CREO DESIGN SOFTWARE IS USED IN A NEW APPROACH OF THERMAL AND CFD ANALYSIS FOR PARABOLIC SHAPED SOLAR DISC COLLECTOR

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ABSTRACT
An energy balance between the solar energy received by the collector and the thermal energy released or lost from the collector may be thought of as a solar thermal energy collector. The collector receiver heat loss must match the solar energy collected if no other method of thermal energy removal is offered. This will concentrate on thermal and CFD analysis utilizing various fluids, including air, water, and various solar collectors, including flat plates and parabolic troughs, which were modeled using CREO design software. Thermal study was conducted on a solar collector made of a variety of materials (aluminum & copper). These numbers are from a CFD study. Moreover, thermal analysis to identify the temperature and CFD analysis to calculate the mass flow rate, pressure drop, and heat transfer rate distribution, heat flux with different materials.
Key words: Flat plate, parabolic trough, CFD, CREO.

INTRODUCTION
A particular kind of solar thermal energy collector is a parabolic trough. It was designed as a long parabolic mirror with a Dewar tube spanning the length of it at the focal point (often coated silver or polished metal). The mirror concentrates the sun's rays so they fall on the Dewar tube. The trough is often rotated to follow the sun as it passes across the sky each day and is oriented on a north-south axis. Instead, the trough can be oriented on an east-west axis, which decreases the collector's overall efficiency owing to cosine loss but only necessitates seasonal alignment of the trough, negating the requirement for tracking motors. This tracking method works correctly at the spring and fall equinoxes with errors in the focusing of the light at other times during the year (the magnitude of this error varies throughout the day, taking a minimum value at solar noon). There is also an error introduced due to the daily motion of the sun across the sky, this error also reaches a minimum at solar noon. Due to these sources of error, seasonally adjusted parabolic troughs are generally designed with a lower solar concentration ratio.

Flat Plate Collectors

These collectors consist of air tight boxes with a glass, or other transparent material, l cover. There are several designs on the arrangement of the internal tubing of flat plate collectors as shown in Figure 1.

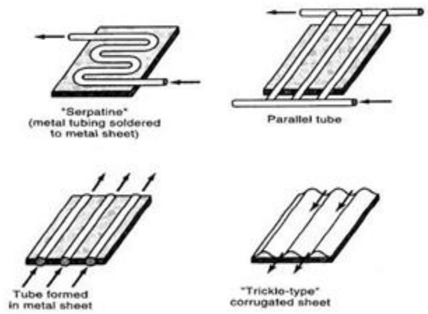


Figure 1 Internal tubing arrangement in flat plate collectors (copyright Saunders College Publishing)

Fig.1.internal tubing arrangement in flatplate collectors

Traditional collectors, like the Serpentine and Parallel tube examples above, consist of a number of copper tubes, known asrisers that are orientated vertically with respect to the collector and placed in thermal contact with a black colored, metal absorbing plate. The use of selective surfaces on absorbers improves the efficiency of solar water heaters significantly due to a very high absorbance (percentage of incoming energy that a material can absorb) and low remittance (percentage of energy that a material radiates away) of electromagnetic radiation. At the top and bottom of the metal absorbing plate, thicker copper pipes, known as headers, assist in the removal of heated water and the arrival of colder water to be heated. Insulation is placed between the absorbing plate and the external wall to prevent heat losses

Whilst the principles of operation for flat plate collectors are fairly consistent, significant improvements in the design of systems, particularly absorber plates have occurred. Flooded plate collectors are similar to their tubed cousins, except that two metal absorbing plates are sandwiched together, allowing the water to flow through the whole plate. The increased thermal contact results in significant improvements in the efficiency of the system. In recent years, much research has been conducted on selective surfaces, which has seen significant improvements in the efficiency of solar water heaters. Today, a majority of absorber plates are composed of solar selective surfaces, made of materials that strongly absorb electromagnetic radiation (i.e. sunlight) but only weakly emit.

