EXPERIMENTAL VERIFICATION AND ENHANCEMENT OF PERFORMANCE BY ANALYSIS OF FLOW THROUGH SOLAR FLAT PLATE COLLECTOR

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Abstract

Solar flat plate collector is a very simple device and is an efficient way to absorb energy from sun rays and use it. Flat Plate Collector is widely used for domestic hot-water, space heating/drying and where the fluid temperature is less than 100^0 C. Any increase in heat transfer enhancement is an added advantage which will save energy.First variables like temperature, mass flow rate has been noted through experimental results using CATIA model design has been done and imported to ICEM CFD where meshing has been done.Analysis has been done through CFX where pre boundary conditions provided and finally results of experiment has been validated through CFD. After proving CFD has an effective tool for analysis. It has been used for further enhancement of heat transfer.In this project passive method is adopted in order to intensify the heat transfer by providing dimples on the inner surface of the tube.

KEY WORDS: INTENSIFY, CFD, CFX, COLLECTOR TUBE

1.Introduction:

A solar thermal tool captures and transfers the heat energy to be had in solar radiation which may be used for assembly requirements of warmth in precise temperature degrees. solar water heating gadget (SWHS) is a device in which materials warm water at 60°C to eighty the use of most effective solar thermal electricity with none special gas.In everyday sun water heater, water is heated by using the solar thermal electricity absorbed via the collectors. The recent water with decrease density moves upwards and cold water with higher density actions down from the tank because of gravity head. A monetary institution of creditors may be arranged in a series – parallel mixture to get higher quantity of warm water. A popular 100 liters insulated tank with a location, will supply water at a temperature of 60 - 80°C[1].

Solar wind heating system is essence of sun collector that is in a big way used in manifold applications along by all of home, trade, and concerning plants fields. Solar set a match to collectors are the consistent element principle of wise type sun heat systems. They draw sun's pretension, redesign its aurora particles into warmness, and before switch the light to a sinuous

(commonly mineral deposit or air). The sun thermal electricity bounded cell is utilized in solar water temperature rising systems, sun join warmers, and solar outlook heating structures. Flat-plate collectors are the restriction not late solar collector for solar water-heating structures in homes and solar out skirt heating. Both oars in water flat-plate collector is an insulated native minerallifeearth container mutually a pitcher or plastic pussyfoot (referred to as the glazing) and a darkish-colored absorber plate. The ones creditors swelter liquid or am relay at temperatures scanty than 80°C[2].

3.Methodology

Experimental results will be noted and heat transfer rate will be calculated And then it will validated through CFD. Further through CATIA we are changing and inserting dimples in the absorber tube (modeling) and it will be imported to ICEM CFD where meshing will be done and analysis will be carried out through CFX using appropriate boundary condition obtained from experimental set up where enhancement of heat transfer will be achieved.

The heat flux will be calculated by using the below given formulae

$q=A_1V_1$

$Q= mw\ Cpw\ \Delta T$

4.Experimental set up

Fig.1 Experimental set up of 200lts solar water heater

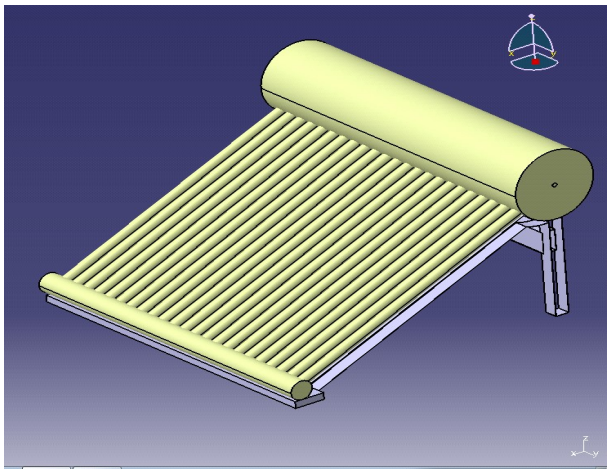

Fig.2 CATIA Model of Experimental Set Up

4.1 Specification

1. Total no. of tubes =24
2. Length of each tube =1531mm
3. Diameter of each tube =58mm
4. Diameter of upper drum =435mm
6. Total length =1900mm
7. Inlet Temperature = 32^0C
8. Outlet Temperature = 62^0C

