# Design And Analysis of Single Slope Solar Still With Impact of Different Climatic Factors Through CFD Analysis

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***Abstract-*** *On the basis of various literature surveys, a single basin active solar still is chosen for any development and performance analysis that is subjected to be coupled with exhausted glass tube solar collector for top temperature water feeding in to the basin of solar still. The developed solar still basin space of 1 m2 is planned to be tested with convert in to double basin by exploitation glass tray within the solar still. Thus heat loss of the higher portion was cut back it provide additional output of the pure water. The experimental found out will analyze by single and double basin active solar still. In present study we investigate the solar still model for different states like MP, Rajasthan for hourly basis 10 am to 3pm total 6 hours by CFD Simulation. From results obtained that peak temperature is occurred in 2 to 3 pm and maximum amount of volume fraction of water is achieved due higher evaporation of impure water. Peak temperature is achieved due to solar rays is attack on the glass and the impure water is start to evaporate. Due to solar radiation water gets heated and vaporizes. The temperature difference between water vapour and glass leads to condensation of vapour in glass surface. The condensed water droplets slide down and get collected in distillate channel. The amount water collected in channel is considered to be the fresh water production rate. Finally we see from the simulated results that Water Volume Fraction in Rajasthan is greater than MP.*

***Keywords***- Solar Still, Radiation Vapour, and CFD Simulation.

## I. INTRODUCTION

A traditional sunlight based still is a typical sun oriented gadget utilized for modifying plentiful saline and salty water into consumable water. Because of its minor efficiency, it is not broadly utilized. Numerous specialists have introduced streamlining or overhauling structures which have been tried hypothetically and tentatively. A schematic outline of a basic traditional sun powered still is appeared in Fig.1. It comprises of a dark painted protected holder where polluted water gathers at shallow profundity. The holder is secured with a slanting glass spread which is fixed firmly to diminish spillage of vapour. This holder is bolstered by a reasonable protecting wooden casing. The sullied water retains sun powered radiation, so gets to be warmed. Expanding tainted water temperature fortifies water atoms to vanish. Convection happens noticeable all around over the surface of water which conveys up the vapour atoms. At the point when the immersed air with vapour comes into contact with the cool internal surface of the straightforward glass spread, build up happens in a portion of the vapour particles. This condensate water descends, amasses in a trough along the lower side of the glass cover and travels through a plastic tube out of the nook. For the most part, a greatest effectiveness of an ordinary sun powered still is around half on account of a full protection. A less protection makes a diminishment of around 14.5% in the effectiveness. In the event that wind speed is expanded from 0 to 1.6 m/s, a slight lessening of about2% in the still execution will happen [4].

## SOLAR STILLS

Solar still is possibly the oldest method of desalination of water. Its principle of working is the greenhouse effect; the radiation from the sun evaporates water inside a closed glass covered chamber at a temperature higher than the atmospheric. A schematic diagram of typical basin type solar still is shown below in figure 1.

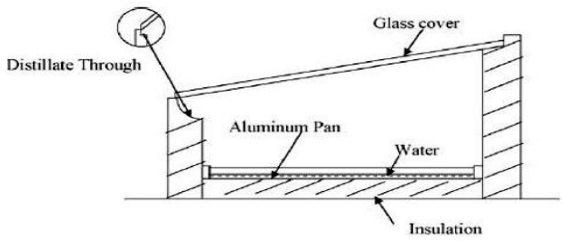


**Figure 1.1: Schematic diagram of a simple Solar Still**

## II. LITRATURE REVIEW

At the point when the water vanished inside the sun powered still, it leaves all contaminants and microorganisms behind the bowl. The vanished and now refined water gathers on the underside of the glass and keeps running into an accumulation through and afterward into an encased holder. In this technique the salts and microorganisms that were available in the first bolster water to sunlight based still, are deserted. Extra water sustained into sun based still flushes out concentrated waste from the bowl of sun based still to maintain a strategic distance from unnecessary salt statement in the bowl. [1].

**Jadav Madhav V** [2] utilized Black stone as bowl material inside single incline sun based still and contrasted and press steel bowl of sunlight based still. He demonstrated that, normal profitability of dark rock bowl sunlight based still is 3.784 L/m2.day and iron steel bowl is 2.358 L/m2.day, implies 38% more. Bowl water temperature of expanded around 87 C contrasted and Iron steel bowl still water of 79 degree Celsius.M.

