Experimental Investigation of CuO and SiO_2 Nano Particles with Water on Solar Flat Plate Collector

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***Abstract*—Renewable energy is an alternative source. Among all renewable energies, we have solar energy in abundance and solar collectors are commonly used to harvest the energy. The conventional fluids which are used as the heat transfer medium in solar collectors suffer from poor thermal and heat absorption properties. It has been found that these conventional fluids have a limited capacity to carry heat up, which in turn limits the collector performance. It has been observed that for conventional fluids, suspending the nanoparticles in a liquid (Nanofluid) can be a good substitute because of the improved thermal properties. A new type solar collector named 'Direct Solar Absorption System' (DSAS) is used as the experimental set-up. DSAS is more efficient collector then the conventional type solar collector.**

Keywords: Nanofluid. Flat-plate, Solarcollector, water-CuO, SiO_2.

I. INTRODUCTION

Sun is the main source of energy in solar system. It offers use the energy of great potential in terms of supplying the world's need. As the primary energy resources are depleting continuously, solar energy draws attention of researchers throughout the world. Solar energy is one of the alternative energies that have vast potential. It is estimated that the earth receives approximately 1000W/m^2 amount of solar irradiation in a day [1]. The solar radiation incident on the Earth's surface is comprised of two types of radiation – beam and diffuse, ranging in the wavelengths from the ultraviolet to the infrared (300 to 200 nm), which is characterized by an average solar surface temperature of approximately 6000°K[2] . The mount of this solar energy that is intercepted is 5000 times greater than the sum of all other inputs – terrestrial nuclear, geothermal and gravitational energies, and lunar gravitational energy[3]. To put this into perspective, if the energy produced by 25 acres of the surface of the sun were harvested, there would be enough energy to supply the current energy demand of the world. When solar radiation incident on a surface then some of this radiation is absorbed and in turn, increase the temperature of the surface. As the temperature of the body increases, the surface loses heat at an increasing rate to the surroundings. Steady-state is reached when the rate of the solar heat gain is balanced by the rate of heat loss to the ambient surroundings The total energy received from the sun, per unit time, on a surface of unit area kept perpendicular to the radiation, in space, just outside the earth's atmosphere is known as Solar Constant. The solar radiation that reaches the surface of the earth is known as beam (direct) radiation, and the scattered radiation that reaches the surface from the sky is known as sky diffuse radiation.

II. EXPERIMENT STUDY

A. *Material selection criteria*

- *Glass*-low iron tempered and durability
- *Absorber plate*-high thermal conductivity,absorbe maximum amount of radiation
- *Tube*-high thermal conductivity
- *Insulation and outer cover*-low thermal conductivity,resistance to heat

B. *Flat plate collector*

It basically consists of a flat surface with high absorbtivity for solar radiation, called the absorbing surface, is a schematic representation of a typical flat-plate solar collector. Typically metal plates, usually of copper, steel or aluminum material with tubing of copper in thermal contact with plates, are the mostly commonly used materials. The absorber plate is usually made from a metal sheet 0.3 to 0.5 mm thickness. For the absorber plate, corrugated galvanized sheet is a material widely available throughout the world and it is one of the simplest particle applications. The methods of bonding and clamping tubes to flat or corrugated sheet is the tube in strip or roll bond design, in which the tubes are formed in the sheet, ensuring a good thermal bond between the sheet and the tube.fig(1)

C. Selection of Materials for flat-plate collectors.

(a)Absorber Plate Materials:

- The collector absorber plate should have high thermal conductivity, adequate tensile and compressive strength, and good corrosion resistance.
- Copper is generally preferred because of its extremely high conductivity and resistance to corrosion. Collectors are also constructed of aluminium, steel and various thermoplastics.
- Absorber plates for flat-plate solar collectors were usually constructed with tubes soldered or welded onto a metal plate, which was then blackened.

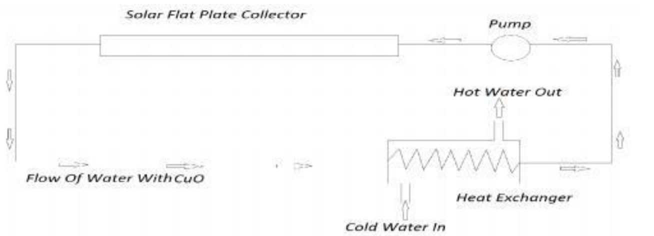
(b) Cover plate

The cover plate through which the solar energy must be transmitted is also extremely important to the function of the collector. The purposes of the cover plate are:

1. To transmit as much solar energy as possible to the absorber plate
2. To minimize heat loss from the absorber plate to the environment
3. To shield the absorber plate from direct exposure to weathering and
4. To receive as much of solar energy as possible for the longest period of time each day.

