CHAPTER 1
INTRODUCTION

1. Overview

Water scarcity is a significant global issue. Water scarcity is expected to afflict 1/4 of the world's population by 2025, with 2/3 of the population experiencing water stress. By 2030, half of the world's population will be under severe water stress. Presently, Water scarcity is afflicting African regions, affecting up to 31% of the population .Asia, America, and Europe are next, with 25%, 7%, and 2% of the population experiencing severe water stress, respectively. Desalination is becoming more important in fulfilling the growing demand for fresh water. Desalination of sea and brackish water can be done in a variety of ways. Flash distillation, multi-effect distillation, membrane distillation, reverse osmosis, forward osmosis, ion exchange, capacitive deionization, electro dialysis, and seawater greenhouse technology are only a few examples.

Desalination energy can come from fossil fuels or alternative energy sources including biomass, wind, solar, geothermal, or industrial waste heat. Sun stills have several advantages over other solar desalination systems, including simplicity, low cost, ease of maintenance, and low environmental impact. They do, however, have drawbacks, such as limited performance, which limit their commercial viability.

Solar energy still relies on the evaporation and condensation processes. Solar energy is used to evaporate the brine inside the solar still, and the condensate is recovered as distilled water. This process is repeated in a double- or multiple-effect solar still, where the heat of condensation is used to fuel a further evaporation process. The use of several effects tends to improve performance, but it comes at a cost. Active components, such as pumps and fans, are another option to improve performance, but they come at a price in terms of cost and complexity.

Efficiency and productivity are two factors that can be used to evaluate a solar still's performance. Efficiency is defined as the ratio of the condensed water's latent thermal energy to the total quantity of solar energy incident on the still in a single-effect still. Immediate effectiveness specifies the efficiency during a short period of time (usually 15 minutes), whereas total efficiency specifies the efficiency over a longer length of time indicates the time for the entire day. The water output per area of solar still per day is known as productivity. A basic passive solar still produces only approximately 25 L/m^2 per day, requiring at least 1 m^2 of space. It takes a lot of space to meet one person's basic needs. The focus of this review is on the Improve the performance of solar stills using existing and emerging technology.

Water, a vital life-sustaining renewable resource, has met our requirements since ancient times and will continue to do so in the future. Freshwater, which is good for home purposes, makes up only

1% of the accessible water. Because of unprecedented population increase and urbanization, the available freshwater supply is on the verge of transitioning from a renewable to a finite resource. This situation can be averted, and people's needs and demands can be met, if salt water, which is abundant, is transformed into drinking water by a desalination process employing solar stills.

1.1 General parameters affecting the performance of solar stills:-

Climatic conditions:

The key climatic factor impacting production is solar radiation intensity. Daily productivity will be proportional to solar irradiation (kJ/m2.day) at constant efficiency. Wind speed and ambient temperature, on the other hand, have an impact on performance. Sebaii (2004) found that the productivity of a solar panel grows only when the wind speed is below the threshold speed of 4.5 m/s. Tiwari et al. (2014) studied the impacts of various meteorological conditions in active and passive distillation systems and discovered that wind improved performance up to the same critical speed of 4.5 m/s, after which productivity remained unchanged. This is because wind improves heat transfer from the cover and hence condensation up to a certain speed, after which no further improvement is possible.

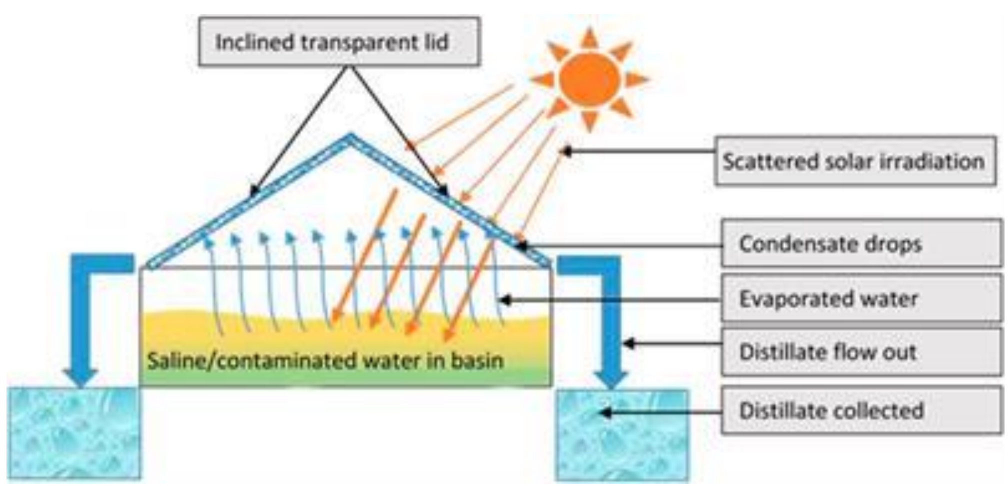

Fig. 1 Saline/contaminated water in basin

Water depth:

The effectiveness of solar stills is affected by water depth in the following way with regard to the period of operation. Smaller depth often boosts effectiveness for short durations (less than two days). To keep the still from drying out over prolonged periods of time, extra depth may be necessary. Singh et al. (2004) conducted a performance study on active and passive stills under Indian climatic circumstances, concluding that water depth, as well as the inclination of the condensing cover and collector, have a significant impact on annual productivity. Rajesh et al. (2006) evaluated the production of active and passive stills at various depths such as 0.05 m, 0.1 m, and 0.15 m, and found that the output was highest at 0.1 m. The decline at great depths could be due to the longer time it takes to warm up the larger volume of water. The decline at great depths could be due to the longer time it takes to warm up the larger volume of water.

1.2 Comparison between Active and Passive

- Passive systems are structures whose design, placement, or materials optimize the use of heat or light directly from the sun as compared the Active systems have devices to convert the sun's energy into a more usable form, such as hot water or electricity.
- Evaporation and condensation processes take place spontaneously in a passive solar still. As compared the Additional components such as solar collectors, condensers, coolers, or other equipment are added to active solar stills to improve performance.
- Passive solar stills can be classified in a variety of ways, including evaporator design and materials (such as wicks), heat storage options, shape, and number of basins. As compared the Pumps, fans, and other powered devices are commonly used to operate this equipment
- Multiple basins or wicks can be used to create multiple-effect distillation, resulting in significantly increased yield. As compared the Active solar stills, in contrast to passive solar stills, usually require energy.

1.3 Comparison between Pyramid Triangular and Tubular Solar still

Pyramid	Triangular	Tubular
The top cover of a pyramid solar still is in the shape of a pyramid.	The top cover of a triangular solar still is in the shape of a triangle.	A tubular solar still is one whose shape is made up of cylindrical tubes.
In the pyramid solar still, shading of side wall on water surface is less	Triangular still has lower productivity and performance than tubular.	Tubular still outperforms the competition in terms of productivity.
condensation in pyramid shape solar still is higher	The cost of produced water in triangular still is lower	Tubular solar still is characterized by having a large condensing and receiving surface area
The cost of produced water in pyramid still is lower	Greater entropy generation is seen in triangular solar still.	The cost of produced water in tubular still is higher than that of triangular
Pyramid type solar still eliminates the requirement of tracking mechanism and reduces the shading effect of side wall	In case of triangular pyramid solar still, convective and evaporative heat transfer coefficient decrease during the sunshine hours with increase in water depth.	Greater strength of the recirculating zones is seen in the tubular solar still.

1.4 Problem Statement

- Fresh water is essential for all life forms on earth.
- The available fresh water on the earth is fixed, but the demand of fresh water is increased.
- The ocean is the only available source for large amount of water.
- But the ocean water contains high salinity, so there is a need to desaline the water.
- Desalination of salt water using solar still which then can be used for drinking or other household purpose.
- 97.5 % ocean water not drinkable, 2.5 % available fresh water.
- By 2030, 2/3rd of the world population will be suffering from water shortages.
- The high rate of population growth and climate change presents increased need for freshwater, and in the next decades many further areas of the world are expected also to require substantial use of desalination.
- The uses of water from the sources like rivers, lakes were being utilized for the growth of industries and agriculture. Also these sources are polluted by industries

- So there is a lack of clean water for the current years
- So our Project which is (Experimental Investigation on Pyramid Solar Still augmented with Solar Water heater in Passive and Active mode) is one of the widely used techniques in producing portable drinking water.
- By using this technique of Active and passive method we assume that the productivity on a Pyramid solar still under constant water mass of 20 kg. Results show that the production of fresh water is about 4.2 kg/m^2/day
- Clean water essential to stop spread of disease & improve overall health.

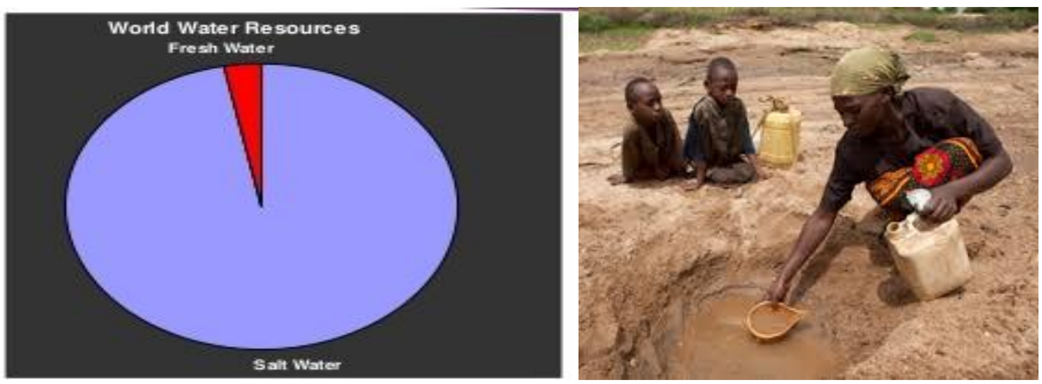

Fig. 2 Problems of Fresh Water in Earth

How Does Solar Still Works?

- Solar still is a device, which is used for desalination purpose.
- Solar water distillation is the process of using energy from the sunlight to separate freshwater from salts or other contaminants.
- The untreated water absorbs heat, slowly reaching high temperatures.
- The heat causes the water to evaporate, cool, and condense into vapour, leaving the contaminants behind.
- Economical process but distillation rate is low.

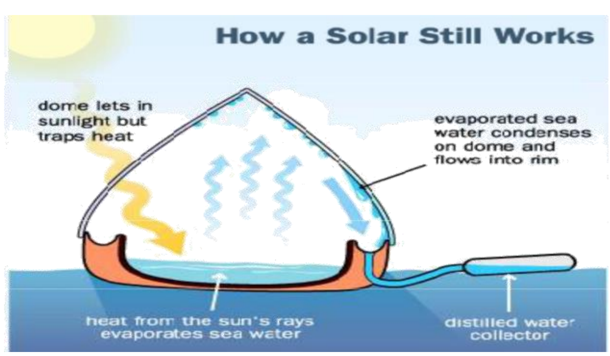

Fig. 3 How Does Solar Still Works?

1.5 Thesis Objectives

The objectives of work are as follows:

- To design, develop and install the experimental system.
- To analyzed and study parameters affecting the performance of Pyramid SS.
- To improve the efficiency and distillate productivity of solar still by integrating the Solar water heater.
- To carry out the performance of a solar still in clear, partially cloudy, cloudy days.
- To carry out the Comparative Analysis of PSS using Passive & Active Technique.
- Economic Analysis

1.6 Thesis Contributions

In this thesis, we show that the key to effective utilization of solar still relies on a set of performance parameters, which eloquently delineates the performance capabilities of the target productivity of desalinate water. Through this set of performance parameters i.e. Pyramid solar still, we can analyze, predict, evaluate and explain on issues related to fresh water in future. So of the important points are,

For high efficiency the solar still should maintain:

- A high feed (distilled) water temperature.
- A large temperature difference between feed water and condensing surface.
- Low-vapor leakage.

A high feed water temperature can be achieved if:

- A high proportion of incoming radiation is absorbed by the feed water as heat. Hence low absorption glazing and a good radiation absorbing surface are required.
- Heat losses from the floor and walls are kept low.
- The water is shallow so there is not so much to heat.

A large temperature difference can be achieved if:

- The condensing surface absorbs little or none of the incoming radiation.
- Condensing water dissipates heat which must be removed rapidly from the condensing surface by, for example, a second flow of water or air, or by condensing at night.

CHAPTER 2
LITERATURE SURVEY & REVIEW

2.1 Review of Literature

The exhaustive literature survey has been carried out through various sources. The comprehensive review of literature is presented below.