**Sakthivel.et.al** [3] led probe regenerative sunlight based still with and without jute fabric. Jute fabric is a medium to give extensive dissipation surface and give and give dormant heat of build up. They demonstrated that, aggregate still yield in regenerative sun oriented still with jute material increments roughly 20% and productivity expanded by 8% with minimal effort alteration as the jute fabric is exceptionally shoddy and effortlessly accessible.

**Omar badran** [4] utilized dynamic sunlight based single incline sun powered as yet utilizing diverse operational parameters like distinctive protection thickness, sun powered force, successful absorptive and Transmissivity hypothetically and contrasted with trial information with pick best component improving sun powered still profitability. He demonstrated from study that dynamic sun powered stills can be of the alternatives for improving profitability of still.

**Kalidasa Murugavel et.al** [5] made a twofold bowl sun oriented still from gentle steel plates and utilized layer of water and also distinctive heat stockpiling materials like quartzite rock, red block pieces, bond solid pieces, washed stones and iron scratches. He found that, still with ¾ size quartzite rock was viable bowl material to expand distillate yield among other sensible heat putting away materials.

**F.F. Tabrizi, A.Z. Sharak** [6], utilized inbuilt sandy heat repository tentatively under atmosphere states of Iran. He demonstrated that, incorporated sandy heat supply increments essentially profitability of sun oriented as yet amid evenings and in addition shady days conditions, and it doesn't require any pumping component and administrators for night mode use.

**K. Kalidasa Murugavel et.al** [7] utilized twofold incline bowl sun oriented still tried with gentle steel plates with least mass of water and distinctive wick materials like light cotton fabric, wipe sheet, waste cotton pieces, coir mate pieces in bowl additionally utilize aluminium blade masterminded in various setup. He found that from examination that, light dark cotton fabric is viable wick material contrasted and other wick materials and additionally aluminium balance secured with cotton fabric and organized long astute was more compelling.

**R.dev et.al** [8] utilized new way to deal with get trademark condition of a twofold incline uninvolved sunlight based still taking into account exploratory perceptions from composite atmosphere states of New Delhi. He presumed that, non straight trademark bends have more exact for breaking down execution, heat testing and further alteration relying upon different parameters connected with configuration atmosphere and operational conditions.

## III. METHODOLOGY

### Computational fluid dynamics

Computational fluid dynamics, sometimes abbreviated as CFD, could be a branch of mechanics that use numerical analysis and algorithms to unravel and analyze issues that involve fluid flows. Computers are accustomed perform the calculations needed to simulate the interaction of liquids and gases with surfaces outlined by boundary conditions. With high-speed supercomputers, higher solutions may be achieved.

**CAD Modelling**: Creation of CAD Model by using CAD modelling tools NX8.5 for creating the geometry of the part/assembly.

**Meshing:** Meshing is a critical operation in CFD. In this operation, the CAD geometry is discretized into large numbers of small Element and nodes. The arrangement of nodes and element in space in a proper manner is called mesh. The analysis accuracy and duration depends on the mesh size and orientations. With the increase in mesh size (increasing no. of element) the CFD analysis speed decrease but the accuracy increase.

**Governing equation-** The governing equations used were 2-dimensional Navier-Stokes equation and continuity equation

since the flow is less than the compressibility Mach number of 0.3, the effect of flow compressibility was not considered hence the airflow in this research was treated as incompressible flow. The whole structure of weather hood model was taken as the computational domain for CFD simulation. Boundary conditions were specified at the front and rear surface of the weather hood model with respect to flow direction. Flow velocity of 5 m/s was set as the inlet boundary condition while static pressure was set as the outlet boundary condition.

