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Study of Heat Transfer by Solar Energy through Heat Pipes by Reflecting Mirror

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Abstract*:-Solar power is energy from the sun that is converted into thermal or electrical energy.Solar energy is the cleanest and most abundant renewable energy source available in the earth which is the radiant light and heat from the sun. Modern technology can harness this energy which includes active and passive works.The passive work includes PV cells, concentrator, Fresnel lens and active work depending on the way they capture and distribute solar energy or convert it into solar power. In all of these systems a working fluid is heated by the concentrated sunlight, and is then used for power generation or energy storage. Concentrating Solar Power (CSP) systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. The concentrated heat is then used as a heat source for a conventional power plant.Concentrating collector use parabolic trough as reflectors to concentrate the incident solar energy onto a smaller receiver or absorber. The main goal for doing this is to increase the temperature of the heat collected from the sun. Increased temperature is a benefit for many industrial process uses.This paper shows the fabrication and experimental setup of trapping the solar energy by parabolic trough through the reflecting mirror of dimension 0.3m x 0.3m and passes the energy rays on pipes of dimension 12.5mm diameter with length 1490mm which is the absorber. The absorbing materials used here are copper and aluminium with heat transfer fluid as water and air. The readings were noted at various times with different materials and HTF and gives the complete study of solar energy trapping by using reflecting mirror.

Keyword: solar energy, HTF, reflecting mirror, concentrator

I.INTRODUCTION

In today's climate of growing energy needs and increasing environmental concern, alternatives to the use of nonrenewable and polluting fossil fuels have to be investigated. One such alternative is solar energy. It is quite simply the energy produced directly by the sun and collected elsewhere, normally the Earth.Much of the world's required energy can be supplied directly by solar power. Methods of collecting and storing solar energy vary depending on the uses planned for the solar generator. In general, there are three types of collectors and many forms of storage units.The three types of collectors are flat-plate collectors, focusing collectors, and passive collectorsFocusing collectors are essentially flat-plane collectors with optical devices arranged to maximize the radiation falling on the focus of the collector. These are currently used only in a few scattered areas. Solar furnaces are examples of this type of collector. Although they can produce far greater amounts of energy at a single point than the flat-plane collectors can, they lose some of the radiation that the flat-plane panels do not. Radiation reflected off the ground will be used by flat-plane panels but usually will be ignored by focusing collectors (in snow covered regions, this reflected radiation can be significant). One other problem with focusing collectors in general is due to temperature. The fragile silicon components that absorb the incoming radiation lose efficiency at high temperatures, and if they get too hot they can even be permanently damaged. The focusing collectors by their very nature can create much higher temperatures and need more safeguards to protect their silicon components.

People use energy for many things, but a few general tasks consume most of the energy. These tasks include transportation, heating, cooling, and the generation of electricity. Solar energy can be applied to all four of these tasks with different levels of success.Heating is the business for which solar energy is best suited. Solar heating requires almost no energy transformation, so it has a very high efficiency. Heat energy can be stored in a liquid, such as water, or in a packed bed. A packed bed is a container filled with small objects that can hold heat (such as stones) with air space between them. Heat energy is also often stored in phase-changing or heat-of-fusion units. These devices will utilize a chemical that changes phase from solid to liquid at a temperature that can be produced by the solar collector. The energy of the collector is used to change the chemical to its liquid phase, and is as a result stored in the chemical itself. It can be tapped later by allowing the chemical to revert to its solid form. Solar energy is frequently used in residential homes to heat water. This is an easy application, as the desired end result (hot water) is the storage facility. A hot water tank is filled with hot water during the day, and drained as needed. This application is a very simple adjustment from the normal fossil fuel water heaters.Of all the energy sources available, solar has perhaps the most promise. Numerically, it is capable of producing the raw power required to satisfy the entire planet's energy needs. Environmentally, it is one of the least destructive of all the sources of energy. Practically, it can be adjusted to power nearly everything except transportation with very little adjustment, and even transportation with some modest modifications to the current general system of travel. Clearly, solar energy is a resource of the future.

II.EXPERIMENTAL SETUP

Experimental setup has been arranged based on the flow of heat energy from the sun to heat pipe shown in the block diagram by means of reflecting mirror and parabolic tough. Water and air are used as heat transfer fluid.

