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Title: DESIGN AND FE ANALYSIS OF SOLAR FLAT PLATE COLLECTOR

Volume 07, Issue 13, Pages: 547–553.

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DESIGN AND FE ANALYSIS OF SOLAR FLAT PLATE COLLECTOR

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ABSTRACT Flat-plate creditors, superior with the useful aid of Hottel and Whillier in the Nineteen Fifties, are the maximum not unusual kind. They embody a darkish flat-plate absorber, a obvious cowl that reduces warmth losses, a warm temperature-transport fluid (air, antifreeze or water) to take away warm temperature from the absorber, and a warmth insulating backing.In this thesis the air go with the go with the glide through solar flat plates is modeled the use of PRO-E layout software program software software application software program software program. The thesis will recognition on thermal and CFD assessment with outstanding fluid air, water and high-quality angles (900,3 hundred,450&600) of the solar flat plates. Thermal evaluation completed for the solar flat plates with the resource of, aluminum & copper at extraordinary warmth transfer coefficient values. These values are taken from CFD assessment.In this thesis the CFD assessment to determine the warmth switch coefficient, warm temperature switch price, mass go with the waft fee, pressure drop and thermal assessment to determine the temperature distribution, warm temperature flux with super materials.Three-D modeled in parametric software application Pro-Engineer and assessment finished in ANSYS.
Keywords: Solar Collector; Drying; Temperature ANSYS; CFD.

I INTRODUCTION

INTRODUCTION TO FLAT PLATE COLLECTORS

Flat-plate creditors, superior via way of way of Hottel and Whillier within the Fifties, are the most commonplace kind. They embody a dark flat-plate absorber, a obvious cowl that reduces warmth losses, a warmth-shipping fluid (air, antifreeze or water) to dispose of warmth from the absorber, and (four) a warmth insulating backing. The absorber includes a thin absorber sheet (of thermally robust polymers, aluminum, metal or copper, to which a matte black or selective coating is finished) often subsidized through a grid or coil of fluid tubing placed in an insulated casing with a tumbler or polycarbonate cover. In water warmth panels, fluid is typically circulated thru tubing to exchange warmth from the absorber to an insulated water tank. This can

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be completed proper now or via a warmth exchanger.

Firure 1: Flat plate thermal device for water heating deployed on a flat roof.

Most air warm temperature fabricators and some water warm temperature producers have a very flooded absorber together with sheets of steel which the fluid passes among. Because the warmth exchange location is more they may be marginally greater inexperienced than traditional absorbers.Sunlight passes thru the glazing and actions the absorber plate, which heats up, changing sun energy into warmth strength. The warmth is transferred to liquid passing via pipes associated with the absorber plate. Absorber plates are generally painted with "selective coatings", which absorb and keep warm temperature better than normal black paint. Absorber plates are commonly manufactured from metal—normally copper or aluminum—due to the reality the metal is a amazing warmth conductor. Copper is greater highly-priced, but is a better conductor and hundreds lots much less liable to corrosion than aluminum. (See: Copper in solar water heaters). In locations with commonplace to be had sun electricity, flat plate lenders are sized about one-1/2 to as a minimum one rectangular foot steady with gallon of in the end's warm water use.

II LITERATURE SURVEY

Solar Flat Plate Collector Analysis

Flat Plate Collector (FPC) is considerably used for home warm temperature-water, place heating/drying and for packages requiring fluid temperature loads a whole lot much less than 100oC. Three number one components related to FPC particularly, absorber plate, pinnacle covers and heating pipes. The absorber plate is selective covered to have immoderate absorptivity. It gets warmth with the beneficial useful resource of manner of solar radiation and via conduction; warmth is transferred to the flowing liquid through the heating pipes. The fluid go together with the drift thru the collector pipes is thru natural (thermosyphon effect) or thru compelled flow into (pump drift). For small water heating structures herbal drift is used for fluid go with the waft. Conventionally, absorbers of all flat plate creditors are without delay copper/aluminum sheets however, which limits on the warm temperature collection surface switch vicinity. Thus, higher warm temperature collection floor area is optimized thru manner of converting its geometry with the same region of traditional FPC. The intention of present take a look at is to evaluate the overall usual performance of FPC with unique geometric absorber configuration. It is expected that with the same collector vicinity higher thermal everyday normal ordinary performance or higher water temperature can be acquired. Thus, fee of the FPC may be in addition bringing down via way of improving the collector efficiency.

