THERMAL PARABOLIC TROUGH COLLECTOR

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Abstract: - Parabolic trough collector technology for using the solar energy in high temperature level application. Parabolic trough collector usead for the production of electricity and applications with relatively higher temperatures. A heat transfer fluid flows through a metal pipe (receiver) with an external selective surface that absorbs reflected solar radiation from the Parabolic trough collector mirror surfaces. The parabolic trough collector is one of the most advanced techniques for medium and high temperature solar concentration. The purpose of this research is to improve the thermal efficiency of the commercial PTC parabolic collector by enhancing the coefficient of heat convection between the working fluid and the absorber. Two are the major variables affecting this parameter, the type of operating liquid and the geometry of the absorber. Three operating liquids, heat oil, heat oil with nanoparticles and pressurized water are therefore explored.

Keywords: - Parabolic trough collector, high temperature, metal pipe, heat transfer fluid, thermal efficiency, operating liquid

Introduction: -

Solar energy is one of the most promising sources of energy for sustainability and faces major problems such as global warming, depletion of fossil fuel and rising electricity prices. Concentrating solar collectors are appropriate technologies with a satisfactory effectiveness to produce helpful heat at medium and high temperatures, up to 800 K [1]. Using renewable energies (RE) provides a excellent opportunity to economically decrease GHG emissions. The expenses and difficulties of integrating RE into an existing energy supply scheme depend primarily on the real system feature, the present share of RE and the accessibility of RE funds [2]. Parabolic trough collector (PTC) is a type of focused collector used in high-temperature applications; the primary applications where PTC is used for solar energy use are electricity manufacturing and industrial procedures [3].

The primary components of this collector are the evacuated tube and the reflector, while an effective operation requires a monitoring scheme. Their thermal efficiency is sufficiently high because the evacuated tube's heat losses are smaller than other standard techniques as flat plate collectors (FPC)[4]. At present, parabolic trough power plants are one of the most mature and prominent solar energy apps for electricity generation. A solar parabolic trough collector (PTC) takes radiant energy from the sun and converts it into helpful heat transfer fluid (HTF) energy that circulates through the solar field [5]. For the calculation of thermal losses and sizing of the solar power plant during preliminary design, the heat transfer assessment of these collectors is essential and also allows to assess the impacts of collector degradation and HTF flow rate control strategies on general efficiency [6].

Proposed Methodology:

A parabolic trough is a sort of solar thermal collector lined with a polished metal mirror that is straight in one dimension and curved in the other two as a parabola. The sunlight entering the mirror parallel to its symmetry plane is cantered along the focal line, where objects designed to be heated are placed. For example, in a solar cooker, food is placed at a trough's focal line, which is cooked when the trough is targeted so that the Sun is in its symmetry plane.

Table 1: Tabulation of Deionized water

Method: Free convection

Sl. No.	Time	Temperature(ºC)
1	10:00 am	28
2	10:30 am	28
3	11:00 am	31
4	11:30 am	32
5	12:00 pm	34
6	12:30 pm	35
7	2:00 pm	35
8	2:40 pm	35.5
9	3:00 pm	36
10	3:30 pm	36.5
11	3:45 pm	37
12	4:00 pm	37.5

Table 2: Fluid: ZnO Nanofluid 0.4% concentration

Method: Free convection

Sl. No.	Temperature of reservoir(ºC)	Temperature of collector(ºC)	Time
1	28	29	10:00 am
2	34	39	10:30 am
3	38	45	11:00 am
4	41	51	11:30 am
5	43	55	12:00 pm
6	44.5	59	12:30 pm
7	45.5	63	1:00 pm
8	47	67.5	1:30 pm
9	48.5	71	2:00 pm
10	49.5	73	2:30 pm
11	50	74.5	3:00 pm
12	50.5	76	3:30 pm
13	50.5	76.5	4:00 pm

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14	49.5	76	4:30 pm

Table 3: Heat flux(Q) in Watt(W)

Time	Day 1(Free convection)
11:00am	17.433
12:00pm	17.433
2:00pm	5.8111
3:00pm	5.8111
4:00pm	8.71667

