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Thermoelectric Cabin Cooling System

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Abstract: ***The countries with hot weather are highly prone to cause interior damage to the car and pose a significant burn threat for babies, disabled and elderly population. The main motive of this system is to decrease the temperature inside the parked car as much as possible in order to make a significant difference for the driver and the passengers. The advantages of this system is that it utilizes solar power which is one of the increasingly used renewable energy sources in the country. The cooling system consists of thermoelectric modules and blowers such that the hot air will be blown out from the car and the interior is cooled. Although the system is tested on a car prototype, it can be further developed for the use on a real car.A thermoelectric module thus uses a pair of fixed junctions into which electrical energy is applied causing one junction to become cold while the other becomes hot. Because thermoelectric cooling is a form of solid-state refrigeration, it has the advantage of being compact and long lasting. It uses no moving parts except for some fans, employs no fluids, and do not require bulky piping and mechanical compressors used in vapour-cycle cooling systems. Such sturdiness favour thermoelectric cooling over conventional refrigeration in certain situations. The compact size and weight requirements, as well as portability in the design, rule out the use of conventional refrigeration.In this proposed work, the main aim is to develop a refrigeration system of cooling chamber. It is necessary to design a system capable of maintaining the temperature of materials between 15°C to 25°C for a long duration. Since the system has to be used in car for a long time under high temperature. Besides the system is meant for outdoor use which delivers sufficient insulation and radiation control mandatory. In order to meet worse scenario, even though the system is to designed for maintaining a fixed chamber temperature throughout the operational period, it is versatile for refrigerating the chamber from ambient temperature to the required temperature.***

Keywords: ***Thermoelectric refrigerator, Refrigeration system, Thermoelectric module, Solar panel***

I. INTRODUCTION :

A thermoelectric module thus uses a pair of fixed junctions into which electrical energy is applied causing one junction to become cold while the other becomes hot[1]. Because thermoelectric cooling is a form of solid-state refrigeration, it has the advantage of being compact and long lasting[2]. It uses no moving parts except for some fans, employs no fluids, and do not require bulky piping and mechanical compressors used in vapour-cycle cooling systems. Such sturdiness favour thermoelectric cooling over conventional refrigeration in certain situations[3]. The compact size and weight requirements, as well as portability in the design, rule out the use of conventional refrigeration.

Thomas Seebeck in 1821 discovered that a continuously flowing current is created when two wires of dissimilar materials are joined together at the ends and heated at one end. This phenomenon is known as the Seebeck Effect[4]. Later in 1834, Jean Charles Athanase Peltier a French watchmaker and physicist found that if two dissimilar metals are joined together and an electrical current is supplied it will produce heating and cooling at the ends and that phenomenon is known as Peltier effect[5][6]. In 1838 Lenz showed that depending on the direction of current flow in the system, heat could be either removed from a junction to convert water into ice, or by reversing the direction of current, heat can be generated to melt ice. The amount of heat absorbed or rejected at the junction is proportional to the electrical current intensity. The constant of proportionality is known as the Peltier coefficient[7].

II. DESIGN :

A. Specifications

Peltier effect refrigeration system consists of three thermoelectric coolers operated by the Peltier effect (which also goes by the more general name thermoelectric effect). The device has two sides, and when a DC electric current flows through the device, it brings heat from one side to the other, so that one side gets cooler while the other gets hotter. The hot side is attached to a heat sink so that it remains at ambient temperature, while the cool side goes below room temperature[8]. In some applications, multiple coolers can be cascaded together for lower temperature. The total system consists of a car setup, a radiator and a cooling fan. An effect whereby heat is given out or absorbed when an electric current passes across a junction between two materials.

The components that are used for solar panel liquid cooling and cleaning system are as follows,

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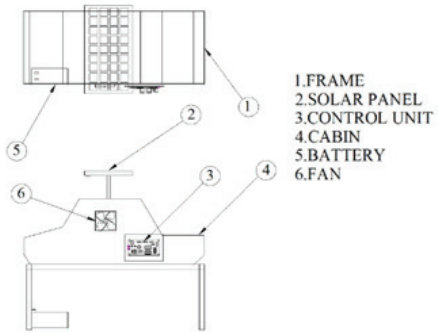

Fig 1. Smart way to reduce car cabin temperature using thermoelectric cooler

B. FRAME

This is made of mild steel material. The whole parts are mounted on this frame structure with the suitable arrangement. Boring of bearing sizes and open bores done in one setting so as to align the bearings properly while assembling. Provisions are made to cover the bearings with grease.