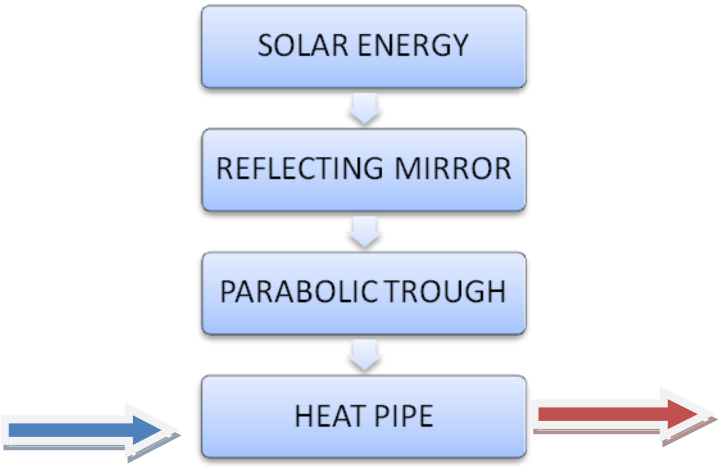

Fig.1. Block diagram of flow of solar energy

The experimental setup consist of reflecting mirror of dimension 0.3m x0.3m in 4 numbers used to reflect the solar energy towards the parabolic trough of dimension 1.2m x0.3m where its again get reflected and reaches the heat pipe made of copper/aluminium. Heat transfer fluid is chosen as water which is from the water tank of dimension 0.3mx0.3mx0.3m through flexible tube of dimension 12.5mm dia and it consist of two control valves. While air has chosen has heat transfer fluid blower is used to surpass the air into the heat pipe.

Fig.2. Experimental setup - Photographic view

The readings were noted for both copper and aluminium pipe of retention time about 70mins and heat transfer fluids such as water and air were passed separately. The study of heat distribution inside the pipe were noted foe water in non-continouous flow and continous flow. The 3-D view of experimental setup was designed in AUTO-CAD shown in figure . The photographic view of experimental analysis.

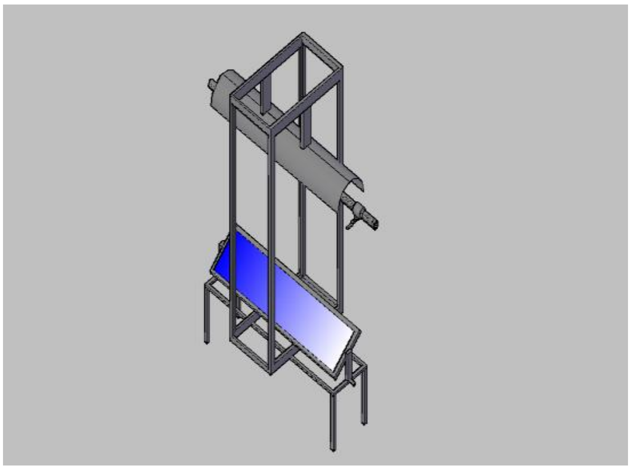

Fig.3. . Experimental setup - modeling view

III. ANSYS-THERMAL ANALYSIS

ANSYS thermal analysis was done in ansys workbench 14.0 and it shows the steady state and transient anlaysis of heat pipe of diameter 12.5mm. The steady state analysis shows the temperature distribution inside the heat pipe when thermal load of 70°c is applied at the surface of the heat pipe.

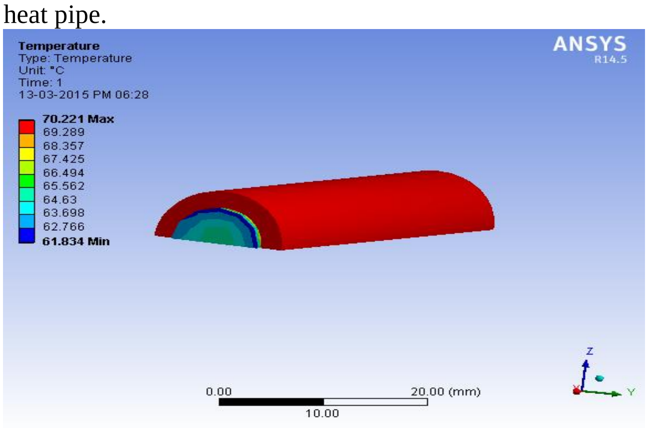

Fig.4. Ansys steady state analysis

The transient analysis shows the temperature distribution inside the heat pipe when thermal load of 70°c is applied at the surface of the heat pipe and after 15th minutes the centre region obtains temperature of 63.514°c

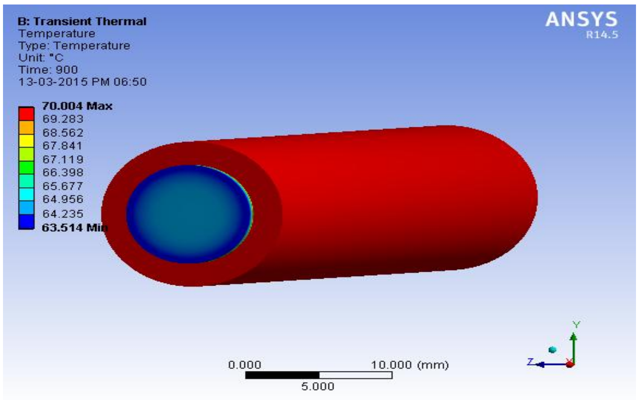

Fig.5. Ansys transient state analysis

IV. MEASURED READINGS

When water is used as an heat transfer fluid in the copper heat pipe 12.5mm diameter and it flows continuously from the water tank to outlet of the pipe the readings noted were tabulated below

