Modelling and performance enhancement of thermosyphon solar water heating system using parallel piping chamber

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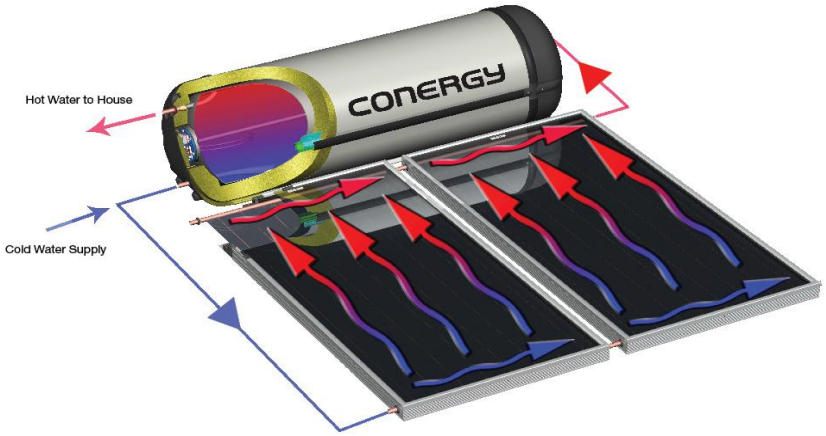
***Abstract*— A solar water heating system for domestic use has been designed and constructed using locally available materials. Solar energy is received by a flat-plate collector consisting of a thin absorber plate, integrated with underneath grids of fluid carrying tubes, and placed in an insulated casing with a transparent glass cover having a cold and a hot water tank integrated in the system. So for performance enhancement of thermosiphon solar water heater an effective use of computational fluid dynamics tool in predicting the flow behaviour of supply of water in tubes by considering design parameters to obtain maximum efficiency such that the needed energy demand can fulfil through thermosyphon solar water heater.**

***Keywords*— Thermosyphon solar water heater, Parallel piping, CFD, Mass flow rate, Efficiency**

I. INTRODUCTION

SINCE THE START OF TIME, HUMANS HAVE BEEN FASCINATED BY THE SUN. ANCIENT CIVILIZATION PERSONIFIED THE SUN, WORSHIPPING AS A GOD OR GODDESS. THROUGHOUT RECORDS, FARMING AND AGRICULTURE EFFORTS HAVE RELIED UPON THE SUN'S RAYS TO DEVELOP PLANTS AND MAINTAIN POPULATIONS. ONLY RECENTLY, HOWEVER HAVE WE EVOLVED THE ABILITY TO HARNESS THE SUN'S TREMENDOUS ELECTRICITY. THE RESULTING TECHNOLOGIES HAVE PROMISING IMPLICATIONS FOR THE DESTINY OF RENEWABLE ENERGY AND SUSTAINABILITY. BELOW, WE HAVE GIVEN QUICK ON SOLAR ENERGY, HOW IT WORKS AND WHAT MAY BE IN STORE FOR THE DESTINY OF SOLAR.



Thermosiphon (or thermosyphon) is a method of passive heat exchange, based on natural convection, which circulates a fluid without the necessity of a mechanical pump. Solar water heating is an accepted technology in the Pacific and is increasingly being used as one of the most cost effective means of heating water in the domestic sector, and also for heating and preheating

