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"CFD MODELING AND ANALYSIS OF SINGLE SLOPE SOLAR STILL PERFORMANCE UNDER VARYING CONDITIONS"

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ABSTRACT

This study investigates the effect of incorporating phase change materials (PCMs) into a single slope solar still to enhance its thermal storage and productivity. A paraffin-based PCM was placed beneath the basin liner to store latent heat during sunshine hours and release it during non-sunshine hours. Experimental results showed that the PCM-enhanced still improved water yield by 25–30% over conventional systems. The extended thermal energy release helped sustain evaporation even after sunset, thus improving night-time productivity. This low-cost modification demonstrates potential for remote and arid regions.. The amount of water collected includes the rate at which fresh water is produced by the channel. The results of the simulation indicate that the water content ultimately rose. Water from the surroundings is purified by a solar still using solar energy. Between 2 and 3 p.m., when solar energy is at its highest for distillation, the most water fraction is generated.

Key Words: *Fraction, water, still, PCM*

I. INTRODUCTION

1.1 GENERAL

Throughout the world, water supplies are at or near capacity owing to rising demand driven by urbanisation, population growth, and agricultural expansion. There is an interest in locating some feasible hubs for purifying water in order to solve this problem. A solar-powered still is a useful tool for purifying seawater and other salty water for human consumption.

As the world's population grows, likewise, the necessity for potable water, and assessments of that resource's quality have grown more stringent. The desalination sector has flourished in numerous nations across the world where sources of clean water are scarce. The annual global supply of water that has been desalinated is expected to reach 54 billion m3 by 2020. The fundamental problem of the twenty-first century is thought to be improving the efficacy and suitability of water decontamination innovation to generate pure water and secure nature in a cost-effective manner. Water in cities is filtered through many remarkable layers of MSF, MED, and RO, and an electric field is generated across these levels. Dissolving salts are able to travel through the films, but water is unable to. This piece provides an overview of the factors (climatic, operational, and plan parameters) and upgrades (wicks, inside and outside condensers, inward and outer reflectors, stage change materials, Stepped sun oriented still, and another strategy improved the yield of the sun-based still using nanoparticles) that have affected the effetiveness of solar-powered stills up until the end of 2014.

Along with food and oxygen, water is one of humanity's most basic need. Only a fraction of the water on Earth is liquid condition at any one time, yet almost all of that may be contaminated with diseases and poisons. That's why water

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filtration is so crucial. Furthermore, regular cleansing systems are easily compromised or bartered away by disasters of all kinds. Untreated Water has a broad variety of diseases and hazardous chemicals, making it difficult for people to plan such events while also protecting their family from potential injury. In order to get pure water, everyone has to seek for the solution to the top problem using the existing energy sources.

Twenty-six countries are struggling due to a lack of water for agricultural and economic development. Eighty percent or more of the world's driest countries regularly experience dry periods. Across the Middle East and Africa, 33% of the population suffers from water scarcity. The development, when added to the effects of industrialization and urbanisation, results in a rising need for water. India's coastal areas, particularly those in the interior, are suffering from a severe lack of desalinated water. This water generation problem may be solved by switching to RES such as chemical oxidation power plants without incurring the associated costs of using fossil fuels, polluting the environment, or degrading the natural environment. Sun-based energy has the capacity to satisfy and complement a wide range of vitality demands, despite the fact that it is a weak source and prone to fluctuations.

II. METHODOLOGY

It is customary to have a computer mimic the behavior of f gasses and liquids susceptible to boundary conditions that come into touch with surfaces. Faster supercomputers may lead to better answers. Intricate simulation scenarios, sonic or turbulent flows, are made more realistic and faster with the help of the software system uncovered by the current study. Such software systems undergo structural experimental validation from the outset, with final validation returned in comprehensive testing, such as flight tests.

