required energy where gas and electricity commonly available. The broadening of gases and electricity tariff's solar energy's becoming good platform and attractive also while the system has established for the community [3]. Renewable energy, solar energy becoming the more safe and suitable system for initiated in the sub-tropical areas of the country's

The most endorsed category of thermic directed technology is exhaustion refrigerate. The structure has simple capacity controlling, mechanism, implementation will be easier, reliability become high, silent operation, long life and less maintenance cost would be a authenticated candidate for the efficiency and the economic utilization of solar energy for cooling appliances [3]. we have concentrate on the improve performance and development of

a simple air conditioner unit system in access to operate using electricity generated from PV(photovoltaic) system.[4]

Replacement of conventional electricity by utilizing the solar energy and installing practical technique to run their air conditioner from solar energy. the air conditioning utilizing solar energy and it obtain feasibility, a lot of testing had been done and research initiated to think, discovered something new and learn, discover the design, solar system which is made of the PV(photovoltaic) system operation would be used for air conditioning.[4]

II.THERMOELECTRIC COOLING

Thermoelectric cooling fixed order employs a pattern of semiconductors pellet intermediate of the two large electrodes. When the direct current voltage source has connected as a intermediate of two electrode and then negative charge side has become chilled and positive charge side be transformed into warmer[5][6] The negative electrode has been put as in form to connected the positive electrode and connected to the heat bore that scatter or depleted thermal energy attentive the external environment and the thermoelectric cooling is utilized in electronic system and computer to cooled the sensitive fundamental inherent such as microprocessors and power amplifiers[7][8]. Technology can be utilize in space or satellite probing to moderating the extremely temperature that occur in elements on the sunlight side and hotter component lie on the darker side of the system [9]. In scientific applications, digital camera and charge join together with the devices is sometimes, cooled by utilizing of the thermoelectric are sometime, cooled by utilizing thermoelectric cooling to minimizing thermal noise, after optimizing the image contrast, sensitivity[9]. In order to thermoelectric cooling are low efficient than compressor based refrigeration process, from a solid or liquid on a small scale where thermal energy must be transferred away, conventional refrigeration system may not be more practical than thermoelectric cooling system. It is having more number of advantage of thermoelectric cooling it includes the absences of the motion mechanical parts, physical strength, adjustability longer at work life and less sustainable requirement.[10]

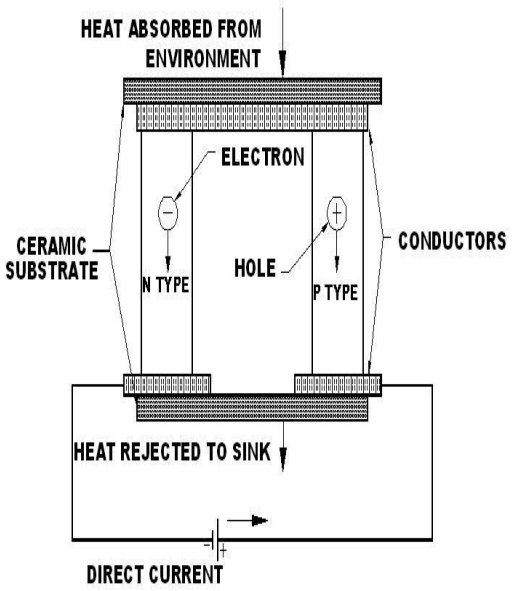

Fig. (1).schematic diagram of thermoelectric cooler

III. DESIGN ANALYSIS AND METHODOLOGY

A. Case Study

In this paper efforts have been made for designing and developing an experimental solar peltier air conditioning prototype with a cooling chamber space of 14.2cm×14.8cm×14.3cm capacity, made up of Aluminium sheet and for thermal insulation a thermocol sheet has been provided outside the box to prevent reversal of heat flow.

The various components required for the development of the proposed prototype with their specifications are given below:

1. Peltier Plate -
    - Dimension: 1.57*1.57*0.12 inch
    - Voltage: 12 V
    - Current(Max): 4.3 -4.6 A
    - Weight: 68 g
    - Material: Bismuth Telluride (Bi_2Te_3)
2. Solar Panel -
    - Voltage: 12 V
    - Current: 3 A
3. Aluminium Box -
    - Length: 22.7 cm
    - Height: 14.8 cm
    - Width: 14.3 cm
4. Battery -
    - Voltage: 12 V
    - Current: 7.5 A
5. Pump -
    - Voltage: 12 V

A digital thermometer is employed for measuring the initial temperature of the surrounding and water. The usage of the pump is to pour water in and out of the aluminium box. The complete model of the proposed prototype is shown in Fig. ()

Fig. (2). Fully Developed Prototype of Solar Powered Air Conditioner.

