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Investigations on optimal cooling with Solar Powered Thermoelectric Refrigeration

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Abstract: ***This paper presents the design of a portable solar thermoelectric refrigerator for people living in remote areas and an outdoor application where electric power supply is absent. Nowadays the energy conception for refrigeration and cooling system is increasing as currently reached 20% of the total electricity conception in the world. Solar thermoelectric cooling, using solar energy, converts the sun's radiant energy into electrical energy and this electric energy is used for the refrigerator. Refrigeration and air conditioning has a huge impact on the environment as they affect the stratospheric ozone which is primarily linked to release as well as global warming, atmospheric pollution and a worldwide shortage of energy. This system is to improve the optimum performance of thermoelectric refrigerator cooling by developing effective methods to radiate the heat from the side of the thermoelectric module. The proposed system reduces the environmental issue and utilizes the free solar energy.***

Keywords: solar power, thermo electric refrigeration, optimum cooling.

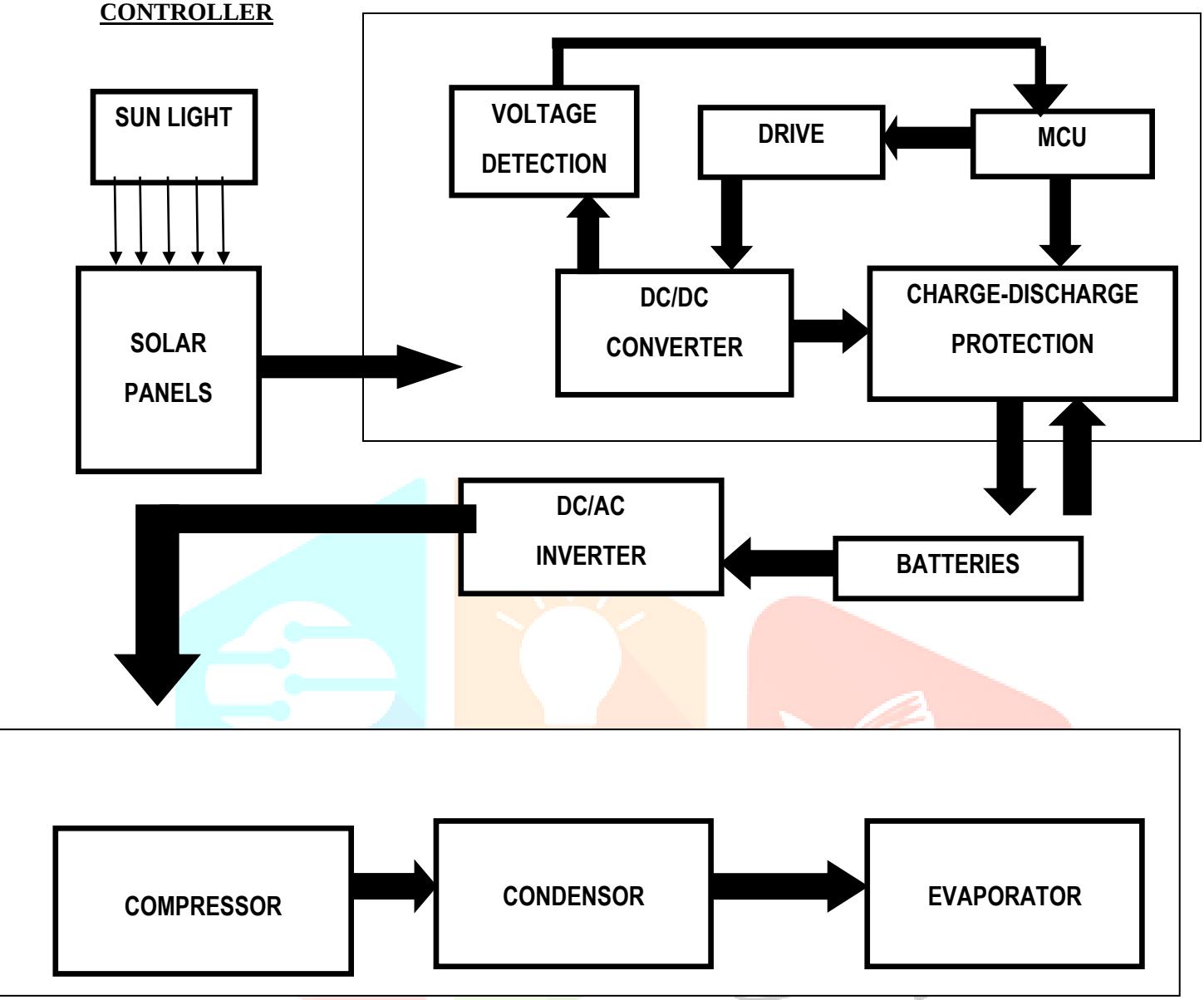
I. INTRODUCTION

The preservation of food and other elements in this modern world is more important. It is mandatory to preserve things for the futuristic demand in times of the crisis. But the power consumption of these preservation areas is yet to be considered. This proposed system uses the concept of the solar refrigeration technology which reduces the power demand for the preservation. The main element of power is the solar energy which is trapped by the solar panel and the solar energy is converted into the DC power supply which powers the overall circuit. Then the DC supply is used to charge the battery which act as the secondary back up power in needy time. The circuit is controlled by the microcontroller development board which acts as the controlling circuit. The converter sends the signal to the voltage divider which doubles the supply and further the supply powers the inverter. This is the place where the dc supply is converted into the ac power supply. The 24V AC is insufficient to power the compressors. A step up transformer is used to boost up the given power into the 230V AC supply. The compressor pumps in the cold air and pumps out the hot air. The input and the output power are monitored by the controller and it is displayed on the LCD display. The temperature sensor senses the overall temperature of the chamber and sends the signal to the controller where the controller monitors the temperature level and intimates the user by displaying the exact condition of the overall system. This is widely helpful in reducing the power consumption and also the areas without the electricity can attain the features of modern technology

II. PROPOSED SYSTEM

A new design has been done to improvise the cooling effect by reducing the temperatures in the compartments using thermoelectric solar refrigeration with the regular demand for improved cooling technology. This enhances performance, reliability, and reduction in operating cost. A thermoelectric cooling may be considered as a potential implementation. The thermoelectric solar refrigeration devices can act as coolers, power generators, or thermal energy sensors and are used in almost all the fields such as military, aerospace, instrumentation, biology, medicine and industrial or commercial products. A temperature reduction of 12^{o}C without any heat load and 10^{o}C with 100 ml of water in refrigeration space at 24^{o}C ambient temperature in the first 30 minutes has been experimentally found as optimized operating conditions.

SOLAR CONTROLLER