Drinking water is still a big problem in dried and remote areas. Single basin solar still is a solution for this problem. This type of solar still is capable of producing clean potable water from available salty or waste water throughout the year. Single slope still is suitable at higher latitude place. Water and energy are two types' inseparable items that govern our lives and promote civilization. Looking to the history of mankind one finds that water and civilization were also two inseparable entities. It is not a coincidence that all great civilizations were developed and flourished near large bodies of water. Rivers, seas, oases and oceans have attracted mankind to their coasts because water is the source of life. The supply of hygienic potable water is one of the major problem faced in underdeveloped and in some developed countries. Since transportation of drinking water from far-off regions is usually not economically feasible / desirable, desalination of available brackish water has been considered as an alternative approach. Several researchers have studied the effects of various designs, operational and climatic parameters. Many designs and modifications of the solar still have been proposed in literature.

Omar O. Bad ran et. al. [5] Evaluating thermal performance of a single slope solar still. In this study, several conclusions can be obtained as follows; (a) the increase in either ambient temperature and/or the solar intensity can lead to an increase the solar productivity, (b) as the water depth decreases from (3.5 cm) to (2 cm), the productivity increases by (25.7 %), (c) The maximum efficiency occurs in early afternoon due to the high solar radiation at this time, (d) the overall heat loss coefficient increases until it reaches the maximum in the afternoon due to higher solar intensity and ambient temperature, and finally, (e) the proposed mathematical model gave good match with experimental results. Future work can be carried out using this model to enhance the design of single solar stills.

Anil Kumar Tiwari et. al. studied [6] Effect of Cover Inclination and Water Depth on Performance of a Solar Still for Indian Climatic Conditions. The study leads to the following conclusions. 1. Overall, 45 degree and 15 degree inclinations of the condensing cover result in maximal annual yields of similar order of magnitude. However, specific summer or winter peak performances are optimized when choosing a condensing cover inclination of 15 degree or 45 degree, respectively. 2. Lowest possible water depth produces maximum yield and efficiency throughout the entire year.

G. N. Tiwari and A. Kumar., [7] Theoretical study of the quality of a tubular solar still for nocturnal output was made. The authors experimentally validated the analysis for a special case of a TSS. TSS daily yield is maximum than conventional still for the same experimental set and climatic parameters.

A. Kumar and J. D. Anand [8] Theoretical analysis of a new multilink tubular solar still has been proposed and investigated. Distillate output and the efficiency from multilink tubular solar still is 3l/m^2 day, 13% higher than that of conventional multilink tubular solar still.

K. S. ISLAM and T. FUKUHARA [9] this study presents a quasi-stable heat and mass transfer setup of a TSS into account the moist air properties inside the still.
To test the proposed model, a Tubular Solar Still indoor output experiment was conducted. From the production experiment it is found that the analytical solutions derived from the current model could reproduce the experimental results on humid air temperature, saline water temperature, cover temperature, and condensation fluxes.

S. Islam and T. Fukuhara [10] they proposed to give heat and mass transfer model, correlations and also developed a technique for measuring the evaporation rate directly from the water surface in a TSS. Also compared the production performance of indoor experiment with experimentation.

A. Ahsan and T. Fukuhara [11] did experimentation and its Experimental results of two Tubular Solar Still (TSS) with different cover materials. An experiment was conducted to investigate the production and evaporation performance of the second model as well as the thermal properties of the tubular cover, moist air and water inside a trough. The evaporation and production fluxes for the second model were found to be slightly lower than the first under the same conditions.

A. Ahsan and T. Fukuhara [12] studied the theory of film wise condensation and developed a production model for a TSS. In addition, this paper will also demonstrate the validity of the proposed condensation theory by comparing hourly production field experimental results with the theoretical.
A. Ahsan, K et al [13] studied the comparison between two models using polythene film and vinyl chloride sheet as a transparent tubular cover. Experiments are conducted using a special technique to examine the quality of evaporation, condensation and distilled water production on the second model.

A. Ahsan and T. Fukuhara [14] Conducted an theoretical study on a new TSS mass and heat transfer model incorporating different mass and heat transfer coefficients in order to calculate the relative humidity, temperature and water vapor density of the humid air and to estimate the condensation flux.

A. Ahsan et al [15] studied the comparison of design, water production, cost and fabrication analysis between the old and new Tubular Solar Still (TSS) is provided. Also obtained, differences in evaporation, convection and condensation mass and heat transfer coefficients are obtained by considering the properties of humid air. Condensation heat and mass transfer coefficients are slightly lower than that of evaporation.

Z. Chen et al [16] studied the characteristics of heat and mass transfer as well as experimental desalination work; a self-made three-effect tubular still is used. The maximum productivity was approximately 1.12 kg/h at 80^{o} c.

H. Zheng et al [17] Experimental studies have been carried out on multi effect tubular solar stills by Zheng et al. The device performance of single, two and three effect was individually analyzed and tested under the constant heating power and temperature. Their results showed that, yield under negative pressure was increased approximately 20.08 kg/(m^2 d).

T. Arunkumar et al [18] A Compound parabolic concentrator concentric tubular with rectangular water desalination basin over the cover with flowing water an air was designed. The system's daily distillate production is enhanced by lowering the water temperature flowing over it. The distillate yield with no cooling flow is found to be 2050 ml/day than that of still with cooling flow of water was 5000 ml/day. Arunkumar et al. experimentally studied two modes without and with air flow between internal and external tubes and estimated the enhancement in distillate output with constant air flow speed of 4.5 m/s throughout the test. Based on performance tests, the rate of water collection was 1445 ml/day without air flow and 2020 ml/day with air flow and efficiencies was 16.2% and 18.9% respectively.

H. Zheng, Z. Chang et al [19] An experimental setup of non-concentrical multi-sleeve tubular solar still is made by Zheng in which an theoretical & experimental study is performed to determine how various gas media, wind, oxygen, helium and carbon dioxide, impact water production quality. The maximum productivity and efficiency at 85 °C was approximately 0.58 kg·h−1 and 31.82% when gas medium is used as oxygen and air.

2.2. Patent Search

Inventor Shen Zhen Luo Zhouyang Liu Chunhong Qi Zhifu Shou Chunhui Luo Yifan Shen Hongpan "Inverted pyramid solar still with light reflection and efficiency enhancement functions". Under the invention, they did the utility model relates to an inverted pyramid solar still with reflection and efficiency enhancement, which comprises a still box body, an illuminated surface, an outer tube, an inner tube, a fresh water collecting container, a water inlet, a concentrated water discharging port, a reflection panel and a frame; the top of the distiller box body is provided with an inverted pyramid-shaped illuminated surface, Application filed by Zhejiang Zheneng Yueqing Power Generation Co ltd, Zhejiang Energy Group Research Institute Co Ltd, 2020-12-22, Application CN202020773572.4U, 2020-05-11, Application granted Application No. CN212198581U.

Inventor William S. Walker, Adrian Saenz, Hillery T. Kemp, John Manford "Solar still countercurrent flow system and apparatus" Under the invention, they did the a solar distillation system includes a solar collector located adjacent to a condenser, the condenser located at an angle with respect to the condenser. The solar distillation system further includes a 2nd effect and an insulated portion located between the condenser and the 2nd effect. Application filed by University of Texas System 2015-10-30 Priority to US14/927,657 Assigned to Board of Regents, The University of Texas system, Application granted Application No. US20160122206A1.

Inventor J. Domingos Avazcal F. Medina Encina F. Medina Regra M. Carrasco Jimenez J. Parra Fernandez-Motta L. Garrido Delgado "Support module for a solar collector having a triangular substructure". Under the invention, they did the invention relates to a support module for a solar collector having a triangular substructure, formed by: a main structure intended to resist the torsional and bending forces of the collector, and an auxiliary structure that balances the assembly and supports the weight of the mirrors and the absorber tube. Application filed by Europe De Constructions Metallica's S A 2011-12-29, 2010-12-30 Application granted Application No. CN2011800638252A.

Inventor Ahmed Al-Garni, Ayman Kassem, Farooq Saeed "Double action solar distiller". Under the invention, they did a solar still includes a relatively shallow chamber with a pyramid shaped transparent cover and a transparent base. The still also includes a pair of rollers and an endless heat absorbing belt rotatable about the rollers. Application US7857945B2 filed by Ahmed Al-Garni, Ayman Kassem, Farooq Saeed 2006-09-28 Assigned to KING Fahd University Of Petroleum & Minerals 2010-12-28 Application granted 2010-12-28.

Inventor Nitto Denko Corp "Distillation apparatus and distillation method". A distillation apparatus which can be automatically replenished with a liquid, does not require a large amount of energy and can be produced at suppressed facility cost is provided. A distillation apparatus (100) for generating distilled water by use of solar heat (72) includes a heat transmissive window. EP2778139A1 Application filed by 2012-08-08.

CHAPTER 3
METHODOLOGY AND EXPERIMENTATION WORKDONE

3 Methodology and Experimentation Work done

Following are the sequence for performing experimentation on PSS using Solar Water Heater of Active and Passive Solar Still are,

- **Case I – Without Absorbing Material**
- **Case II- Iron Rod**
- **Case III- Limestone**
- **Case IV- Black Paint**
- **Case V- Tiles**
- **Case VI- Sand**
- **Case VII- River Stone**

Fig.4 Experimental Setup

3.1 Components & Equipment's used in Project

- **GI Tank-** We have used it as water tank which can store about (200 liters) in both Active and Passive pyramid solar still.
- **Toughened Glass**- We have use toughness Glass because it is compressed and tempered with heat and cold during production, which it much greater strength and shatter-resistance compared to normal float glass.it can sustain temp of about 250^0C.
- **PVC Pipes** - Poly vinyl chloride pipes we have used this to circulate the water form storage tank to Solar Heater and pipe can sustain temp of about with pressure (38^oC) and without pressure (60^0C).
- **Solar water-** it will provide us preheated water which is about temperature of 60-80^0C. which is supply to Active pyramid solar still which will provide us more efficiency for production of fresh water.
- **MS Steel Tray-**We will be using it in Active Pyramid Solar Still because of this tray we were going to add many materials in this tray which will give us More efficiency of Fresh Water.
- **K type Thermocouple** - We are using Thermocouples because it will provide us the temperature reading which range is between (-200 to 1260^0C).
- **Anemometer:** An anemometer is a device used for measuring wind speed and direction. It is also a common weather station instrument. Air temperature range is from -10 to 60^0C.
- **Pyranometer:** A pyranometer is a type of actinometer used for measuring solar irradiance on a planar surface and it is designed to measure the solar radiation flux density from the hemisphere above within a wavelength range 0.3 μm to 3 μm.
- **Temperature indicator:** Temperature indicator is a very easy to use and cost-effective control device that helps to determine and display, e. g., the duration of exposure to excessive temperatures. Temperature Range: 0-1200 degree C
- **Data Logger:** A data logger is an electronic device that records data over time or in relation to location either with a built in instrument or sensor or via external instruments and sensors. Increasingly, but not entirely, they are based on a digital processor. Range between 100 to +600˚C

3.2 Case I – Without Absorbing Material:-

Fig. 5 Case I – Without Absorbing Material

An experiment was conducted at a location in Nagpur at (GH Raisoni Academy of Engineering And Technology). After cleaning both sets and configuring the instruments necessary for the measurement of various parameters, each experiment began. On an hourly basis, the distillate production, solar radiation, wind speed, temperature of different still components, and ambient temperature were all measured. The water depth in both tanks was adjusted by two levels in this experiment. In both tanks, we conducted testing at two different water levels: 20 mm and 50 mm.

In this Case 1 (Without Absorbing Material), we didn't include a tray or any phase transition material in this experiment since we wanted to keep things simple in Active Solar Still. The water depth in both tanks was the same. An experiment on March 26, 2022 (summer) from 10 a.m. to 5 p.m. with a 50mm water depth, we obtain an average water productivity of around 14.29%. And on 5/04/2022 (summer) from 10 a.m. to 5 p.m. with a water depth of 20 mm, we obtained an average water productivity of around 17.66%. On December 27, 2021 (winter), from 10 a.m. to 5 p.m., with a water depth of 50 mm, we receive a productivity of roughly 5.69%. And on 05/01/2022 2021 (winter) from 10 a.m. to 5 p.m. with a water depth of 20mm, we receive a productivity of 3.38%.

In Passive Solar Still, winter water output averages 2.08 % with a 50 mm water level, 3.38 percent with a 20 mm water level, while summer water output averages 3.12 percent with a 50 mm water level, and 3.90 percent with a 20 mm water level. When we compare the two, we observe that active solar still outperforms passive solar.

3.3 Case II- Iron Rod:-

Fig. 6 Case II- Iron Rod

An experiment was conducted at a location in Nagpur at (GH Raisoni Academy of Engineering And Technology). After cleaning both sets and configuring the instruments necessary for the measurement of various parameters, each experiment began. On an hourly basis, the distillate production, solar radiation, wind speed, temperature of different still components, and ambient temperature were all measured. The water depth in both tanks was adjusted by two levels in this experiment. In both tanks, we conducted testing at two different water levels: 20mm and 50mm.