S. No	Time taken for every 10mins	TEMPERATURE AT INLET(°C)	TEMPERATURE AT CENTRE OF COPPER TUBE	TEMPERATURE AT OUTLET(°C)
1	10	30	34	34
2	20	30	43	46
3	30	30	48	51
4	40	30	54	58
5	50	30	60	65
6	60	30	66	67
7	70	30	67	69

Table. 1. Readings for copper heat pipe

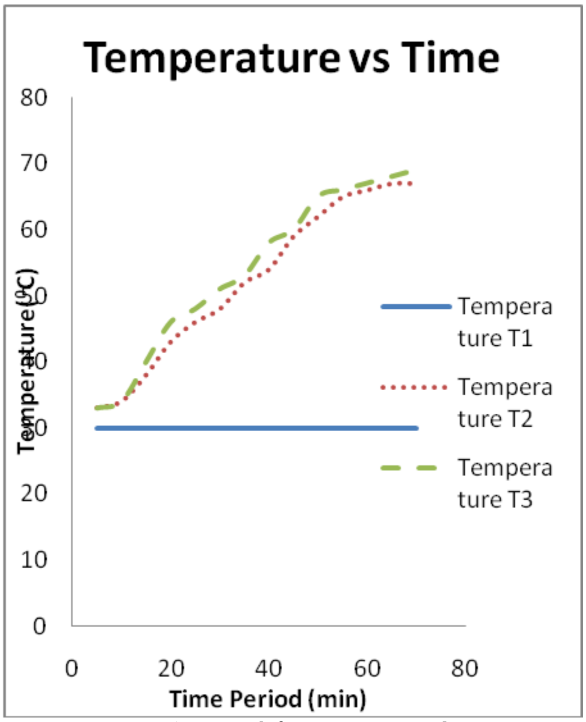

Fig.6. Graph for copper pipe readings

S.No	Time taken for every 10mins	TEMPERATURE AT INLET(°C)	TEMPERATURE AT CENTRE OF ALUMINIUM TUBE	TEMPERATURE AT OUTLET (°C)
1	10	30	31	31
2	20	30	41	44
3	30	30	45	46
4	40	30	51	56
5	50	30	56	57
6	60	30	63	64
7	70	30	65	65

Table. 2. Readings for Aluminium heat pipe

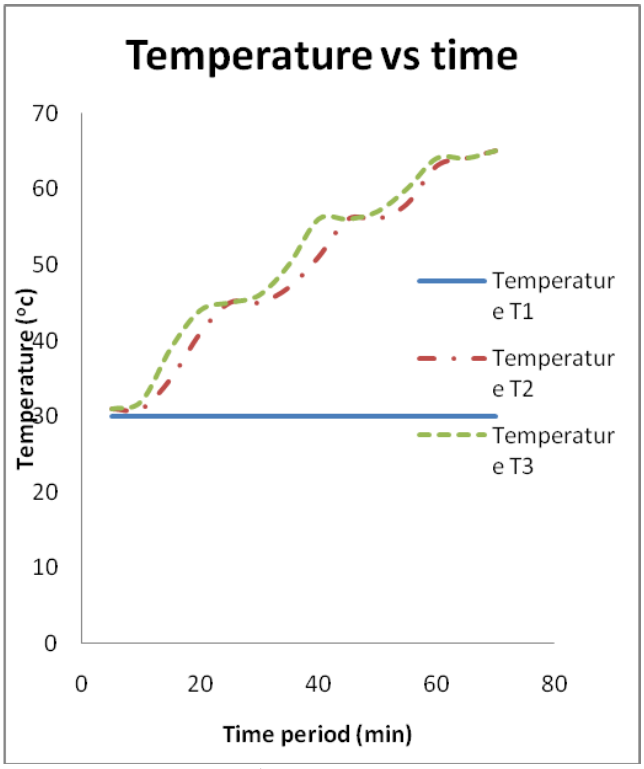

Fig.7. Graph for Aluminium pipe readings

When water is used as an heat transfer fluid in the copper heat pipe 12.5mm diameter and it set to stand in the heat pipe and closed at both ends which shows the thermal balance of heat distribution inside the pipe from minimium of 30°c to 52°c in the pipe and the readings noted were tabulated below