Table 4: Heat Transfer Coefficient(h) in W/m^{2}K

Time	Day 1(Free convection)
11:00am	145.649
12:00pm	45.994
2:00pm	14.5943
3:00pm	8.3227
4:00pm	10.7888

Table 5: Tabulation Of 0.4% Zno Nanofluid:

Table 4.5: Heat flux(Q) in Watt(W)

Time	Day 1(Free convection)
11:00am	57.62306
12:00pm	28.81139
1:00pm	14.40556
2:00pm	17.28667
3:00pm	8.643333
4:00pm	2.881111

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Table 6: Heat Transfer Coefficient(h) in W/m^{2}K

Time	Day 1(Free convection)
11:00am	361.0639
12:00pm	76.01328
1:00pm	24.47861
2:00pm	21.66358
3:00pm	9.218333
4:00pm	2.859889

Table 7: Nusselt Number (Nu) Vs. Rayleigh Number (Ra)

Time	Nu	Gr	Ra=Gr*Pr
11:00am	5.661338	293560	1246441
12:00pm	1.191858	697205	2960296
1:00pm	0.383815	1082503	4596250
2:00pm	0.339676	1467800	6232203
3:00pm	0.14454	1724665	7322838
4:00pm	0.044842	1853098	7868156

Result:

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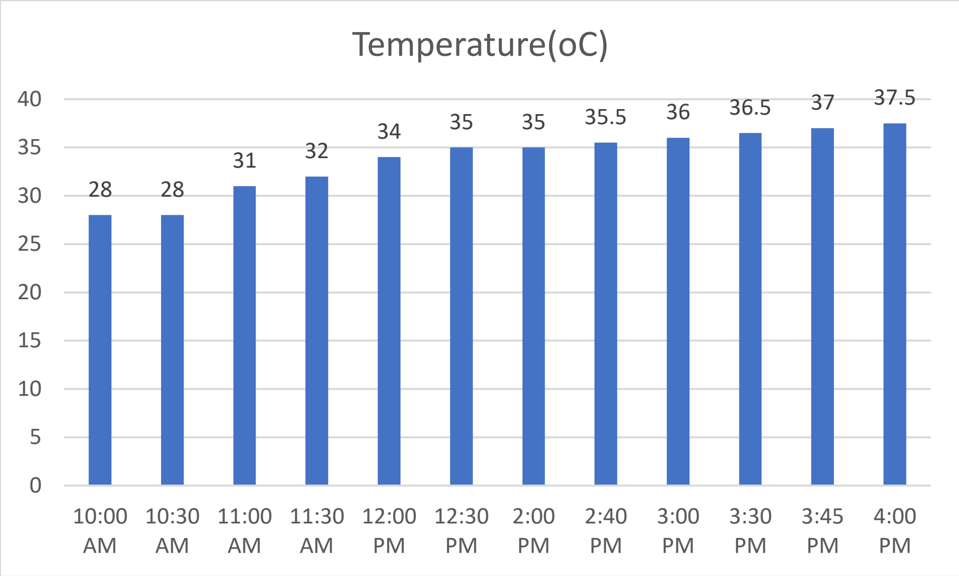

Figure 1: Temperature variation for deionized water

The above figure 1 is shows Temperature variation for deionized water. Here we can see the temperature is increased according to time. Mean the temperature is high in 4.00pm and low in 10am.