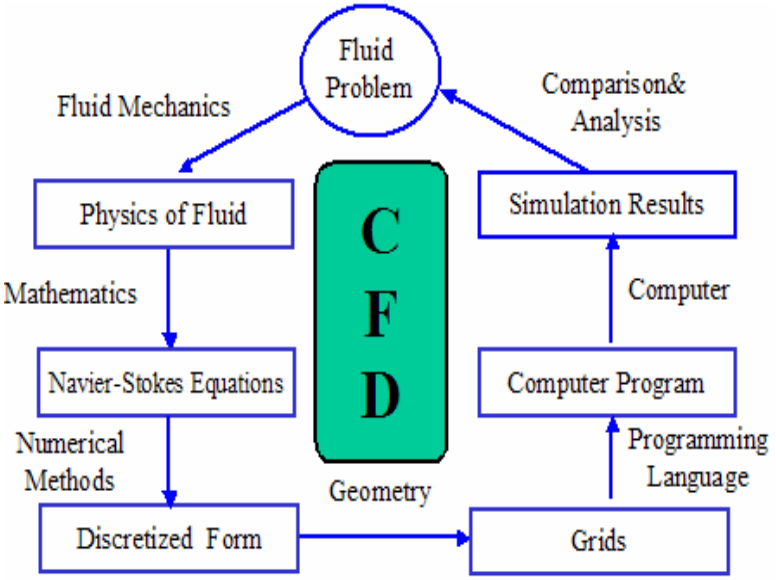

Fig 1 Process of CFD

III. CFD TECHNOLOGY

In this part, we will go through the CFD tools required to complete a simulation, as well as the procedure one takes to solve a task victimization CFD. The pre-processor, the processor, and the post-processor—the three basic components of process CFD simulations—are described. Depending on the complexity of the mesh and the scale of the computations, there is a wide range of relevant hardware and related costs, as well as a variety of affordable CFD software systems, such as Fluent, ANSYS CFX, and ACE. Costs associated with using an industrial CFD program on a yearly basis might reach $200,000 USD or more. More powerful computer processors and RAM would be required for more complex transient scenarios with fine meshes than for simpler examples with coarse meshes. To get started, you may need to spend as little as $3000–$5000 (USD) on a standard engineering digital computer (i.e. 32 GB of process RAM and quad processors) or a combination of multiple processors working in parallel.

The project's work was done using a laptop computer with a two-gigahertz dual-core CPU and UNIX operating system software obtained for free from the website Caelinux. The move from Caelinux included ASCII text file tools like

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Salomé for constructing and meshing in pure mathematics, Open FOAM for CFD computations, para View for visualizing findings, and many more important scientific and mathematically related programs. This experiment used CFD calculations that are typically made for 1-2 million cells or more, but were only applied to roughly 50,000 cells. Transient simulation took 2-3 days on my machine while running in parallel on each CPU, whereas the steady-state solvers completed their work in 1-3 hours.

3.1 CAD Modeling

Part / Assembly to create geometry using CAD modeling tools to build CAD models NX8.5 shown in fig.4.2.

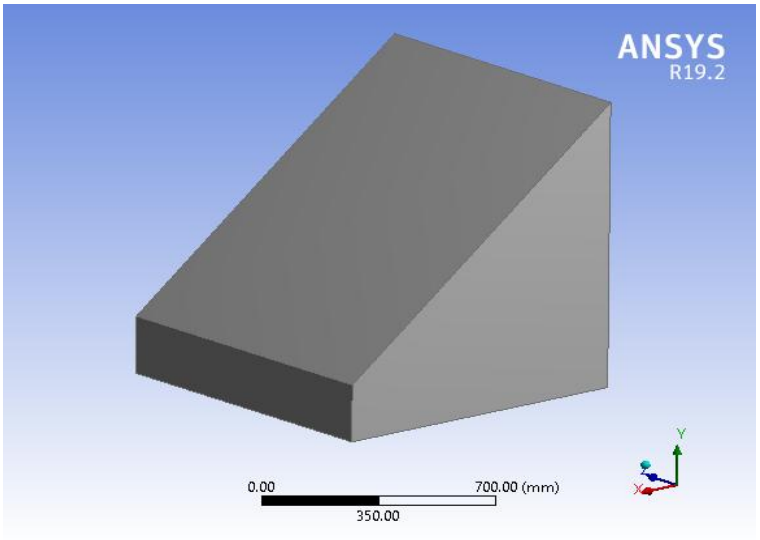

Fig 1 CAD Model

Overall dimension is the normal size of single basin double slope solar that is still being used in this project.

Table No. 1 Geometry of solar still

Width	1 mm
Length	1 mm
Wood thickness	8mm
Glass thickness	4 mm
Glass Slope	30°

Meshing

The process of meshing in CFD is crucial. This process involves removing a great deal of very minor components and nodes from the CAD geometry. Spacetime components and a network of nodes called a mesh. The efficiency and speed of the analysis are both affected by the mesh size and orientation. The accuracy of a CFD analysis improves as the number of components is increased, albeit at the expense of analysis speed.

