

Thermal Performance of Solar Water Heater with Nano fluids

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Abstract

This paper aims that to present an analytical investigation on the performance of energy on the solar water heater with hybrid Nano fluids where we are using Al_2O_3 with SIC, Al_2O_3 with CUO, and TiO_2 with SiO_2 , which are hybrid Nano fluid and we are using water as base fluid. These hybrid Nano fluids are used to increase the Thermal Efficiency of the solar water heaters. Objective of this research work is to find out the thermal efficiency of flat plate solar collector for different working fluids and comparing different working fluid for flat plate solar collector and checking the best effective results out of them.

Keywords: nanofluids; renewable energy; solar energy, water heater

1. Introduction

Sunlight based vitality is one of the cleaner types of sustainable power source assets. The regular sun oriented gatherer is a settled innovation, which has different applications, for example, water warming, space warming and cooling. Nonetheless, the warm productivity of these authorities is restricted by the assimilation properties of the working liquid, which is extremely poor for commonplace traditional sunlight based level plate gatherer. As of late utilization of Nano liquids, which is fundamentally fluid nanoparticles colloidal scattering as a working liquid has been found to upgrade sun based level plate gatherer warm proficiency most extreme by 30 percent. Prerequisite of vitality is expanding step by step since total populace is additionally expanding. Vitality can be sort of inexhaustible or non-sustainable. Sustainable is the type of vitality that can be reused and are effectively accessible in nature like sun powered vitality, geothermal vitality, wind vitality, tidal vitality and so forth non-sustainable power source goes under the sort of vitality which is gotten from non-renewable energy source as like coal, oil and other sub-parts. The non-sustainable power source supplies are getting depleted with constant use. So to finish this necessity there is just a single excellent way that is to utilization of sun based vitality in immediate or backhanded manner.

Sun based vitality is most regular vitality, which gives enormous measure of intensity. The wellspring of sun powered vitality is sun watts are the vitality which strike on earth surface. Sun gives us 35 thousand times more force than we really need. In any case, of complete sun based vitality arriving at the world's surface just 7 to 8% is being used. Vitality originates from sun as electromagnetic wave which has frequency in the middle of 0.2 to 0.4 micrometers. Sun based radiation can partition one is immediate radiation and other is diffuse radiation.

Sunlight based vitality is utilized in different fields like Heating and cooling of private structure, sun oriented water warming, sun based drying of farming and animal items, Salt creation by vanishing of seawater, sun based

cookers, and sun powered motors for water siphoning, Solar Refrigeration, Solar electric force age and sun based photograph voltaic cells [1].

2. Experimental Setup

It has been observed from the literature review of flat plate solar collector using Nano fluid as working fluid that by using Nano fluid as working fluid enhances the performance of flat plate solar collector. And also increases the heat transfer rate between fluid and plate of solar collector.

There are many types of equipment's used in this experimental work. For examine the efficiency, flat plate solar collector is used in this experimental work [2]. Flat plate solar collector comes under tube and plate type collector. The work of solar collector is to collect solar energy [3]. That heat energy is useful for many works. There is different type of material is used in bases of their work. For example aluminum is used in absorber. More information about experimental set up.

Different components of flat plate solar collector.

- Header pipe
- Riser tube
- Absorber plate
- Casing
- Insulation
- Glass cover

All riser tubes are associated with header. Distance across of header is 3 cm and thickness of header pipe is 0.25 cm. first working liquid goes to header with assistance siphon. There are two header pipes right now. Riser tubes are associated with header and working liquid goes through riser tube. There are eight number of cylinder in level plate sunlight based gatherer arrangement. Distance across of riser tube is 2 cm and thickness of riser tube is 0.25 cm. Crafted by safeguard is to assimilate heat from source and move that heat vitality to working liquid which is moving through riser tube. Thickness of aluminum sheet is 0.3cm.

Packaging can characterize as holder which serves to holds the other part and shields them from the climate. It is made of wooden which has low warm conductivity so heat misfortune is low. Length of packaging is 70 cm and breath is 50cm. It is utilized to diminish the warmth misfortune from base and both side of level plate sun based authority. Thermo coal is utilized as protection material. Thickness of warm protection is 5 cm.

Sun powered radiation goes through glass spread. Glass spread assists with diminishing warmth misfortune from front side of level plate sun based authority. There is just one glass spread is utilized right now. Water stream sensor is utilized to gauge mass stream pace of working liquid which is streaming in exploratory arrangement. Water stream sensor is made of plastic body, water rotor and Hall Effect sensor [4]. Water stream sensor can quantify stream rate from 1kg/min to 30kg/min. Water stream sensor gauges the mass stream rate in kg/min.

3. Results and Discussion

The formula needed to calculate the collector efficiency, useful energy gain, reduced temperature parameter, and specific heat of hybrid Nano fluids is given below in this section. Thermal efficiency of solar collector is the ratio of total heat energy gain to the total input energy.

$$\eta = \frac{\dot{m}c_p(T_{out} - T_{in})}{IA_c}$$

C_p (Nano fluid) = C_p (volume fraction of nanoparticle) + C_p (1-volume fraction of nanoparticle)

Useful energy gain is calculated by using temperature difference, specific heat and mass flow rate.

$$Q_u = \dot{m}c_p(T_{out} - T_{in})$$

Reduce temperature parameter

Reduce temperature parameter is calculated by using ambient temperature, inlet temperature and intensity.

$$\frac{T_a - T_{in}}{I}$$

In this section different parameters like inlet temperature, outlet temperature, mass flow rate was measured and the calculation was done on different mass flow rate with different hybrid Nano fluids in the month of April while taking intensity of sun as 1160 w/m².

