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A Novel Hybrid Solar System Using Nanofluid

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Abstract

This paper presents a novel based hybrid solar system using Nanofluids. The conversion efficiency of the commercial solar cell is about 6-15%. More than 85% of the incoming solar energy is either reflected or absorbed as heat energy. In order to get more electricity and thermal power from hybrid system, it is necessary to cool the solar cell and decrease its temperature. The conventional heat transfer fluids such as water, Ethylene Glycol etc. are used as a coolant in the commercial hybrid solar cell. But the conventional coolants are having poor thermal conductivity compared to nanoparticle suspended fluid (Nanofluid). In this paper the performance of the solar photovoltaic cell is investigated experimentally. The experimental result shows that the electrical and thermal efficiency of hybrid solar system increases considerably by using the nanofluid as a working fluid.

Keywords: hybrid system; nanofluidefficiency; heat transfer.

1. Introduction

Solar energy is one of the cleanest renewable sources of energy available. Hybrid system is the integration of photovoltaic cell and solar thermal collector in which the photovoltaic cell converts photos into electricity and thermal collector capture the remaining energy and removes waste heat from the PV module. The overall efficiency of this system is comparatively high than the individual Photovoltaic system or a solar thermal system .In this system a thermal collector is placed underneath of the PV panel to remove the heat generated in the PV panel, because the Photovoltaic cells suffer from a drop in efficiency with the rise in temperature due to increased resistance. Such system should to cool by fluid stream like air, water, refrigerant or any other coolant to improve the efficiency by lowering the resistance of PV panel. In this paper the nanofluid is used as a coolant to remove the heat from PV panel to improve the efficiency.

2. Selection of PV Cell

PV cell are used to convert solar energy into electrical energy. This electrical energy can be used to power appliances in the home. The selection of PV cell depends upon the following factors which are[2]:-

- Determination of power consumption
- Calculation of total watt hours use per day by each appliances
- Calculation of total watt hours needed by the PV cell
- Size of PV module

Equation

Total appliance use= (Appliance power) X (No. of hours running) (1)

Total PV panel energy needed= (Total appliance use) X (1.3) (2)

Total W_p of PV panel capacity needed= (Total PV panel energy needed)/3.4 (3)

No. of PV panel needed= (Total W_p of PV panel capacity needed)/110 (4)

3. Al_2O_3 /Waternanofluid

In this experiment Al_2O_3 /water nanofluid is used and the nanoparticle size is less than 50 nm . The steps include Sonication and Magnetic Stirring. Sonication is a process in which probe sonicator is dipped into the base fluid containing the nanoparticles. When power is switched on the probe produces high frequency ultrasound which disperses the nanoparticles evenly. The dispersion of particles using sonication provides stability to nanoparticles in the base fluid than magnetic stirring. Magnetic stirring is a process in which the nanoparticle are added to a beaker containing base fluid continuously rotated in a magnetic field with a stirrer capsule inside the beaker.

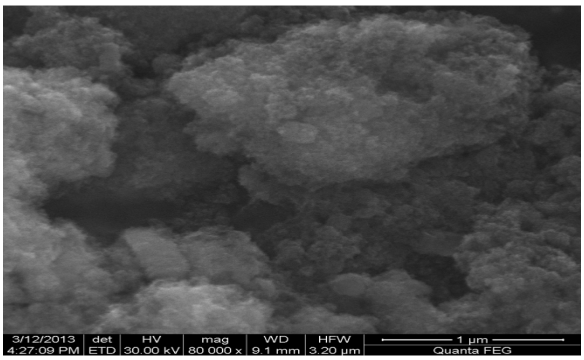

Fig. 1: SEM Image of Al_2O_3/water (0.5 volume %) Nanofluid before sonication.

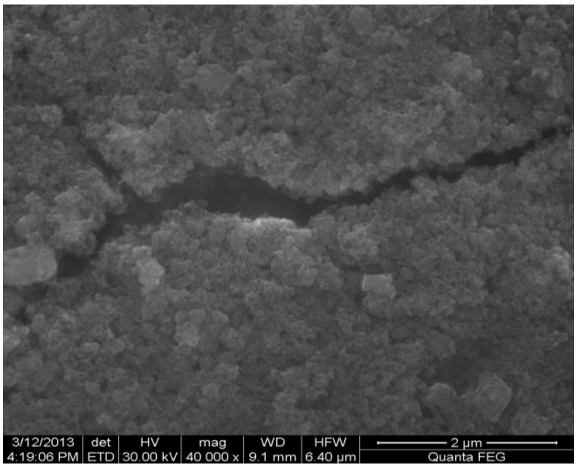

Fig. 2: SEM Image of Al_2O_3/water (0.5 volume %) Nanofluid after sonication.

