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Performance Analysis of Solar Flat Collector Using Tracking System for Different Absorber Materials

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ABSTRACT: Flat-plate collectors are stationary collectors that use solar radiation in order to heat water used especially in domestic household. Their thermal efficiency depends on several factors as: working fluid type, transmittance of the transparent covering, absorbance and emissivity of the absorber plate, the type of the flow tubes, thermal insulation, etc. So, in our project work, we select the types of materials, Aluminium, copper, CPVC materials when compared to the conventional material i.e, copper we are going to find the comparison of performance of two collectors using solar tracking system. The experiment is going to conduct for Al and CPVC collectors separately and results may show that efficiency for Al collector will be higher, but when black paint is coated to CPVC pipes the efficiency will be nearly equal to Al collectors.

I. INTRODUCTION

Flat-plate collectors are the most common type of solar hot fluid panels. They are useful in meeting hot fluid needs for residential water, space heating, industrial application, etc. In principle, flat-plate collectors are more simple design, low maintenance and easy to operate. This type collector consist of an absorber, a transparent cover, a heat transport fluid and a heat insulating material.

Regarding the absorber, this material is a major component of the flat plate solar collectors, which play an important role in heat transfer between the absorber and the transport medium. Correspondingly, materials of high thermal conductivity are widely used in heat sink applications. The absorber acts as a conductive material that absorb heat from the incoming solar energy and then the heat is transferred to the transport medium in the fluid conduit. Copper, aluminum, brass and steel are the common material used in the absorber due to their high thermal conductivity.

II. LITERATURE REVIEW

Ramalingam Senthil (2021) Enhancement of absorptance of absorber surfaces of a flat plate solar collector using black coating with graphene: The absorber plate is a mild steel substrate with a mixed coating of graphene and black paint. Three samples are prepared, the different ratios of black paint to graphene being 1:1, 1:2, and 1:3. The average absorptivity of the graphene and black paint coated samples are determined to be about 0.87 and 0.82, respectively

Manoj Verma et.al (2023): A review of performance improvements in design features of liquid flat-plate solar collector: Natural gas, oil, and coal have been found appropriate for fulfilling individual energy requirements, but the inadequate supply of these fuels turns out to be the major deficiency.

Yogesh Kumar et.al (2022):Recent Developments in the Thermal Performance of Flat Plate Solar Water heaters with reflectors-This article reviewed the innovations of flat plate solar collectors for improved thermal performance with reflectors in solar water heaters. The impact of combining flat plate solar collectors and reflectors for thermal performance improvements is discussed in this article.

III. PROPOSED METHODOLOGY

- Literature survey: Referring some journals which are existed on this topic.
- Problem identification: After refer all journals we have identified what was lagging in their project.
- Select suitable material: Selecting which material is suitable for that particular object.
- Analysis on different material: After selection of material have analyze which gives better than copper.
- Compare outcomes: after analyze different material has to compare to previous.

IV. SCHEMATIC DIAGRAM

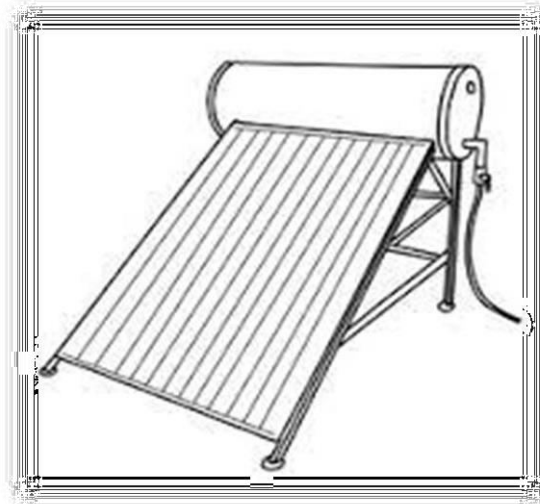


Fig: Schematic Diagram of solar flat plate collector

V. OBJECTIVES

- To absorb more heat by using tracking system.
- To reduce weight of the collector.