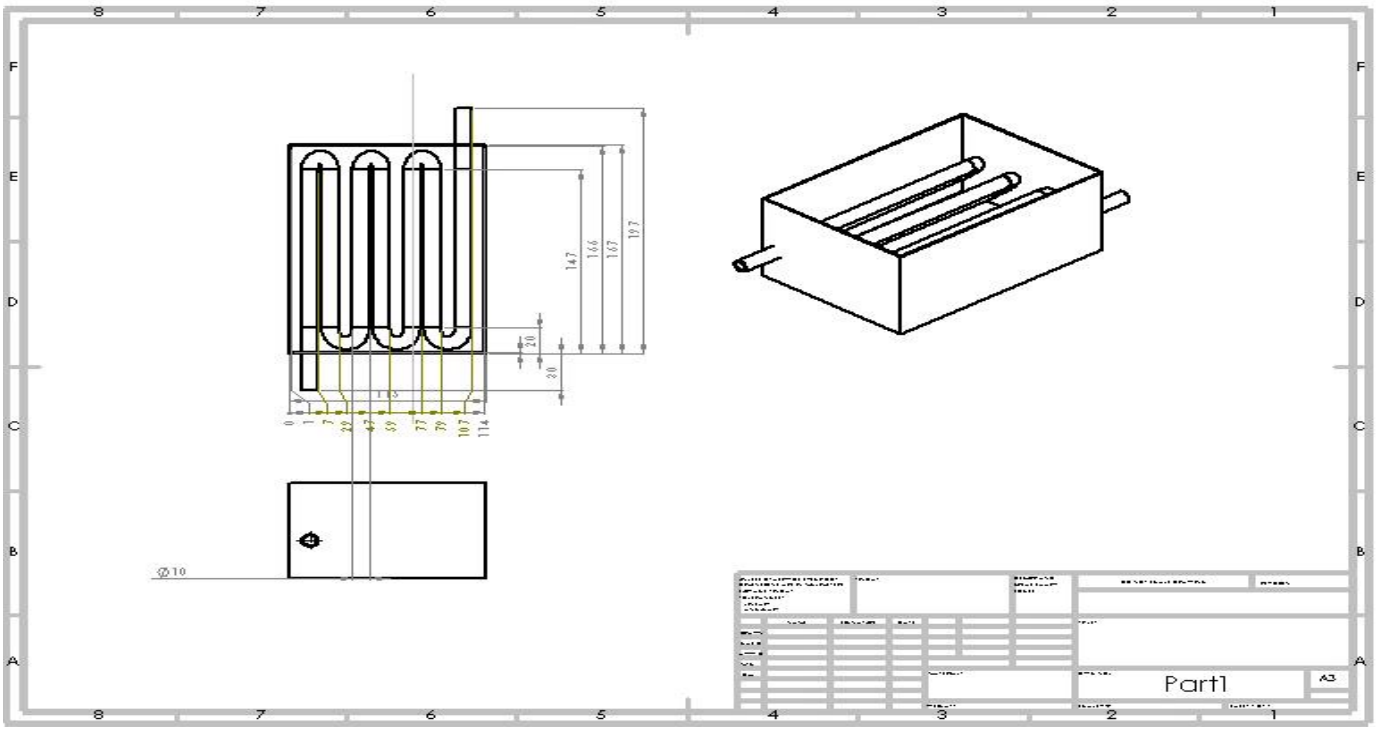
in commercial situations such as hotels, laundries and restaurants and in government institutions such as hospitals and health centres.