LITERATURE REVIEW

A Novel Parabolic Trough Concentrating Solar Heating for Cut Tobacco Drying System.[1] A novel parabolic trough concentrating solar heating for cut tobacco drying system was established. The opening width effect of V type metal cavity absorber was investigated. A cut tobacco drying mathematical model calculated by fourth- order Runge-Kutta numerical solution method was used to simulate the cut tobacco drying process. And finally the orthogonal test method was used to optimize the parameters of cut tobacco drying process. The result shows that the heating rate, acquisition factor, and collector system efficiency increase with increasing the opening width of the absorber. The simulation results are in good agreement with experimental data for cut tobacco drying process.

Design, Fabrication and Experimental Testing of Solar Parabolic Trough Collectors with Automated Tracking Mechanism.

This paper was concerned with an experimental study of parabolic trough collector's with its sun tracking system designed and manufactured. To facilitate rapid diffusion and widespread use of solar energy, the systems should also be easy to install, operate and maintain. In order to improve the performance of solar concentrator,different geometries and different types of reflectors were evaluated with respect to their optical and energy conversion efficiency.To assure good performance and long technical lifetime of a concentrating system, the solar reflectance of the reflectors must be high and long term stable. Development of a Compound

Parabolic Solar Concentrator to Increase Solar Intensity and Duration of Effective Temperature.[3] For efficient drying of product through indirect drying method, a compound parabolic concentrator (CPC) was installed. Six numbers of semi- cylindrical parabolic concentrators were interpolated on are Receiver plate for direct conversion of solar energy to thermal energy by trapping the maximum incident rays into metallic tubes which were placed on focus lines of the parabolas. Experiments were carried to study the comparative performance of a solar flat plate collector and compound parabolic concentrator of same size.
Dehydration of Persimmon by Concentrating Parabolic Trough Solar Air Heater.[4] Parabolic Trough Solar (PTS) air heater was developed locally to solve the drying of persimmon with a parabolic trough and a drying box which contains a reflected steel sheet, an absorber tube, an angle iron and a fully insulated home script refrigerator. Solar irradiance results were noted for the months of Oct- Dec, 2012. Four air mass flow rates were conducted with one natural flow rate of 0.53 kg minute-1 (M-1) and three convective air mass flow rates of 1.35 kg M-1, 1.87 kg M-1 and 1.97 kg M-1 respectively.

SOFTWERES USED IN PARABOLIC SOLAR TROUGH AND FLAT PLATE COLLECTORS

PTC CREO, formerly known as Pro/ENGINEER, is 3D modeling software used in mechanical engineering, design, manufacturing, and in CAD drafting service firms. It was one of the first 3D CAD modeling applications that used a rule- based parametric system. Using parameters, dimensions and features to capture the behavior of the product, it can optimize the development product as well as the design itself. The name was changed in 2010 from Pro/ENGINEER Wildfire to CREO. It was announced by the company who developed it, Parametric Technology Company (PTC), during the launch of its suite of design products that includes applications such as assembly modeling, 2D orthographic views for technical drawing, finite element analysis and more. PTC CREO says it can offer a more efficient design experience than other modeling software because of its unique features including the integration of parametric and direct modeling in one platform.

Fig:2 3D model of parabolic trough Diameter of parabolic trough-225mm Length -1115mm Stand height- 400 mm

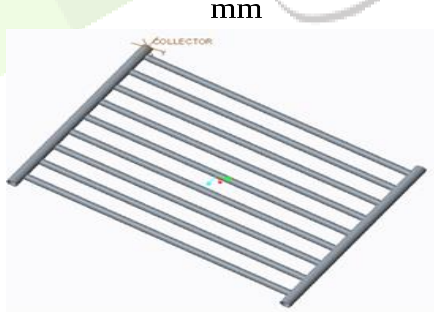


Fig: 3 3d Models of Flat plate collector Diameter of tube-30mm Length -1005mm

Thickness -6mm A.ANSYS

ANSYS is capable of both steady state and transient analysis of any solid with thermal boundary conditions. Steady-state thermal analyses calculate the effects of steady thermal loads on a system or component. Users often perform a steady-state analysis before doing a transient thermal analysis, to help establish initial conditions. A steady-state analysis also can be the last step of a transient thermal analysis;

performed after all transient effects have diminished. ANSYS can be used to determine temperatures, thermal gradients, heat flow rates, and heat fluxes in an object that are caused by thermal loads that do not vary over time.