We introduced Phase Change Material in Case 2, which is an iron rod put on a GI tray in an active solar still. Because of the addition of this phase transition substance, efficiency has increased. (The average thermal conductivity of iron rods at steady-state circumstances is 0.804 W/cm/K And Thermal Capacity of 298.2 K.)

In summer, On March 28, 2022 from 10 a.m. to 5 p.m. with a 50mm water depth, we achieve an average water productivity of roughly11.95%. And on April 6, 2022, from 10 a.m. to 5 p.m., with a water depth of 20 mm, we acquired an average water productivity of around 15.06%.

In winter, On December 28, 2021 from 10 a.m. to 5 p.m. And on December 28, 2021, with a 50mm water depth, we achieve an average water productivity of roughly 4.68% and on January 06, 2022, from 10 a.m. to 5 p.m., with a water depth of 20 mm, we acquired an average water productivity of around 6.75%.

In Passive Solar Still, in summer water output averages 3.64% percent with a 50mm water level, 4.68% And percent with a 20 mm water level, while in winter water output averages 1.95% percent with a 50 mm water level, and 3.17% percent with a 20 mm water level. When we compare the two, we observe that active solar still outperforms passive solar.

3.4 Case III- Limestone:-

Fig. 7 Case III- Limestone

An experiment was conducted at a location in Nagpur at (GH Raisoni Academy of Engineering And Technology). After cleaning both sets and configuring the instruments necessary for the measurement of various parameters, each experiment began. On an hourly basis, the distillate production, solar radiation, wind speed, temperature of different still components, and ambient temperature were all measured. The water depth in both tanks was adjusted by two levels in this experiment. In both tanks, we conducted testing at two different water levels: 20mm and 50mm.

We introduced Phase Change Material in Case 3, which is a Limestone put on a GI tray in an active solar still. Because of the addition of this phase transition substance, efficiency has increased. (The average thermal conductivity of Limestone at steady-state circumstances is 1.3 W/mK at 840 J/g K.)

In summer, On March 29, 2022 from 10 a.m. to 5 p.m. with a 50mm water depth, we achieve an average water productivity of roughly 10.39%, and on April 7, 2022, from 10 a.m. to 5 p.m. With a water depth of 20 mm, we acquired an average water productivity of around 12.99% percent.

In winter, on December 29, 2021from 10 a.m. to 5 p.m. And on December 29, 2021, with a 50mm water depth, we achieve an average water productivity of roughly 4.10% and on January 07, 2022, from 10 a.m. to 5 p.m., with a water depth of 20 mm, we acquired an average water productivity of around 5.97%.

In Passive Solar Still, in summer water output averages 3.12% percent with a 50mm water level And 3.58% percent with a 20 mm water level, while in winter water output averages 1.56 % percent with a 50 mm water level, and, 3.64% percent with a 20 mm water level. When we compare the two, we observe that active solar still outperforms passive solar.

3.5 Case IV- Black Paint:-

Fig. 8 Case IV- Black Paint

An experiment was conducted at a location in Nagpur at (GH Raisoni Academy of Engineering And Technology). After cleaning both sets and configuring the instruments necessary for the measurement of various parameters, each experiment began. On an hourly basis, the distillate production, solar radiation, wind speed, temperature of different still components, and ambient temperature were all measured. The water depth in both tanks was adjusted by two levels in this experiment. In both tanks, we conducted testing at two different water levels: 20mm and 50mm.

We introduced Phase Change Material in Case 4, which is a Black Paint put on a GI tray in an active solar still. Because of the addition of this phase transition substance, efficiency has increased. (The average thermal conductivity of Black Paint at steady-state circumstances is 0.19 W/ (mK) And Thermal Capacity of 1470 J/ (kgK)

In the summer, On March 30, 2022 from 10 am to 5 pm with a 50mm water depth, we achieve an average water productivity of approximately 11.30%, and on April 08, 2022 from 10 am to 5 pm with a water depth of 20 mm, we acquired an average water productivity of around 14.29%.

In Winter From, December 30, 2021, from 10 a.m. to 5 p.m. With a 50mm water depth, we achieve an average water productivity of roughly 3.64% on January 08, 2022.From 10 a.m. to 5 p.m., with a water depth of 20 mm, we acquired an average water productivity of around 5.71%.

In Passive Solar Still, in summer water output 3.12% percent with a 50mm water level and 4.08% percent with a 20 mm water level, while in winter water output averages 1.30%percent with a 50 mm water level, and, 3.12% percent with a 20 mm water level. When we compare the two, we observe that active solar still outperforms passive solar.

3.6 Case V- Tiles:-

Fig. 9 Case V- Tiles

An experiment was conducted at a location in Nagpur at (GH Raisoni Academy of Engineering And Technology). After cleaning both sets and configuring the instruments necessary for the measurement of various parameters, each experiment began. On an hourly basis, the distillate production, solar radiation, wind speed, temperature of different still components, and ambient temperature were all measured. The water depth in both tanks was adjusted by two levels in this experiment. In both tanks, we conducted testing at two different water levels: 20mm and 50mm.

We introduced Phase Change Material in Case 5, which is a Tiles put on a GI tray in an active solar still. Because of the addition of this phase transition substance, efficiency has increased. (The average thermal conductivity of Tiles at steady-state circumstances is 0.37 W/m.K 1000 J/kgK.

In the summer, On March 31, 2022, from 10 am to 5 pm with a 50mm water depth, we achieve an average water productivity of approximately 10.91% and on April 11, 2022
With a water depth of 20 mm, we acquired an average water productivity of around 12.99%

In winter, On January 03, 2022, from 10 a.m. to 5 p.m. With a 50mm water depth, we achieve an average water productivity of roughly 3.64% and on January11, 2021.From 10 a.m. to 5 p.m., with a water depth of 20 mm, we acquired an average water productivity of around 6.75%.

In Passive Solar Still, in summer water output 3.38% percent with a 50mm water level and 4.16% percent with a 20 mm water level, while in winter water output averages 2.08%percent with a 50 mm water level, and, 4.16 % percent with a 20 mm water level. When we compare the two, we observe that active solar still outperforms passive solar.

3.7 Case VI- Sand:-

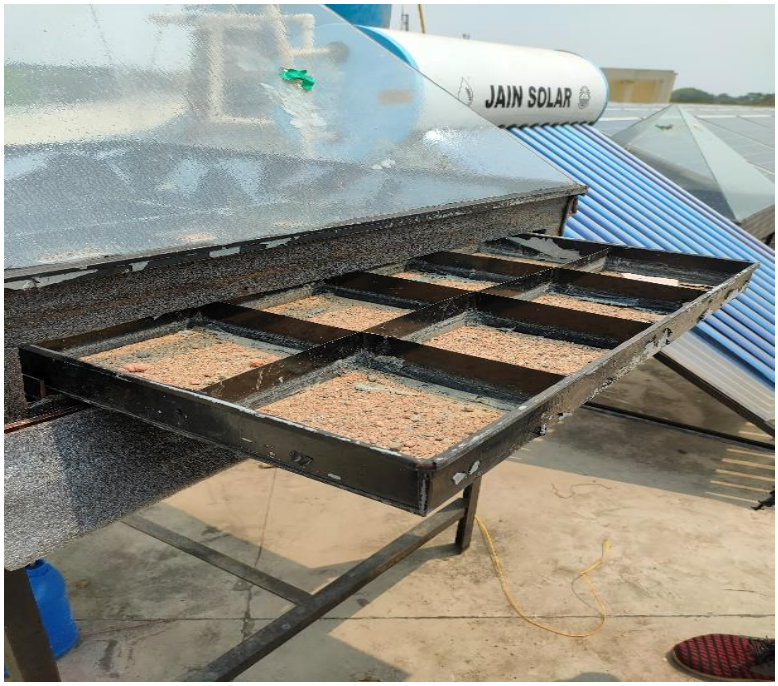

Fig. 10 Case VI- Sand

An experiment was conducted at a location in Nagpur at (GH Raisoni Academy of Engineering And Technology). After cleaning both sets and configuring the instruments necessary for the measurement of various parameters, each experiment began. On an hourly basis, the distillate production, solar radiation, wind speed, temperature of different still components, and ambient temperature were all measured. The water depth in both tanks was adjusted by two levels in this experiment. In both tanks, we conducted testing at two different water levels: 20mm and 50mm.

We introduced Phase Change Material in Case 6, which is a Sand (Dry Coarse Sand) put on a GI tray in an active solar still. Because of the addition of this phase transition substance, efficiency has increased. (The average thermal conductivity of Tiles at steady-state circumstances 2.05 W/m/oC and thermal Capacity is 800 J/kg K

In the summer, On April 1, 2022 From 10 am to 5 pm with a water depth of 50mm, we obtain an average water productivity of 11.69%, and on April 12, 2022 we obtained an average water productivity of roughly 14.55 % with a water depth of 20 mm.

In winter, On December 31, 2021, from 10 a.m. to 5 p.m., with a 50mm water depth, we obtain an average water productivity of around 3.90 % and on January 10, 2022 from 10 a.m. to 5 p.m., with a water depth of 20 mm. We obtained an average water productivity of roughly 6.23 %.

In Passive Solar Still, in summer water output was 3.25% percent with a 50mm water level and 3.71% percent with a 20 mm water level, while in winter water output averages 2.86%percent with a 50 mm water level, and 3.90% percent with a 20 mm water level. When we compare the two, we observe that active solar still outperforms passive solar.

3.8 Case VII- River Stone

Fig. 11 Case VII- River Stone

An experiment was conducted at a location in Nagpur at (GH Raisoni Academy of Engineering And Technology). After cleaning both sets and configuring the instruments necessary for the measurement of various parameters, each experiment began. On an hourly basis, the distillate production, solar radiation, wind speed, temperature of different still components, and ambient temperature were all measured. The water depth in both tanks was adjusted by two levels in this experiment. In both tanks, we conducted testing at two different water levels: 20mm and 50mm.

We introduced Phase Change Material in Case 7, which is River Stone put on a GI tray in an active solar still. Because of the addition of this phase transition substance, efficiency has increased. (The average thermal conductivity of Tiles at steady-state circumstances 2.99 W/mK and thermal Capacity is 1000 J/kg K

In the summer, with a water depth of 50 mm, we obtained an average water productivity of 10.91%, and on April 4, 2022, and on April 13, 2022, we obtained an average water productivity of roughly 14.29% with a water depth of 20 mm.

In winter, On January 04, 2021, from 10 a.m. to 5 p.m., with a 50mm water depth, we obtained an average water productivity of around 4.18% and on January12, 2022. From 10 a.m. to 5 p.m. with a water depth of 20 mm, we obtained an average water productivity of roughly 5.97%.

In Passive Solar Still, in summer water output was 3.12% percent with a 50mm water level and 4.16% percent with a 20 mm water level, while in winter water output averages 2.39%percent with a 50 mm water level, and 3.64% percent with a 20 mm water level. When we compare the two, we observe that active solar still outperforms passive solar.