5. Experimental result calculation

$Q= m_w Cp_w \Delta T$
$Q=0.11*4187*(62-32)$
$Q=13942.71$ W/s
$q = A_1 V_1$
$V_1=1.11*10^{-4}/((\pi/4)*(.025)^2)$
$V_1=0.2262$m/sec

6.Results and Discussion

6.1 Results for Model 1

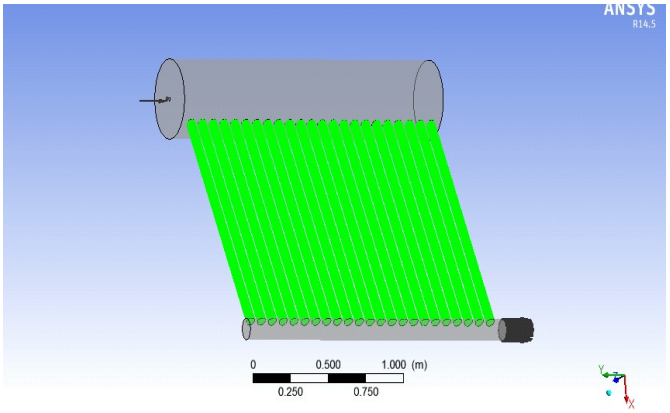

Fig.3 Boundary condition provided through CFX-PRE

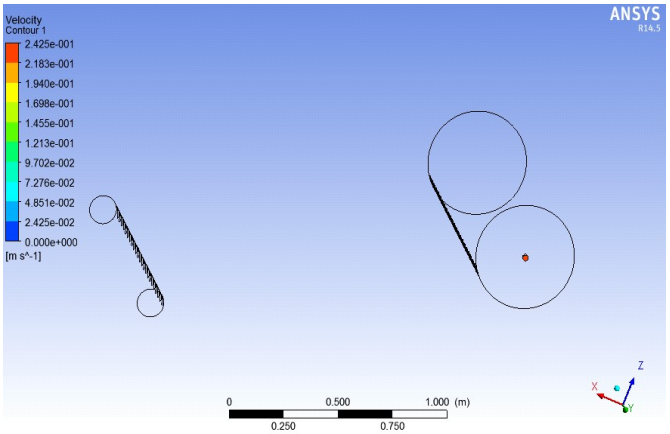

Fig.4 Velocity Contour

Velocity contour is as shown in fig which clearly validates the boundary condition at inlet which is 0.22m/sec.

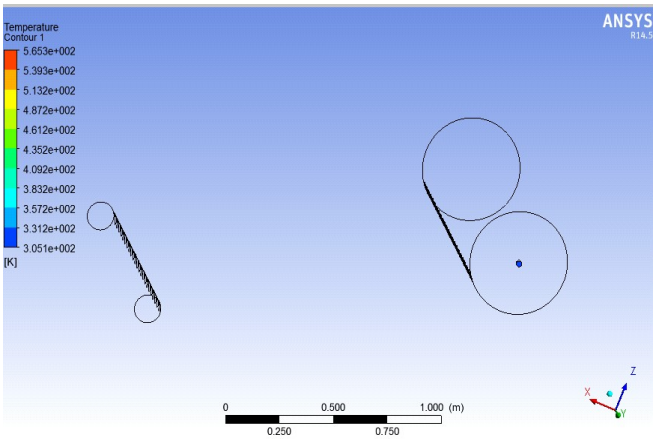

Fig.5 Temperature contour at inlet

Temperature contour at inlet is as shown in fig which clearly validates the experimental results which is 305K (32^0 c).

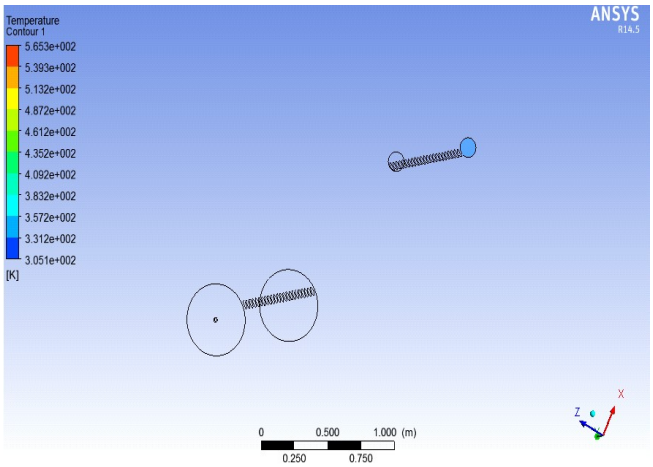

Fig.6 Temperature contour at outlet

Temperature contour at out let is as shown in fig which clearly validates the nearest experimental results which is 332K (58^0 c)

