

# EFFECT OF CLIMATE & DESIGN PARAMETERS ON THE SINGLE BASIN DOUBLE SLOPE SOLAR STILL USING CFD

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**Abstract:** To sustain life on earth for man's basic needs is water. The use of technical and human knowledge as well as their waste disposal with the passage of time due to water pollution, water shortages caused to lead the world. The problem of solar distillation is one of the best techniques from other available technologies to solve. However, due to its low productivity in the market cannot be commercial. So that solar is still plenty of work efficiency or productivity could be improved. Still actively using various operating parameters of the single slope solar performance theoretically studied and compared with experimental data for validation purposes, the best is still to increase productivity is to explore factors. In present study we use double slope single basin solar still and simulate the system from CFD (Fluent14.5) for 6 hours (from 10pm to 3 pm) in Bhopal city. From simulation results we can now conclude that maximum purify water is obtained at 2-3 pm. In simulation results flow phenomenon is stable in nature so that the system will be accurate as per the given boundary conditions.

**Keywords:** Solar still, CFD, Double glass single basin, Fluent, Distillation, ANSYS, etc.

## 1. INTRODUCTION

The overall solicitation for compact water is persistently developing due to modern, populace and farming development, the outcome is water releases that have as of now achieved genuine sums in numerous spots of the world. To conquer this issue, there is an interest for some supportable hotspots for the water refinement. Sun oriented still is an important gadget that can be utilized for decontaminating of salty and salt water for drinking purposes. In this article, a survey of components influencing sun based still creation (climatic conditions, operations and outline parameters) and upgrade systems (wicks, inward and outside condensers, interior and outer reflectors, stage change materials, Stepped sun powered still and another strategy enhanced the sun powered still yield by utilizing nano-particles ) has been contended. Utilizing of wipe solid shapes as a part of the bowl water brought on a critical upgrade in sun powered still generation (up to 273%) while utilizing cuprous oxide nano-particles expanded the refined yield by 133.64% and 93.87% with and without the fan separately.

The solicitation for savouring water the world is developing and assizes on drinking water quality has turned out to be more extreme [1].Owing to the lacking crisp water assets in numerous nations everywhere throughout the world, desalination industry has been broadly developed inside these nations. It is unsurprising that the around the world desalinated water supply will get to be 54 billion m<sup>3</sup> for each year by 2020 [2]. Enhancing the proficiency and adequacy of water decontamination innovation to yield clean water and secure nature in a reasonable way is considered as the fundamental test of the 21st century [3]. Subsequently, genuine endeavours are in progress everywhere throughout the world to keep away from this approaching emergency with protection of the current restricted new water supply and to change the a lot of accessible seawater by various desalination advancements. In desalination innovations, the saline or salty water is vanished by the utilization of warm vitality and the resultant steam is gathered and dense as a last item. Warm advancements incorporate Vapor Compression (VC), Multi Stage Flash (MSF), Multi Effect Distillation (MED) though film innovations incorporates Microfiltration (MF), Nano filtration (NF),Ultra filtration (UF) and Reverse Osmosis (RO). MSF, MED, and RO are industrially connected in tremendous limits in urban areas and water is gone through several extraordinary layers, opposite to which there is an electric field. Water does not go through the films while dissolving salts pass specifically. In this article, a survey of components influencing sun powered stills efficiency(climatic, operational and plan parameters) and upgrade strategies up to the end of 2014(wicks, inside and outside condensers, inward and outer reflectors, stage change materials, Stepped sun oriented still and another strategy enhanced the sun based still yield by utilizing nano-particles ) have been contended.

Water is that the fundamental need for human along the edge of sustenance and air. There's for all intents and purposes no water left on Earth that is protected to drink while not refinement. only one of Earth's water is amid a late, fluid state, and almost every one of this can be tainted by every sicknesses and lethal chemicals. Hence, filtration of water gives is amazingly important. Besides, ordinary purging frameworks are just broken or traded off by debacles, normal or something else. This winds up in a truly troublesome situation for individuals end enamouring to orchestrate such things, and keep themselves and their families safe from the bunch ailments and harmful chemicals present in untreated water. Everyone requirements to look out the answer of on top of drawback with the out there wellsprings of vitality in order to accomplish immaculate water. Luckily there's a response to those issues. It's an innovation that is not just fit for evacuating a truly extensive variety of contaminants in definitely one stage, however is simple, taken a toll productive, and earth inviting.