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A Performance Assessment of Solar Flat Plate Collector System with Heat Storage Tank

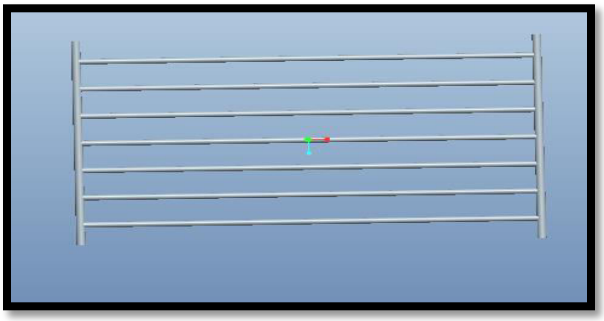
Solar lenders and thermal strength garage Components are the 2 middle subsystems in sun thermal electricity systems. This paper offers the thermal vast famous standard normal performance assessment of a glazed sun flat plate collector tool with warmness storage tanks. Special interest is centered on the have an effect on of the gadget parameters at the aspect of the functionality of thermal garage and thermal load on the overall normal common performance of the collector tool. The crucial tool variables collectively with the sun insolation at the tilted collector floor, the useful strength, the temperature inside the storage tank, and the collector widely wide-spread performance are investigated on summer season and iciness solstices.

III. SYSTEM ANALYSIS

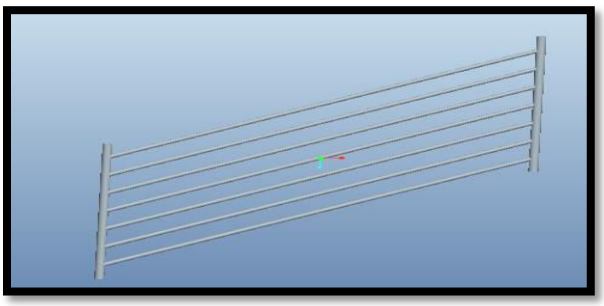
Models of solar flat plate using pro-e wildfire 5.0

The sun flat plate is modeled the usage of the given specifications and layout components from records e-book. The isometric view of solar flat plate is tested in under determine. The sun flat plate profile is sketched in sketcher and then it's miles extruded solar flat plate the use of extrude choice.

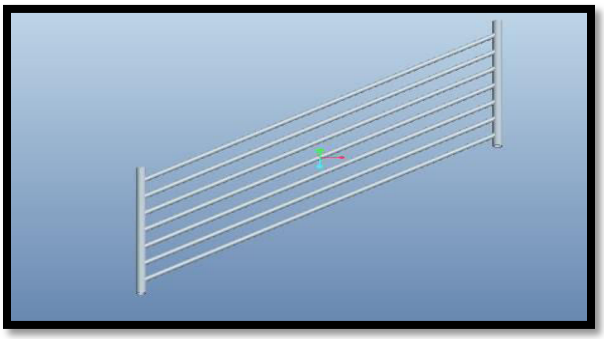
Solar flat plate at 90^0 3D models



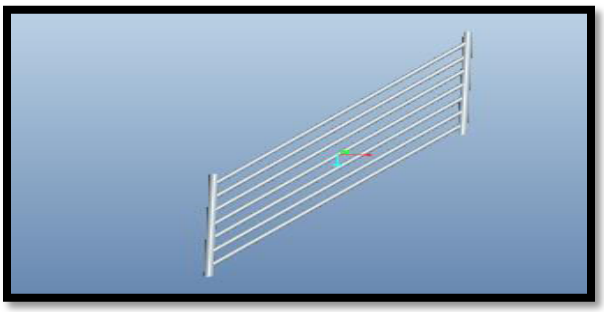
Solar flat plate at 30^0 3D models



Solar flat plate at 45^0 3D models



Solar flat plate at 60^0 3D models



CFD ANALYSIS OF SOLAR FLAT PLATES

SOLAR FLAT PLATE ANGLES 90^0,60^0,45^0 & 30^0

FLUID –AIR & WATER

MATERIAL PROPERTIES OF AIR

Thermal conductivity

= 0.024w/m-k

Density

= $1.225kg/m^3$

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Viscosity
= 1.98×10^{-5} kg/m-s