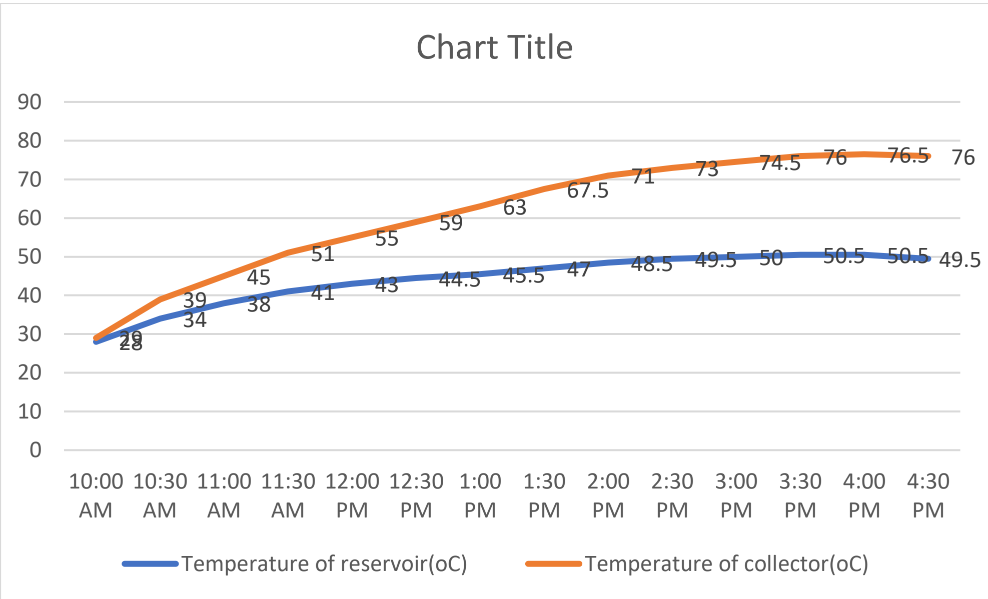

Figure 2: Temp variation for nano fluid

The above figure shows the Temp variation for nano fluid. Here we can see the temperature of reservoir and temperature of collector.

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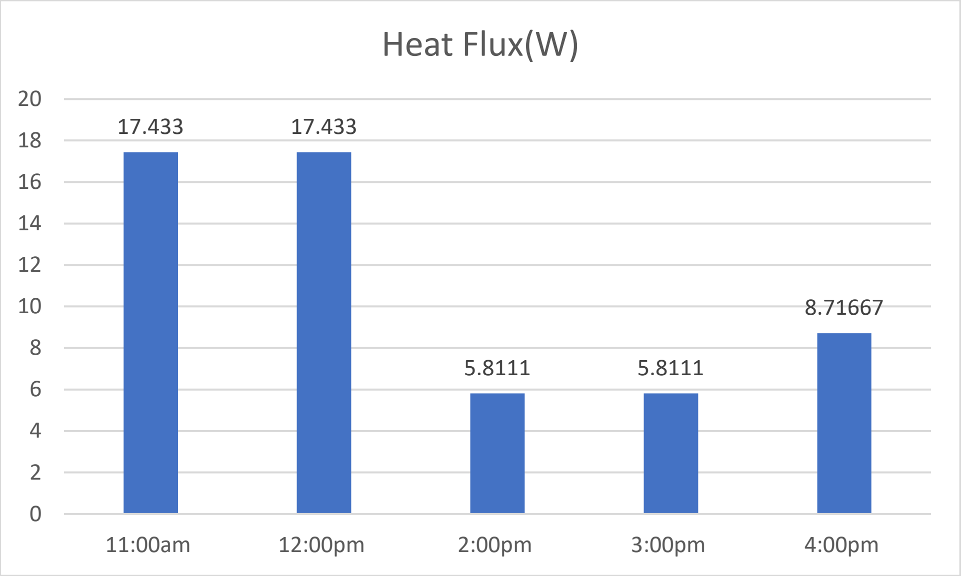

Figure 3: Heat Flux for deionized water

The figure 3 show the Heat Flux for deionized water. Heat flu is high in 12.00 pm and 11.00am and lo in 2.00pm to 3.00pm.