S.No	Time taken for every 10mins	TEMPERATURE AT INLET(°C)	TEMPERATURE AT CENTRE OF COPPER TUBE	TEMPERATURE AT OUTLET(°C)
1	10	30	31	32
2	20	30	34	36
3	30	30	40	42
4	40	30	45	46
5	50	30	48	49
6	60	30	50	51
7	70	30	51	52

Table. 3. Stagnant Water temp. in copper pipe

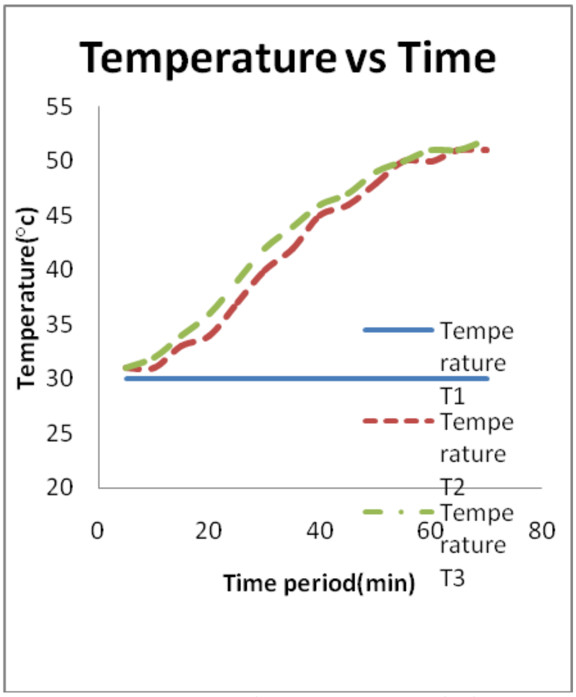

Fig.8. Graph for water as heat transfer fluid

When air is used as an heat transfer fluid in the copper heat pipe 12.5mm diameter and it flows continuously from the water tank to outlet of the pipe the readings noted were tabulated below

S.No	Time taken for every 10mins	TEMPERATURE AT INLET(°C)	TEMPERATURE AT CENTRE OF COPPER TUBE	TEMPERATURE AT OUTLET(°C)
1	10	30	34	34
2	20	34	35	35
3	30	36	37	37
4	40	38	39	39
5	50	40	41	42
6	60	46	47	47
7	70	48	48	48

Table. 4. Air as heat transfer fluid

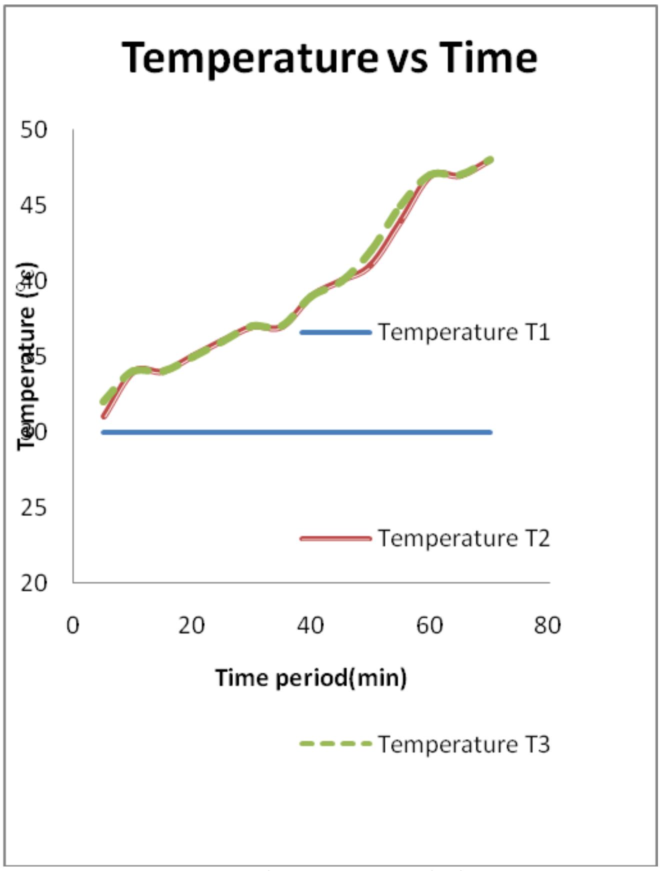

Fig.9. Graph for air as heat transfer fluid

V. RESULT AND DISCUSSION

The result and discussion shows that copper heat pipe has more thermal absorbitivity than tha aluminium heat pipe due to its thermal properties

Water has more specific heat than air so heat transfer fluid as water shows higher heat energy absorbtion and temperature distribution inside the heat pipe

When water flows continuously for 70 mins the temperature distribution inside the heat pipe does not remains in thermal equilibrium and when water stands in the heat pipe for 70 mins its remains in thermal equilibrium at 70th minutes.

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