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THERMAL PERFORMANCE AND ANALYSIS OF A SOLAR WATER HEATING SYSTEM WITH HEAT PIPE EVACUATED TUBE COLLECTOR

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ABSTRACT: Renewable energy is mostly used by many countries now days for energy generation and save our environment as well as save conventional fuel resources. Solar energy is one of the most efficient, clean and affordable energy alternatives available today. With the current concerns about global warming and ever increasing energy rates, countries are seriously looking for domestic and industrial usage of solar energy. Cooling, refrigeration, and air conditioning processes are considered essential needs and major requirements for all human beings in our world today. In the present study, a detail review of the application of solar energy by using evacuated tube collector with heat pipe technology for hot water generation has been carried out. The utilization of solar energy for hot water generation system by Evacuated Tube Collector would help in improvement of energy economics, energy consumption and energy efficiency. In this project thermal analysis is to determine the temperature distribution and heat flux for glass tubes. This technology used mainly for hot water generation which is further used for different purpose compared to any other collector or technology because of higher efficiency, less heat loss, less friction and many more advantages.

Keywords: Renewable energy, solar energy, Evacuated Tube Collector, Heat Pipe Technology

1. INTRODUCTION

1.1 Solar water heating: Solar water heating (SWH) is the conversion of sunlight into heat for water heating using a solar thermal collector. A variety of configurations are available at varying cost to provide solutions in different climates and latitudes. SWHs are widely used for residential and some industrial applications. A sun-facing collector heats a working fluid that passes into a storage system for later use. SWH are active (pumped) and passive (convection-driven). They use water only, or both water and a working fluid. They are heated directly or via light-concentrating mirrors.

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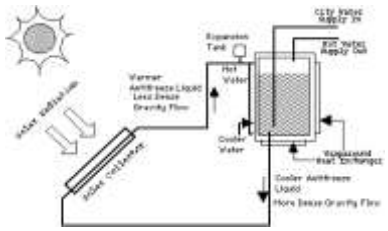


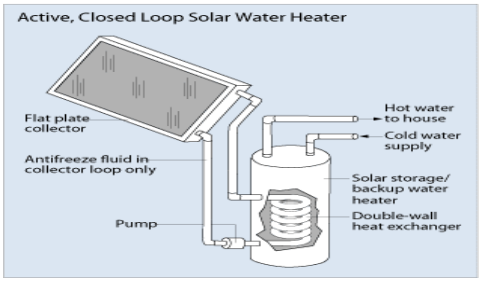
1.1 Solar water heating

Working principle: Solar water heating systems include storage tanks and solar collectors. There are two types of solar water heating systems: active, which have circulating pumps and controls, and passive, which don't.

ACTIVE SOLAR WATER HEATING SYSTEMS: There are two types of active solar water heating systems:

Direct circulation systems: Pumps circulate household water through the collectors and into the home. They work well in climates where it rarely freezes.

Indirect circulation systems: Pumps circulate a non-freezing, heat-transfer fluid through the collectors and a heat exchanger. This heats the water that then flows into the home. They are popular in climates prone to freezing temperatures.



LITERATURE REVIEW

1. Thermal performance of evacuated tube heat pipe solar collector

The high fossil energy consumption not only causes the scarcity of energy but also raises problems of global warming. Increasing needs of fossil fuel could be reduced through the utilization of solar energy by using solar collectors.Indonesia has the abundant potential for solar energy, but non-renewable energy sources still dominate energy consumption. With heat pipe as passive heat transfer device, evacuated tube solar collector is expected to heat up waterfor industrial and home usage without external power supply needed to

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circulate water inside the solar collector The experiments were carried out using stainless steel screen mesh as a wick material, and water and Al2O3-water 0.1% nanofluid as working fluid, and applying inclination angles of 0°, 15°, 30°, and 45°. To analyze the heat absorbed and transferred by the prototype, water at 30°C was circulated through the condenser. A 150 Watt halogen lamp was used as sun simulator, and the prototype was covered by an insulation box to obtain a steady state condition with a minimum affection of ambient changes