The electrical power drives the compressor to circulate refrigerant through a vapour compression refrigeration loop that extracts heat from an insulated enclosure. This enclosure includes the thermal receiver and a phase change material. Condenser is a device or unit used to condense a substance from its gaseous to liquid state by cooling it. A refrigerator uses a condenser to extract the heat from interior chamber of the unit to the outside air. The compressor is used to increase the pressure and the saturation temperature of the refrigerant vapour to high enough level so the refrigerant can condense by rejecting its heat through the condenser. It is an important component together with other major components in a refrigeration system such as compressor, condenser and expansion device. The reason for refrigeration is to remove heat from air, water or other substance. In this case the liquid refrigerant is expanded and exported. An evaporator fan draws air from the refrigerator and blows it over the evaporator coils. The liquid refrigerant absorbs heat from the air and blows back into the refrigerant. The liquid refrigerant starts to vaporize as it heats up and moves to the compressor.

III. CIRCUIT DESCRIPTION

This system consists of the circuits for solar power generation, voltage divider and DC to AC power conversion. Photovoltaic modules uses light energy which contains photons from the Sun light and generate electricity by the photovoltaic effect. The majority of modules is wafer-base crystalline silicon cells or thin-film cells. The structure of solar module has load carrying member is fixed on the top or bottom layer. Cells should have protection coating to meet mechanical damages and free from moisture. Most modules are rugged and flexible in generating photoelectric voltages manufactured based on thin-film cells. The cells must be connected electrically in series and parallel to generate required voltage levels. A PV junction box is connected to the backside of the solar panel and is easy to interface with output circuits. Externally, photovoltaic modules use MC4 connectors. This type is to facilitate easy weatherproof connections to the rest of the system. USB power interface can also be used. Solar cells have electrical connections in series to achieve a desired output voltage or in parallel to provide desired load current requirements. Bypass diodes are connected externally to maximise the output energy from each module sections. Unique solar PV modules uses as concentrators in which light is focused by optical devices on smaller cells. Solar panels also use metal frames consisting of racking components, brackets, reflector shapes, and troughs to better support the panel structure.

A solar inverter is used for both grid-connected and off-grid systems as specially designed circuits. They are designed with photovoltaic arrays to meet the requirement of maximum power point tracking and anti-islanding protection. Solar micro-inverters are custom built design to convert solar panel output of dc into required magnitude and frequency ac output so that overall efficiency of the system is marginally improved. The output from several micro-inverters is connected in parallel to synchronise with electrical grid. This simple low power dc to ac inverter (dc to ac converter) circuit converts 24V DC to 230V. It can be used as inverters for home needs to enable light loads at the time of electricity failure. The inverter converts the dc power supply into the ac power supply with the help of the relay circuits which are present inside the inverter. The 24V dc is converted into the 24V ac supply. The 24V dc is insufficient to run the compressor so the step up transformer is used to boost up the voltage to 230 V ac supply.A voltage divider is a simple circuit which turns a large volume into a smaller one using just two series resistors and an input voltage, an output is a fraction of the input.