B. Designing and Working of the proposed prototype

The designing and working of the proposed prototype are shown in the following steps:

1. Solar panel is energized by the photons of the sunrays through which battery is attached. The battery is attached to the solar panel through a charging circuit consisting of an LED, a resistor and a diode. LED is used to see whether the battery is charging or not. A diode is used for unidirectional flow of current in the circuit i.e. only from solar panel to the battery. Since battery is of 2 Ampere Hour, it could destroy the solar panel. So, to protect the solar panel from overcurrent a diode is used. A resistor is used to drop some voltage so that LED can glow without being destroyed.
2. From the battery, we took a pair of terminals and is attached to the main switch.
3. Thereafter, main switch is connected in series with the battery and all other switches are in parallel connection with the main switch.
4. From second and the third switch, the two Peltier plates are connected. Fourth switch is connected to cooling fan and from the last switch, pump is connected.
5. A cooling fan is attached inside the aluminium box to circulate cold air coming from the cold side of the peltier element.
6. The designed Aluminum box consist of two chambers. One is the cooling chamber and other is the chamber where water is poured from the pump. Since a peltier is never connected to the supply without cooling medium, hence a water chamber is used for cooling the peltier plate.
7. Before switching on the main switch close the lid of the aluminum box first and calibrate the water temperature and the chamber air temperature. As for the working of the proposed project, switch ON the main switch first and after that gently switch ON the second and the third switch to power the Peltier plates. After that switch on the fan which will regulate the cool air inside the aluminium box.
8. Supply is provided to the Peltier plates and the fan for 15 minutes.
9. After 15 minutes, we calibrate the water and the chamber air temperature again and it is revealed that the temperature recorded is 4° C less than the temperature recorded before and the water temperature has been risen by 0.8° C.
10. After calibrating we switch off the main switch and all other switches.

IV. RESULTS & CONCLUSION

A. *Efficiency of prototype*

- Heat gained by the water = $m \times C \times \Delta T$

  Where, m = density*volume

  Volume = 8.5×14.8×14.3 cm^3

  Density (ρ) of water = 1000 kg/m^3

  C_w = specific heat of water i.e. 4.18 kJ/kgK
- Initial temp of water (t_c) = 28°C

  Temp of water after heating for 15 min (t_f)= 28.8°C

  Temperature of the cooling chamber after 15 min (t_{air}) = 34^o C

  Temp of the cold side of peltier plate after 15 min ($t_{surface}$) = 5^oC
- Cooling in the chamber is calculated by Newton's Law of Cooling and which is given by = $h \times A \times (t_{air} - t_{surface})$
- Since, according to the law of Thermodynamics, rate of heat transfer through convection in cooling chamber is equal to the heat gained by water

  $\Rightarrow h \times A \times (t_{air} - t_{surface}) = m \times C_w \times (t_f - t_c)$

  $\Rightarrow$ h = 72.027 W/m^2K
- Rate of cooling in cooling chamber = $h \times A \times (t_{air} - t_{surface})$ = 6.684 W
- Now, efficiency of the prototype (η) = Output/ Input

  $\Rightarrow \eta$ = 6.684/ (V× I)

  $\Rightarrow \eta$ = 6.684/ (12×1.23)

  $\Rightarrow \eta$ = 0.4538

  $\Rightarrow \eta$ % = 45.388%

B. *Results*

The results obtained from the proposed prototype are summarized as:

- Amount of cooling produced in the cooling chamber is 6.684 Watts
- The efficiency of the prototype is 45.39%.

C. *Conclusion*

The literature regarding the investigation of thermoelectric air conditioner using different modules has been thoroughly reviewed. From the review of the pertinent literature presented above, it can be inferred that thermoelectric technology using different modules used for cooling as well as heating application has considerable attention. Many researchers try to improve the Coefficient of Performance (COP) of the thermoelectric air-conditioner using different material.

The proposed system was targeted as an AC and temperature of the cooled air is shown to be lower than the ambient temperature. The idea of AC is based on Peltier effect, as when a current flow through thermoelectric

module it generates a heat transfer and temperature difference across the ceramic substrates causing one side of the module to be cold and the other side to be hot. The results and analysis shows that for the prevalent conditions, the compressor less AC is significantly more economical to own and operate then the conventional AC. Despite a slightly higher initial cost, the thermoelectric AC proves to be more economical, mainly due to its significantly lower operating cost. The experimental results of developed prototype of peltier AC system show that the efficiency of the prototype is found to be 45.28%.

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