3.9 Circuit Diagram

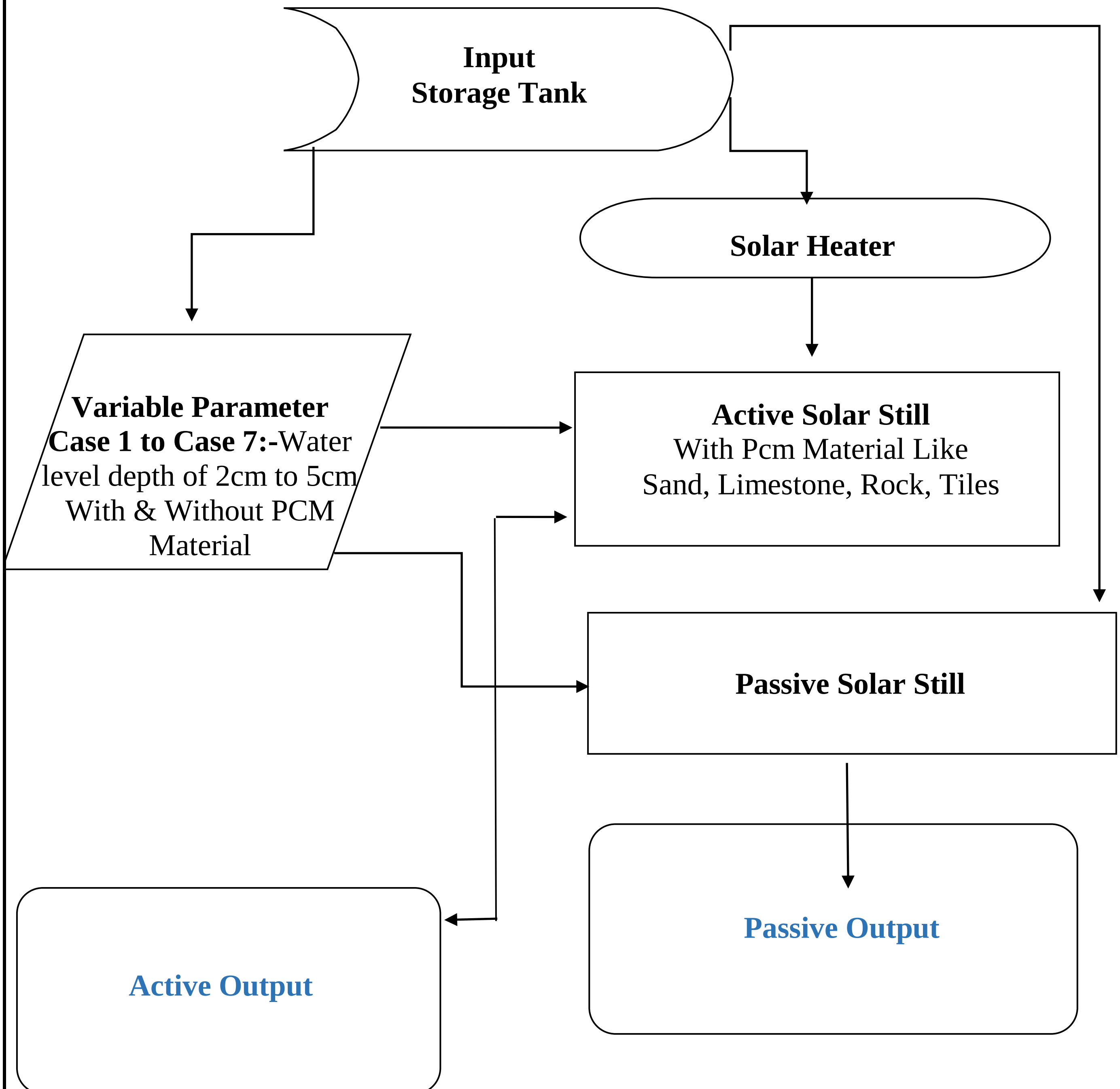

Fig. 12 Circuit Diagram

3.10 Work Plan

Months Activities	SEPT'21	OCT'21	NOV'21	DEC'21	JAN'22	FEB'22
Literature Reviews	√	√				
Component Identification & Selection		√				
Designing		√	√			
Experimental Analysis				√	√	
Fabrication				√	√	
Testing and Debugging					√	√
Preparation of Project Report						√

CHAPTER 4
DESIGN & CALCULATION

4. Design & Calculation

4.1 Design of Experimental Setup

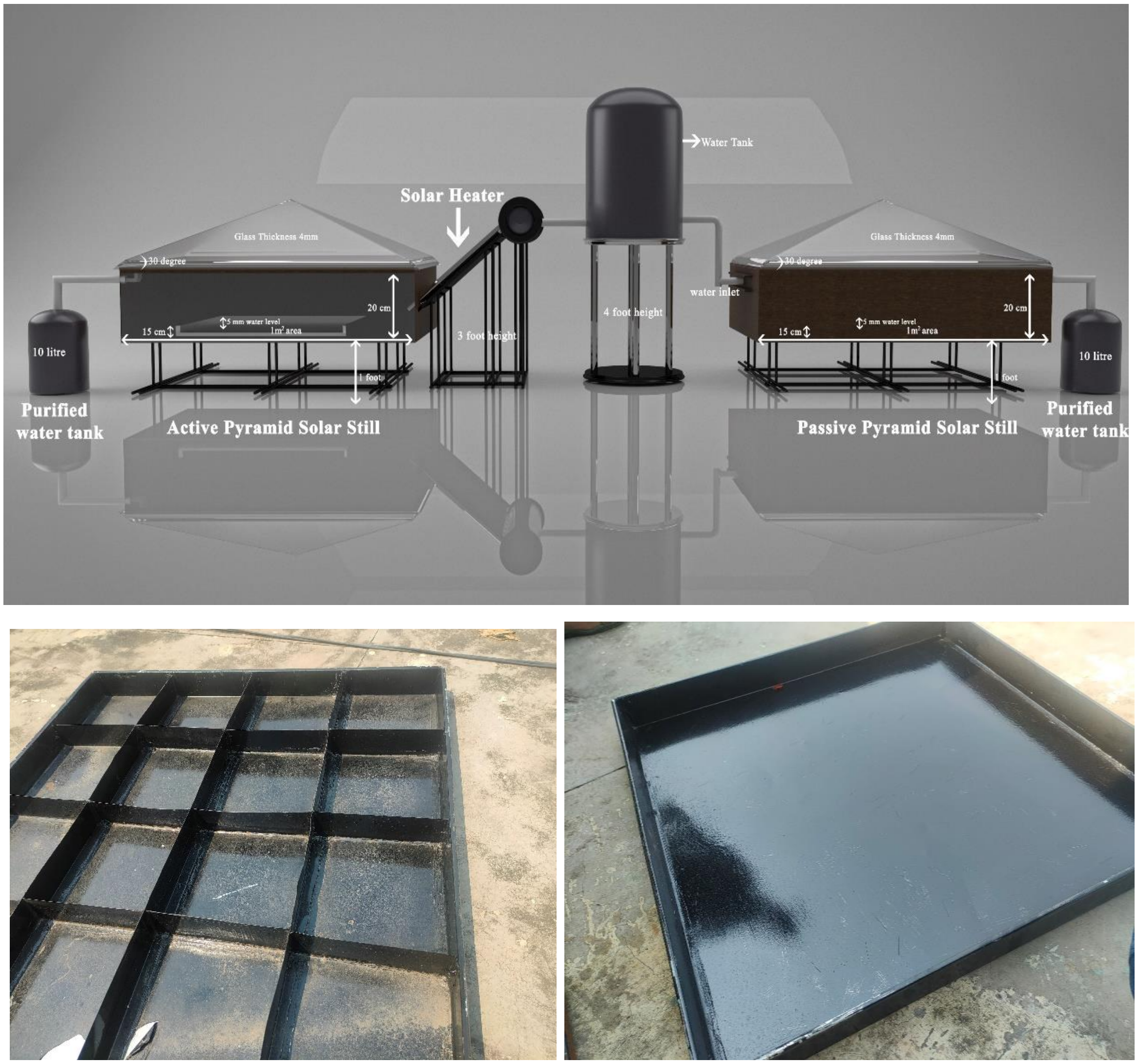

Fig 13: Design of Experimental Investigation on Pyramid Solar Still augmented with Solar Water heater in Passive and Active mode

4.2 Efficiency of Solar Heater

So first, we'll need to calculate how much Energy was put into to the system by finding the total Power,

Pin, eff = (96%) * Pin = Watts (Pin, eff is the total Heat Power coming out of the heat lamps) 96% efficient, meaning that they convert 96% of their energy directly into heat.

Finally, we need to convert Heat Power (Pin) to Heat Energy (Qin).

$$\eta_d \text{ (daily thermal efficiency)} = \frac{\sum \dot{m}(\text{hourly distillate}) \times h_{fg}(\text{vaporization latent heat})}{\sum A \text{ (system area)} \times I(\text{daily average solar radiation})}$$

Qin = Pin, eff * Δt = Watt-hours (This is the total Heat Energy put into the system)

Next, we need to figure out how much Heat Energy our solar water heaters were able to collect (Ct)

Qout = m * Cp * ΔT

Where, "m" is the total Mass of the water, "Cp" is the Specific Heat of water and "ΔT" is the Temperature Change during the test period (in o F).

Finally, we need to figure out the last term in our equation: the Temperature Difference (ΔT) of the water. This Temperature Difference (ΔT) of the water was achieved by putting Heat Energy (Qout) into the system:

ΔT = Tf – Ti = °F

Now that we've calculated how much Heat Energy (Qin) was put INTO to the system (our solar water heaters) and how much Heat Energy (Qout) we were able to get OUT of the system in order to increase the water temperature, we can determine the Efficiency our hot water heater:

Efficiency (η) **=** Heat Energy Out/Heat Energy In = Qout/Qin

4.3 Readings & Tabulations

T1 - Outer surface temp of east side facing Passive still

T2 - Inside Passive still vapour temp

T3 - Outer surface temp of south side facing Passive still

T4 - Inside passive still water temp

T5 - Outer surface temp of east side facing active still

T6 - Outer surface temp of south side facing active still

T7 - Absorber plate temp Active still

T8 - Inside Active still water temp

T9 - Inside Active still vapour temp

T10 - Ambient Temp (surrounding)

T11 - Inlet water temp of Active still

T12 - Inlet water temp of solar heater

SI - Solar intensity

WV -Wind Velocity

PASS - Productivity of Active Solar Still

PPSS - productivity of Passive Solar still

4.4 Observation and Calculation of Winter Session:

Observation Table 3: Case I for Winter Water Depth 5cm

Absorbing material **Without Absorbing Material**					Date **27/12/2021**						Water Depth **5 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	29	32	28	31	33	32	35	38	40	22	53	30	2.015	10	140	70
12:00 PM	32	35	31	34	37	35	39	40	43	25	59	32	2.249	10	380	130
1:00 PM	36	39	35	37	40	39	43	50	49	28	62	32	2.315	10	550	190
2:00 PM	35	37	34	36	44	43	48	53	55	30	67	30	1.973	9	430	150
3:00 PM	33	34	32	33	41	40	46	49	53	29	65	29	1.677	9	320	130
4:00 PM	30	30	31	31	38	37	43	48	50	27	63	28	1.579	7	220	90
5:00 PM	27	29	26	28	35	33	38	44	45	24	58	26	1.312	7	150	40
Total															2200ml	800ml

Observation Table 4: Case II for Winter Water Depth 5cm

Absorbing material **Iron Rod**					Date **28/12/2021**						Water Depth **5 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	28	31	26	28	33	31	33	37	39	21	54	28	2.125	10	180	60
12:00 PM	31	33	29	31	35	34	35	39	41	23	57	30	2.254	11	300	130
1:00 PM	37	38	31	36	41	39	42	45	47	27	61	31	2.487	10	420	180
2:00 PM	35	36	35	34	44	41	48	51	52	25	65	27	1.867	8	370	150
3:00 PM	34	35	32	32	42	40	45	47	50	24	64	26	1.486	8	220	120
4:00 PM	31	31	31	31	37	38	43	46	49	22	62	25	1.534	12	180	80
5:00 PM	26	28	27	28	35	34	40	41	43	21	59	23	1.247	10	130	30
Total															1800mL	750ml

Observation Table 5: Case III for Winter Water Depth 5cm

Absorbing material **Limestone**					Date **29/12/2021**							Water Depth **5 cm**				
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	27	30	26	27	33	31	35	37	39	22	55	29	1.884	8	150	40
12:00 PM	30	34	28	30	36	35	37	40	42	24	58	30	2.243	12	220	100
1:00 PM	37	38	31	34	41	39	41	45	48	27	62	33	2.510	10	360	140
2:00 PM	36	36	36	35	43	41	46	48	50	26	66	32	1.971	11	280	120
3:00 PM	34	35	33	33	42	39	45	47	49	24	64	28	1.672	11	230	100
4:00 PM	32	32	31	31	36	37	41	44	47	22	61	27	1.417	10	200	70
5:00 PM	27	30	28	29	34	33	40	42	45	21	59	25	1.173	8	140	30
Total															1600mL	600ml

Observation Table 6: Case IV for Winter Water Depth 5cm

Absorbing material **Black Paint**					Date **30/12/2021**						Water Depth **5 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	27	29	25	28	32	30	36	37	39	23	54	28	1.627	11	170	50
12:00 PM	29	35	29	30	35	33	39	39	43	24	57	31	1.927	8	230	80
1:00 PM	36	38	32	33	41	38	41	42	48	26	62	33	2.437	9	330	130
2:00 PM	35	37	38	36	43	40	44	47	51	26	67	32	1.994	8	220	100
3:00 PM	33	34	35	34	40	37	42	45	49	25	65	29	1.764	8	190	70
4:00 PM	32	31	33	31	37	36	38	43	46	23	62	26	1.423	8	160	40
5:00 PM	28	30	29	28	33	32	37	41	44	21	59	25	1.158	8	100	30
Total															1400ml	500ml

Observation Table 7: Case V for Winter Water Depth 5cm

Absorbing material **Sand**					Date **31/12/2021**							Water Depth **5 cm**				
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	28	29	26	27	31	29	34	36	38	23	56	27	1.841	10	170	60
12:00 PM	32	34	29	29	36	32	37	39	44	26	59	30	2.012	8	220	140
1:00 PM	37	38	31	32	41	37	40	43	49	28	63	33	2.248	11	390	180
2:00 PM	35	36	34	35	44	41	44	48	52	27	67	32	2.385	9	310	150
3:00 PM	32	35	33	34	40	38	43	45	48	25	66	29	1.727	8	270	130
4:00 PM	30	32	31	33	37	36	39	42	45	24	64	27	1.354	10	200	100
5:00 PM	28	31	29	28	34	33	37	40	43	22	61	26	1.174	8	130	40
Total															1700mL	800ml