C. BLOWER

A centrifugal fan is a mechanical device for moving air or other gases. These fans increase the speed of air stream with the rotating impellers. They use the kinetic energy of the impellers or the rotating blade to increase the pressure of the air/gas stream which in turn moves them against the resistance caused by ducts, dampers and other components. Centrifugal fans accelerate air radially, changing the direction (typically by 90°) of the airflow.
They are sturdy, quiet, reliable, and capable of operating over a wide range of conditions. Centrifugal fans are constant displacement devices or constant volume devices, meaning that, at a constant fan speed, a centrifugal fan will pump a constant volume of air rather than a constant mass. This means that the air velocity in a system is fixed even though the mass flow rate through the fan is not. The centrifugal fan is one of the most widely used fans. At the one end of the blower the hose is fitted. The air forces the seed to the outer side.

D. BATTERY

Lead acid battery is used for storing the electrical energy from the solar panel for lighting the street.

LEAD-ACID WET CELL

Where high values of load current are necessary, the lead-acid cell is the type most commonly used. The electrolyte is a dilute solution of sulfuric acid (H2SO4). In the application of battery power to start the engine in an auto mobile, for example, the load current to the starter motor is typically 200 to 400A. One cell has a nominal output of 2.1V, but lead-acid cells are often used in a series combination of three for a 6-V battery and six for a 12-V battery. The lead acid cell type is a secondary cell or storage cell, which can be recharged. The charge and discharge cycle can be repeated many times to restore the output voltage, as long as the cell is in good physical condition. However, heat with excessive charge and discharge currents shortens the useful life to about 3 to 5 years for an automobile battery.

E. CONTROL UNIT

In automotive electronics, Electronic Control Unit (ECU) is a generic term for any embedded system that controls one or more of the electrical system or subsystems in a motor vehicle. These systems are sometimes referred to as the car's computer. Technically there is no single computer but multiple ones. Sometimes one assembly incorporates several of the individual control modules. Some modern motor vehicles have up to 80 ECUs. Embedded software in ECUs continues to increase in line count, complexity, and sophistication. Managing the increasing complexity and number of ECUs in a vehicle has become a key challenge for original equipment manufacturers (OEMs).

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F. SOLAR PANEL

Solar panel refers either to a photovoltaic module, a solar thermal energy panel, or to a set of solar photovoltaic (PV) modules electrically connected and mounted on a supporting structure[9]. A PV module is a packaged, connected assembly of solar cells. Solar panels can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 320 watts. The efficiency of a module determines the area of a module given the same rated output an 8% efficient 230 watt module will have twice the area of a 16% efficient 230 watt module.

III. RESULT AND DISCUSSION :

The solar panel is mounted at the top of the refrigerator. The cooling fan is mounted at inside of the refrigerator. The thermoelectric modules are made of semiconductor materials electrically connected in series configuration and thermally in parallel to create cold and hot surfaces. Although they are less efficient than the vapour compression system. The button switch is fixed under the solar panel. The energy from the solar panel stored in the lead acid battery. The refrigerator gets cooled by the help of solar panel. The cooling fan gets rotate and make a refrigeration cool by the solar power energy. The refrigeration gets cooling by the solar panel. So it is called solar powered thermo electric refrigeration system.

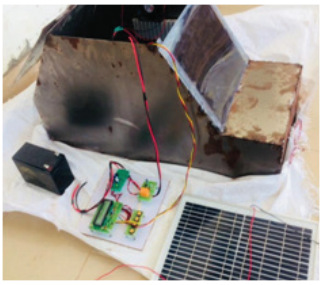

Fig. 2 Experimental set up

IV. CONCLUSION AND FUTURE WORK :

Thermally powered air conditioning is a good example of a synergistically appealing application, with high insulation often occurring where demand for air 216 conditioning is greatest. It is also conventionally powered by electricity, offering the potential to offset a high-value fuel source. In addition, solar powered air conditioning offers electricity utility companies in hot countries a way to reduce their peak requirement and thus reduce their costs by using their centralized generation plants more efficiently. There may also be technical benefits for grid operations. It is a mechanical cycle and is therefore ideally suited to electricity. While solar PV could theoretically be used to provide this power, the high cost combined with the high load requirements of cooling units makes it uneconomic except in certain niche markers, such as for offgird vaccine refrigeration. In many hot countries, the peak yearly demand from electricity grids is during the middle of the day in summer months. Indeed, cooling-induced brownouts are 217 common in the US and the ‘peak effect’ due to air conditioning can be expected to rise in response to population shifts to warmer regions, air conditioning penetration to cooler climates, and the possible effects of climate change itself. The identification of a number of Solar Cooling and Heating Program designs in development could signify a breakthrough in the cost of solar power. While applications for Solar Heating and Cooling Program are not restricted to solar cooling, this would appear to be a very attractive combination and one that could find early commercialization. More detailed research will be required to assess both the technical and economic potential of Solar Cooling and Heating Program, but the future seems to be bright for this emerging technology. There is a lot of scope for further study in this area for achieving sustainable development.

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