This enables continuous stirring of the nanoparticles and is only possible if the nanoparticle used is nonmagnetic materials. Fig1. Shows the SEM image of the Al2 O3 /water nanofluid prepared before sonication. Fig 2 shows the image of suspended nanoparticles in the water after sonication in that the nanoparticles are distributed more evenly.

4. Experimental Setup

A flat plate solar collector is attached to a PV panel. The solar flat plate collector consists of an oscillatory tube below which a mirror is kept so as to prevent the loss of incident light rays. This setup in kept at an angle to maximize the solar collecting area. Fig 3, shows the experimental setup consists of three storage tanks. The first storage tank is used for storing the nanofluid and the other two are used to store city water and hot water respectively. One pump is used to pump nanofluid into the solar collector, the output of the solar collector is attached to the heat exchanges that exchange the heat from hot nanofluid to cold water then the cold water becomes hot water by circulation the nanofulid to the thermal collector. In this setup two types of sensors are used to monitor the water temperature and water level. When water gets heated sufficiently it is released for household purposes. Further the sensor also checks the temperature of the nanofluid and releases water into the solar collector so as to cool down the fluid

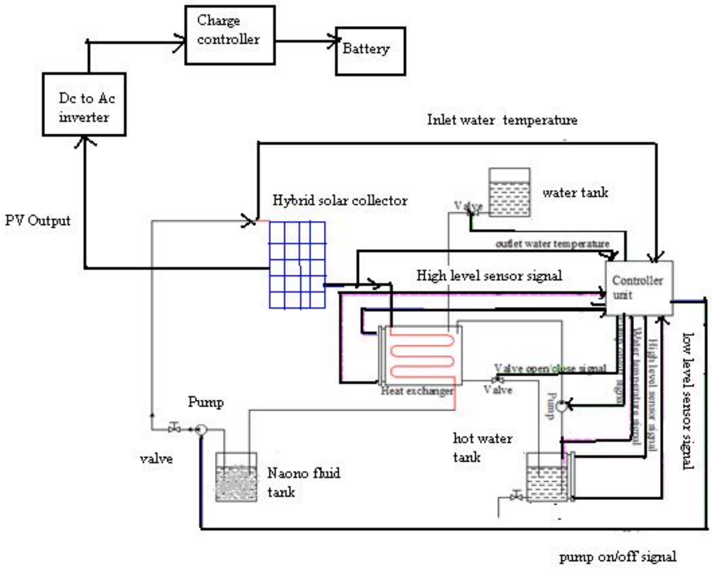

Fig. 3: Hybrid solar system for hot water supply and battery charging.

5. Results and Conclusions

Typical solar cells have an efficiency of 6-15%, using the PV/T technology it can be observed that the electrical efficiency increases. Further using nanofluid having excellent heat transfer characteristics in the thermal collector the electrical efficiency of the PV panel as well as the thermal efficiency of the solar collector would increase. The experimental results have been taken using LABVIEW interfaced DAC card in that the thermal collector is kept for 15 min to capture the sun energy .the results shows (Fig4, 5) that the rise in temperature of thermal collector using nanofluid compared to the water as a heat transfer fluid

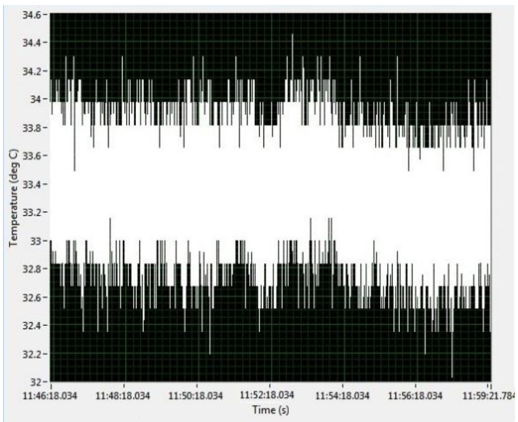

Fig. 4: Temperature rise using nanofluid in thermal collector.

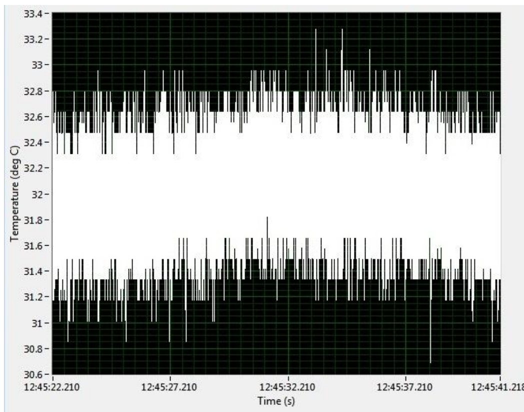

Fig. 5: Temperature rise using water in thermal collector.

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