A. CFD

Computational fluid dynamics, usually abbreviated as CFD, is a branch of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions. With high-speed supercomputers, better solutions can be achieved. Ongoing research yields software that improves the accuracy and speed of complex simulation scenarios such as transonic or turbulent flows. Initial experimental validation of such software is performed using a wind tunnel with the final validation coming in full-scale testing, e.g. flight tests.

Refrigerant properties R- 30 properties Density = 1326.6 kg/m3

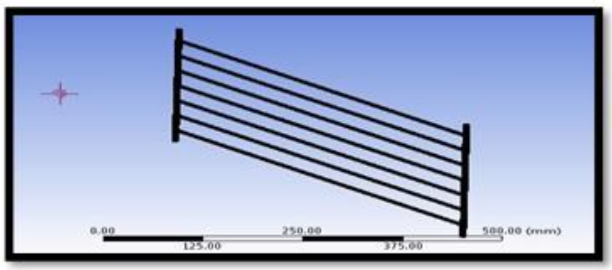
Specific heat = 1043.0 j/kg/k Thermal conductivity = 0.0042 w/m-k Viscosity = 0.000279 kg/ms

R-160 properties

Density = 921.0 kg/m3 Specific heat = 1023.0 j/kg/k

Thermal conductivity = 0.0337 w/m-k Viscosity = 0.00043 kg/m-s

CFD ANALYSIS OF SOLARFLATPLATE



The model is designed with the help of CREO and then import on ANSYS for Meshing and analysis. The analysis by CFD is used in order to calculating pressure profile and temperature distribution. For meshing, the fluid ring is divided into two connected volumes. Then all thickness edges are meshed with 360 intervals. A tetrahedral structure mesh is used. So the total number of nodes and elements is 6576 and 3344.

CFD Boundary conditions

Mass Flow Rate → 0.0105Kg/s and Inlet

Temperature – 303K

Thermal analysis Boundary conditions

Temperature – 313K Convection -1.80e+03

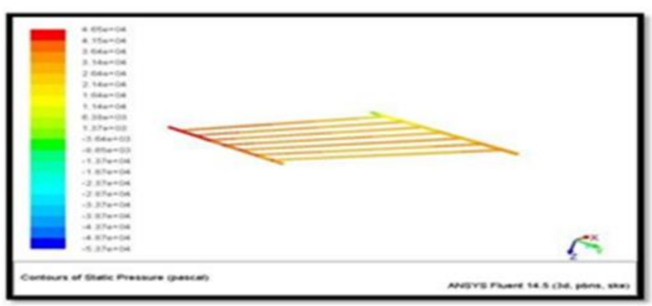


Fig.5. Static Pressure

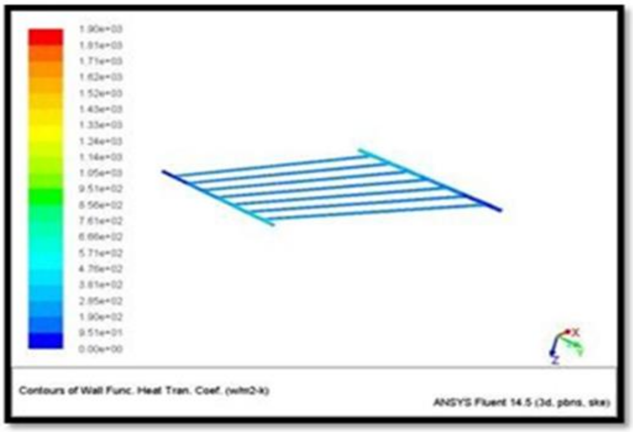


Fig.5. Heat transfer coefficient

Mass Flow Rate	(kg/s)
inlet	0.010499999
interior-partbody	0.026461512
outlet	-0.010539424
wall-partbody	0
Net	-3.9424747e-05
Total Heat Transfer Rate	**(w)**
inlet	790.97839
outlet	-793.94824
wall-partbody	0
Net	-2.9698486