MATERIAL PROPERTIES OF WATER

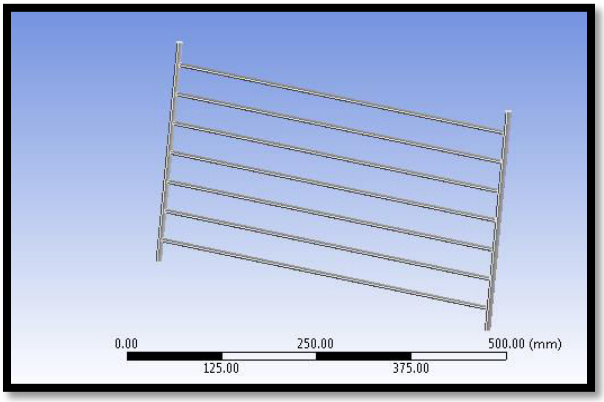
Thermal conductivity
= 0.024w/m-k

Density
= $1.225kg/m^3$

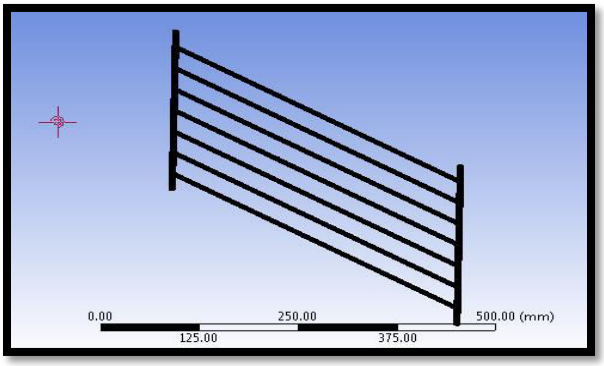
Viscosity
= 1.98×10^{-5} kg/m-s

→→Ansys → workbench→ select analysis system → fluid flow fluent → double click

→→Select geometry → right click → import geometry → select browse →open part → ok



→→ select mesh on work bench → right click →edit → select mesh on left side part tree → right click → generate mesh →



Model → energy equation → on.

Viscous → edit → k- epsilon

Enhanced Wall Treatment → ok

Materials → new → create or edit → specify fluid material or specify properties → ok

Select air and water

Boundary conditions → select water inlet → Edit → Enter Mass Flow Rate → 0.0105Kg/s and Inlet Temperature – 353K

Solution → Solution Initialization → Hybrid Initialization →done

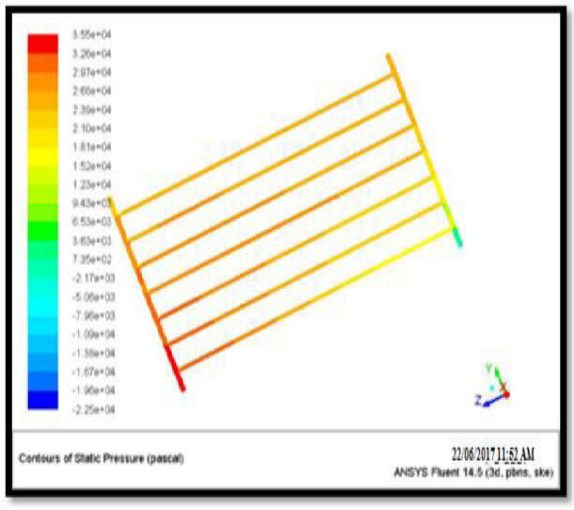
Run calculations → no of iterations = 50 → calculate → calculation complete