VI. REQUIREMENT OF COMPONETS

1. Absorber plate:



Fig : A Flat Plate Absorber (Aluminum)

It is made up of Aluminum. The surface is covered with a flat black material of high Absorption. If metal is used it is possible to apply a selective coating that maximizes the Absorption of solar energy and minimizes the radiation emitted by plate.

2. Flow passage



Fig :Flow passage (CPVC Pipes)

The flow passages conduct the working fluid through the collector. If the Working fluid is a liquid, the flow passage is usually a tube that is attached to or is a part of absorber plate. If the working fluid is air, the flow passage should be below the absorber plate to minimize heat losses. The flow passages here we used is CPVC Pipes.

3. Flat Plate Collector



Fig: CPVC collector

A CPVC pipes used to make collector fig is CPVC flat plate collector to absorb the heat with black coated.

Measuring devices

1. Solar power meter



Fig : Solar Power meter

A solar power meter is a device that can measure solar power or sunlight in units of W/m^2 , either through windows to verify their efficiency or when installing solar power devices. Solar meters accumulate PV yield production and local energy consumption to monitor and analyse PV plant performance.

Specification:

- Display: $3\frac{1}{2}$ Digits 1999 counts.
- Measuring Range: 0 to 1999 W/m^2 .
- Dimensions: 185x55x30mm. Weight: 150g.
- Spectral Response: 400~1100nm.
- Operating Temperature: 0~50°C (32~122°F).
- Power Supply: Two AAA Batteries.
- Angular Accuracy: Cosine calibration < 5% (angle < 60°).

2. Thermometer



Fig : Thermometer



A Thermometer is an Instrument that measures temperature. It can measure the temperature of a solid such as food, a liquid such as water, or gas such as air. The three most common units of measurements for temperature are Celsius, Fahrenheit, and Kelvin.

VII. RESULT:

Formula used to calculate the efficiency for both aluminum and CPVC

$$\eta = \frac{mC_p(T_o - T_i)}{A \times I}$$

Mass flow rate of water = Time taken to fill 1 litre of Jug × 0.72 = kg/sec

C_p = 4.182 kJ/kgk.

T_o = Outlet Temperature of water Deg c

T_i = Inlet Temperature of water Deg c

Area = L × B = 2.035 × 1.03 = 2.10m² I = Radiation w/m²

Readings of experiment for CPVC (without using tracking system)

Sl no	Time	Radiation (w/m ²)	Inlet temp	Outlet Temp	Mass Flow Rate of water(kg/s)	Efficiency
1	9:00AM	490	26.5	34.5	9.18*0.72=6.6	21.45%
2	12:00PM	795	28.2	43.2	9.59*0.72=6.9	25.92%
3	2:00PM	790	30	46	9.45*0.72=6.8	27.42%
4	4:00PM	550	27.7	37.2	9.45*0.72=6.8	23.39%

Readings of experiment for Aluminium (without using tracking system)

zSl no	Time	Radiation (w/m ²)	Inlet temp	Outlet Temp	Mass Flow Rate of water(kg/s)	Efficiency
1	9:00AM	310	29.2	35.9	9.1*0.72=6.5	29.3%
2	12:00PM	670	31.9	44.66	11.7*0.72=8.2	32.3%
3	2:00PM	824	32.6	51.91	10.4*0.72=7.1	34.4%
4	4:00PM	681	31.2	44.3	11.7*0.72=8.1	32.1%



Efficiency chart Without Tracking System

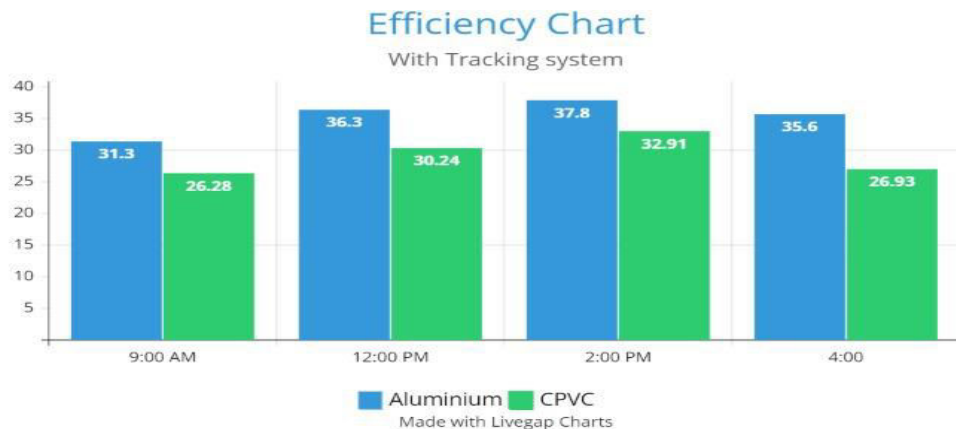


Readings of experiment for CPVC (using tracking system)