Mesh models of single-basin, double-slope solar stills are shown in Figures 3

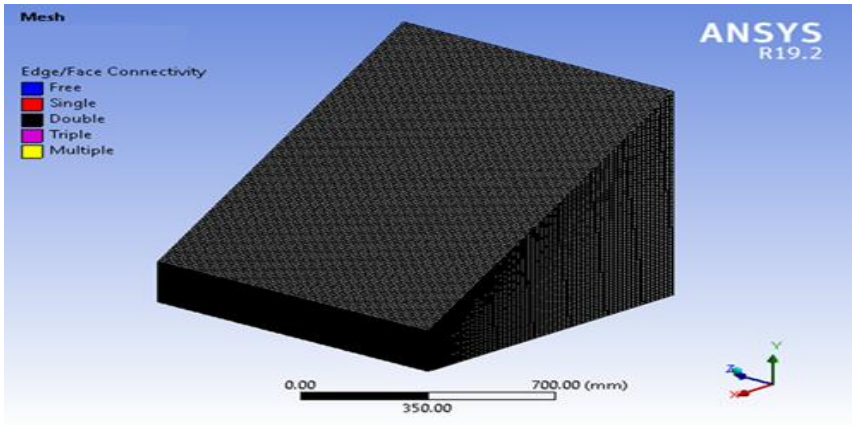

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Fig 3 Mesh Model

IV. RESULT AND DISCUSSION

Simulation Results

To examine how well the Solar still evaporates and produces water, a numerical simulation was run. Water is used in the solar still as the working fluid. The following are the features of dispersion within the Solar still:

