DESIGN AND FABRICATION OF U-TUBE SOLAR HEAT PIPE

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ABSTRACT

The most widely used solar collector is liquid flat plate collector. It is simple in design. It has no moving parts and little maintenance. In today's solar industries it is mostly used in solar systems. They are used for water heating, space heating & cooling and low temperatures cycle for power generation. Maximum temperature achieved by the water filed u-tube type flat plate collector is 40^{o}C to 50^{o}C.

"For various industrial applications the maximum temperature required for the process is up to 100^{o}C" and to achieve these temperature we can use different combination of liquid with water in the flat plate collector. This present study is related to the design, development and the implementation of new type of "Solar Heat Pipe". In the present work we have archive the maximum temperature 82^{o}C at an angle of 27^{0}C for glycerin-water composition. We have tested the different types of liquids like Transformer oil, Glycerin-water & Rice Bran oil.

Keywords: *Flat plate collector, Transformer oil, Glycerin & Rice Bran oil.*

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The heat pipe is a highly effective passive device for transmitting heat at high rates over considerable distances with extremely small temperature drops, exceptional flexibility, simple construction, and easy control with no external pumping power.

Heat pipe system is most important topic to study for engineers, scientists and graduate students. Being aware of this situation, this subject is a self-contained document of the state-of-the-art heat pipe science and technology. The physical significance and performance characteristics, as well as the technological and experimental issues thorough presentation of the basic and advanced techniques for analysing various heat pipe systems under a variety of operating conditions and limitations.

The subject of heat pipe science has tremendous importance in a large variety of traditional engineering disciplines. The heat pipe science has its foundation in several classical fields, such as fluid mechanics, heat transfer, thermodynamics and solid mechanics. For scientists and engineers or worldwide student to apply a variety of complex physical phenomena and fundamental laws in the thermal-fluids area to a relatively simple

system heat pipe system is used. This includes the steady and unsteady forced laminar and turbulent convective heat and mass transfer. Also compressible vapour effects, phase-change phenomena, boiling, condensation/evaporation, two-phase flow, rotating flows, thin film flows, liquid flow in rarefied gases, interfacial heat and mass transfer, magneto-hydrodynamic flows, and conjugate heat transfer effects included.

The energy recovery from secondary resources has become an important issue at European Union level. The European Commission proposed the promotion and development of "intelligent city" initiative, by investments in "clean" energy. In this way the investments are aimed at improving energy efficiency and climate change mitigation through the use of sustainable energy, thus supporting the environment

In energy conservation programs, a significant progress being made for heat exchangers development. The heat pipe heat exchanger is a type of heat exchangers, which are increasingly used in different technological processes due to its advantages (high thermal conductivity, low cost, low volume, easy to manufacture, etc.).Heat pipe consists of three parts namely: evaporation section, adiabatic section and condensation section.

Problem Identification

The most widely used solar collector is liquid flat plate collector, it is simple in construction and has no moving parts and relatively little maintenance. In today's solar industry it is mostly used in solar systems. They are used for water heating, space heating & cooling and low temperatures cycle for power generation. Maximum temperature achieved by the water filed u-tube type flat plate collector is 60^{o}C to 70^{o}C.

"For various industrial applications the maximum temperature required for the process is up to 100^{o}C" and to achieve these temperature we can use different combination of liquid with water in the flat plate collector. This present study is related to the design, development and the implementation of new type of "Solar Heat Pipe". In the present work we have archive the maximum temperature 82^{o}C at an angle of 27^{0}C for glycerin-water composition. We have tested the different types of liquids like Transformer oil, Glycerin-water & Rice Bran oil.

Design & Fabrication

Design consideration, Design Procedure, And Fabrication Detail

Box:

a. Take a large plywood sheet with t = 1 cm
b. Mark on it dimensions 58 x 58 x 10 cm
c. Cut the plywood in required dimensions
d. Prepare a sure wooden box from it
e. Place a glass of the same dimensions above it
f. On inner side of box made compartment of 15 cm an with thin copper sheet
g. Paint the box with black colour
h. Drill the compartment in order to pass copper coil through it
i. Make two drills on the box on its both sides for inlet & outlet of copper tube.

Copper Tube

a. Taking hollow copper tube of length 540 cm with 0.8 mm internal diameter

b. Bend the copper tube in following dimensions
Width of tube: 45 cm
Center distance between two half turn: 10 cm
Bend (Curve) radius: 2cm

Input Parameters

Sr. No.	List of Components	Quantity
1.	Wooden Box	3
2.	Copper Tubes	3
3.	Transformer Oil	6lit
4.	Rice Bran Oil	6lit
5.	Glycerin	1kg
6.	Table Stand	3
7.	Glass	3
8.	Copper Sheet	3
9.	Solarimeter	1
10.	Thermometer	3
11.	Coating	250ml

Observation Table:

Sr. No	Ø	altitude	δ	LAT	hr angle	ω (w/m2)	θ	r_b	r_d	r_r	I_t	S	F'	(Fr)	q_u	ql	T_{pm}	T_{fo}	ε	ηi	Fluid	β
1	19.88	75.38	20.53	11 HR 28 min	8	990	13.87	0.979	0.97	0.006	1199.94	959.52	0.568	0.558	411.66	354.01	394.52	338.01	0.761	41.19%	Glycerine + water	9
														0.5267	388.57	377.17	398.24	320.8		45.05%	transformer oil	
														0.4775	351.9	413.85	407.46	410.38		38.76%	rice barn oil	
2	19.88	75.38	20.53	11 HR 28 min	8	1100	7.96	0.9986	0.97	0.006	1329.47	1088.6	0.568	0.558	591.8	496.78	428.19	318.25	0.761	53.59%	Glycerine + water	18
														0.5267	388.57	377.17	398.24	320.8		35.06%	transformer oil	
														0.4775	351.9	413.85	407.46	410.38		31.71%	rice barn oil	
3	19.88	75.38	20.53	11 HR 28 min	8	1200	9.765	0.9971	0.97	0.006	1504.75	1171.9	0.568	0.558	411.66	354.01	394.52	338.01	0.761	52.94%	Glycerine + water	27
														0.5267	388.57	377.17	398.24	320.8		33.80%	transformer oil	
														0.4775	351.9	413.85	407.46	410.38		29.07%	rice barn oil	

Table. Chart of performance analysis.