→→ Results → graphics and animations → contours → setup

SOLAR FLATPLATE AT 90^0

FLUID-AIR

STATIC PRESSURE



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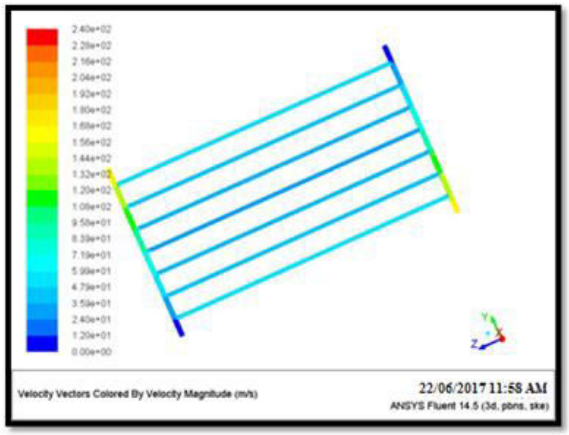
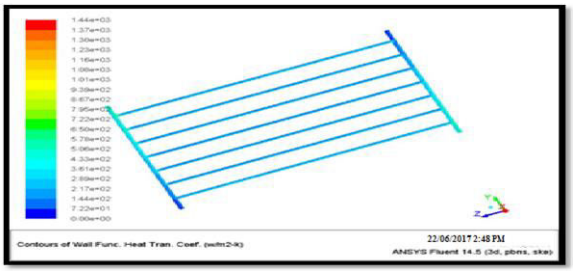
VELOCITY



HEAT TRANSFER COEFFICIENT



MASS FLOW RATE & HEATTRANSFER RATE

Mass Flow Rate	(kg/s)
inlet	0.010499999
interior-partbody	0.03278254
outlet	-0.010510959
wall-partbody	0
Net	-1.0959804e-05

Total Heat Transfer Rate	(w)
inlet	790.97839
outlet	-791.80414
wall-partbody	0
Net	-0.82574463

IV PROBLEM DISCRIPTION

Air waft thru sun flat plates is modeled the usage of PRO-E layout software program program software software. The thesis will reputation on thermal and CFD evaluation with unique fluids air, water and specific angles (900,3 hundred,450&six hundred) of the solar flat plates. Thermal assessment finished for the sun flat plates thru the use of aluminum & copper at one-of-a-type heat switch coefficient values.

Fluids	Angle of plate	material
Air	0^0,30^0,45^0&60^0	Copper
Water		aluminum

FLUID	FLUE GAS
Temperature at RA & GT inlets	857 K & 901 K
Mass Flow Rate at RA & GT inlets	337 Kg/s & 147 Kg/s
Density (ρ)	0.6214.5 kg/m^3
Viscosity (μ)	0.0284 Kg/ m-s
Conductivity (k)	0.042749 W/m−K
Specific Heat (C_p)	1099.87 J/kg−K

Table 1:Input Data

V RESULTS

CFD ANALYSIS RESULTS TABLE

Angle (^{0})	Fluids	Pressure (Pa)	Velocity (m/s)	Heat transfer coefficient (w/m^2-k)	Mass flow rate (kg/s)	Heat transfer rate(w)
90^0	Air	3.55e+004	2.40e+02	1.44e+03	1.0958e-05	0.82574
	Water	1.5e+02	2.95e-01	7.91e+03	3.23e-05	10.122314
60^0	Air	4.65e+04	3.40e+02	1.90e+03	3.9424e-05	2.9698
	Water	1.66e+02	4.68e-01	1.33e+04	0.0001913	59.8955
45^0	Air	4.68e+04	2.85e+02	1.64e+03	2.5503e-05	1.920105
	Water	1.40e+02	3.14e-01	9.36e+03	7.77e-05	24.3361
30^0	Air	3.70e+04	2.39e+02	1.22e+03	5.0231e-05	3.1235e-05
	Water	1.30e+02	2.90e-01	6.78e+03	3.7843628	9.75878