II. **LITERATURE REVIEW**

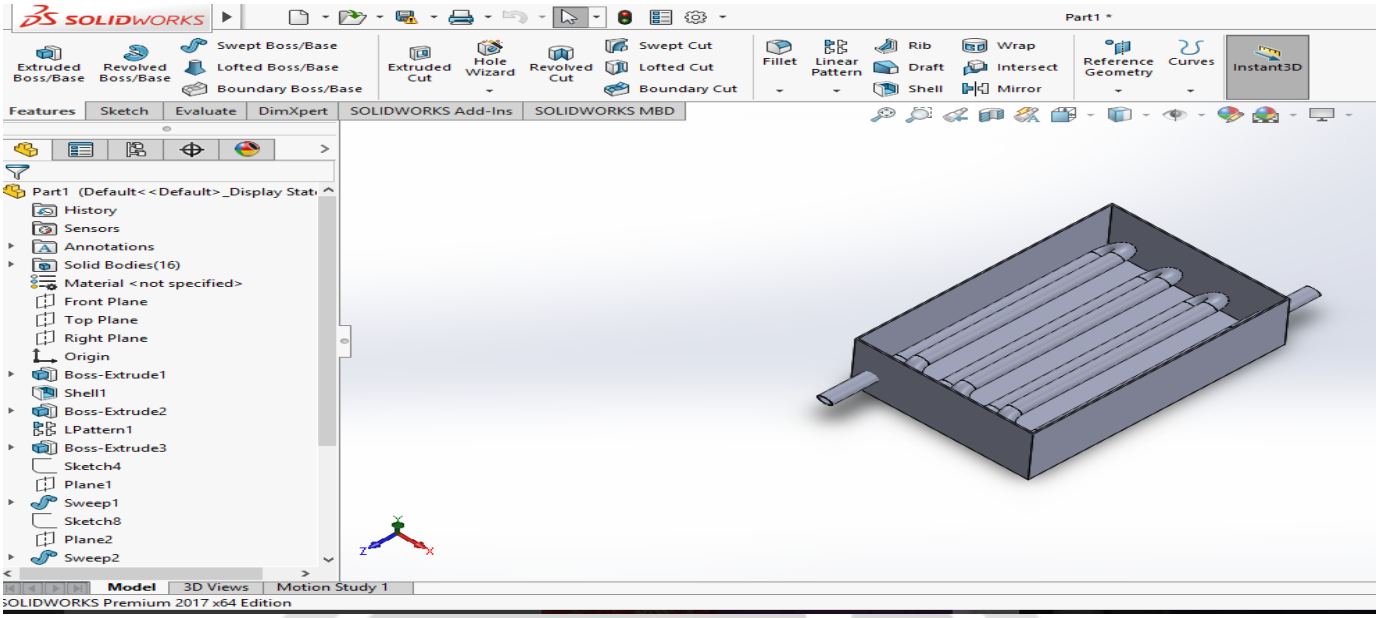
S.N.Agbo & G.O. UNACHUKWU [1] DESIGN and performance features of a domestic thermosyphon solar water heater for an average sized family in Nsukka Urban M. Yahva, K. Sopian, M. Syahri, S. Abdullah, M.A. Alghoul and A. Zahrim[2] CFD of solar hot water system with integrated storage system Abdollah Riahi and Hessam Taherian[3] Experimental investigation on the performance of thermosyphon solar water heater in the south caspian sea Dr. Hosni . Abu-mulaweh[4] A prototype of a solar water heating system was constructed and tested. The solar collector rotated as the sun position/angle was changing, indicating the functionality of the control system that was design to achieve this task. YI-Mei Liu, Kung-Ming Chung, Keh-Chin Chang, Tsong-Sheng Lee[5] Performance of Thermosyphon Solar Water Heaters in Series G.N. Okonkwo and A.O.C. Nwokoye[6] Experiment work of 6 month on solar water heater in Nigeria. Nosa Andrew Ogie,Ikponmwosa Oghogho, and Julius Jesumirewhe[7] Design and Construction of a Solar Water Heater Based on the Thermosyphon Principle B. Freegah, T. Asim[8] Computational fluid dynamics based analysis of a closed thermosyphon solar water heater Bandar Fadhl , Luiz C. Wrobel, Hussam Jouhara[9] Numerical modelling of temperature distribution in a 2-phase closed thermosyphon S. Sadhishkumar, T. Balusamy [10] fabricated and experimented a single phase thermosyphon to utilize solar energy for water heating S. Suresh, K. Kuppan, D. Balamurali, P. Lawrence

III. **METHODOLOGY**

A. Drafting of thermosiphon solar water heater:-



Modelled thermosyphon solar water heater:-



Here thermoyphon solar water heater is modelled in solidworks software. And its 2-D and 3-D model are as above in the figure.to carry out prediction of mass flow rate, temperature streamline and meshing this model is inserted into ansys from where using ansys-fluent we had carried out predictions.

IV COMPUTATIONAL FLUID DYNAMICS ANALYSIS

The .sldasm was inserted into the ansys software for analysis.Initially meshing was done on the tswh and boundary conditions was applied.fine meshing was done on the tswh for better visualization and results.based on the meshing nodes and elements were calculated.