Observation Table 8: Case VI for Winter Water Depth 5cm

Absorbing material **Tiles**					Date **03/01/2022**							Water Depth **5 cm**				
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	27	29	25	28	32	30	34	37	39	22	54	28	1.842	9	160	100
12:00 PM	31	35	29	30	35	33	38	39	43	25	57	31	2.235	10	220	150
1:00 PM	36	38	32	33	41	38	40	42	48	28	62	33	2.438	8	340	250
2:00 PM	35	37	38	36	43	40	45	47	51	27	67	32	2.347	8	290	200
3:00 PM	33	34	35	34	40	37	42	45	49	25	65	29	1.972	6	220	180
4:00 PM	32	31	33	31	37	36	39	43	46	24	62	26	1.542	7	160	140
5:00 PM	29	30	29	28	33	32	38	41	44	21	59	25	1.271	7	110	80
Total															1600mL	1100ml

Observation Table 9: Case VII for Winter Water Depth 5cm

Absorbing material **River Stone**					Date **04/01/2021**						Water Depth **5 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	28	28	26	29	32	29	33	37	38	23	55	27	1.652	12	150	90
12:00 PM	30	34	30	31	36	32	37	40	42	27	58	32	1.897	10	220	150
1:00 PM	35	38	33	34	41	37	40	43	47	30	67	35	2.278	10	390	210
2:00 PM	36	39	39	37	44	41	44	48	51	28	71	34	1.924	8	300	170
3:00 PM	33	35	36	35	40	36	41	45	48	26	69	30	1.574	8	240	130
4:00 PM	31	32	33	32	37	33	39	43	45	25	64	28	1.352	8	190	110
5:00 PM	29	31	28	29	34	31	37	40	43	22	60	26	1.129	7	120	60
Total															1600ml	920ml

Calculation Table 10: Case I for Winter Water Depth 5cm

Absorbing material **Without Absorbing Material**				Date **27/12/2022**				Water Depth **5 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	2.015	22	35	38	40	140	2419113.356	11.41266	2.3923	0.2138
12:00 PM	2.249	25	39	40	43	380	2409838.006	27.64774	5.1459	1.9794
1:00 PM	2.315	28	43	50	49	550	2400600.813	38.72659	7.2321	3.3052
2:00 PM	1.973	30	48	53	55	430	2389107.972	35.35532	8.4414	5.5954
3:00 PM	1.677	29	46	49	53	320	2393697.955	31.01444	5.1867	2.0882
4:00 PM	1.579	27	43	48	50	220	2400600.813	22.7111	3.954	0.9164
5:00 PM	1.312	24	38	44	45	150	2412153.265	18.72578	1.6306	0.0227

Calculation Table 11: Case II for Winter Water Depth 5cm

Absorbing material **Iron Rod**				Date **28/12/2022**				Water Depth **5 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	2.125	21	33	37	39	180	2423765.328	15.84	1.0973	0.3011
12:00 PM	2.254	23	35	39	41	300	2419113.356	26.4	1.8509	1.6121
1:00 PM	2.487	27	42	45	47	420	2402906.535	36.96	3.9371	4.9379
2:00 PM	1.867	25	48	51	52	370	2389107.972	32.56	6.1464	5.2281
3:00 PM	1.486	24	45	47	50	220	2395996.524	19.36	4.8917	2.7209
4:00 PM	1.534	22	43	46	49	180	2400600.813	15.84	3.659	0.9491
5:00 PM	1.247	21	40	41	43	130	2407525.131	11.44	1.3356	0.0339

Calculation Table 12: Case III for Winter Water Depth 5cm

Absorbing material **Limestone**				Date **29/12/2022**				Water Depth **5 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp .Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.884	22	35	37	39	150	2419113.356	13.2	1.0803	0.0981
12:00 PM	2.243	24	37	40	42	220	2414470.909	19.36	1.8339	1.2121
1:00 PM	2.510	27	41	45	48	360	2405214.641	31.68	3.9201	3.5379
2:00 PM	1.971	26	46	48	50	280	2393697.955	24.64	6.1294	4.8281
3:00 PM	1.672	24	45	47	49	230	2395996.524	20.24	4.8747	2.3209
4:00 PM	1.417	22	41	44	47	200	2405214.641	17.6	3.642	0.1491
5:00 PM	1.173	21	40	42	45	140	2407525.131	12.32	1.3186	0.0279

Calculation Table 13: Case IV for Winter Water Depth 5cm

Absorbing material **Black Paint**				Date **30/12/2022**				Water Depth **5 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp .Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.627	23	36	37	39	170	2421470.909	14.96	1.0803	0.0191
12:00 PM	1.927	24	39	39	43	230	2409838.006	20.24	3.8339	0.8741
1:00 PM	2.437	26	41	42	48	330	2405214.641	29.04	5.9201	1.1999
2:00 PM	1.994	26	44	47	51	220	2398297.476	19.36	7.1294	3.4901
3:00 PM	1.764	25	42	45	49	190	2402906.535	16.72	3.8747	2.9829
4:00 PM	1.423	23	38	43	46	160	2412153.265	14.08	2.642	1.0189
5:00 PM	1.158	21	37	41	44	100	2414470.909	8.8	0.3186	0.0182

Calculation Table 14: Case V for Winter Water Depth 5cm

Absorbing material **Sand**				Date **31/12/2022**				Water Depth **5 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp .Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.841	23	34	36	38	170	2421438.147	14.08	1.7703	
12:00 PM	2.012	26	37	39	44	220	2423765.328	19.36	4.5239	0.0814
1:00 PM	2.248	28	40	43	49	390	2407525.131	29.92	6.6101	1.1118
2:00 PM	2.385	27	44	48	52	310	2398297.476	25.52	7.8194	2.4376
3:00 PM	1.727	25	43	45	48	270	2400600.813	19.36	4.5647	5.7278
4:00 PM	1.354	24	39	42	45	200	2409838.006	14.08	3.332	3.2206
5:00 PM	1.174	22	37	40	43	130	2423765.328	9.68	2.0086	1.0488

Calculation Table 15: Case VI for Winter Water Depth 5cm

Absorbing material **Tiles**				Date **3/1/2022**				Water Depth **5 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.842	22	34	37	39	160	2421438.147	14.96	1.4803	0.1386
12:00 PM	2.235	25	38	39	43	220	2412153.265	19.36	4.2339	1.3318
1:00 PM	2.438	28	40	42	48	340	2407525.131	34.32	6.3201	3.6576
2:00 PM	2.347	27	45	47	51	290	2395996.524	27.28	7.5294	5.9478
3:00 PM	1.972	25	42	45	49	220	2402906.535	23.76	4.2747	2.4406
4:00 PM	1.542	24	39	43	46	160	2409838.006	17.6	3.042	1.2688
5:00 PM	1.271	21	38	41	44	110	2412153.265	11.44	0.7186	0.3297

Calculation Table 16: Case VII for Winter Water Depth 5cm

Absorbing material **River Stone**				Date **4/1/2022**				Water Depth **5 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapor Temp. Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.652	23	33	37	38	150	2423765.328	13.2	1.2803	0.0385
12:00 PM	1.897	27	37	40	42	220	2414470.909	19.36	4.0339	1.8117
1:00 PM	2.278	30	40	43	47	390	2407525.131	34.32	6.1201	3.1375
2:00 PM	1.924	28	44	48	51	300	2398297.476	26.4	7.3294	4.4277
3:00 PM	1.574	26	41	45	48	240	2405214.641	21.12	4.0747	2.9205
4:00 PM	1.352	25	39	43	45	190	2409838.006	16.72	2.842	0.7487
5:00 PM	1.129	22	37	40	43	120	2414470.909	10.56	1.0186	0.0914

4.5 Winter Daily Efficiency for 5 cm Water Depth - Daily Efficiency of still without absorbing material

Ŋ =APH/3600G

A-Area of Basin in m^2

G-solar radiation in w/m2

H-latent heat of water, P-collecting water in liter

= 1*2.2*2403587.454/3600*674.74

= 2.17%

Daily Efficiency of still using Iron rod

= 0.88*1.8*2405573.666/3600*668.57

= 1.58%

Daily Efficiency of still using Limestone

= 0.88*1.6*2405890.451/3600*661.88

=1.42%

Daily Efficiency of still using Black paint

= 0.88*1.4*2409193.106/3600*634.11

= 1.30%

Daily Efficiency of still using Sand

= 0.88*1.7*2412175.747/3600*655.25

= 1.52%

Daily Efficiency of still using Tiles

= 0.88*1.6*2408858.696/3600*701.84

= 1.34%

Daily Efficiency of still using River stone

=0 .88*1.6*2410511.771/3600*607.16

=1.55%

4.6 Winter Daily Efficiency of Passive Still for 5 cm Water Depth.

Ŋ =APH/3600G

A-Area of Basin in m^2

G-solar radiation in w/m2

H-latent heat of water, P-collecting water in liter

= 1*0.8*2393798.954/3600*674.74

= 0.78%

Daily Efficiency of still

= 1*0.75*2339568.268/3600*668.57

= 0.72%

Daily Efficiency of still

= 1*0.6*2325963.896/3600*661.88

=0.58%

Daily Efficiency of still

= 1*0.5*2365186.359/3600*634.11

= 0.51%

Daily Efficiency of still

= 1*0.8*2326562.348/3600*655.25

= 0.78%

Daily Efficiency of still

= 1*1.1*2436985.196/3600*701.84

= 1.06%

Daily Efficiency of still

=1*0.92*2356685.596/3600*607.16

=0.9%

Observation Table 17: Case-I Winter Session for 2 cm Depth

Absorbing material **Without Absorbing Material**					Date **05/01/2022**						Water Depth **2 cm**				
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	28	30	25	27	31	28	34	36	37	24	53	28	1.842	10	300	170
12:00 PM	31	33	28	32	35	31	35	38	41	25	59	33	2.174	10	450	190
1:00 PM	36	36	33	34	40	35	39	42	47	27	66	34	2.247	10	670	330
2:00 PM	38	40	37	38	44	40	44	46	50	29	70	35	2.083	9	630	210
3:00 PM	37	38	36	35	41	37	41	45	49	28	69	32	1.872	9	550	160
4:00 PM	34	35	33	32	37	34	38	42	44	26	65	29	1.652	7	400	140
5:00 PM	30	32	28	29	34	32	35	40	42	23	61	26	1.318	7	250	100
Total															3200mL	1300ml

Observation Table 18: Case-II Winter Session for 2 cm Depth

Absorbing material **Iron Rod**					Date **06/01/2022**						Water Depth **2 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	27	28	24	25	30	26	33	35	36	22	54	26	1.674	10	200	130
12:00 PM	32	31	30	29	33	29	35	37	40	24	60	30	1.941	11	350	200
1:00 PM	37	36	35	33	38	34	39	42	46	28	67	33	2.157	10	550	310
2:00 PM	39	40	36	37	43	39	43	45	49	30	72	34	2.282	8	450	190
3:00 PM	38	38	34	35	41	37	41	43	47	29	69	32	1.751	8	400	160
4:00 PM	35	36	32	31	38	35	37	42	44	26	68	28	1.453	12	350	130
5:00 PM	30	32	27	28	34	32	36	39	41	23	64	25	1.257	10	300	100
Total															2600ml	1120ml

Observation Table 19: Case-III Winter Session for 2 cm Depth

Absorbing material **Limestone**					Date **07/01/2022**						Water Depth **2 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	27	28	24	25	30	26	33	35	37	24	55	26	1.852	8	300	190
12:00 PM	32	31	30	29	33	29	37	37	40	25	61	30	2.131	12	420	210
1:00 PM	37	36	35	33	38	34	39	42	46	29	68	33	2.375	10	600	330
2:00 PM	39	40	36	37	43	39	44	45	49	31	74	34	2.028	11	380	220
3:00 PM	38	38	34	35	41	37	41	43	47	28	70	32	1.845	11	320	190
4:00 PM	35	36	32	31	38	35	38	42	44	27	69	28	1.671	10	180	160
5:00 PM	30	32	27	28	34	32	36	39	41	23	65	25	1.359	8	100	100
Total															2300mL	1400ml

Observation Table 20: Case-IV Winter Session for 2 cm Depth

Absorbing material **Black Paint**					Date **08/01/2022**						Water Depth **2 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	27	29	25	28	32	30	34	37	39	22	54	28	1.742	11	220	120
12:00 PM	29	35	29	30	35	33	38	39	43	25	57	31	1.935	8	420	200
1:00 PM	36	38	32	33	41	38	40	42	48	28	62	33	2.278	9	580	310
2:00 PM	35	37	38	36	43	40	45	47	51	27	67	32	2.147	8	390	180
3:00 PM	33	34	35	34	40	37	42	45	49	25	65	29	1.972	8	310	160
4:00 PM	32	31	33	31	37	36	39	43	46	24	62	26	1.652	8	180	130
5:00 PM	29	30	29	28	33	32	38	41	44	21	59	25	1.371	8	100	100
Total															2200ml	1200ml