A.CFD Analysis of Parabolic Solar Trough

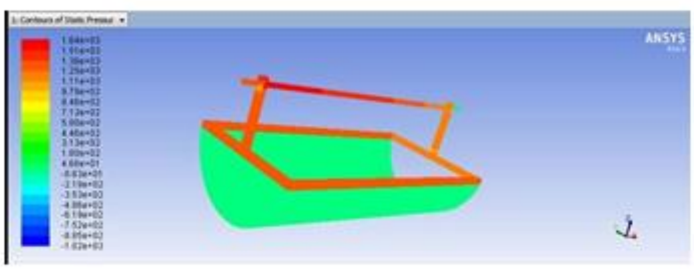


Fig 6: Static Pressure

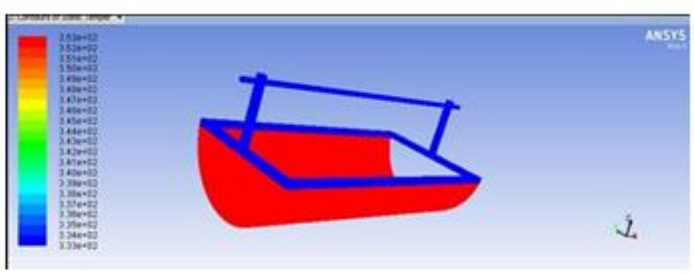


Fig 7: Temperature

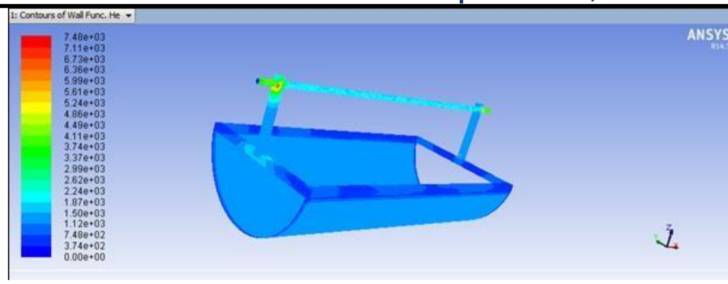


Fig 8: heat transfer coefficient

Mass Flow Rate	(kg/s)
inlet	1.4999995
interior-____msbr	-9.4357023
outlet	-1.5012258
wall-____msbr	0
Net	-0.001226306

Total Heat Transfer Rate	(w)
inlet	218614.02
outlet	-219101.16
wall-____msbr	310.48871
Net	-176.65192