Results & Discussion

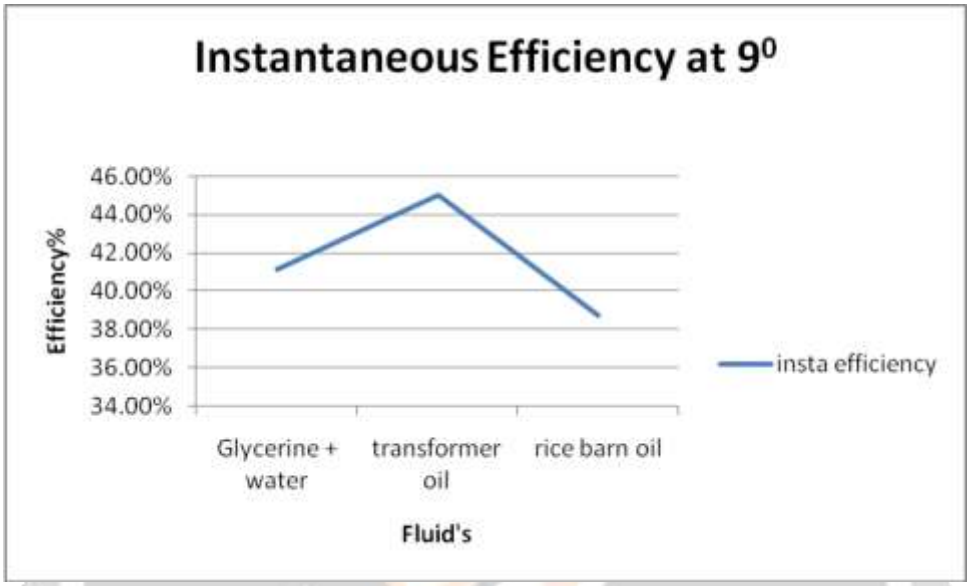

Fig. Graph for Instantaneous Efficiency at 9^0 v/s Fluid's

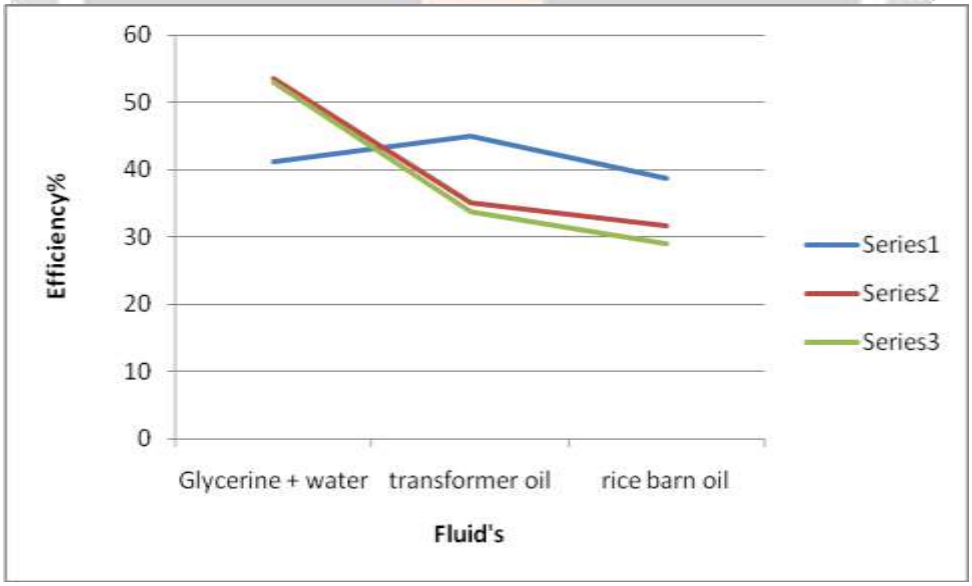

Fig. Graph of overall Efficiency of Fluid's at different angles.

Conclusion

The present study of U-tube solar heat pipe provides the perfect solution for future use in Industries for energy optimization and maximum utilization of natural energy i.e. solar energy. This new concept of U-tube solar heat pipe is revolutionary concept that represents perfect symbioses between pioneering design and cutting edge eco-computable technology.

The result obtained after testing the set up revels that instantaneous efficiency of transformer oil at an inclination angle 9^o is 45.05% which is higher than other two fluids. This average rise in efficiency for transformer oil is 9% for glycerin plus water mixture and 11% for rice bran oil.

The result obtained after testing the set up revels that instantaneous efficiency of glycerin plus water at an inclination angle 18^o is 53.59% which is higher than other two fluids. This average rise in efficiency for glycerin plus water is 18% for transformer oil and 20% for rice bran oil.

The result obtained after testing the set up revels that instantaneous efficiency of glycerin plus water at an inclination angle 27^o is 52.93% which is higher than other two fluids. This average rise in efficiency for glycerin plus water is 19% for transformer oil and 21% for rice bran oil.

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