The majority of our earth surface is secured by water; at the same time, under 125th of aggregate out there water is new water that is for the most part out there in lakes, waterways and underground. Once more, concerning 33% of that potential new water may be utilized for human longings on account of blended components. Around 1.1 billion people amid this world have insufficient access

to safe drinkable. There are 26 nations don't have enough water to deal with farming and financial advancements. At least 80th of bone-dry and dry nations have genuine intermittent dry spells. 33% of Africans and the majority of Middle-East people live while insufficient water. The development - Coupled with assembling and urbanization winds up in an expanding interest for water. In India, the deficiency of desalinated water is extreme in beach front zones, especially inside the remote waterfront regions. Renewable vitality based for the most part concoction change plants will settle this water generation drawback while not exacting any fossil vitality consumption, natural compound contamination and ecological debasement. Notwithstanding the impediments of being a weaken source and irregular in nature, sun oriented vitality has the potential for meeting and supplementing various vitality needs.

### 1.2 How Does a Conventional Solar Still Work

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 about 2% in the still execution will happen [4].

## 2. LITERATURE

### Work Done So Far

A sun oriented still works sing the fundamental standards of dissipation and buildup. The polluted saline water into sun powered still and sun's beam enter a glass surface creating the water to heat up through the nursery impact and subsequently, vanish. 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/m<sup>2</sup>.day and iron steel bowl is 2.358 L/m<sup>2</sup>.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 bad ran [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. R.dev et.al.[9] made a transformed safeguard sun based as yet having bended reflector to heat it from top and base with single slant sun based still. He utilized prompt addition and misfortune efficiencies by exploratory information for atmosphere states of Muscat, Oman. He likewise contrasted comparable working and atmosphere conditions and single slant sun oriented still furthermore he discovered every year expense of distillate yield of Inverted safeguard sunlight based still and single incline sun based still were 0.95 and 0.54 Rs .A.J.N. Khalifa[10] concentrated on writing on connection between spread tilt point and profitability of straightforward sun powered stills in different seasons for connection between ideal tilt edge and scope edge and presumed that, bay tilt edge ought to be bigger in winter and

littler in summer, expanding tilt edge would build efficiency and greatest profitability accomplished by utilizing spread tilt angle near the scope of spot. S.abdullah et.al.[11] made four indistinguishable sun powered stills utilized different engrossing materials utilized as a part of single incline sun oriented still like uncoated and covered permeable medium called metallic wiry wipes and staying two utilized dark volcanic rocks and with no medium in atmosphere states of Jordan. From analysis, he found that, uncoated wipe has most noteworthy water gathering amid day time took after by dark shakes and covered wiry wipes.

Individuals can remain a live for a few days without sustenance, yet can't live for over a week without water. We have all heard it said that we ought to drink at least 8 glasses of water every day. Be that as it may, drinking the base will just keep up a base level of wellbeing. Our body will use no less than 8 glasses of water every day under typical, moderately latent movement to keep up fundamental real capacities like assimilation, temperature control, joint oil, and skin hydration. Every time we breathe out, flicker our eyes, or make any sort of development by any stretch of the imagination, we go through a portion of the accessible water in our framework.

Today crisp water interest is expanding ceaselessly as examined by El-Sebaii et al., [12] in light of the mechanical advancement, strengthened agribusiness, change in standard of life and expansion on the planet populace. Just 3% of aggregate water is consumable yet this sum is additionally equally not conveyed over the earth. Absence of crisp water is a prime element in repressing local/temperate improvement. Frequently, water sources are saline/containing unsafe microorganisms, in this way can't be utilized specifically to drink reason. The seas constitute an endless wellspring of water yet are unfit for human utilization because of their salt substance in the scope of 3% to 5%. What's more, there are numerous seaside areas where seawater is rich however consumable water is not accessible. In this way it is a pressing requirement for spotless and immaculate savouring water numerous nations.

### 3. OBJECTIVE OF THE STUDY

On the basis of different literature survey, a double slope basin solar still is selected for further development and performance analysis. The developed solar still basin area of 1 m<sup>2</sup> is proposed to be tested with convert in to double basin by using glass tray inside the solar still. So heat loss of the upper portion was reduce it give more output of the pure water.

### 4. SCOPE OF THE STUDY

On the basis of different literature survey, a double basin active solar still is selected for further development and performance analysis which is subjected to be coupled with evacuated glass tube solar collector for high temperature water feeding in to the basin of solar still. The developed solar still basin area of 1 m<sup>2</sup> is proposed to be tested with convert in to double basin by using glass tray inside the solar still. So heat loss of the upper portion was reduce it give more output of the pure water.

The Numerical set up will analyze by double glass single basin active solar still. The problem will analyze on Ansys (Fluent) software. This Numerical setup has been prepared for the climate of Bhopal city for the performance of the single basin double glass active solar stills and to analysis the efficiency of solar still from 10pm to 3 pm at different design parameters.

