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Solar Panel Cooling System

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ABSTRACT

This project highlights two different cooling techniques to diminish the operating temperature of the PV cells. This review project focuses on the enhancement of the performance of the small domestic use PV systems by maintaining the temperature of the cells as low as possible. Distinctive cooling practices have been look over experimentally and numerically the bearing of the operating temperature of the cells on the electrical and thermal performance of the PV systems. It was notorious that the water spray cooling system has a proper crash on the PV panel performance. So the water cooling is one way to augment the electrical efficiency of the PV panel. The performance was evaluated under three different cases:

(a) without panel cooling,
(b) with water cooling on beneath the surface of the panel with copper tube,
(c) with water cooling beneath the surface of the panel with jute.

The outcome of different cooling cases on the various performance parameters such as voltage, current, power output, pump efficiency and system efficiency has been analyzed and discussed. The results showed that the water cooling on the bottom of the panel and beneath the surface of the panel with jute has considerable influence on performance enhancement when compared to other cases.

I. INTRODUCTION

The renewable energy use becomes more popular during the increase of human population and the environmental issues. The solar energy is one of the main type of the renewable energy sources that has attracted many researchers in the region of the world to work on. There are two types of energy that can be produced from the solar energy, electrical energy and thermal energy. The electrical energy can be produced by using photovoltaic (PV) cells.

The PV cell openly converts the incident solar irradiance to electricity. The most efficient, sustainable, and eco-friendly systems are the PV modules which convert small part of the solar irradiance to electricity. The residual part of the solar irradiation then converts into heat, which increases the temperature of the cells and reduces the performance of the PV module. The maximum accepted PV cells temperature with solar irradiance of 1000 W/m2, 70% of absorption rate and no-winds is 60°C while for the winds speed of higher than 4 m/s the PV cells temperature is lower than 40°C. The maximum output power, short circuit current and open circuit voltage are the main parameters which are influenced by the temperature discrepancy of the cells temperature. As the temperature increases, the open circuit voltage and the maximum output power reduces and the short circuit current rises. The impact of the temperature of the cell on the performance of mono-crystalline silicon photovoltaic cell was investigated experimentally. The impact of the cell temperature on the performance of the photovoltaic panel with continuous irradiance value were investigated experimentally and numerically. Finally, Results indicated that the efficiency and output power were reduced with the raised temperature of the cell. The decrease in efficiency is caused by the temperature difference and therefore the location of the PV panel is a key factor to be considered.

II. METHODOLOGY

This project is alienated into two divisions, hardware development and programming. Figure. 1 demonstrates block diagram of the project.

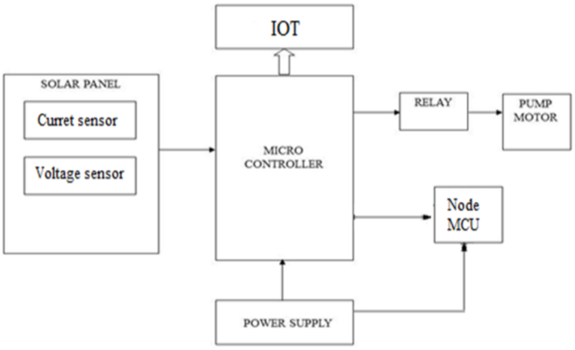


Figure 1: Block diagram of the project

The objective of the project is to develop the comparative study of three cooling system such as atmospheric air, cooper pipe and jute. It is used to eliminate the waste heat and reduce the cost of the panel with efficient cooling system. It helps to improve the efficiency of the solar panel. The LDR senses the light intensity of the panel and the temperature senor senses the temperature of the panel. When the excessive heat occurs in the panel, the microcontroller sends the signal to the relay. The relay operates the pump motor and the water pump limits the excessive heats due to the sunlight through the copper pipe. Jute is fitted under the solar panel. The two ends are immersed in water to reduce the heat. Figure 2 and Figure 3 shows the cooling system using copper pipe and jute.