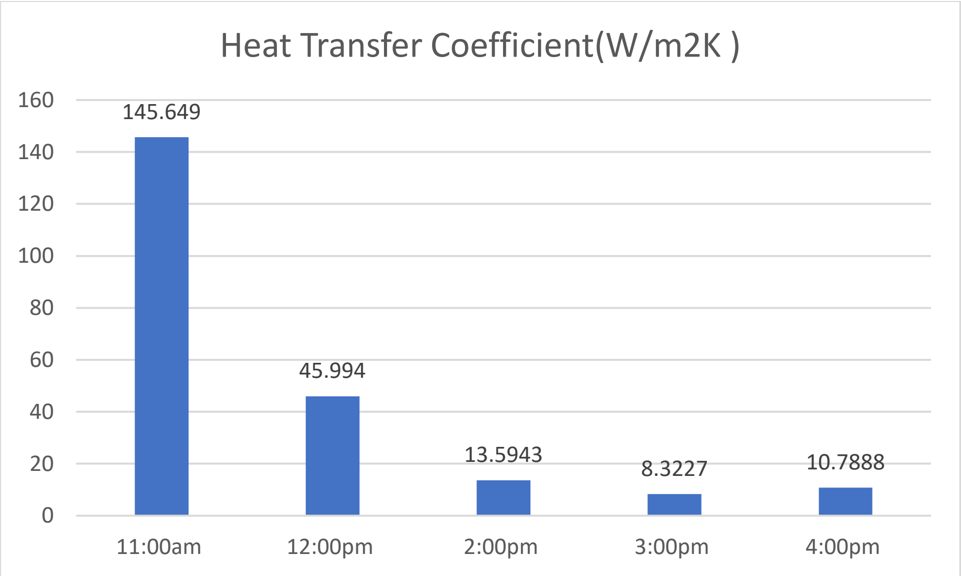

Figure 4: Heat Transfer Coefficient for deionized water

The figure 4 shows the Heat Transfer Coefficient for deionized water. Here the heat transfer coefficient is high in 11.00am and low in 2.00pm.

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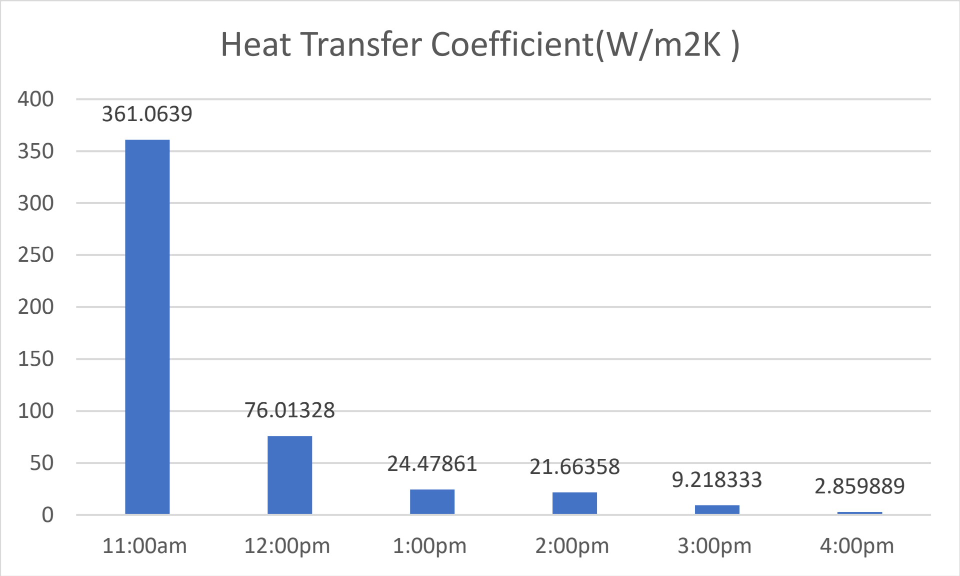

Figure 5: Heat Flux for Nano-fluid

The figure 5 shows the Heat Flux for Nano-fluid and it I high in 11.00am value is 361.0639 and low value is 2.859889 at 4.00pm.