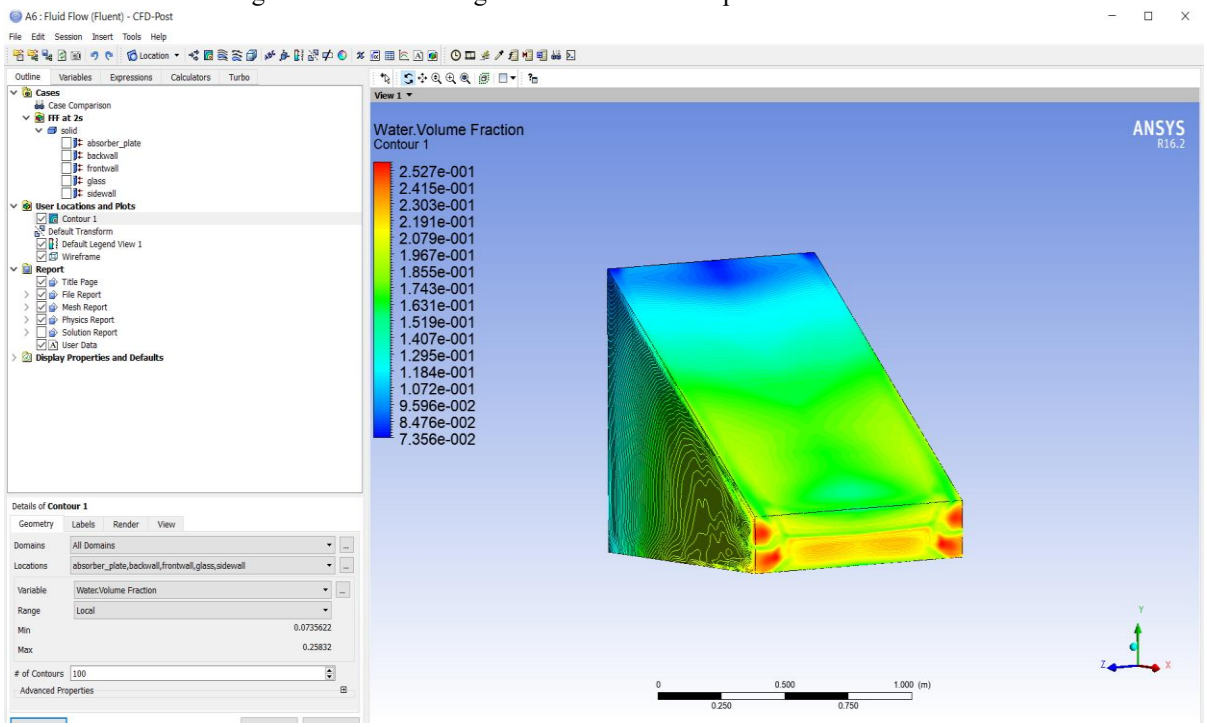

Fig. 4 Single slope with wooden wall water volume fraction results

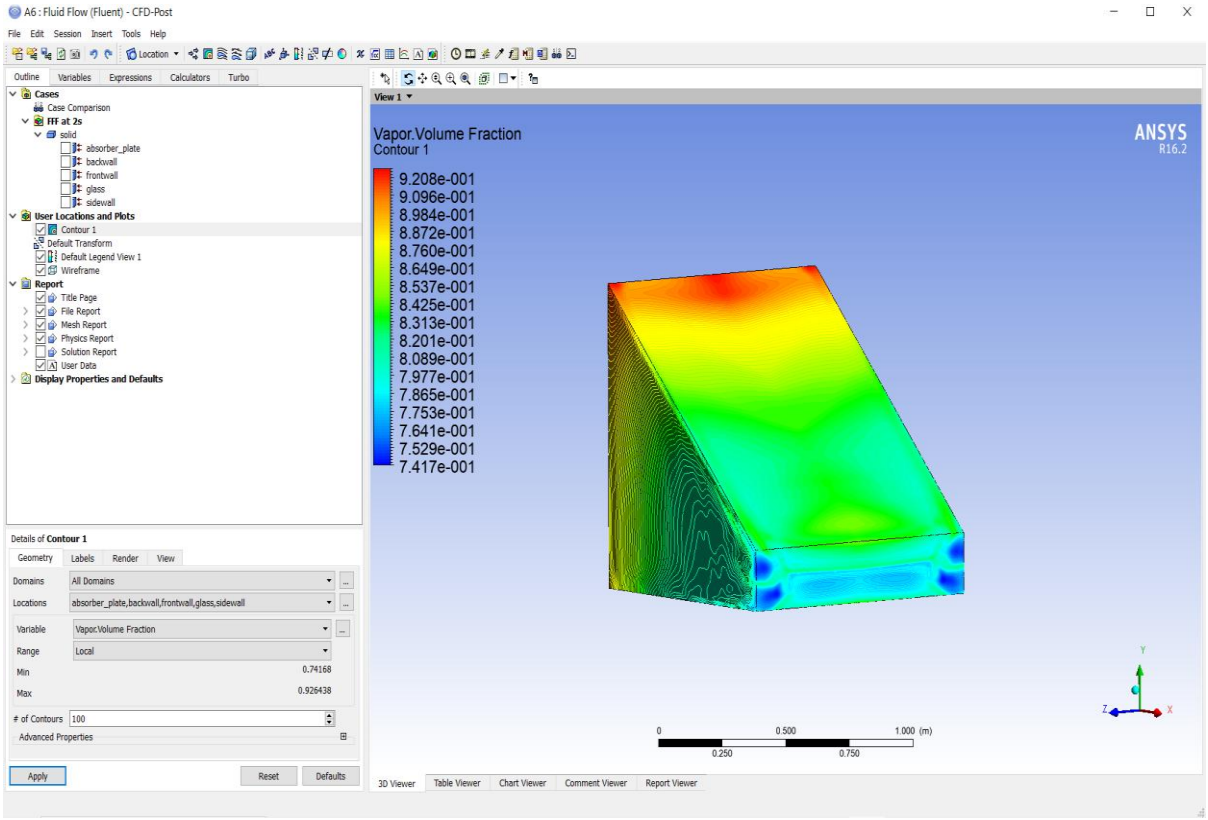

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Fig. 5 Volume fraction for a single slope with a wooden wall