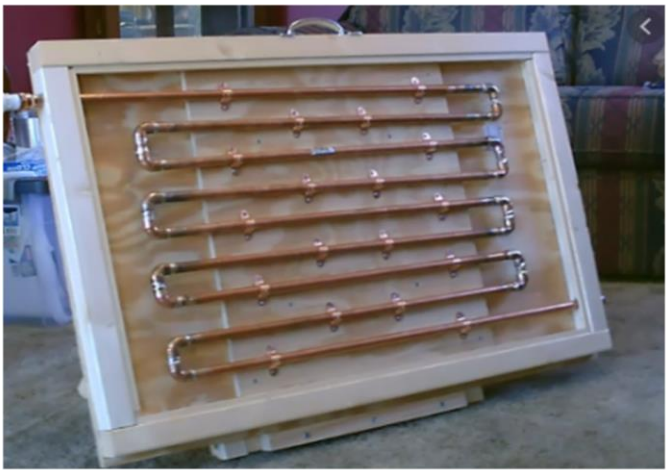


Figure 2: Cooling system using copper pipe

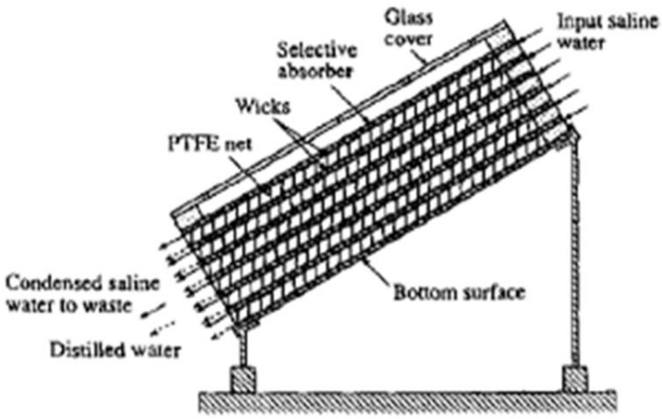
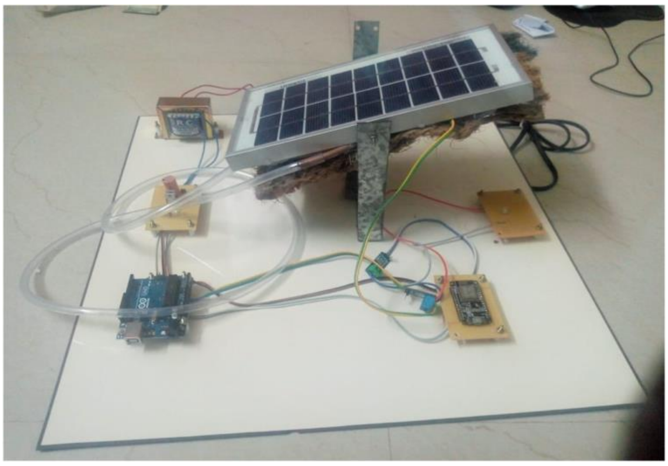


Figure 3: Cooling system using jute



System operation:

1) Sensors:

A sensor is a contrivance that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other phenomena. The output is generally a signal that is converted to human related and usable form.

A. Light Dependent Resistor (LDR):

An LDR is a component that has a (variable) resistance that revise with the light intensity that cataract upon it. This agrees to them to be used in light sensing circuits. LDR's are light dependent devices whose resistance is decreased when light falls on them and that is increased in dark. It can perceive the quantity of light falling on it and thus can prophesy days and nights. These resistors are frequently used in a lot of circuits where it is requisite to sense the incidence of light. LDRs are cheap and are readily available in many size and shapes. They requisite very small power and voltage for its manoeuvre. Figure 4 shows the LDR sensor circuit.

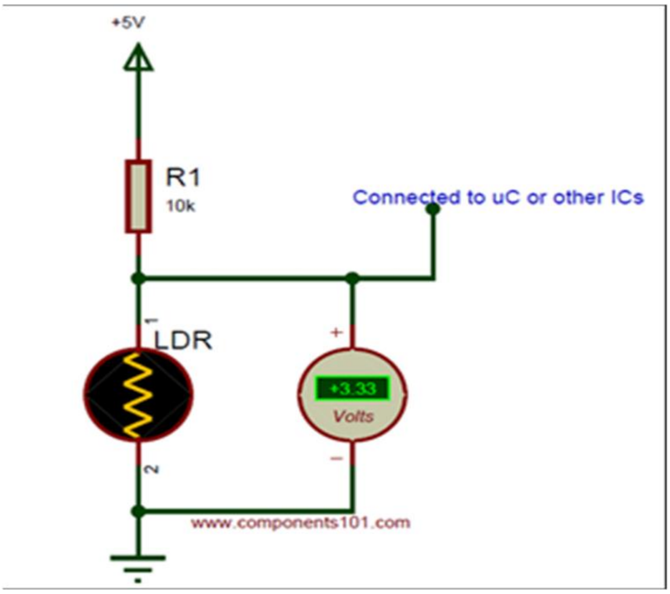


Figure 4: LDR sensor circuit

Light Sensor (LDR) circuit is shown in fig. 5. The relationship between the resistance RL (LDR) and light intensity Lux for a typical LDR is shown in (1).

RLDR = 500/Lux (1)

If the LDR connected to 5V through a 3.3k Ω resistor, using the voltage divider rule, the output voltage of LDR is shown in (2).

Vo=5×(RLDR/ (RLDR +3.3)) (2)

Light intensity measurement formula is shown in (3).