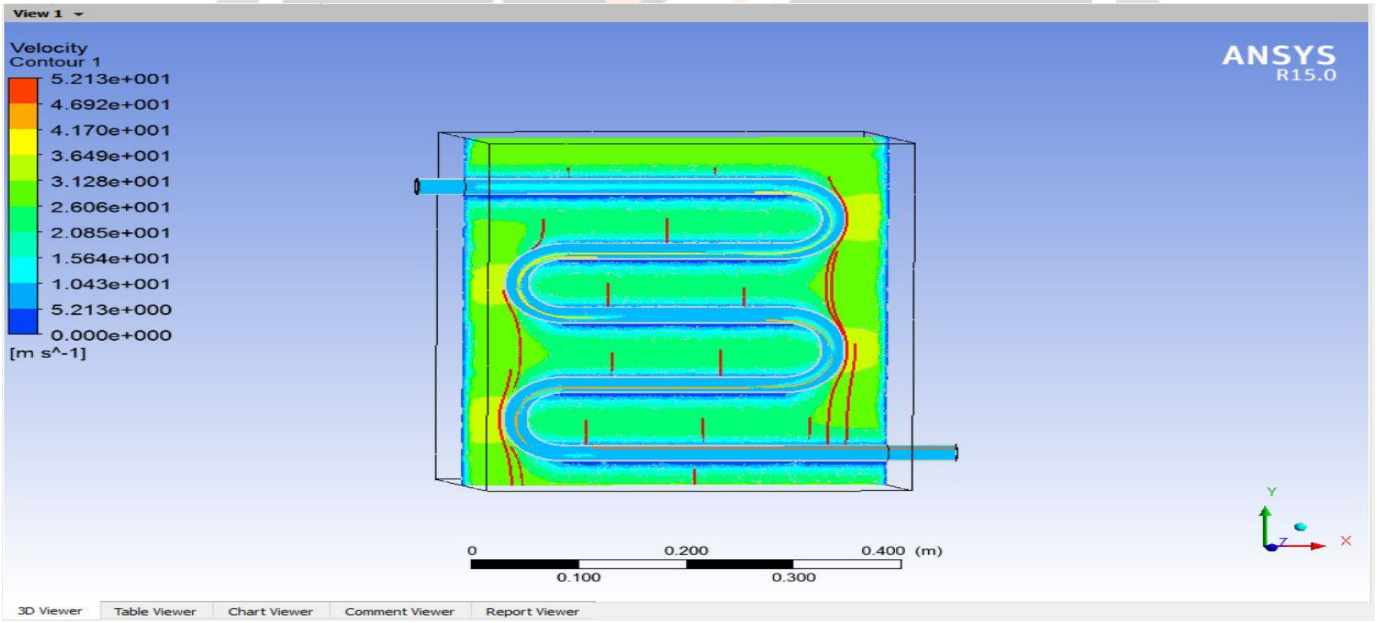


FIGURE 4.1 VELOCITY CONTOUR

Here we have given inlet velocity at 10m/s. After simulation looking at the velocity outputs the velocity of water also increased. That means we can achieve the mass flow rate for higher efficiency what we want to achieve.