### 5. METHODOLOGY

CAD Modelling: Part / Assembly to create geometry using CAD modelling tools to build CAD models NX8.5.

Meshing: meshing in CFD is an important job. In this operation, the CAD geometry is discretized large number of small elements and nodes. An appropriately called mesh nodes and a system of elements in space. Analysis accuracy and duration depending on mesh sizes and orientations. CFD analysis speed decreases with an increase in mesh size, but increase accuracy (increasing number of elements).

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.

Type of Solver- Pressure Based, absolute velocity formulation and steady is used.

Physical model- k-ε Turbulence model, RNG and standard wall function is used.

Material (Fluid)- AIR , Glass , Plywood is used

Boundary Condition- Velocity of air at inlet is 10m/s and wall flux is 10w/m<sup>2</sup>

Solution Method- Second order

Solution Initialization- Initialized the solution to get the initial solution for the problem.

Run Solution: Run the solution by giving 1000 no of iterations.

5.2 Cad Model and Mesh Models

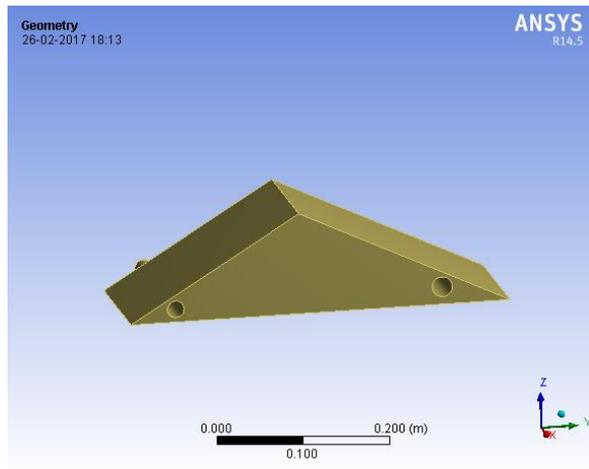


Figure 5.1 CAD Model

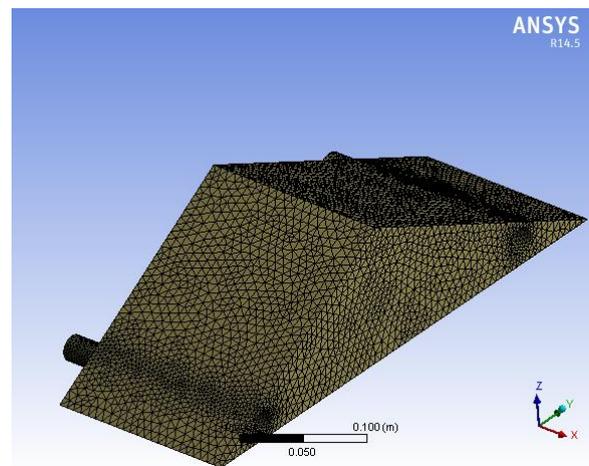


Figure 5.2 Mesh Model with nodes