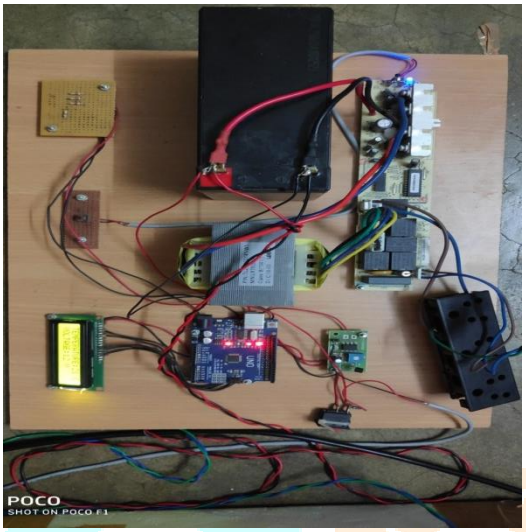
The analog sensor on the Arduino board senses the voltage on the analog pin and converts it into a digital format that can be processed by the microcontroller. The input voltage is fed to the analog pin (A0) using a simple voltage divider circuit comprising resistors R1 (100K) and R2 (10K). With the values used in the voltage divider it is possible to feed voltage from 0V to 50V into the Arduino board. The junction on the voltage divider circuit connected to the Arduino analog pin. In other words, when measuring 50V, the Arduino analog pin will be at its maximum voltage of 5V.

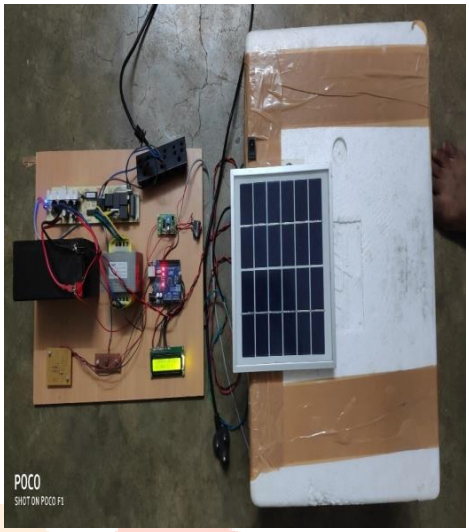
The LM35 series of sensors are integrated circuit to measure the temperature with an output voltage directly proportional to the centigrade temperature. The low output impedance, linear output and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy. Temperature sensor is a device which senses variations in temperature across it. It gives readings in centigrade (degree Celsius) since its output voltage is linearly proportional to temperature. The LM35 temperature sensor is used to detect precise centigrade temperature. The output voltage of this IC sensor is linearly comparative to the Celsius temperature. The operating voltage range of this LM35 ranges from -55 to 150C and it has low-self heating.

IV.OUTPUT AND RESULT

Hardware Modules:

The proposed hardware prototype module for experiment is as shown below.





The results of battery charging with respect to time in a day are tabulated.

TIME	TEMPERATURE	SOLOR OUTPUT VOLTAGE IN V	BATTERY OUTPUT POWER DC IN W	REFREGERATION TEMPERATURE
6 am	25	3	36	25
7 am	26	3	38	24.8
8 am	28	3.1	40	24.6
9 am	30	3.1	43	24.2
10 am	33	3.1	36	24
11 am	35	3.2	50	23.7
12 pm	36	3.2	53	23.4
1 pm	37	3.3	56	22.8
2 pm	38	3.5	60	22.1
3 pm	40	3.5	63	21.6
4 pm	37	3.3	67	21.1
5 pm	36	3.2	70	20.3
6 pm	35	3.2	72	19.4

V. CONCLUSION

This proposed system minimises the electrical necessity of the household by using the alternate way of power source for refrigeration which is solar power. The solar-powered panel powers the battery and the battery act as the secondary source fed the motor and the inverter circuit. The motor drives the condensing unit of the refrigerator which is the heat sink. The inverter is used to power other small household appliances, which is an additional feature of this system. This system saves energy as well as the economy of the individual. The futuristic developments may lead to a great impact on the energy sector as well as the storage facility in space. As the moisture in the unit is used to cool the unit and it is completely sealed it can be used in a vacuum atmosphere

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