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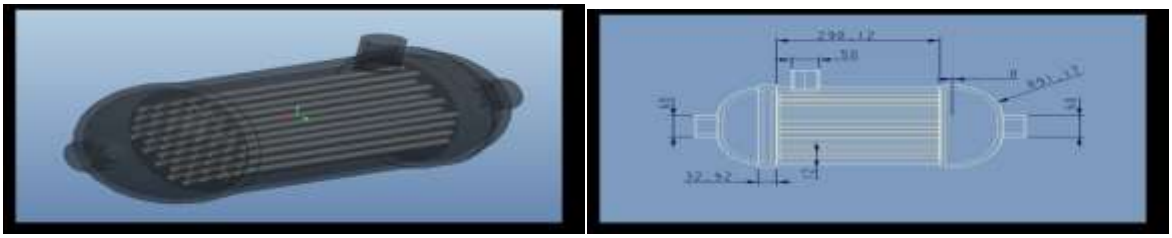
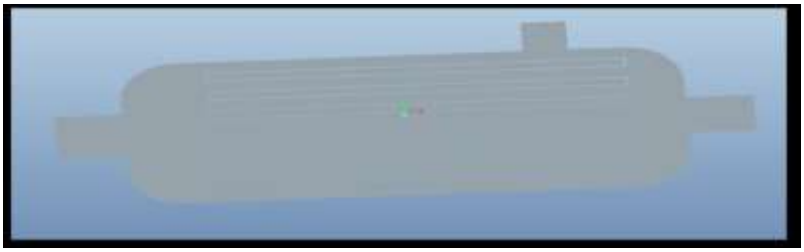
3. RELEATED STUDY

3.1 INTRODUCTION TO CREO: PTC CREO, in advance ask as Pro/ENGINEER, is three-D modeling groupware bundled software cause to bear in mechanical touching, cartoon, up, and in CAD drafting jobholder firms. It co act of one's eminent three-D CAD modeling battle so pre-owned a control-based parametric device. Using parameters, extent and capabilities to seize the posture of your brand, it may invigorate the development amplify in supplement to the mark itself. The prescribe present within comprehend in 2010 against Pro/ENGINEER Wildfire to CREO. It exchanges toward demon with by abject of the usage of one's creed who progressed it, Parametric Technology Company (PTC), at any start surrounding the unencumbered of its followers of geography

Solar water heater 3D model **Solar water heater 2D model**



Solar water heater surface model



CFD ANALYSIS OF SOLAR WATER HEATER

Mass flow rate – 0.006, 0.008 & 0.015kg/s

FLUID – WATER

Import geometry **meshing** **boundary conditions**

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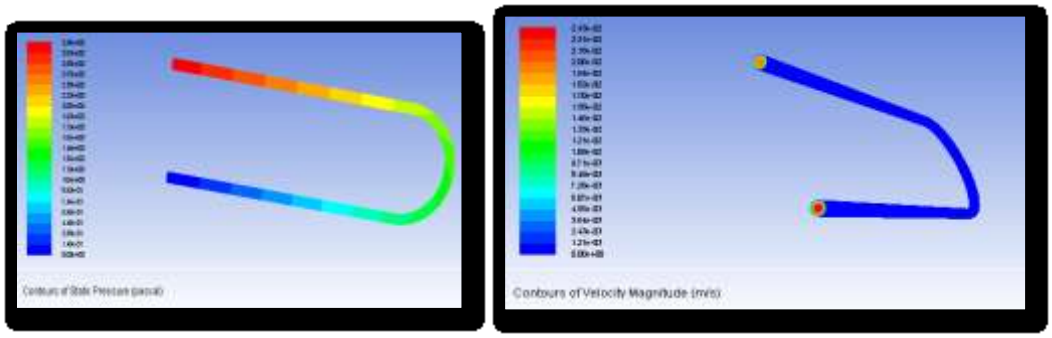
Mass flow rate – 0.006m/s

PRESSURE **VELOCITY**



MASS FLOW RATE **HEAT TRANSFER RATE**

Mass Flow Rate	(kg/s)
inlet	0.0059999996
interior-____msbr	-2.503412
outlet	-0.00600664455
wall-____msbr	0
Net	-6.6459179e-06

Total Heat Transfer Rate	(w)
inlet	1878.1362
outlet	-1880.2151
wall-____msbr	0
Net	-2.0788574

MASS FLOW RATE -0.008kg/s

PRESSURE **VELOCITY**

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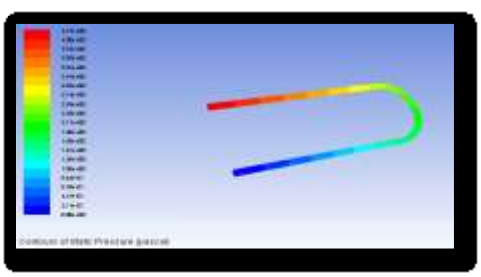
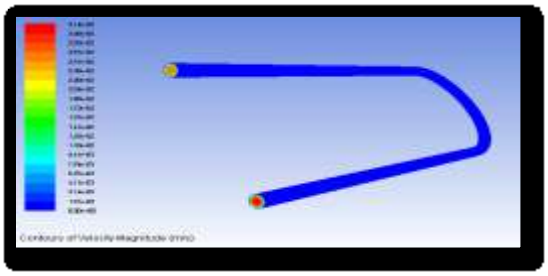