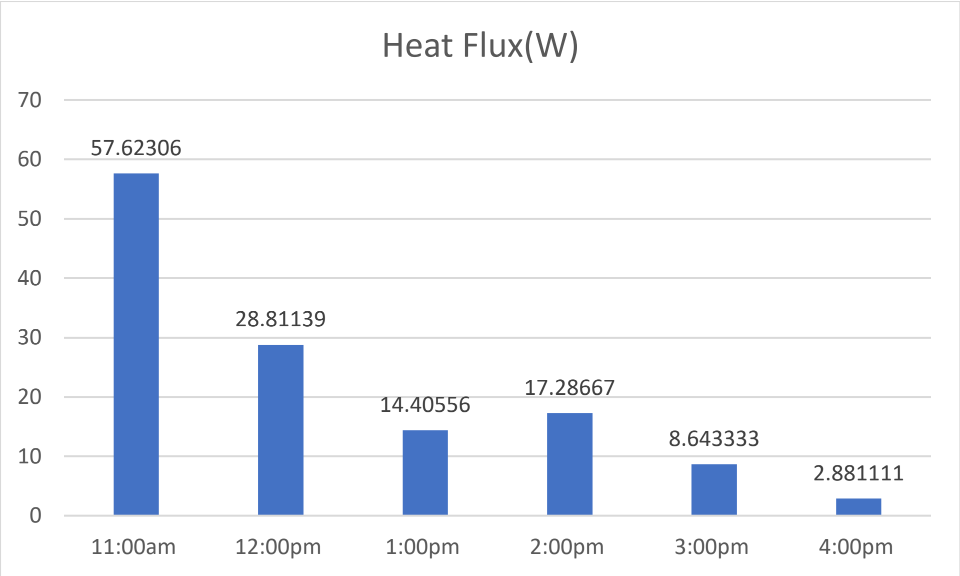

Figure 6: Heat Transfer Coefficient for Nanofluid

The figure 6 shows the Heat Transfer Coefficient for Nanofluid. Heat flux is high at time 11.00am and low at 4.00pm.

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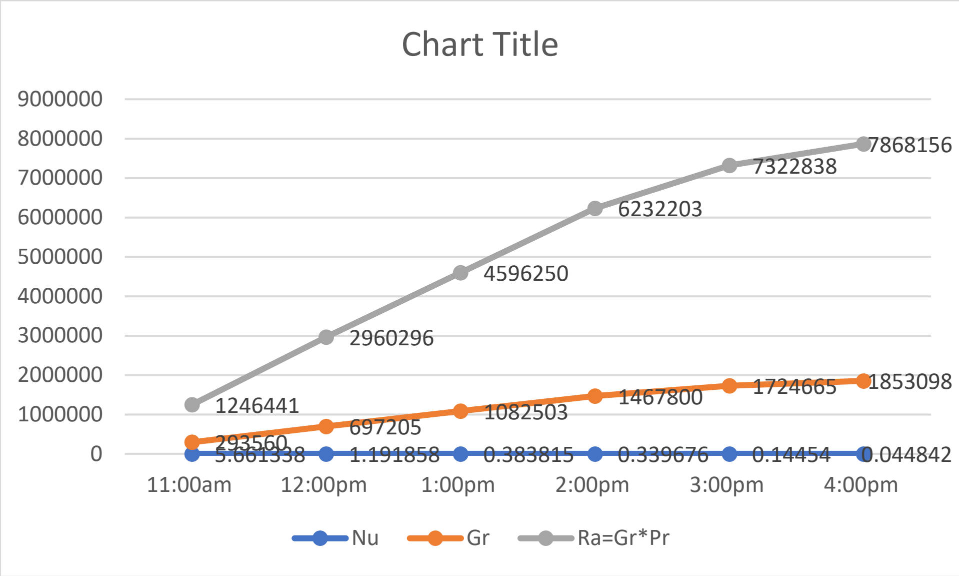

Figure 7: Comparison of Nusselt Number (Nu), Gr and Rayleigh Number (Ra)

The above figure 7shows the Comparison of Nusselt Number (Nu), Gr and Rayleigh Number (Ra).

Conclusion: -

An extensive heat transfer model has been created for the thermal analysis of solar parabolic trough receivers. The model suggested included a thorough study of radiative heat transfer and more precise correlations of heat transfer. From the experimentation it was discovered that there was an expansion of 34.6% in the last temperature came to by the store. By water it was seen that the most extreme temperature came to was 41.5oC yet by utilizing nanofluid temperatures up to 52oC was come to. By the expansion of nanoparticles to the base liquid the thermal conductivity estimation of the base liquid is expanded as appeared in the counts whereas the particular warmth esteem diminishes i.e. there is increment in warm conduction however in the meantime the temperature rises and fall happens at a quicker rate.

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reference of already accomplished work as a starting building block of its paper.
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