Sl no	Time	Radiation (w/m ²)	Inlet temp	Outlet Temp	Mass Flow Rate of water(kg/s)	Efficiency
1	9:00AM	490	26.5	36.3	9.18*0.72=6.6	26.28%
2	12:00PM	795	28.2	45.7	9.59*0.72=6.9	30.24%
3	2:00PM	790	30	49.2	9.45*0.72=6.8	32.91%
4	4:00PM	550	27.7	38.6	9.45*0.72=6.8	26.83%

Readings of experiment for Aluminum (using tracking system)

Sl no	Time	Radiation (w/m ²)	Inlet temp	Outlet Temp	Mass Flow Rate of water(kg/s)	Efficiency
1	9:00AM	315	29.2	36.7	9.1*0.72=6.5	31.3%
2	12:00PM	650	31.9	45.6	12.3*0.72=8.8	36.3%
3	2:00PM	815	32.6	52.9	10.8*0.72=7.7	37.8%
4	4:00PM	675	31.2	45.2	12.1*0.72=8.7	35.6%



VIII. CONCLUSION

Deciding which Collector to Build :- S0, Which is the best to Build ? It probably depends on what your Aims, skills and Budget are, but we will go out a limb and offer the following comparisons in a few Categories

Performance: -

Performance is a small plus for the Aluminum collector-about 8% more than the CPVC. CPVC Average Efficiency is 23- 24%, where Aluminum Efficiency 32-33.

Because the thermal conductivity of CPVC Pipes is 0.136w/mk & for Aluminum is 180w/mk. Ease To Build: -

The CPVC Collector is easier to build than the Aluminium Collector. In Aluminum Collector Involves soldering process (Fins Soldering).

Cost: -

The Main Aim of these project is to lower the cost of collector by using Alternative material for fluid transfer using CPVC instead of Aluminum.

CPVC-1 Feet price -15-17 Rs Aluminum-1 Feet Price -30-32 Rs

Aluminum Fins adds cost to Aluminum collector which is 350 per kg which is not necessary for CPVC Collector.

REFERENCES

1. Hassan Fathabadi: Impact of utilizing reflector, single-axis and two axis sun trackers on the performance of an evacuated tube solar collector (2020).
2. Ramalingam Senthil et.al: Enhancement of absorptance of absorber surfaces of a flat plate solar collector using black coating with graphene (2021).
3. Kolthoum Missaoui et.al: Dynamic performance analysis of a solar adsorption system: the effect of operating conditions and collectors area (2023).
4. Suman Debnath et.al: Energy and exergy analysis of plain and corrugated solar air collector: effect of seasonal variation (2022).
5. Jeya Sankar et.al: Thermal analyses on nanocarbon-Cr2O3 coated fins and solar collector with nanostructured materials (2022).
6. Sukanta Nayak et.al: Experimentally validated axisymmetric simulation for thermo-fluid performance of an active flat plate solar water heater at low flow rates (2023).
7. El Yazid Flilihi et.al: Contribution to improving the thermal performances of a solar collector using CFD approach: Solar water heater application (2022).
8. Yogesh Kumar et.al: Recent developments in the thermal performance of flat plate solar water heaters with reflectors (2022).
9. Markndeyulu Vuggirala et.al: The role of nanofluids in the performance augmentation for the solar collectors used in solar water heating (2023).
10. Rajneesh Kumar et.al: Performance analysis of nanofluids based direct absorption solar collector of different configurations: A two-phase CFD modeling (2022).
11. Suraj Choudhary et.al: Time-based assessment of thermal performance of flat plate solar collector using magnesium oxide nanofluid (2020).



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