Observation Table 21: Case-V Winter Session for 2 cm Depth

Absorbing material **Sand**					Date **10/01/2022**						Water Depth **2 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	28	30	25	27	31	28	34	36	37	24	53	28	1.842	10	200	160
12:00 PM	31	33	28	32	35	31	37	38	41	25	59	33	2.074	8	320	200
1:00 PM	36	36	33	34	40	35	40	42	47	27	66	34	2.247	11	600	390
2:00 PM	38	40	37	38	44	40	45	46	50	29	70	35	2.183	9	470	300
3:00 PM	37	38	36	35	41	37	43	45	49	28	69	32	1.972	8	380	250
4:00 PM	34	35	33	32	37	34	39	42	44	26	65	29	1.652	10	350	200
5:00 PM	30	32	28	29	34	32	35	40	42	23	61	26	1.317	8	280	100
Total															2600ml	1600ml

Observation Table 22: Case-VI Winter Session for 2 cm Depth

Absorbing material **Tiles**					Date **11/01/2022**							Water Depth **2 cm**				
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	28	30	25	27	31	28	36	36	37	24	53	28	1.542	9	180	160
12:00 PM	31	33	28	32	35	31	38	38	41	25	59	33	1.874	11	370	200
1:00 PM	36	36	33	34	40	35	41	42	47	27	66	34	2.147	8	560	360
2:00 PM	38	40	37	38	44	40	43	46	50	29	70	35	2.283	8	440	290
3:00 PM	37	38	36	35	41	37	40	45	49	28	69	32	1.972	6	380	250
4:00 PM	34	35	33	32	37	34	38	42	44	26	65	29	1.652	7	270	130
5:00 PM	30	32	28	29	34	32	35	40	42	23	61	26	1.317	7	200	110
Total															2400ml	1500ml

Observation Table 23: Case-VII Winter Session for 2 cm Depth

Absorbing material **River Stone**					Date **12/01/2022**						Water Depth **2 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	28	29	26	27	31	29	34	36	38	23	56	27	1.641	12	150	180
12:00 PM	32	34	29	29	36	32	37	39	44	26	59	30	1.912	10	280	200
1:00 PM	37	38	31	32	41	37	40	43	49	28	63	33	2.248	10	550	350
2:00 PM	35	36	34	35	44	41	44	48	52	27	67	32	1.985	8	480	230
3:00 PM	32	35	33	34	40	38	43	45	48	25	66	29	1.627	8	400	180
4:00 PM	30	32	31	33	37	36	39	42	45	24	64	27	1.354	8	280	160
5:00 PM	28	31	29	28	34	33	37	40	43	22	61	26	1.174	7	160	100
Total															2300ml	1400ml

Calculation Table 24: Case-I Winter Session for 2 cm Depth

Absorbing material **Without Absorbing Material**				Date **05/01/2022**				Water Depth **2 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.842	24	34	36	37	300	2421438.417	26.4	8.1043	0.7855
12:00 PM	2.174	25	35	38	41	450	2419113.356	39.6	10.8579	1.5985
1:00 PM	2.247	27	39	42	47	670	2409838.006	58.96	12.9441	3.3567
2:00 PM	2.083	29	44	46	50	630	2398297.476	55.44	14.1534	6.5499
3:00 PM	1.872	28	41	45	49	550	2405214.641	48.4	10.8987	3.8456
4:00 PM	1.652	26	38	42	44	400	2412153.265	35.2	9.666	2.5336
5:00 PM	1.318	23	35	40	42	250	2419113.356	22	7.3426	0.9889

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Calculation Table 25: Case-II Winter Session for 2 cm Depth

Absorbing material **Iron rod**				Date **06/01/2022**				Water Depth **2 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp . Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.674	22	33	35	36	200	2423765.328	17.6	4.5743	0.3554
12:00 PM	1.941	24	35	37	40	350	2419113.356	30.8	7.3279	2.5486
1:00 PM	2.157	28	39	42	46	550	2409838.006	48.4	9.4141	5.8744
2:00 PM	2.282	30	43	45	49	450	2400600.813	39.6	10.6234	6.1646
3:00 PM	1.751	29	41	43	47	400	2405214.641	35.2	7.3687	3.6574
4:00 PM	1.453	26	37	42	44	350	2414470.909	30.8	6.136	1.4856
5:00 PM	1.257	23	36	39	41	300	2416790.937	26.4	3.8126	0.5465

Calculation Table 26: Case-III Winter Session for 2 cm Depth

Absorbing material **Limestone**				Date **07/01/2022**				Water Depth **2 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp . Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.852	24	33	35	37	300	2423765.328	26.4	3.6485	0.3872
12:00 PM	2.131	25	37	37	40	420	2414470.909	36.96	6.4021	0.4564
1:00 PM	2.375	29	39	42	46	600	2409838.006	52.8	8.4883	2.4552
2:00 PM	2.028	31	44	45	49	380	2398297.476	33.44	9.6976	4.3156
3:00 PM	1.845	28	41	43	47	320	2405214.641	28.16	6.4429	6.15561
4:00 PM	1.671	27	38	42	44	180	2412153.265	15.84	5.2102	3.2545
5:00 PM	1.359	23	36	39	41	100	2416790.937	8.8	2.8868	1.042

Calculation Table 27: Case-IV Winter Session for 2 cm Depth

Absorbing material **Black Paint**				Date **08/01/2022**				Water Depth **2 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.742	22	34	37	39	220	2421438.417	19.36	2.9485	0.2643
12:00 PM	1.935	25	38	39	43	420	2412153.265	36.96	5.4021	3.2563
1:00 PM	2.278	28	40	42	48	580	2407525.131	51.04	7.4883	5.6213
2:00 PM	2.147	27	45	47	51	390	2395996.524	34.32	9.6756	6.5465
3:00 PM	1.972	25	42	45	49	310	2402906.535	27.28	7.0429	3.5924
4:00 PM	1.652	24	39	43	46	180	2409838.006	15.84	5.3102	1.6489
5:00 PM	1.371	21	38	41	44	100	2412153.265	8.8	1.6868	0.1466

Calculation Table 28: Case-V Winter Session for 2 cm Depth

Absorbing material **Sand**				Date **10/01/2022**				Water Depth **2 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.842	24	34	36	37	200	2421438.417	17.6	4.2935	1.3334
12:00 PM	2.074	25	37	38	41	320	2414470.909	28.16	7.0471	3.3661
1:00 PM	2.247	27	40	42	47	600	2407525.131	52.8	9.1333	4.1163
2:00 PM	2.183	29	45	46	50	470	2395996.524	41.36	10.3426	6.2146
3:00 PM	1.972	28	43	45	49	380	2400600.813	33.44	7.0879	3.6454
4:00 PM	1.652	26	39	42	44	350	2409838.006	30.8	5.8552	2.1446
5:00 PM	1.317	23	35	40	42	280	2419113.356	24.64	3.5318	0.1654

Calculation Table 29: Case-VI Winter Session for 2 cm Depth

Absorbing material **Tiles**				Date **11/01/2022**				Water Depth **2 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.542	24	36	36	37	180	2416790.937	15.84	5.3235	0.1355
12:00 PM	1.874	25	38	38	41	370	2412153.265	32.56	8.0771	2.6463
1:00 PM	2.147	27	41	42	47	560	2405214.641	49.28	10.1633	4.7545
2:00 PM	2.283	29	43	46	50	440	2400600.813	38.72	11.3726	5.6126
3:00 PM	1.972	28	40	45	49	380	2407525.131	33.44	8.1179	3.7164
4:00 PM	1.652	26	38	42	44	270	2412153.265	23.76	6.8852	2.4667
5:00 PM	1.317	23	35	40	42	200	2419113.356	17.6	4.5618	0.9855

Calculation Table 30: Case-VII Winter Session for 2 cm Depth

Absorbing material **River Stone**				Date **12/01/2022**				Water Depth **2 cm**		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp .Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.641	23	33	36	38	150	2423765.328	13.2	3.8605	1.5612
12:00 PM	1.912	26	37	39	44	280	2414470.909	24.64	6.6141	3.6732
1:00 PM	2.248	28	40	43	49	550	2407525.131	48.4	8.7003	5.5445
2:00 PM	1.985	27	44	48	52	480	2398297.476	42.24	9.9096	6.3544
3:00 PM	1.627	25	43	45	48	400	2400600.813	35.2	6.6549	3.2518
4:00 PM	1.354	24	39	42	45	280	2409838.006	24.64	5.4222	1.6489
5:00 PM	1.174	22	37	40	43	160	2414470.909	14.08	3.0988	0.6466

4.7 Winter Daily Efficiency for 2 cm Water Depth - Daily Efficiency of still without absorbing material

Ŋ =APH/3600G

A-Area of Basin in m^2

G-solar radiation in w/m2

H-latent heat of water, P-collecting water in liter

= 1*3.2*2412166.931/3600*678.24

= 3.16%

Daily Efficiency of still using Iron rod

= 0.88*2.6*2412827.713/3600*643.62

=2.38 %

Daily Efficiency of still using Limestone

= 0.88*2.3*2411504.366/3600*681.94

=1.98%

Daily Efficiency of still using Black paint

= 0.88*2.2*2408858.735/3600*673.56

=1.92 %

Daily Efficiency of still using Sand

= 0.88*2.4*2409854.737/3600*683.33

=2.24%

Daily Efficiency of still using Tiles

= 0.88*2.6*2410507.344/3600*657.69

=2.15 %

Daily Efficiency of still using River stone

=0 .88*2.3*2409852.653/3600*614.10

=2.20%

4.8 Winter Daily Efficiency of Passive Still for 2 cm Water Depth.

Ŋ =APH/3600G

A-Area of Basin in m^2

G-solar radiation in w/m2

H-latent heat of water, P-collecting water in liter

= 1*1.3*2361768.365/3600*678.24

= 1.25 %

Daily Efficiency of still

= 1*1.12*2334245.146/3600*643.62

= 1.08%

Daily Efficiency of still

= 1*1.4*2352731.465/3600*681.94

= 1.34%

Daily Efficiency of still

= 1*1.2*2348227.321/3600*673.56

= 1.16%

Daily Efficiency of still

= 1*1.6*2354987.113/3600*683.33

= 1.53 %

Daily Efficiency of still

= 1*1.5*2366301.122/3600*657.69

= 1.43%

Daily Efficiency of still

=1*1.4*2230343.417/3600*614.10

=1.32%

4.9 Observation and Calculation of Summer Session:

Observation Table 31: Case-I Summer Session for 5 cm Depth

Absorbing material **Without Absorbing Material**					Date **26/03/2022**						Water Depth **5 cm**				
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	48	58	46	54	52	53	56	58	60	36	68	40	2.138	10	700	100
12:00 PM	51	62	50	59	56	57	59	61	65	39	76	42	2.286	10	850	140
1:00 PM	53	60	54	62	58	59	62	63	68	40	82	45	2.196	10	950	300
2:00 PM	54	59	56	64	55	56	64	66	70	42	89	46	1.856	9	1050	260
3:00 PM	52	51	53	60	51	53	63	61	62	41	84	41	1.586	9	700	200
4:00 PM	47	48	48	55	48	50	60	57	60	38	78	39	1.385	7	650	120
5:00 PM	45	46	44	52	45	46	58	55	58	35	72	37	1.116	7	600	80
Total															5.5L	1.2L

Observation Table 32: Case-II Summer Session for 5 cm Depth

Absorbing material **Iron Rod**					Date **28/03/2022**						Water Depth **5 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	47	50	48	52	46	45	50	56	59	38	65	40	1.543	11	550	100
12:00 PM	52	55	52	56	50	52	59	59	65	40	77	43	1.973	10	650	150
1:00 PM	53	59	53	58	54	44	63	62	70	41	86	45	1.886	10	800	350
2:00 PM	50	56	49	55	51	53	62	60	68	39	100	46	1.78	9	950	300
3:00 PM	49	52	47	52	49	50	60	58	64	37	93	42	1.392	9	750	250
4:00 PM	47	50	46	51	48	48	59	57	62	36	84	41	1.205	10	500	170
5:00 PM	44	47	42	49	45	46	56	53	59	35	80	39	1.089	10	400	80
Total															4.6L	1.4L