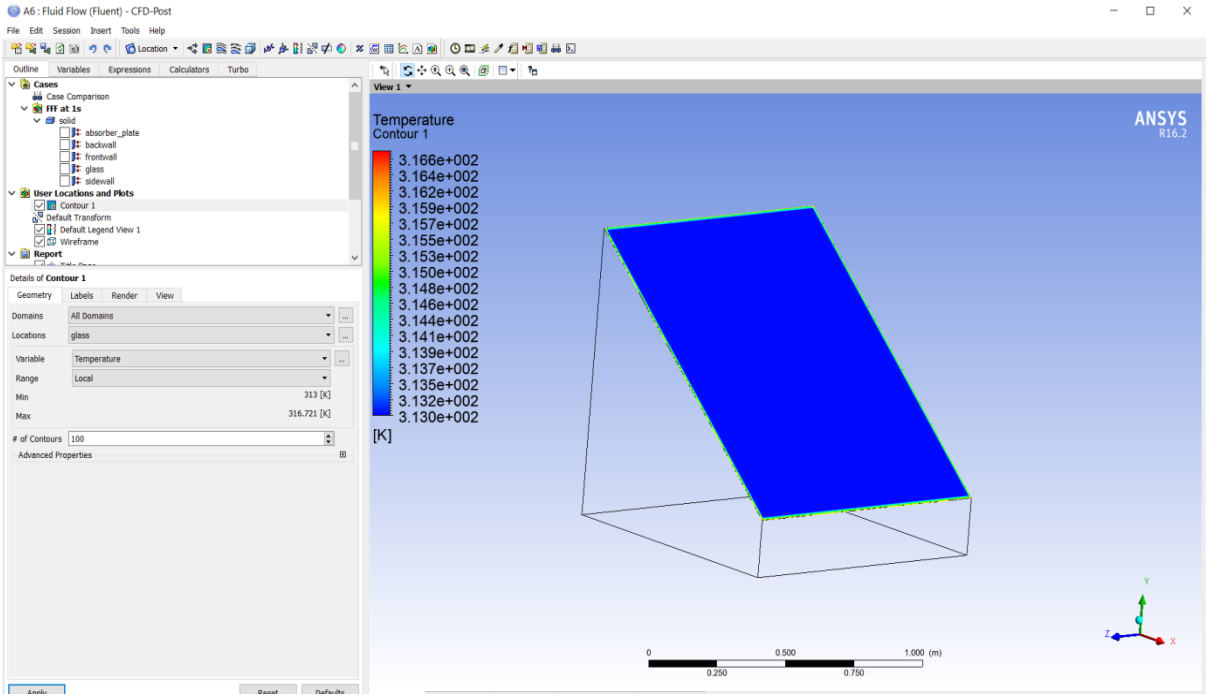

Fig. 6 Single slope with wooden wall temperature results

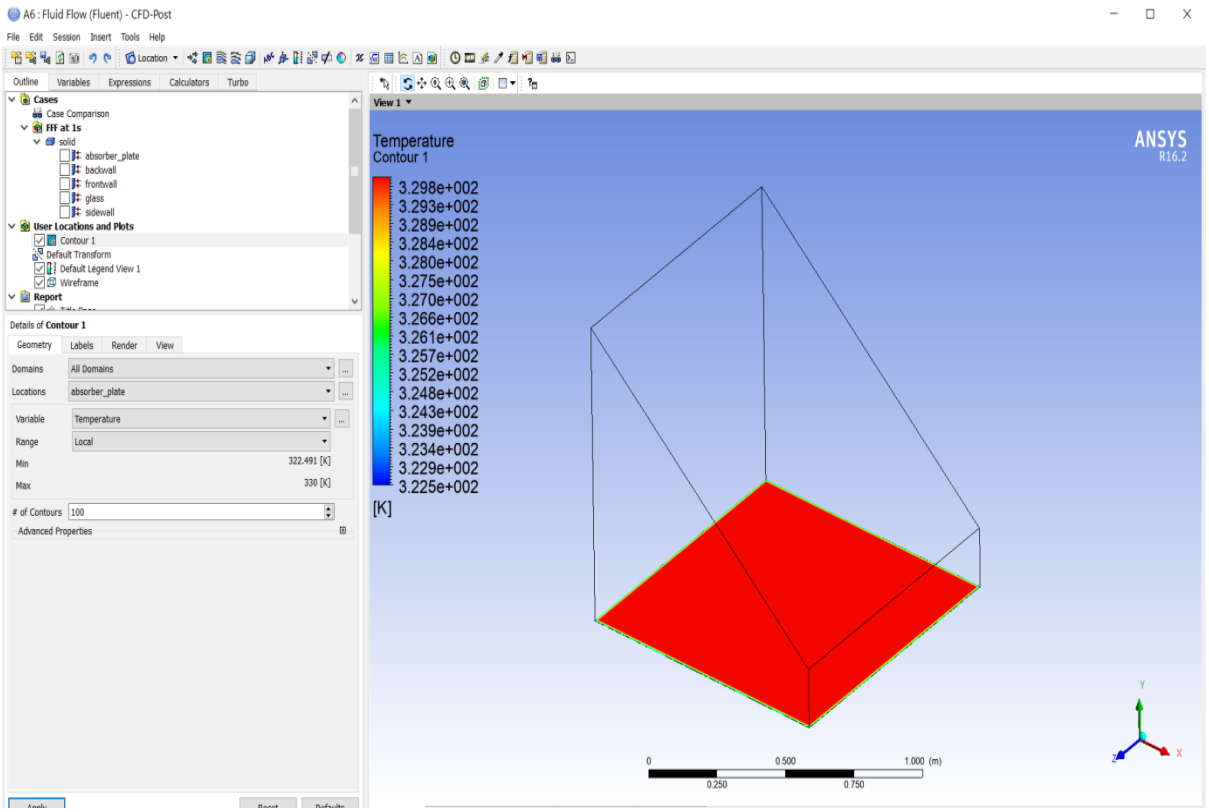

Fig. 7 The temperature derives from a single slope with a wooden wall.