**CAD MODEL and MESH Models**

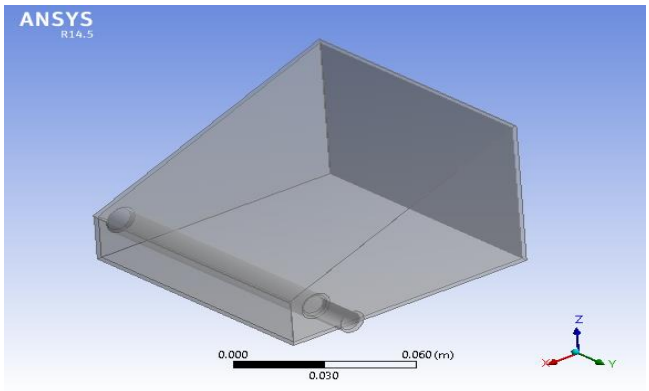


**Figure 2 CAD Model**

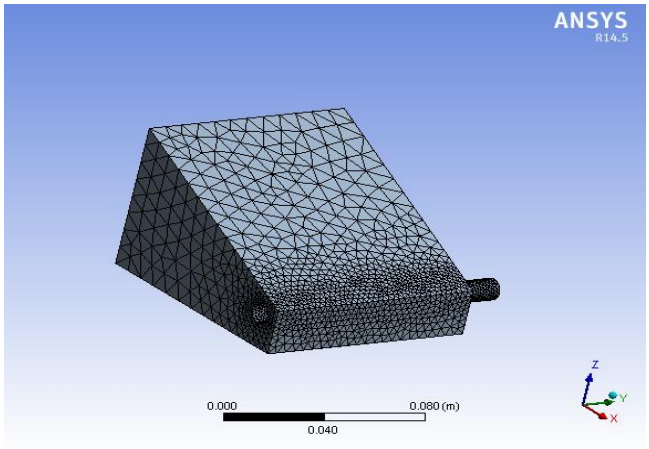


**Figure 3 Mesh Model**

## IV. RESULTS AND DISCUSSION

In this section setup is ready for the various climates (MP, and Rajasthan) for the performance of the only basin active solar stills and to analysis the efficiency of solar still at totally different design parameter. Additionally this experimental data are also verified on CFD software. In present study we have investigated the solar still model for different states like MP and Rajasthan on hourly basis from 10 am to 3pm total 6 hours by CFD Simulation. From results, we can conclude that peak temperature is occurs between 2 to 3 pm and maximum amount of volume fraction of water is achieved due to higher evaporation of impure water. The amount of water collected in channel is considered to be the fresh water production rate. Finally we see from the simulated results that Water Volume Fraction in Rajasthan is greater than MP.