Observation Table 33: Case-III Summer Session for 5 cm Depth

Absorbing material **Limestone**					Date **29/03/2022**						Water Depth **5 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	44	57	43	55	49	48	56	58	60	37	90	41	1.693	9	400	100
12:00 PM	49	60	50	58	52	51	59	60	64	40	94	43	2.145	11	500	140
1:00 PM	51	63	54	60	55	54	63	65	69	42	97	45	1.962	11	750	300
2:00 PM	48	59	52	56	52	55	62	62	67	41	96	44	1.714	11	850	260
3:00 PM	46	54	48	54	48	49	59	57	63	39	92	42	1.767	11	600	200
4:00 PM	44	50	44	53	46	47	55	56	61	38	90	40	1.505	10	500	120
5:00 PM	42	47	42	50	43	44	53	54	59	35	82	37	1.124	8	400	80
Total															4L	1.2L

Observation Table 34: Case-IV Summer Session for 5 cm Depth

Absorbing material **Black Paint**					Date **30/03/2022**						Water Depth **5 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	47	52	43	46	45	42	52	55	58	36	86	40	1.987	10	650	100
12:00 PM	50	59	48	54	51	46	55	58	60	38	90	42	2.564	8	650	140
1:00 PM	53	64	53	59	52	49	58	61	63	39	92	43	2.566	8	700	300
2:00 PM	51	58	50	63	49	50	61	63	65	40	91	41	2.344	7	850	260
3:00 PM	47	56	47	58	48	47	59	60	64	39	93	40	1.931	7	600	200
4:00 PM	43	49	43	53	46	45	57	58	61	37	82	38	1.524	9	500	120
5:00 PM	40	46	40	48	43	42	54	55	59	36	74	35	1.011	9	400	80
Total															4.3L	1.2L

Observation Table 35: Case-V Summer Session for 5 cm Depth

Absorbing material **Tiles**					Date **31/03/2022**						Water Depth **5 cm**						
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	51	53	40	46	42	41	57	58	60	34	80	39	2.041	6	500	100
12:00 PM	54	61	44	52	46	44	60	62	63	36	84	41	2.293	6	600	150
1:00 PM	57	64	49	61	50	47	62	64	66	39	90	45	2.358	8	750	320
2:00 PM	56	62	51	63	53	51	64	63	67	38	92	43	2.410	8	850	280
3:00 PM	52	51	48	57	49	46	60	61	62	36	86	42	1.598	7	600	220
4:00 PM	47	48	46	55	48	42	56	57	59	35	85	40	1.385	7	500	150
5:00 PM	44	50	43	53	44	40	52	53	55	32	81	38	1.005	7	400	80
Total															4.6L	1.3L

Observation Table 36: Case-VI Summer Session for 5 cm Depth

Absorbing material **Sand**					Date **01/04/2022**						Water Depth **5 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	48	58	40	54	41	37	43	42	44	35	82	37	1.934	6	500	100
12:00 PM	51	61	47	58	49	39	51	50	53	38	86	41	2.284	7	550	180
1:00 PM	54	63	52	62	55	44	60	57	60	39	90	43	2.187	11	700	300
2:00 PM	51	59	54	61	53	51	65	59	65	41	95	38	2.079	14	900	270
3:00 PM	50	57	50	59	50	49	63	56	64	38	88	40	1.628	8	750	200
4:00 PM	49	56	48	58	47	47	61	53	61	37	86	39	1.537	12	650	120
5:00 PM	43	49	44	51	46	44	55	51	58	36	80	36	1.124	9	450	80
Total															4.5L	1.25L

Observation Table 37: Case-VII Summer Session for 5 cm Depth

Absorbing material **River Stone**					Date **04/04/2022**						Water Depth **5 cm**				
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	44	56	45	55	49	47	57	58	60	38	94	42	2.159	10	550	100
12:00 PM	50	59	49	59	51	50	60	60	64	39	95	44	2.202	10	600	140
1:00 PM	54	62	55	61	54	52	63	62	67	40	91	45	2.786	12	700	300
2:00 PM	51	63	52	63	55	54	65	62	65	42	94	47	2.249	8	850	260
3:00 PM	50	58	48	60	53	51	62	60	63	41	98	46	1.985	8	600	200
4:00 PM	48	56	47	58	52	50	61	58	61	39	88	44	1.540	8	500	120
5:00 PM	44	53	44	55	49	48	58	55	59	37	86	41	1.385	7	400	80
Total															4.2L	1.2L

Calculation Table 38: Case-I Summer Session for 5 cm Depth

Absorbing material Without Absorbing Material				Date 26/03/2022				Water Depth 5 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	2.138	36	56	58	60	700	2366301.122	52.6	12.19	0.4803
12:00 PM	2.286	39	59	61	65	850	2359505.564	59.5	15.95	2.2339
1:00 PM	2.196	40	62	63	68	950	2357245.146	69.2	17.63	5.3201
2:00 PM	1.856	42	64	66	70	1050	2352731.465	90.3	22.50	6.5294
3:00 PM	1.586	41	63	61	62	700	2366301.122	70.9	14.66	3.2747
4:00 PM	1.385	38	60	57	60	650	2370843.417	75.5	11.63	1.042
5:00 PM	1.116	35	58	55	58	600	2373118.141	86.6	10.73	0.2814

Calculation Table 39: Case-II Summer Session for 5 cm Depth

Absorbing material Iron Rod				Date 28/03/2022				Water Depth 5 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapor Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.543	38	50	56	59	550	2361768.365	57.1	9.18	0.4803
12:00 PM	1.973	40	59	59	65	650	2357245.146	52.7	12.95	2.2339
1:00 PM	1.886	41	63	62	70	800	2357245.146	67.8	13.63	5.3201
2:00 PM	1.78	39	62	60	68	950	2361768.365	85.5	19.5	6.5294
3:00 PM	1.392	37	60	58	64	750	2361768.365	76.4	13.66	3.2747
4:00 PM	1.205	36	59	57	62	500	2366301.122	66.6	9.63	1.042
5:00 PM	1.089	35	56	53	59	400	2370843.417	59.1	8.73	0.2814

Calculation Table 40: Case-III Summer Session for 5 cm Depth

Absorbing material Limestone				Date 29/03/2022				Water Depth 5 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tab (o C)	Basin Water Temp. Tb (o C)	Vapor Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.693	37	56	58	60	400	2383884.692	38.2	9.15	0.8103
12:00 PM	2.145	40	59	60	64	500	2359505.564	37.3	11.95	1.5339
1:00 PM	1.962	42	63	65	69	750	2352731.465	61	12.63	4.3201
2:00 PM	1.714	41	62	62	67	850	2354987.113	79.3	18.5	6.2294
3:00 PM	1.767	39	59	57	63	600	2367749.297	55.0	14.66	3.2747
4:00 PM	1.505	38	55	56	61	500	2373118.141	53.5	9.63	2.5042
5:00 PM	1.124	35	53	54	59	400	2393564.089	57.8	8.73	0.5121

Calculation Table 41: Case-IV Summer Session for 5 cm Depth

Absorbing material Black Paint				Date 30/03/2022				Water Depth 5 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapor Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.987	36	52	55	58	650	2422959.946	53.1	9.6	0.3558
12:00 PM	2.564	38	55	58	60	650	2399400.341	41.2	12.45	3.1094
1:00 PM	2.566	39	58	61	63	700	2352731.465	44.3	15.13	5.1956
2:00 PM	2.344	40	61	63	65	850	2354987.113	58.9	19	6.4049
3:00 PM	1.931	39	59	60	64	600	2359505.564	50.5	14.25	3.1502
4:00 PM	1.524	37	57	58	61	500	2366301.122	53.3	9.13	1.9175
5:00 PM	1.011	36	54	55	59	400	2370843.417	64.3	8.23	0.4059

Calculation Table 42: Case-V Summer Session for 5 cm Depth

Absorbing material Tiles				Date 31/03/2022				Water Depth 5 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapor Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	2.041	34	57	58	60	500	2359505.564	39.2	11.6	0.5645
12:00 PM	2.293	36	60	62	63	600	2354987.113	41.8	13.45	2.4055
1:00 PM	2.358	39	62	64	66	750	2352731.465	50.8	14.13	4.6255
2:00 PM	2.410	38	64	63	67	850	2352731.465	56.3	20.36	7.5585
3:00 PM	1.598	36	60	61	62	600	2354987.113	60	12.16	3.8551
4:00 PM	1.385	35	56	57	59	500	2383884.692	58.4	9.13	1.8155
5:00 PM	1.005	32	52	53	55	400	2387749.297	64.5	7.23	0.1545

Calculation Table 43: Case-VI Summer Session for 5 cm Depth

Absorbing material Sand				Date 01/04/2022				Water Depth 5 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapor Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.934	35	43	42	44	500	2422959.946	42.5	12.6	0.595
12:00 PM	2.284	38	51	50	53	550	2370843.417	38.7	13.45	2.2563
1:00 PM	2.187	39	60	57	60	700	2366301.122	51.4	15.13	4.3119
2:00 PM	2.079	41	65	59	65	900	2361768.365	69.4	20.36	7.2161
3:00 PM	1.628	38	63	56	64	750	2366301.122	74	13.16	5.1896
4:00 PM	1.537	37	61	53	61	650	2370843.417	68	10.13	3.7354
5:00 PM	1.124	36	55	51	58	450	2393564.089	65	8.23	0.2893

Calculation Table 44: Case-VII Summer Session for 5 cm Depth

Absorbing material River Stone				Date 04/04/2022				Water Depth 5 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tab (o C)	Basin Water Temp. Tb (o C)	Vapor Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	2.159	38	57	58	60	550	2361768.365	40.8	9.6	1.9446
12:00 PM	2.202	39	60	60	64	600	2361768.365	43.6	13.45	4.6982
1:00 PM	2.786	40	63	62	67	700	2357245.146	40.2	14.13	7.7844
2:00 PM	2.249	42	65	62	65	850	2357245.146	60.4	18.36	8.9937
3:00 PM	1.985	41	62	60	63	600	2361768.365	48.4	14.16	4.739
4:00 PM	1.540	39	61	58	61	500	2366301.122	52.1	11.13	3.5063
5:00 PM	1.385	37	58	55	59	400	2373118.141	46.5	9.23	1.1829

4.10 Daily Efficiency of still without absorbing material with 5cm water depth

Ŋ =APH/3600G

A-Area of Basin in m^2

G-solar radiation in w/m2

H-latent heat of water, P-collecting water in liter

= 1*5.5*2363720.854/3600*686.52

= 5.26%

Daily Efficiency of still using Iron rod with 5cm water depth

=0.88*4.6*2362420.03/3600*538.72

= 4.35%

Daily Efficiency of still using Limestone with 5cm water depth

= 0.88*4*2373188.801/3600*612.36

= 3.55%

Daily Efficiency of still using Black paint with 5cm water depth

= 0.88*4.3*2071977.031/3600*716.04

= 3.40%

Daily Efficiency of still using Tiles with 5cm water depth

= 0.88*4.2*2365734.173/3600*673.2

= 3.60%

Daily Efficiency of still using Sand with 5cm water depth

= 0.88*4.5*2378940.211/3600*656.64

= 3.98%

Daily Efficiency of still using River stone with 5cm water depth

=0 .88*4.2*2362744.95/3600*735.48

= 3.29%

4.11 Summer Daily Efficiency of Passive Still for 5 cm Water Depth.

Ŋ =APH/3600G

A-Area of Basin in m^2

G-solar radiation in w/m2

H-latent heat of water, P-collecting water in liter

= 1*1.2*2359505.564/3600*686.52

= 1.14%

Daily Efficiency of still

= 1*1.4*2136387.113/3600* 632.72

= 1.31%

Daily Efficiency of still

= 1*1.2*2252731.465/3600* 643.36

= 1.16717%

Daily Efficiency of still

= 1*1.2*2322731.365/3600*716.04

= 1.08%

Daily Efficiency of still

= 1*1.3*2354987.113/3600*673.2

= 1.26%

Daily Efficiency of still

= 1*1.25*2343884.692/3600*656.64

= 1.23%

Daily Efficiency of still

=1*1.2*2387749.297/3600*735.48

=1.06%

Observation Table 45: Case-I Summer Session for 2 cm Depth

Absorbing material **Without Absorbing Material**					Date **05/04/2022**							Water Depth **2 cm**				
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	48	58	50	55	55	54	62	59	52	36	62	44	2.138	8	780	180
12:00 PM	51	61	52	59	57	58	64	61	68	39	64	46	2.276	8	1050	200
1:00 PM	54	62	53	60	60	59	67	63	69	41	65	47	2.296	10	1450	350
2:00 PM	56	60	52	62	55	57	65	66	71	42	68	45	1.876	9	1100	300
3:00 PM	49	55	48	57	52	51	59	60	63	39	71	42	1.786	9	920	250
4:00 PM	47	49	47	55	46	43	57	58	59	37	65	41	1.585	7	850	120
5:00 PM	44	46	45	54	42	41	54	55	57	35	59	40	1.216	7	650	100
Total															6.8 L	1.5L