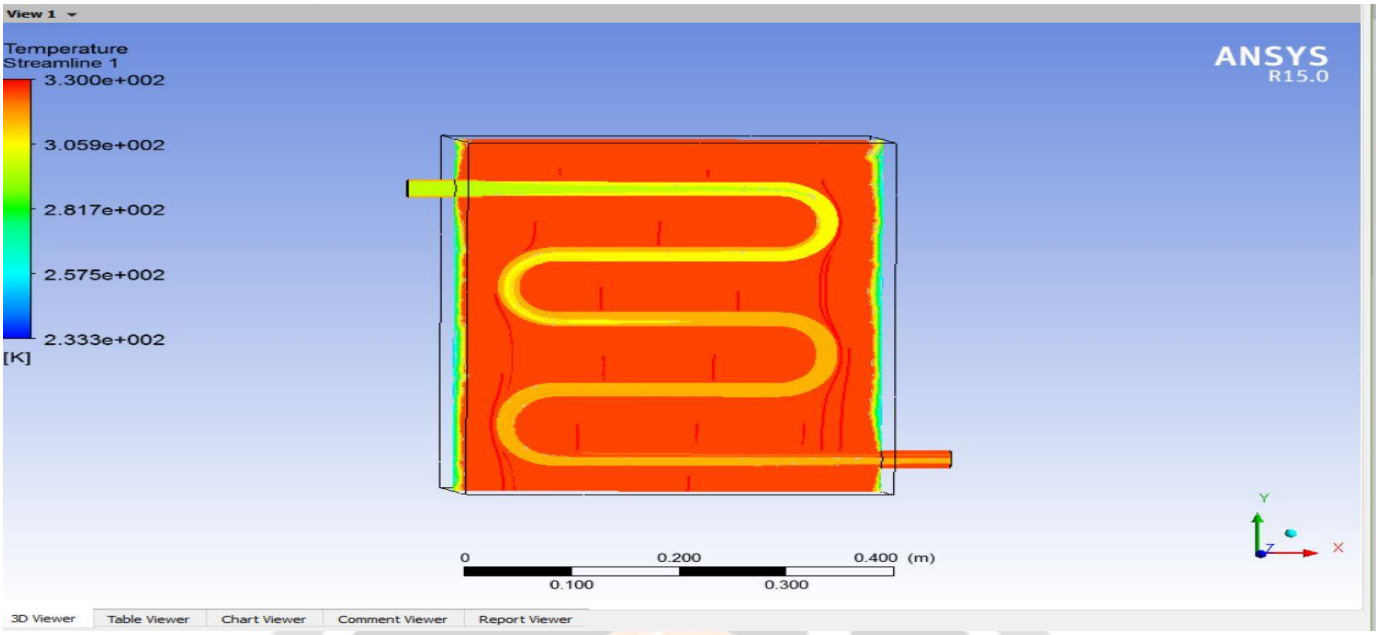


FIGURE 4.2 TEMPERATURE STREAMLINES

Here inlet temperature was measured and it was 20˚C or 293K. And after looking at streamlines we can say that temperature of water is increasing rapidly. That will give the efficiency what we want to achieve.