6.1.1 CFD Results for Model 1

$Q= m_w Cp_w \Delta T$

Q=0.11*4187*(58-32)

Q=11874.82 W/s

6.2 Resultes for Model 2

Enhancement of Heat transfer through passive Method by providing Dimples inside collector Tube

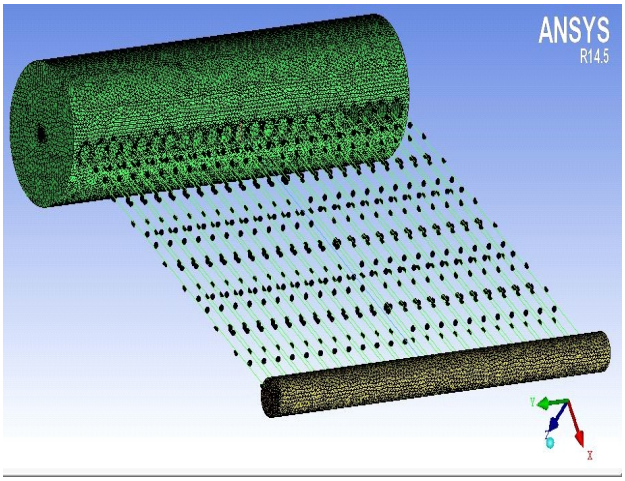

Fig.7 Meshing done after providing dimples inside pipe

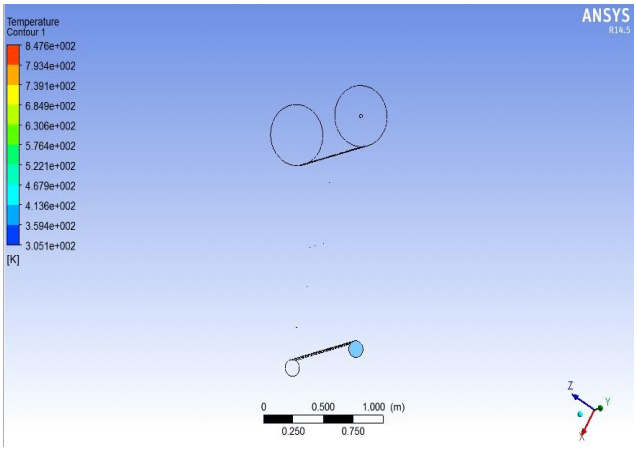

Fig.8 Temperature contour at outlet

Temperature contour at out let is as shown in fig which is an enhancement of heat transfer which is 350k (77^0 c)

6.2.1 CFD Results for Model 2

$Q= m_w Cp_w \Delta T$

Q=0.11*4187*(77-32)

Q=20725.85 Watts

TABLE 1

	Experiment	Model 1	Model 2
Inlet Temperature in ^{0}C	32	62	32
Outlet Temperature in ^{0}C	62	58	77
Heat transfer Q Watts	13942.17	77	20725.85
Enhancement of Temperature Model2 with Experimental results	19.48%		

CONCLUSION

1.The evacuated tube solar water heating device is one of the efficient way for house hold purpose not because of it is efficient as compare to other mean of water heating devices but also it is eco-friendly and non-polluting device.

2. CFD tool has been proved as an effective tool to validate experimental results

3. CFD tool is used to enhance heat transfer by providing dimples which is a passive method of enhancement of heat transfer.

4. Enhancement of temperature of model 2 with experimental results found to be of 19.48%
5.Hence by providing passive method heat transfer intensification can be achieved.

SCOPE FOR FUTURE WORK

- Enhancement can be achieved by active method also which can be taken as further analysis
- Since heat transfer intensification depends on shape of the domain, further analysis can be carried out changing the shape of the domain
- Further study can be carried out by changing the inclination of solar flat plate collector

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