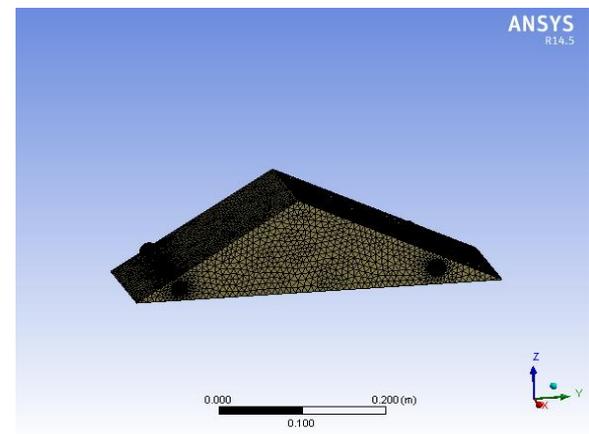


Figure 5.3 Mesh Model

## 6. RESULTS

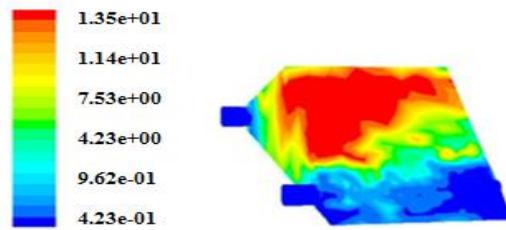


Figure 6.1 Turbulent Kinetic Energy

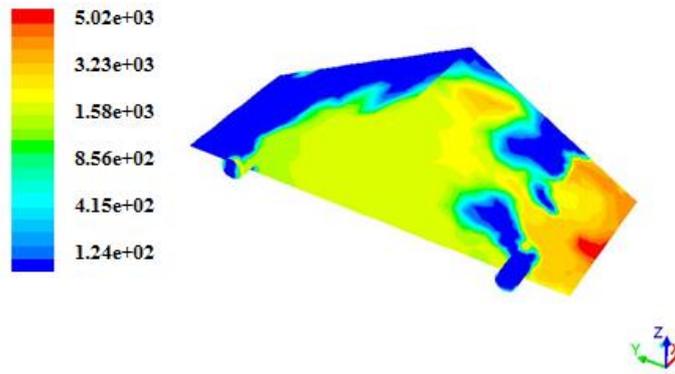


Figure 6.2 Turbulent Dissipation Rate

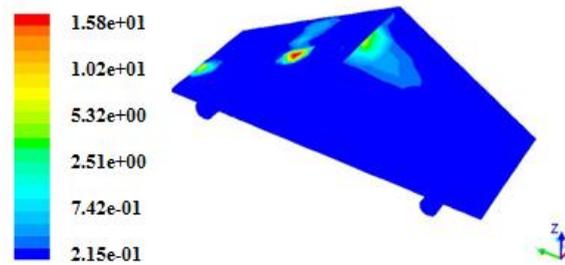


Figure 6.3 Surface Nusselt numbers

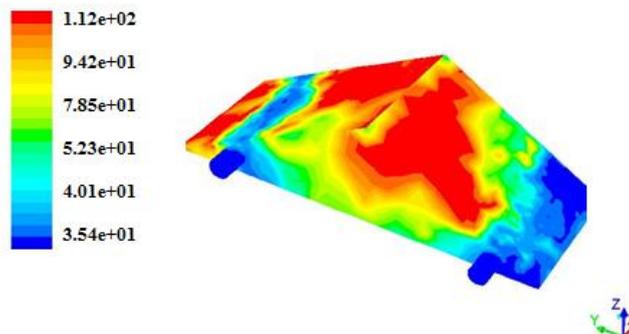


Figure 6.4 Pressure Variation

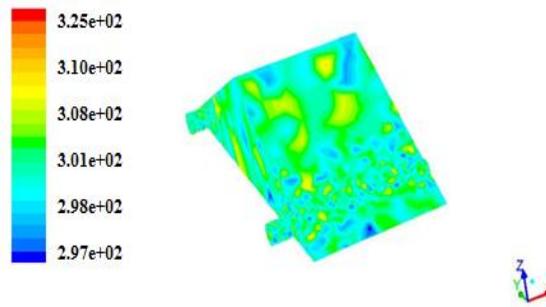


Figure 6.5 Temperature Variation

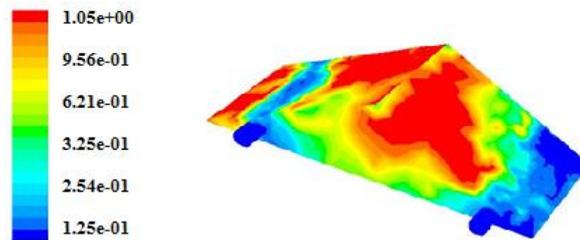


Figure 6.6 Water Volume (Vapor+Liquid) Fraction Contour

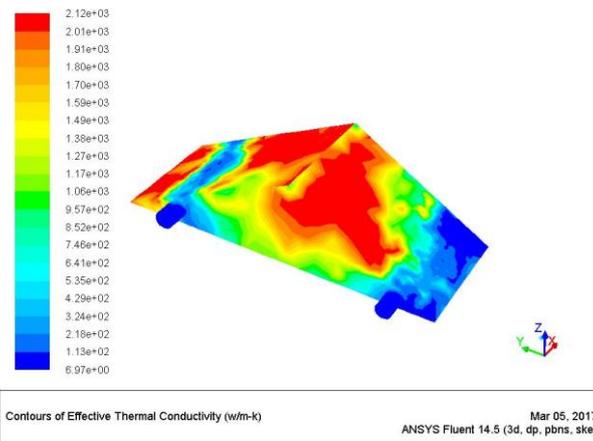


Figure 6.7 Contour of effective thermal conductivity

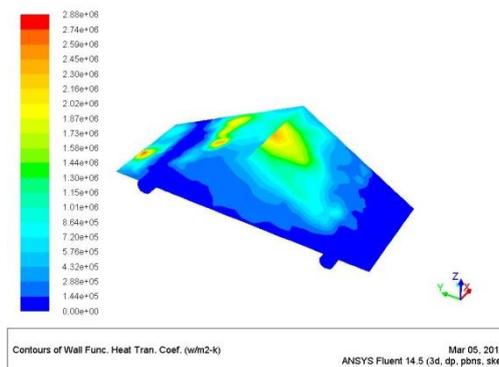


Figure 6.8 Contour of heat transfer coefficient

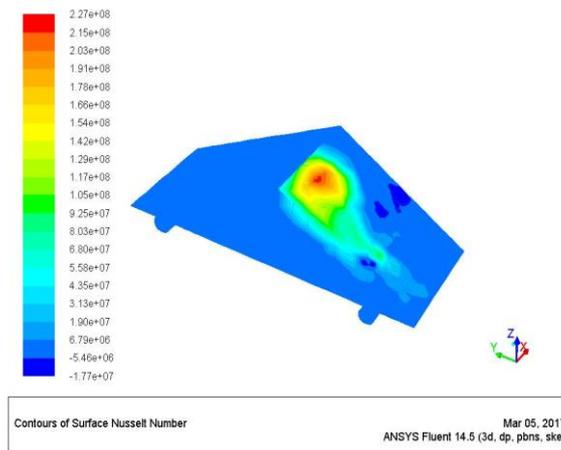


Figure 6.9 Surface Nusselt Number

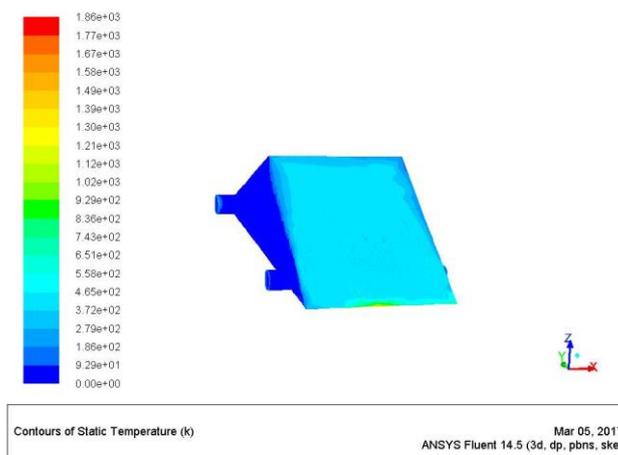


Figure 6.10 Static Temperature

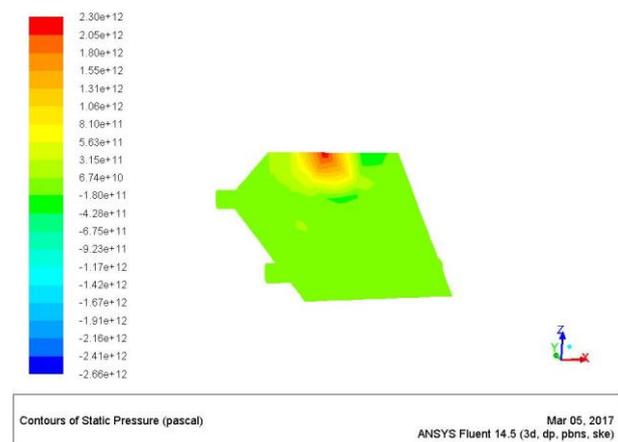


Figure 6.11 Static Pressure

## 7. CONCLUSION

The demand for fresh water in the world is growing every day. There are many ways to achieve fresh water and solar distillation is one of them. Solar distillation is a simple, small-scale and costs in homes or small communities to provide safe water, effective techniques. Solar stills can be used for different types of solar distillation is the simplest and most economical and still traditional basin type solar still. In present study we use double slope single basin solar still and simulate the system from CFD (Fluent14.5) for 6 hours (from 10 pm to 3 pm) in Bhopal city. and maximum amount of volume fraction of water is achieved due higher evaporation of impure water. The peak temperature is achieved due to the attack on the glass and solar rays begin to evaporate impure water. Caused by water heated by solar radiation and is vaporized. Water vapour and the temperature difference between the surface of glass in the glass leads to condensation of vapour. Condensed water droplets are collected in the bottom of the slide

and distilled channel. Water collected in the amount of fresh water production rate of the channel is considered. Finally we see that the water content of the final simulated results.

**Results Table**

CITY	10PM	11PM	12PM	1PM	2PM	3PM
<b>BHOP AL</b>	<b>1.25e- 01</b>	<b>2.54e- 01</b>	<b>3.25e- 01</b>	<b>6.21e- 01</b>	<b>9.56e- 01</b>	<b>1.05e+ 00</b>

**Table no. 1**

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