Table 1 Water at 1160W/m²

Mass flow rate	T _{in} (in degree cel.)	T _{out} (in degree cel.)	Useful energy gain (w)	Efficiency	Efficiency (%)
1 kg/min	26.3	44.2	74.85	0.1720	17.20
2 kg/min	25.6	38.2	105.38	0.2422	24.22

Table 2 (TiO₂+SiO₂) Nano fluids at 1160W/m²

Mass flow rate	T _{in} (in degree cel.)	T _{out} (in degree cel)	Useful energy gain (w)	Efficiency	Efficiency (%)
1 kg/min	28.3	49.3	87.40	0.2009	20.09
2 kg/min	27.9	45.2	144.005	0.3310	33.10

Table 3 (Al₂O₃+SiC) Nano fluids at 1160W/m²

Mass flow rate	T _{in} (in degree cel.)	T _{out} (in degree cel)	Useful energy gain (w)	Efficiency	Efficiency (%)
1 kg/min	28.4	54.2	107.79	0.2477	24.77
2 kg/min	28.3	46.4	151.24	0.3476	34.76

Table 4 ($\text{Al}_2\text{O}_3+\text{CuO}$) Nano fluids at 1160W/m^2

Mass flow rate	T_{in} (in degree cel)	T_{out} (in degree cel.)	Useful energy gain(w)	Efficiency	Efficiency (%)
1 kg/min	28.3	56.3	116.81	0.2685	26.85
2 kg/min	30.2	50.2	166.88	0.3836	38.36

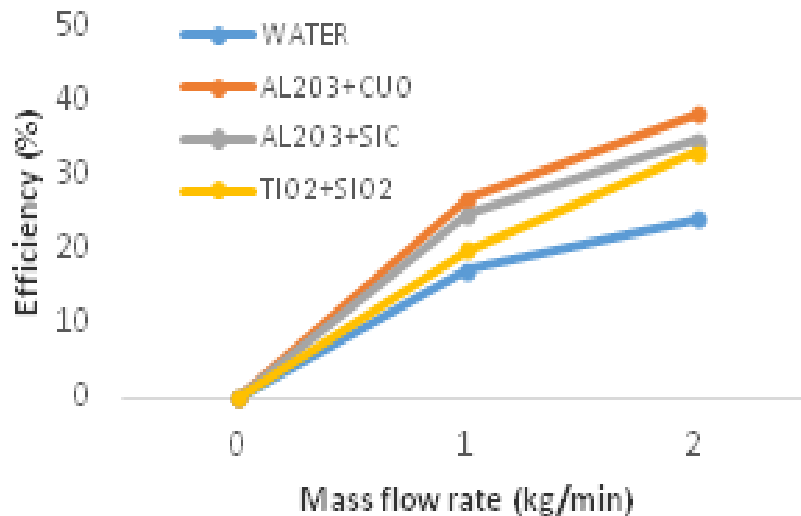


Figure 2 Efficiency v/s mass flow rate graph of different hybrid Nano fluids

Figure 2 shows the efficiency of Water and different hybrid Nano fluids at different flow rates. The results shows that the efficiency of the collector is increasing with increase in mass flow rate of the fluid. Out of the various hybrid Nano fluids used the ($\text{Al}_2\text{O}_3+\text{CuO}$) Nano fluids has higher efficiency as compare to other Nano fluids. The ($\text{Al}_2\text{O}_3+\text{SIC}$) comes second in efficiency and ($\text{TiO}_2+\text{SiO}_2$) has least efficiency out of all the three hybrid Nano fluids. The hybrid Nano fluid used in increasing the efficiency of solar flat plate conductor is increasing the efficiency up to 15% as compared to the base fluid.

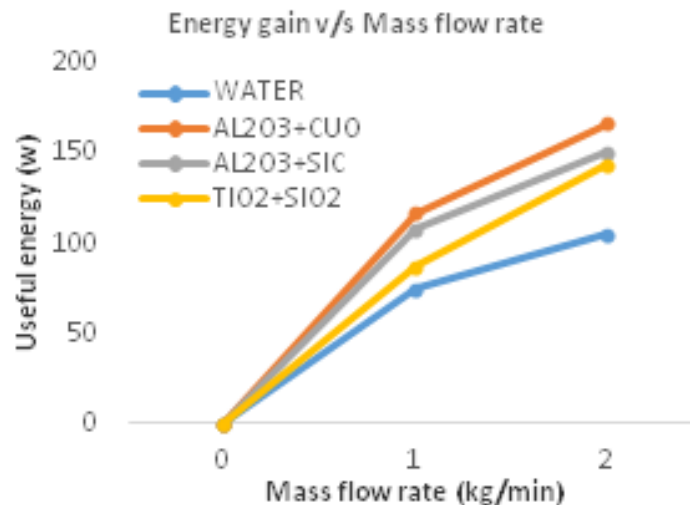


Figure 3 Energy gain v/s mass flow rate of different hybrid Nano fluids.

Figure 3 shows the relation between useful energy gain and mass flow rate of various hybrid Nano fluids. The useful energy gain increases with the increase in mass flow rate of the fluid. ($\text{Al}_2\text{O}_3+\text{CuO}$) hybrid Nano fluids has best energy gain at both the mass flow rate which is followed by ($\text{Al}_2\text{O}_3+\text{SiC}$) and ($\text{TiO}_2+\text{SiO}_2$) hybrid Nano fluid solutions.

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