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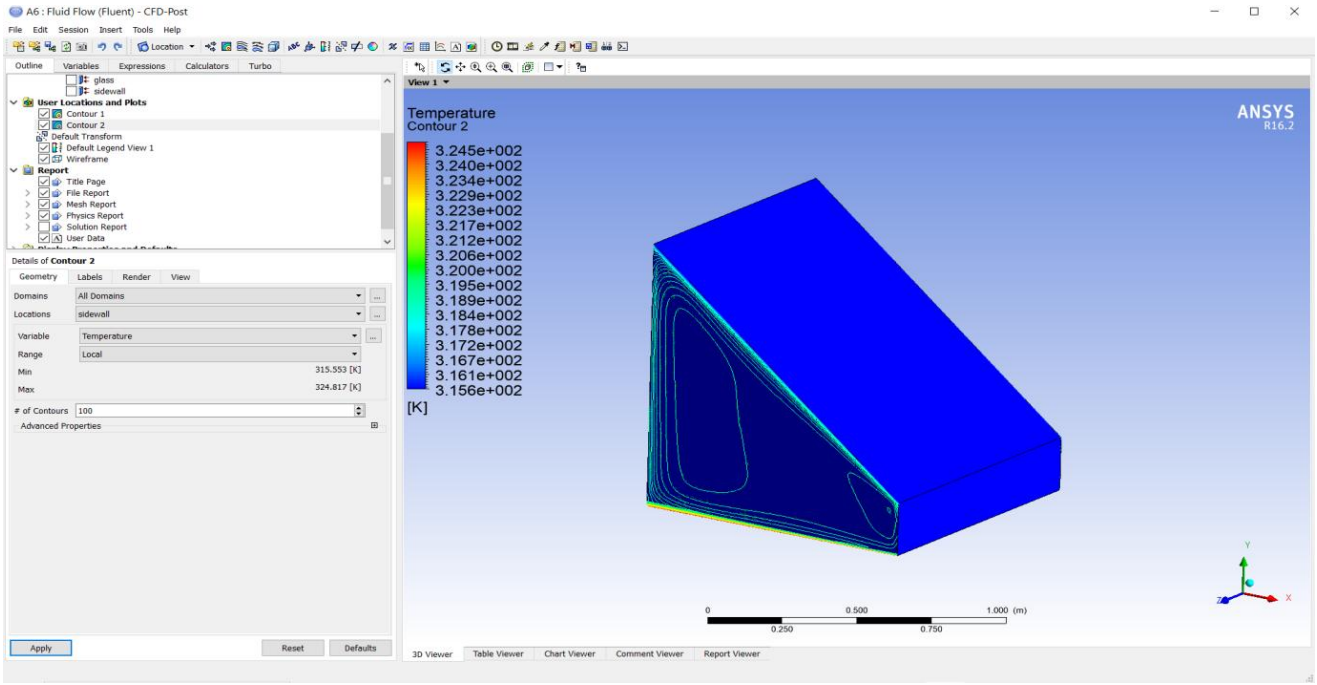