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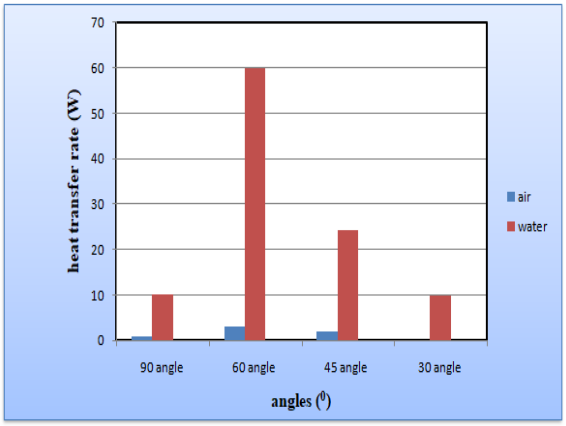
THERMAL ANALYSIS RESULTS TABLE

Angle (^{0})	Fluids	Materials	Temperature(^{0}C)	Heat flux (w/mm^2)
90^0	Air	Aluminum alloy	100.02	0.23116
		Copper alloy	100.01	0.23266
	Water	Aluminum alloy	100.12	1.2086
		Copper alloy	100.05	1.251
60^0	Air	Aluminum alloy	100	0.42828
		Copper alloy	100	0.43219
	Water	Aluminum alloy	100	2.7404
		Copper alloy	100.02	2.9136
45^0	Air	Aluminum alloy	100.03	0.48297
		Copper alloy	100.01	0.4867
	Water	Aluminum alloy	100.18	2.5964
		Copper alloy	100.08	2.7089
30^0	Air	Aluminum alloy	99.879	0.3138
		Copper alloy	99.869	0.31565
	Water	Aluminum alloy	100.01	1.6679
		Copper alloy	99.916	1.7216

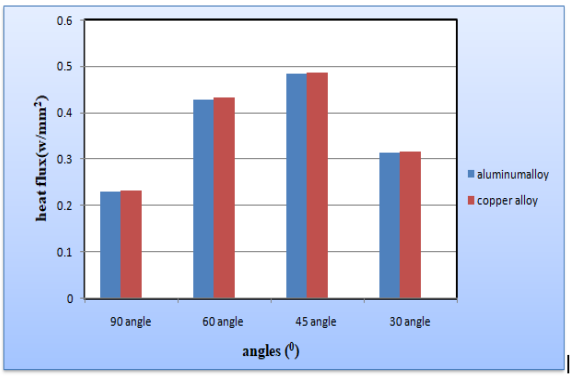
GRAPHS

HEAT TRANSFER RATE PLOT

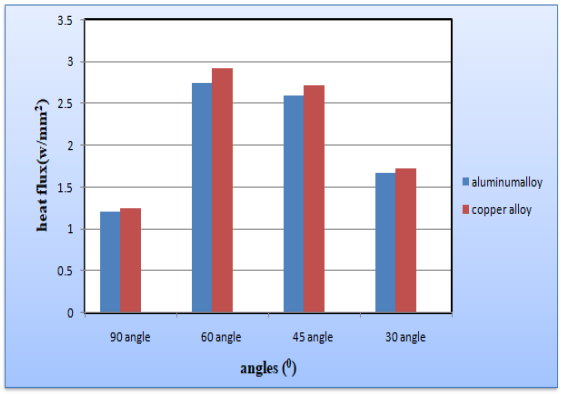


HEAT FLUX PLOT

FLUID- AIR



FLUID- WATER



VI CONCLUSION

In this thesis the air go together with the go together with the waft through solar flat plates is modeled the usage of PRO-E format software program application software program software. The thesis will focus on thermal and CFD evaluation with exquisite fluids air, water and one-of-a-kind angles (900,three hundred,450&600) of the sun flat plates. Thermal evaluation completed for the sun flat plates via aluminum & copper at superb warmth switch coefficient values. These values are taken from CFD assessment at first rate Reynolds numbers.By looking at the CFD evaluation the stress drop & tempo values are extra for water fluid at 600 solar flat plate creditors. The extra warm temperature transfer price at six hundred angles thru fluid water.By looking on the thermal assessment, the taken specific warmth switch coefficient values are from CFD evaluation. Heat flux charge is greater for copper fabric than aluminum at 600 solar flat plate creditorsSo we are in a position to complete the copper material is better for solar flat plates.

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