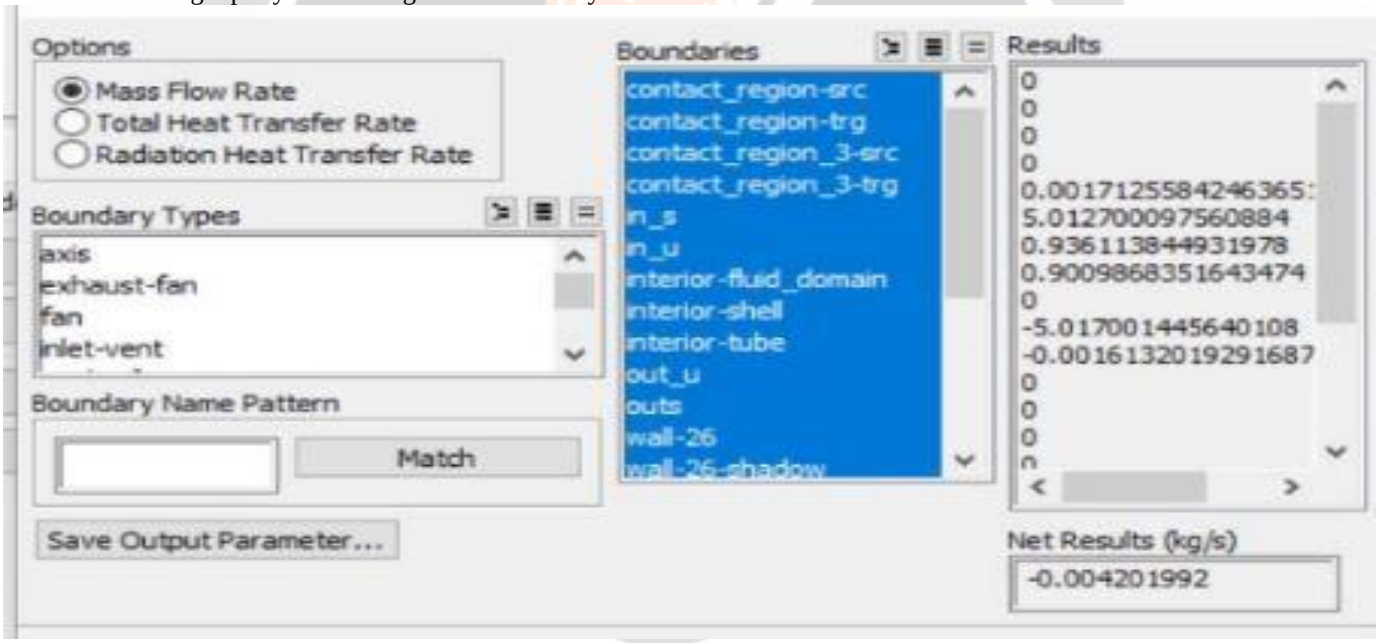


FIGURE 4.3 MASS FLOW RATE

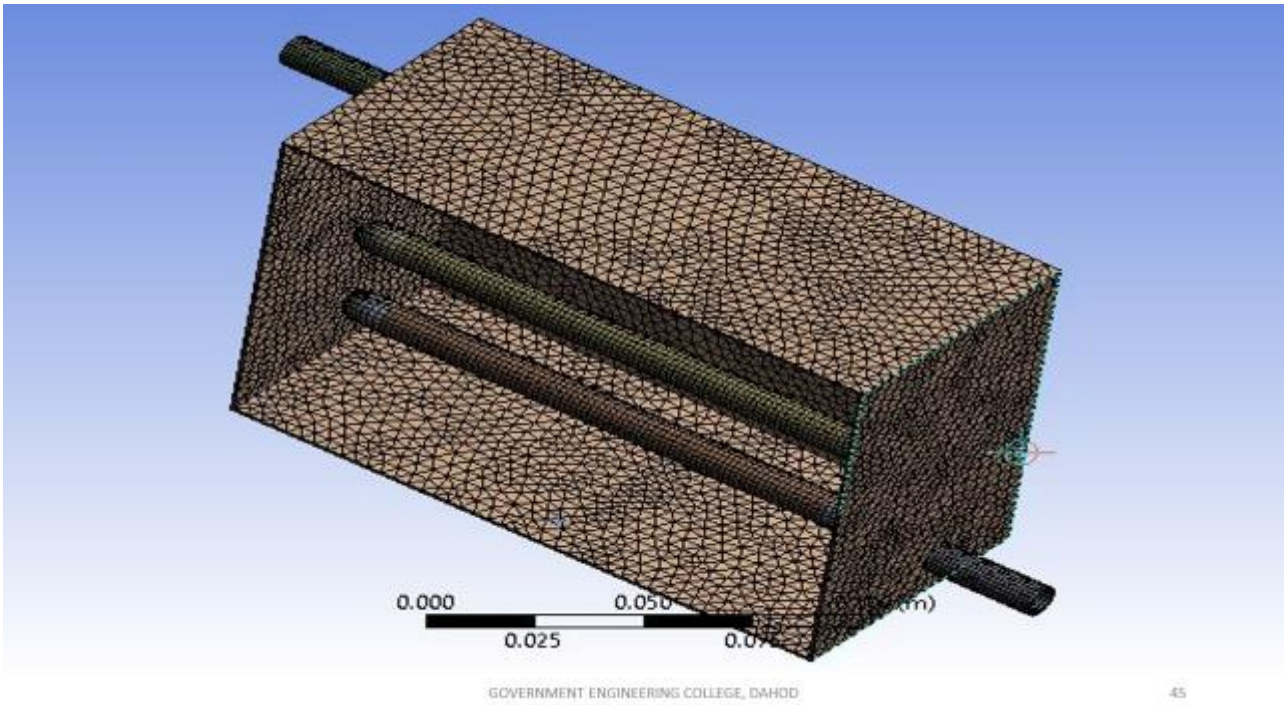


FIGURE 4.4 FINE MESHING

Domain	Nodes	Elements	Tetrahedra	Wedges	Pyramids
fluid_domain	33630	27312	0	0	0
shell	85811	475487	475487	0	0
tube	26325	15184	0	3504	0
All Domains	145766	517983	475487	3504	0

TABLE 4.1 MESHING REPORTS

V. CONCLUSIONS

From the CFD simulation we got velocity contour, temperature distribution streamlines, mass flow rate etc to understand about the efficiency of thermosyphon solar water heater.To get the velocity contour graph here the input value of velocity is 10 m/s given for better output. As we can see the velocity contour the velocity of the water is increasing rapidly that means it is giving better results for velocity. To get temperature streamlines the input temperature of water is given 299 K for better output. As we seen the temperature streamlines after giving input of 299 K temperature of water inside the tube is also increasing with respect to time.

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