Lux =((2500/Vo)–500)/3.3 (3)

B. Temperature Sensor:

Here LM35 is used as a temperature sensor.LM35 is a temperature sensor that outputs an analog signal which is proportional to the direct temperature. The output voltage can easily be read to obtain a temperature reading in Celsius. With LM35,the temperature can be measured more exactly than with a thermistor. It also mobs low self heating and does not cause more than 0.1◦c temperature rise in still air. The working principle of LM35 temperature sensor we have to know the linear scale factor. In the features of LM35 it is given to be +10 mills volt per degree centigrade. It means that with augment in output of 10 mills volt by the sensor vout pin the temperature value increases by one. For example, if the sensor is yield 100 mills volt at vout pin the temperature in centigrade will be 10-degree centigrade. The same goes for the negative temperature reading. If the sensor is yield -100 mills volt the temperature will be -10 degrees Celsius.

2) Liquid Crystal Display (LCD):

LCD (Liquid Crystal Display) is a variety of flat panel display which utilizes liquid crystals in its primary kind of operation. LEDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smart phones, televisions, computer monitors and instrument panels.

Numerous types of LCDs are available in market such as 16x2, 16x4, 20x2, 20x4, graphical LCDs (128x64) etc.. In this paper, 20x4 LCD display is used to display the values of the measured parameters.

3) I2C Module:

I2C is a serial protocol for two-wire interface to link up low-speed devices like microcontrollers, EEPROMs, A/D and D/A converters, I/O interfaces and other related peripherals in embedded systems. The preliminary I2C provisions definite maximum clock frequency of 100 kHz.
I2C merges the best features of SPI and UARTs. With I2C, you can link up multiple slaves to a single master (like SPI) and you can have multiple masters scheming single, or multiple slaves.

4) Arduino Uno:

Arduino is an open source electronics platform or board which can be easily programmed, erased and reprogrammed at any instant of time. It is a microcontroller board pedestal on the ATmega 328. It has 6 MHz ceramic resonator, a USB connector, reset button and a power jack.It has 14 digital I/O pins and ICSP header.

5) Two channel Relay:

A relay is defined as an electrically operated switch, their main task is controlling circuits by a low-power signal or when some circuits must be inhibited by one signal. The Arduino relay module is considered for a wide range for micro controllers such as the Arduino board, AVR, PIC, ARM, with digital outputs.
Two channel relays that are electrically isolated from the controlling input. The relays can be worn to switch higher voltage and current loads than a microcontroller can conventionally achieve.

6) Pump motor:

A DC motor is whichever of a class of rotary electrical machines that renovates direct current electrical energy into mechanical energy. It works on the fact that a current carrying conductor placed in a magnetic field experiences a force which causes it to rotate with respect to its original position.

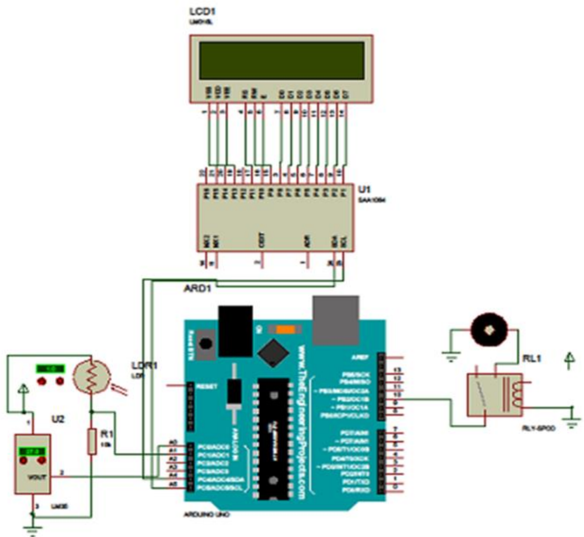


Figure 5: Connection diagram of the project

The efficiency of the solar panel is calculated by using the below formula (5).

Maximum Efficiency=Pmax/(E*Ac)*100 % (5)

III.CONCLUSION

The present article has tinted different techniques of cooling for small domestic use photovoltaic panel. It is concluded that: The temperature of the PV cell decreases about 12° C by means of heat sink with air cooling. In case of air cooling the electrical efficiency of the system does not always increase with increasing the bunch flow rate of the air but there is a best possible value of heap flow rate. This work effectively demonstrated the choice of a heat pipe cooling solution for concentrating photovoltaic cells. Heat pipes can be used to submissively remove the heat, accepting a high heat flux at the CPV cell, and rejecting the heat to fins by natural convection, at a much lower heat flux. Copper and aluminium heat pipes with various working fluids were examined, and a copper heat pipe was chosen, with water as the working fluid. By using jute material as a cooling pad beneath the panel surface the efficiency increase at particular rate. And also this method is cheapest cooling technique than other methods.

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