B. Thermal Analysis Of Solar Parabolic Trough

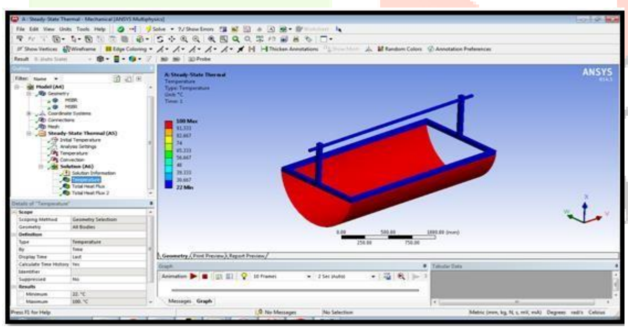


Fig 9: Temperature

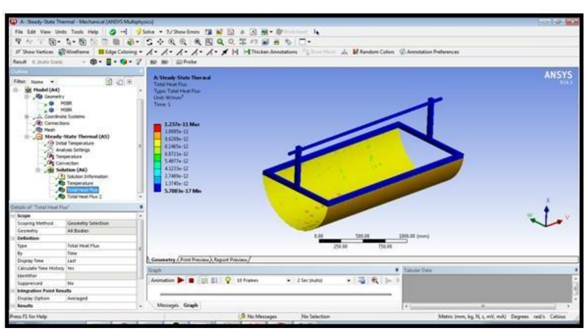


Fig 10: Heat flux

C. Thermal Analysis Solar Flat Plate Collector

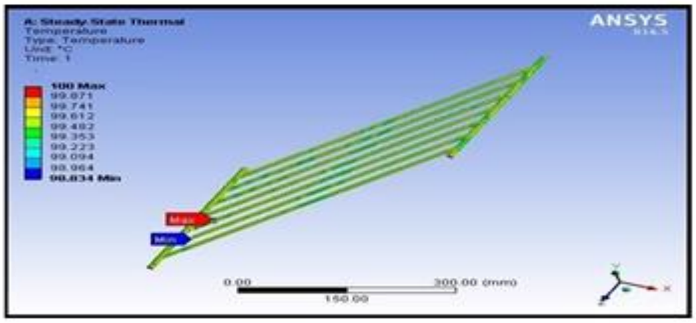


Fig 10: Temperature

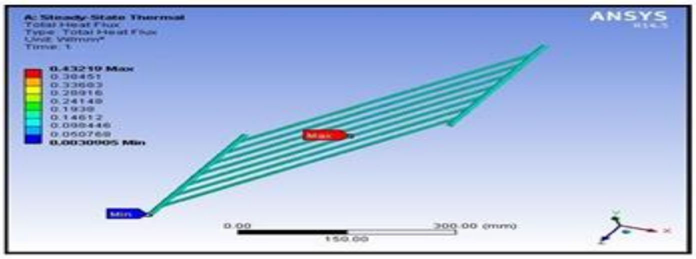


Fig 11: heat flux

RESULTS AND DISCUSSIONS

Table: 1 CFD Analysis results of Solar Flat Plate

Fluids	Pressure (Pa)	Heat transfer coefficient (w/m^2-k)	Mass flow rate (kg/s)	Heat transfer rate(w)
AIR	3.55e+004	1.44e+03	1.0958e-05	0.82574
WATER	4.65e+04	1.90e+03	3.9424e-05	2.9698
R30	4.68e+04	1.64e+03	2.5503e-05	1.920105
R160	3.70e+04	1.22e+03	5.0231e-05	3.1235e-05

Table: 2 CFD Analysis results parabolic trough

FLUID	PRESSURE (pa)	HEAT TRANSFER COFEEICENT	MASS FLOW RATE	HEAT TRANSFER RATE
AIR	1.30E+06	2.11E+03	0.00412	150.8656
WATER	1.64E+03	7.48E+03	0.0012263	176.651
R 30	1.24E+03	2.87E+02	0.001788	48.89
R 160	1.79E+03	9.84E+02	0.0013078	51.32959

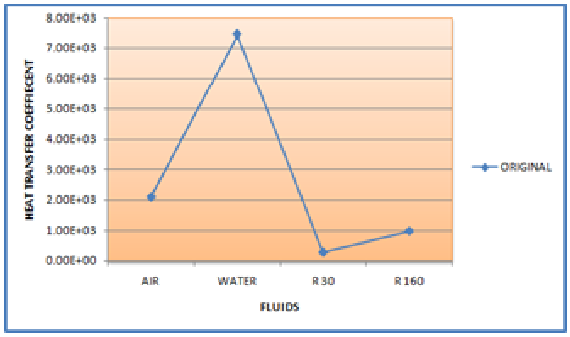
Table: 3 Thermal analysis results of parabolic trough

MATERIAL	HEAT FLUX
STEEL	1.7002E-12
ALUMINUM ALLOY	4.5574E-12
COPPER	1.237E-11

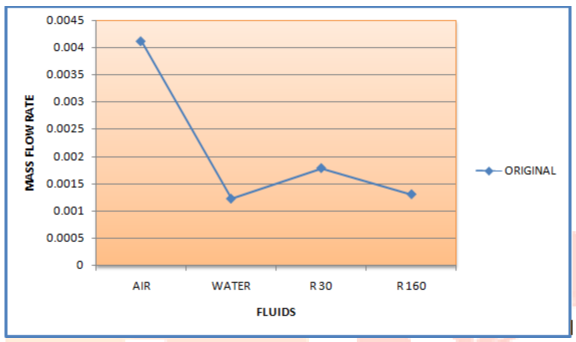
Table: 4 Thermal analysis results of solarflat plate

MATERIAL	HEAT FLUX
Aluminum alloy	0.42828
Copper alloy	0.43219

Graph:1 plotted between heat transfercoefficient and different working fluids



graph :2 plotted between mass flow rateand different working fluids



CONCLUSION

In this paper, the fluid flow through solar collectors (flat plate and parabolic trough) ismodeled using design software. The thesis will focus on thermal and CFD analysis with different fluids air, water,R30 and R60 of the solar collectors. Thermal analysis done for the solar collectors by aluminum &copper materials. By observing the CFD analysis the pressure drop & velocity values are more for water fluid at solar parabolic trough collectors compared with flat plate collector. The more heat transfer rate at fluid water.By observing the thermal analysis Heat flux value is more for copper material than aluminum and steel at solar collector So we can conclude the copper material is better for solar collectors.

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