- The most critical factors for the cover plate materials are strength, durability, non-degradability and solar energy transmission.
- Tempered glass is the most common on to a flat-plate collector, is highly resistance to breakage both from thermal cycling and from natural events. Glass is also effective in reducing radiated heat loss because it is opaque to the longer wavelength infra-red radiation re-emitted by the hot absorber plate.

`D. Work model



Solar flat plate collector

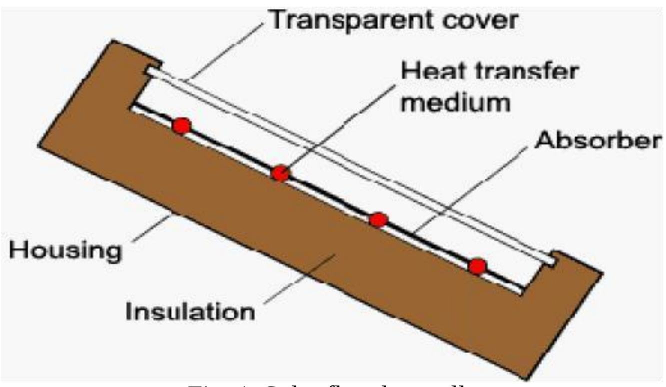


Fig..1. Solar flat plate collector

E. Pyranometer

A pyranometer is an instrument which measures total or global radiation over a hemispherical field of view. It is a sensor that is designed to measure the solar radiation flux density from a field of view of 180 degrees. The name pyranometer is originated from greek word "pyr" meaning "fire" and "ano" meaning "above sky". The pyranometer measures both beam as well as diffused radiations. To make a measurement of irradiance, the sensitive surface of pyranometer. The temperature difference between hot and cold junctions is a function of the radiation falling on the surface. A pyranometer produces voltage as a function of the incident radiation, from the thermopile detectors. The black coating on the thermopile sensor absorbs the solar radiation. This radiation is converted to heat. The heat flows through the sensor to the pyranometer housing. The thermopile sensor generates a voltage output signal that is proportional to the solar radiation

F. Properties of nano-fluids

Thepropertiesof nanoparticles and thermal properties of Nano fluidsas thebasis of research on Nano fluids application.Specific heat, thermal conductivity and density of different nanoparticles. Improvement in thermal properties of nanofluids such as thermal conductivity and convective heat transfer. However, all this special characteristics cannot be achievedunless the nanoparticles are properly dispersed and stable. Surfactants can play a major role in achieving better dispersion and stability of nanofluids.

G. Insulation

Insulation which should be provided at the back and sides to minimize the heat losses. Thermal insulation of 25 to 50mm thickness is usually placed behind the absorber plate to prevent the heat losses from rear surface. Insulation material is generally mineral wool or glass wool or a heat resistant fiber glass.

III. TESTING DETAIL

- Performance test on water with copper oxide
- Performance test on water with silicon di oxide
- Performance test on water

IV. CONCLUSION

A Direct Absorption Solar Collector was modeled numerically using a 2-dimensional heat transfer analysis. A nanofluid a mixture of water and copper oxide and silicon die oxide nanoparticle was used as the working fluid in the solar collector. The influences of various parameters, such as nanoparticle size and volume fraction, and collector geometry on the collector efficiency were studied, and finally the performance of this collector was compared with that of a conventional flat-plate type collector. The collector efficiency was found to increase with particle volume fraction, Finally the results showed about 10% higher absolute efficiencies for the nanofluid-based Direct Absorption Solar Collector in comparison with conventional flat-plate type collectors that use pure water, under similar operating conditions.

1. By using CuO nanofluid in DASC efficiency enhancement on the order of 4 – 6%, when compared to water.
2. One of the main reasons of getting higher efficiency is the very small particle size, which enhances the absorption capacity of nanofluid so, improvement in efficiency could be obtained by using various particle size distribution.
3. By overcoming the above problems the improvement of collector efficiency can be achieved up to 5– 10 %

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