**RESULTS FOR RAJSTHAN**

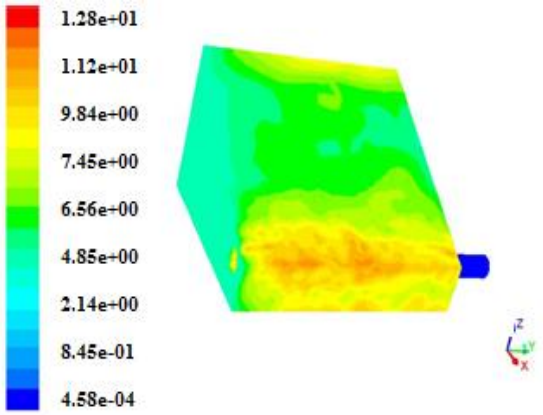


**Figure 4.1 Turbulance Kinetic Energy**

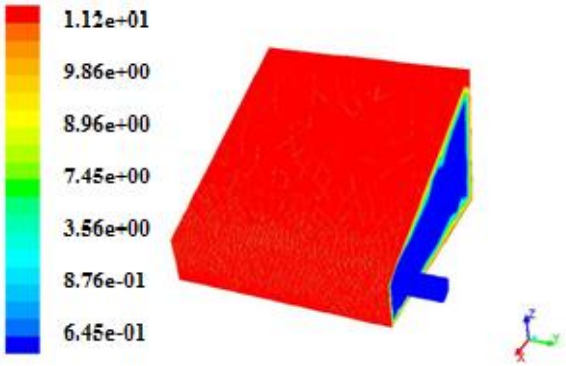


**Figure 4.2 Surface Nusselt Number**

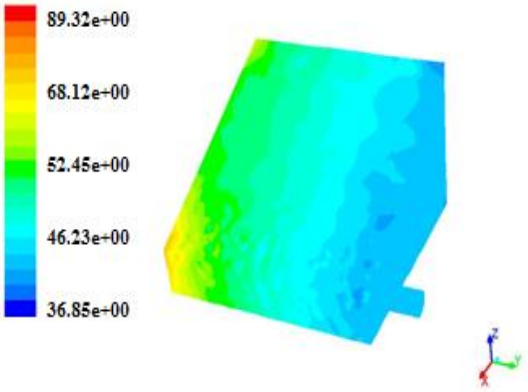


**Figure 4.3 Pressure Variation**

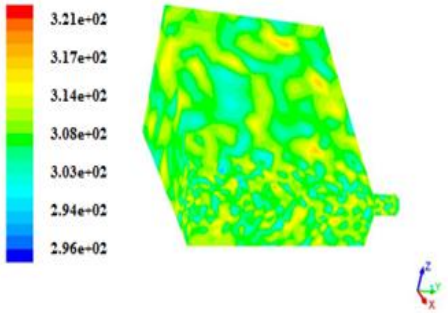


**Figure 4.4 Temperature Variation**

**RESULTS FOR MADHYA PRADESH (M.P.)**

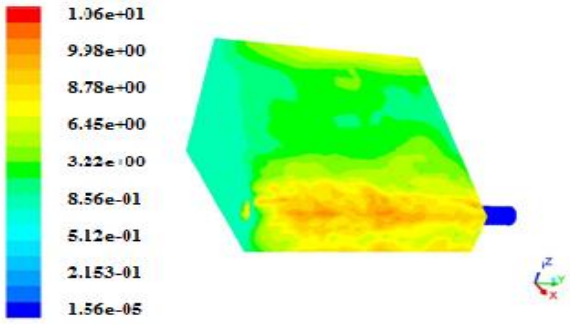


**Figure 5.1 Turbulance Kinetic Energy**

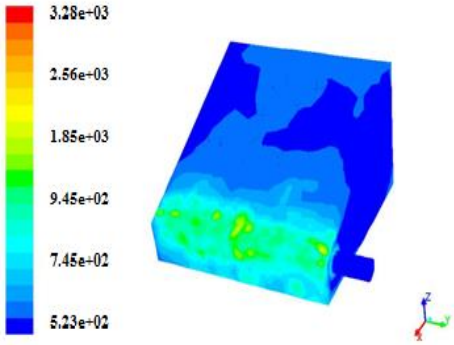


**Figure 5.2 Turbulance Dissipation Rate**

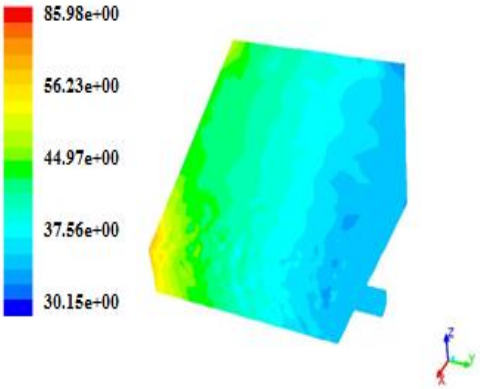


**Figure 5.3 Pressure Variation**

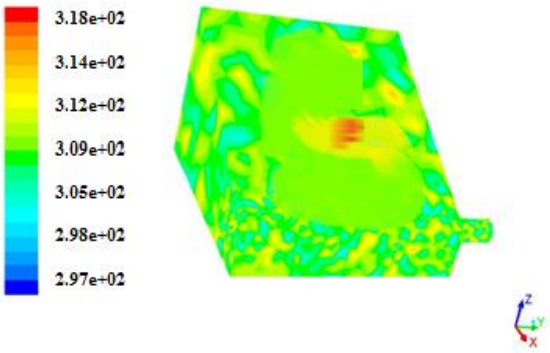


**Figure 5.4 Temperature Variation**

## V. CONCLUSION

The demand for fresh water is growing everyday in the world. There are many methods of obtaining pure/fresh water and Solar Distillation is one of them. Solar distillation is an easy, small scale & cost effective technique for providing safe water at homes or in small communities. Due to solar radiation water gets heated and vaporizes. The temperature difference between water vapour and glass leads to condensation of vapour in glass surface. The condensed water droplets slide down and get collected in distillate channel. The amount water collected in channel is considered to be the fresh water production rate.

## REFERENCES

[1] Tiwari G N, Tiwari A K, “Solar distillation practice for water Desalination Systems”, Anamaya publication, pp. 1-10.

[2] Jadav M., “Performance of black granite basin solar still”, International Journal of Tech Science, Vol.2 (2), 2011, pp. 161-168.

[3] Shakthiwel M., Shanmugasundaram S., Alwarsamy T., "An experimental study on a regenerative solar still with energy storage medium-Jute Cloth", Desalination, 264 (2010), pp. 24-31.
[4] Badran O., "Theoretical analysis of solar distillation using Active solar still", International Journal of thermal & environment engineering, Vol.3 No.2, 2011, pp 113-120.
[5] Murugavel K. K., Sivakumar S, Ahmed J. R., Chockalingam K. S. K., Srithar K., "Single basin double slope solar still with minimum basin depth and energy storing materials", Applied Energy, 87 (2010) pp 514-523.
[6] Tabrizi F. F., Sharak A. Z., "Experimental study of integrated basin solar still with sandy heat reservoir", Desalination 253 (2010), pp 195-199.
[7] Murugavel K. K., Shrithar K., "Performance study on basin type double slope solar still with different wick materials and minimum mass of water", International Journal of renewable energy, Vol. 36, 2011 pp. 612-620.
[8] Dev R., Tiwari G. N., "Characteristic equation of the inverted absorber solar still", Desalination 269 (2011), pp 67-77.