Fig 8 Temperature results from a single slope with a wooden wall

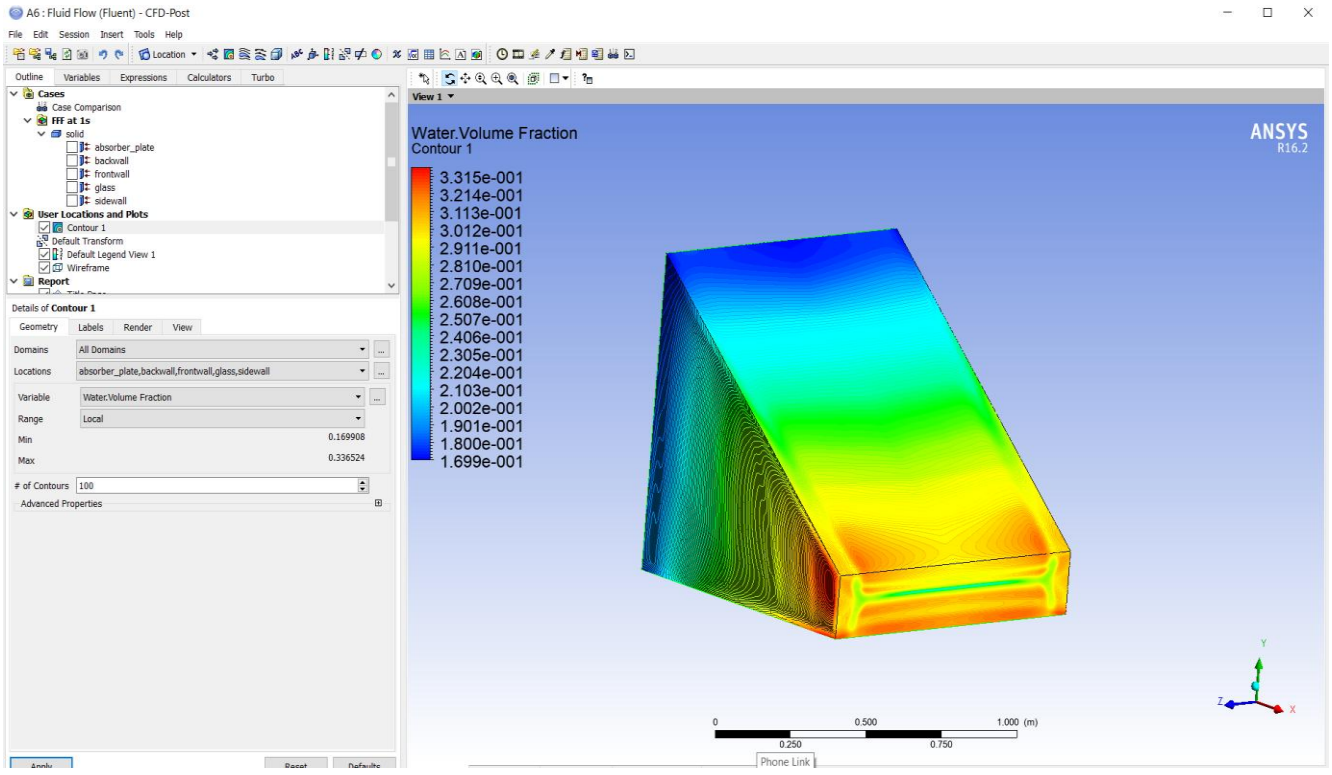

Fig. 9 Water volume fraction from a single slope with a glass wall

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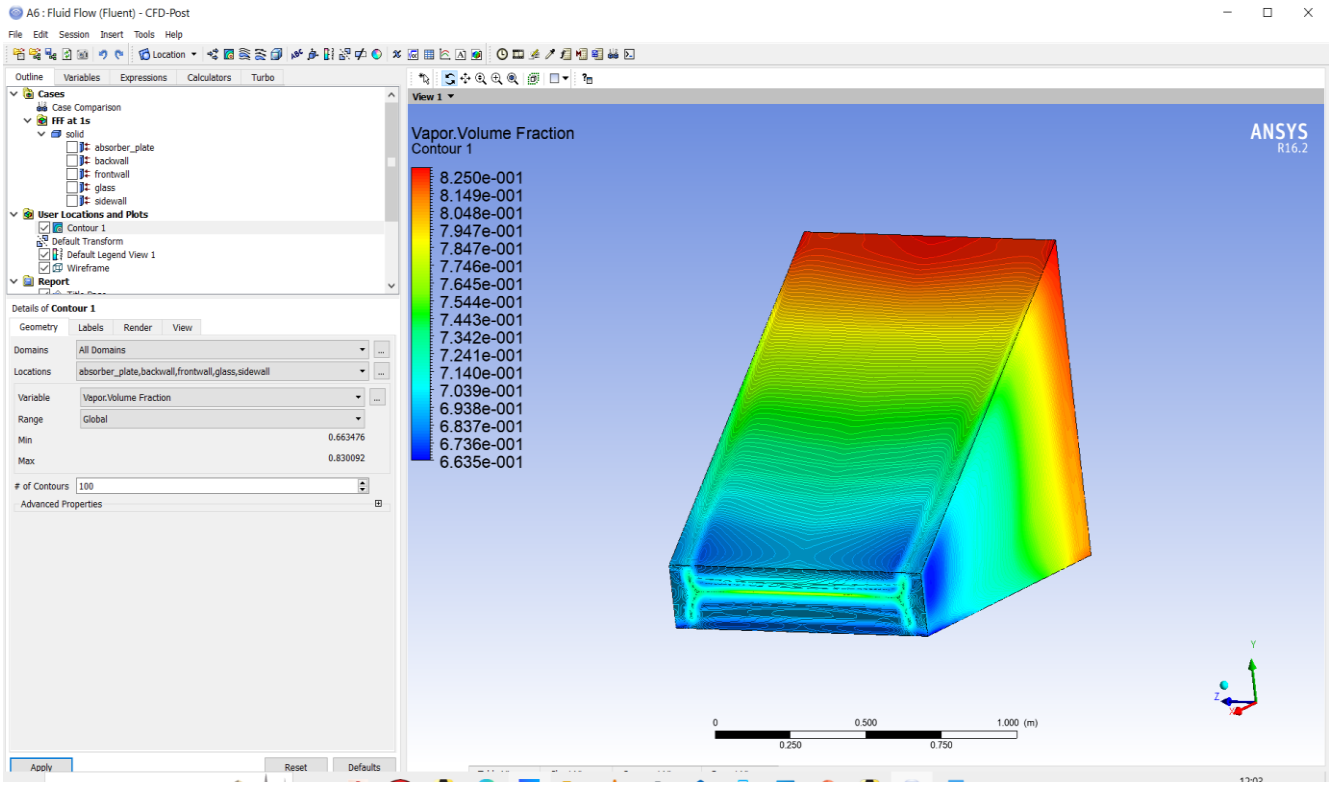

Fig. 10 The vapor-water volume fraction of a single slope with a glass wall is obtained.