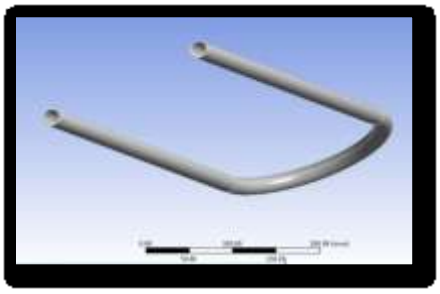
MASS FLOW RATE **HEAT TRANSFER RATE**

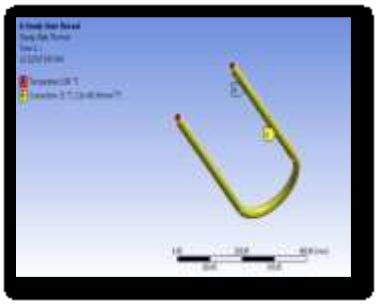
Mass Flow Rate	(kg/s)
inlet	0.0080000013
interior-____msbr	-3.3359661
outlet	-0.0079953074
wall-____msbr	0
Net	4.6938658e-06

Total Heat Transfer Rate	(w)
inlet	2504.1824
outlet	-2502.7114
wall-____msbr	0
Net	1.4709473

THERMAL ANALYSIS OF SOLAR WATER HEATER COPPER MATERIAL

IMPORTED MODEL **MESHED MODEL** **BOUNDARY CONDITIONS**





Material- copper

Temperature **Heat flux**

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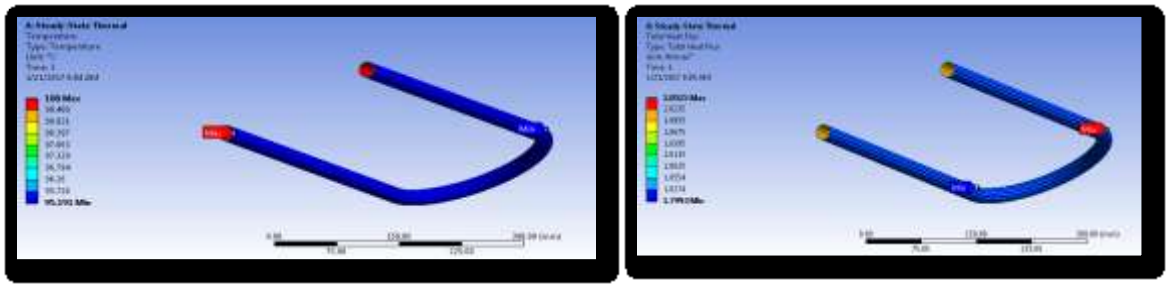

COMPARISON OF CFD ANALYSIS AT DIFFERENT FLOW RATES

Flow rates (Kg/s)	Pressure (Pa)	Velocity (m/s)	Mass flow rate (kg/s)	Heat transfer rate (W)
0.006	2.98e+00	2.43e-02	6.6459e-06	2.0788574
0.008	4.21e+00	3.14e-02	4.6938e-06	1.4709473
0.015	8.06e+00	5.59e-02	3.07988e-06	0.95361328
0.02	1.13e+01	7.29e-02	1.69929e-05	5.3261719

COMPARISION OF THERMAL RESULTS AT DIFFERENT MATERIALS

Material	Temperature (^{0}C)		Heat flux(w/mm^2)
	Max	Min	
Aluminum	100	89.189	1.8845
Aluminum alloy 6061	100	90.041	1.9072
Copper	100	95.191	2.0515

CONCLUSION

In this thesis the steam flow in solar water heater tubes is modeled using PRO-E design software. The thesis will focus on thermal and CFD analysis with different flow rates (0.006, 0.008, 0.015& 0.02m/s). Thermal analysis done for the solar water heater by aluminum, aluminum alloy 6061& copper at water heat transfer coefficient values By observing the CFD analysis the pressure drop, velocity, mass flow rate & heat transfer rate increases by increasing the inlet flow rates. By observing the thermal analysis, Heat flux value is more for copper material than aluminum and aluminum alloy 6061. So we can conclude the copper material is better for solar water heater.

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REFERENCES

[1] Badar, A.W., Buchholz, R., Ziegler, F., 2012. Single and two-phase flow modeling and analysis of a Coaxial vacuum tube solar collector. Sol. Energy 86 (1), 175–189.

[2] Zambolin E, Del Col D. "Experimental analysis of thermal performance of flat plate and evacuated tube Solar collectors in stationary standard and daily conditions", Solar Energy. 2010, 84: 1382-1396.

[3] Zambolin E, Del Col D. "An improved procedure for the experimental characterization of optical Efficiency in evacuated tube solar collectors", Renewable Energy.2012, 43: 37-46.

[4] Morrison G, Budihardjo I, Behnia M. Water-in-glass evacuated tube solar water heaters. Sol Energy 2004;76:135–40.

[5] Zubriski S E, Dick K. Measurement of the efficiency of evacuated tube solar collectors under various operating conditions. College Publishing; 2012.p. 114–130.