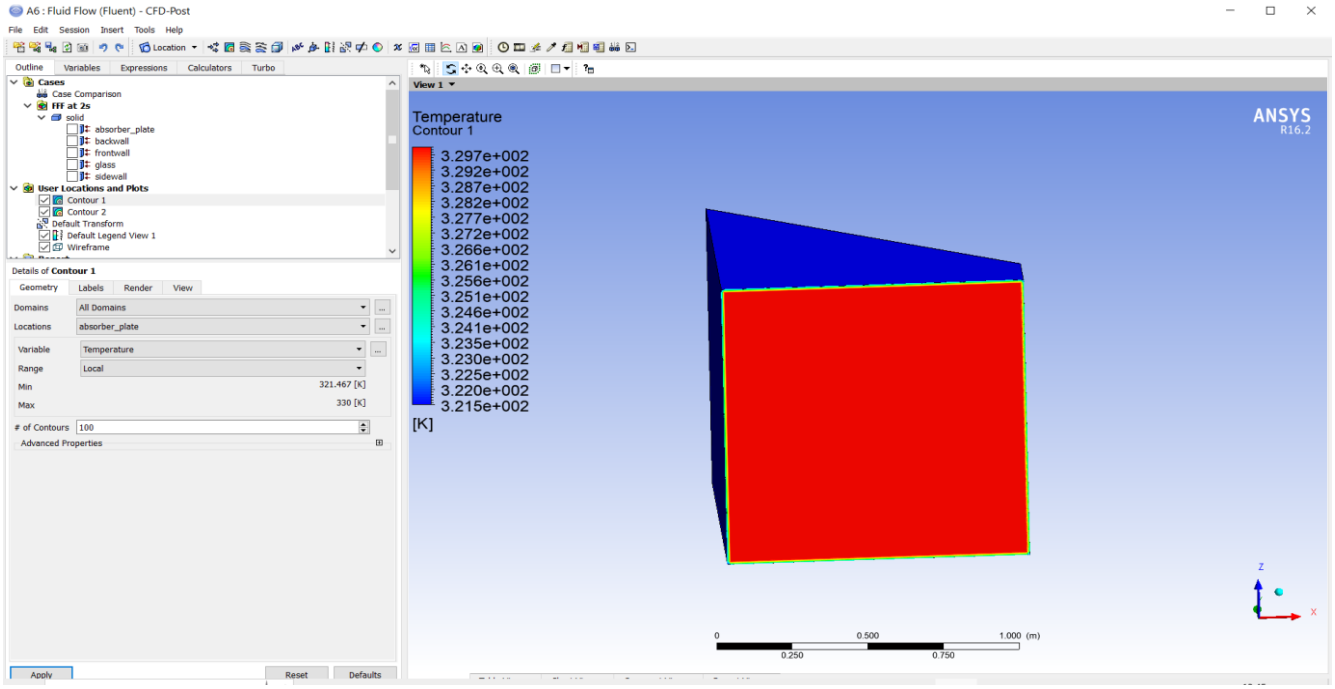

Fig.11 The temperature of one glass-covered slope wall produces the desired effects.

V. CONCLUSION

Every day, more people across the thirst for pure water over the world. There are many ways to create drinkable water, including using the sun to distill water. Solar distillation is a cheap, low-cost -impact method of purifying water for use

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in households and small communities. Basin-style sun simplest, most cost-effective, and traditional method distillation. A single-slope, single-basin solar still with a glass and timber wall is used in this study conducted in Bhopal, India, to model the system for an hour using CFD software. A glass-topped sloping single-basin solar still wall may evaporate more impurities, resulting in a larger volume fraction of water. The attack on the glass caused the temperature to reaches its height, rays start to evaporate the polluted water. Solar energy vaporizes water, causing this effect. Water vapor condenses in a glass as a result of the temperature difference between the interior and exterior. At the base of the slide, the distilled water is gathered in droplets. The amount of water collected includes the rate at which fresh water is produced by the channel. The results of the simulation indicate that the water content ultimately rose.

VI. FUTURE SCOPE

A study of the literature revealed that a double-basin active solar still was chosen to undergo further development and performance investigation, and this still was then linked with an evacuated glass tube solar collector to supply heated water in the basin of the solar still.

It is advised to use a glass tray within the solar still to evaluate the 1 m2 basin area intended for solar stills with a double basin adjusting various design factors (geometry).

It is recommended to use a glass tray within the solar still to test the recently built solar still, which has a double basin and a basin size of 1 m^3.

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