Observation Table 46: Case-II Summer Session for 2 cm Depth

Absorbing material **Iron Rod**					Date **06/04/2022**						Water Depth **2 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	48	51	48	53	45	44	53	57	61	37	69	40	1.443	10	680	300
12:00 PM	50	57	51	55	49	47	63	60	68	41	81	42	1.923	11	910	350
1:00 PM	52	60	53	59	51	50	64	61	72	42	87	44	1.766	10	1180	400
2:00 PM	54	58	50	58	53	52	62	66	69	39	95	45	1.878	8	950	320
3:00 PM	49	53	49	55	50	49	60	63	68	38	92	43	1.492	8	850	180
4:00 PM	47	49	47	51	49	47	58	57	65	36	83	41	1.295	12	680	150
5:00 PM	44	48	46	49	47	45	55	53	60	34	79	40	1.189	10	550	100
Total															5.8L	1.8L

Observation Table 47: Case-III Summer Session for 2 cm Depth

Absorbing material **Limestone**					Date **07/04/2022**						Water Depth **2 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	43	57	42	55	49	48	56	58	60	38	86	42	1.593	8	500	150
12:00 PM	49	60	51	57	51	53	60	62	63	40	94	44	2.195	12	710	220
1:00 PM	52	62	53	60	56	57	63	65	68	41	95	45	1.862	10	1050	350
2:00 PM	51	61	52	58	55	56	61	64	67	42	97	45	1.854	11	850	230
3:00 PM	47	56	47	56	49	51	58	59	64	40	95	43	1.749	11	760	180
4:00 PM	45	51	45	54	47	48	57	57	61	38	95	42	1.608	10	650	150
5:00 PM	42	48	43	51	45	43	54	55	59	36	82	37	1.254	8	480	100
Total															5L	1.4L

Observation Table 48: Case-IV Summer Session for 2 cm Depth

Absorbing material **Black Paint**					Date **08/04/2022**						Water Depth **2 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	44	51	42	46	45	41	49	39	44	33	83	43	1.785	11	550	180
12:00 PM	47	58	48	53	51	48	55	47	53	38	91	45	2.678	8	800	210
1:00 PM	51	61	51	58	54	50	59	56	61	40	93	46	2.946	9	1120	350
2:00 PM	52	62	49	60	49	51	57	58	63	39	94	45	2.734	8	890	280
3:00 PM	49	57	47	57	47	48	56	61	68	38	93	44	1.972	8	790	250
4:00 PM	45	50	44	52	45	43	54	55	61	36	86	44	1.483	8	700	180
5:00 PM	42	47	41	46	41	40	52	53	58	35	74	41	1.214	8	650	120
Total															5.5L	1.5L

Observation Table 49: Case-V Summer Session for 2 cm Depth

Absorbing material **Tiles**					Date **11/04/2022**						Water Depth **2 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	48	51	39	44	43	40	59	60	58	36	83	38	2.127	9	500	160
12:00 PM	53	59	43	51	47	43	62	62	61	38	87	40	2.273	11	710	200
1:00 PM	58	63	48	59	51	48	64	66	63	39	91	43	2.427	8	1080	390
2:00 PM	55	61	54	62	55	52	65	64	65	41	89	44	2.671	8	850	300
3:00 PM	53	57	50	60	52	47	63	63	62	37	85	42	1.427	6	740	250
4:00 PM	46	49	48	57	48	44	59	58	59	35	86	41	1.281	7	650	200
5:00 PM	42	47	45	54	44	42	57	56	55	34	80	40	1.114	7	470	100
Total															5L	1.6L

Observation Table 50: Case-VI Summer Session for 2 cm Depth

Absorbing material **Sand**					Date **12/04/2022**						Water Depth **2 cm**					
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	46	56	41	54	43	38	43	40	45	34	83	36	1.752	10	650	180
12:00 PM	49	60	50	57	52	40	54	55	61	38	87	39	2.197	8	800	280
1:00 PM	52	62	55	64	56	44	61	59	63	40	94	42	2.415	11	1120	330
2:00 PM	54	61	50	63	54	50	63	57	66	42	95	44	2.019	9	890	230
3:00 PM	51	58	48	58	50	49	64	56	64	41	87	41	1.758	8	780	180
4:00 PM	48	56	47	55	48	47	60	54	62	38	85	39	1.455	10	760	130
5:00 PM	43	51	41	52	45	44	57	51	59	36	81	36	1.243	8	600	100
Total															5.6L	1.4L

Observation Table 51: Case-VII Summer Session for 2 cm Depth

Absorbing material **River Stone**					Date **13/04/2022**						Water Depth **2 cm**				
Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	SI	WV	PASS	PPSS
11:00 AM	43	56	44	56	49	48	56	58	61	38	90	40	2.201	12	700	170
12:00 PM	48	60	51	59	52	53	59	59	64	40	92	43	2.310	10	920	200
1:00 PM	51	63	54	61	55	54	61	62	66	41	95	46	2.786	10	1080	390
2:00 PM	53	62	53	63	54	57	64	63	65	40	94	44	2.674	8	860	300
3:00 PM	50	57	50	62	53	54	63	60	63	39	98	43	1.872	8	730	250
4:00 PM	49	55	49	58	50	51	60	59	62	37	91	42	1.470	8	660	190
5:00 PM	46	49	47	55	49	44	54	56	59	35	86	40	1.185	7	550	100
Total															5.5L	1.6L

Calculation Table 52: Case-I Summer Session for 2 cm Depth

Absorbing material Without Absorbing Material				Date 5/04/2022				Water Depth 2 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	2.138	36	62	59	52	780	2366801.156	58.6	13.59	1.9446
12:00 PM	2.276	39	64	61	68	1050	2359505.564	73.9	16.35	4.6982
1:00 PM	2.296	41	67	63	69	1450	2354987.113	97.3	21.03	7.7844
2:00 PM	1.876	42	65	66	71	1100	2348227.321	93.4	25.9	8.9937
3:00 PM	1.786	39	59	60	63	920	2361768.365	82.6	17.06	4.739
4:00 PM	1.585	37	57	58	59	850	2366301.122	86.1	15.03	3.5063
5:00 PM	1.216	35	54	55	57	650	2373118.141	86.1	9.13	1.1829

Calculation Table 53: Case-II Summer Session for 2 cm Depth

Absorbing material Iron Rod				Date 06/04/2022				Water Depth 2 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp. Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.443	37	53	57	61	680	2366301.122	75.7	10.09	2.7086
12:00 PM	1.923	41	63	60	68	910	2361768.365	75.8	14.85	4.4622
1:00 PM	1.766	42	64	61	72	1180	2352731.465	96.5	19.53	7.5484
2:00 PM	1.878	39	62	66	69	950	2348227.321	80.6	23.4	9.7577
3:00 PM	1.492	38	60	63	68	850	2357245.146	91.18	15.56	6.503
4:00 PM	1.295	36	58	57	65	680	2366301.122	84.36	10.53	3.2703
5:00 PM	1.189	34	55	53	60	550	2393564.089	75.1	7.63	1.9469

Calculation Table 54: Case-III Summer Session for 2 cm Depth

Absorbing material **Limestone**				Date **07/04/2022**				Water Depth 2 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp. Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.593	38	56	58	60	500	2366301.122	50.4	10.49	1.713
12:00 PM	2.195	40	60	62	63	710	2357245.146	51.7	13.25	4.4666
1:00 PM	1.862	41	63	65	68	1050	2348227.321	89.1	16.93	6.5528
2:00 PM	1.854	42	61	64	67	850	2352731.465	73.2	24.8	7.7621
3:00 PM	1.749	40	58	59	64	760	2361768.365	69.6	13.96	4.5074
4:00 PM	1.608	38	57	57	61	650	2366301.122	64.	11.93	3.2747
5:00 PM	1.254	36	54	55	59	480	2373118.141	61.6	8.03	0.9513

Calculation Table 55: Case-IV Summer Session for 2 cm Depth

Absorbing material **Black Paint**				Date **08/04/2022**				Water Depth 2 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.785	33	49	39	44	550	2422959.946	50.6	11.59	1.91657
12:00 PM	2.678	38	55	47	53	800	2373118.141	48.1	15.35	4.67017
1:00 PM	2.946	40	59	56	61	1120	2366301.122	61.7	19.03	6.75637
2:00 PM	2.734	39	57	58	63	890	2357245.146	52.1	25.9	7.96567
3:00 PM	1.972	38	56	61	68	790	2359505.564	64.1	17.06	4.71097
4:00 PM	1.483	36	54	55	61	700	2366301.122	75.8	15.03	3.47827
5:00 PM	1.214	35	52	53	58	650	2370843.417	86.1	12.13	1.15487

Calculation Table 56: Case-V Summer Session for 2 cm Depth

Absorbing material **Tiles**				Date **11/04/2022**				Water Depth 2 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	2.127	36	59	60	58	500	2361768.365	37.6	10.09	1.9458
12:00 PM	2.273	38	62	62	61	710	2357245.146	49.9	14.85	4.0994
1:00 PM	2.427	39	64	66	63	1080	2352731.465	71.0	17.53	8.1856
2:00 PM	2.671	41	65	64	65	850	2348227.321	50.7	24.4	9.3949
3:00 PM	1.427	37	63	63	62	740	2354987.113	82.9	18.56	6.1402
4:00 PM	1.281	35	59	58	59	650	2366301.122	81.5	13.53	3.9075
5:00 PM	1.114	34	57	56	55	470	2370843.417	67.9	11.63	1.5841

Calculation Table 57: Case-VI Summer Session for 2 cm Depth

Absorbing material **Sand**				Date **12/04/2022**				Water Depth 2 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp .Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	1.752	34	43	40	45	650	2407525.131	60.6	12.39	1.713
12:00 PM	2.197	38	54	55	61	800	2373118.141	58.6	16.15	3.2132
1:00 PM	2.415	40	61	59	63	1120	2361768.365	74.3	20.83	6.2115
2:00 PM	2.019	42	63	57	66	890	2366301.122	70.8	25.7	5.7855
3:00 PM	1.758	41	64	56	64	780	2370843.417	71.4	17.86	3.7626
4:00 PM	1.455	38	60	54	62	760	2393564.089	84.8	14.83	2.984
5:00 PM	1.243	36	57	51	59	600	2377674.742	77.9	11.93	0.9493

Calculation Table 58: Case-VII Summer Session for 2 cm Depth

Absorbing material **River Stone**				Date **13/04/2022**				Water Depth 2 cm		
Time	Solar Intensity Ib (W/m2)	Ambient Temp. Ta (o C)	Absorber Basin Temp. Tb (o C)	Basin Water Temp. Tw (o C)	Vapour Temp.Tv (o C)	Hourly Productivity (ml/Hr)	Latent heat of Vaporization of water (J/kg)	Hourly Thermal Efficiency (%)	Exergy Efficiency of Active Still (%)	Exergy Efficiency Of Passive Still
11:00 AM	2.201	38	56	58	61	700	2366301.122	51.1	10.39	2.42728
12:00 PM	2.310	40	59	60	64	920	2361768.365	63.8	16.15	5.18088
1:00 PM	2.786	41	61	64	66	1080	2352731.465	61.9	18.83	7.26708
2:00 PM	2.674	42	64	63	63	860	2354987.113	51.4	23.7	8.47638
3:00 PM	1.872	39	63	61	65	730	2361768.365	62.5	19.86	5.22168
4:00 PM	1.470	37	60	57	62	660	2366301.122	72.1	14.83	3.98898
5:00 PM	1.185	35	54	55	60	550	2370843.417	74.7	12.93	1.66558

4.12 Daily Efficiency of still without absorbing material with 2cm water depth

Ŋ =APH/3600G

A-Area of Basin in m^2

G-solar radiation in w/m2

H-latent heat of water, P-collecting water in liter

= 1*6.8*2361529.826/3600*677.46

= 6.58%

Daily Efficiency of still using Iron rod with 2cm water depth

=0.88*5.8*2363734.09/3600*582.99

=5.64%

Daily Efficiency of still using Limestone with 2cm water depth

= 0.88*5*2369813.24/3600*598.24

= 4.56%

Daily Efficiency of still using Black paint with 2cm water depth

= 0.88*5.5*2363753.494/3600*617.76

= 5.14%

Daily Efficiency of still using Tiles with 2cm water depth

= 0.88*5*2321871.993/3600*607.18

= 4.67%

Daily Efficiency of still using Sand with 2cm water depth

= 0.88*5.6*2331569.288/3600*628.25

= 5.27%

Daily Efficiency of still using River stone with 2cm water depth

=0 .88*5.5*2354207.053/3600*611.83

= 5.17%

4.13 Summer Daily Efficiency of Passive Still for 2 cm Water Depth.

Ŋ =APH/3600G

A-Area of Basin in m^2

G-solar radiation in w/m2

H-latent heat of water, P-collecting water in liter

= 1*1.5* 2236301.122/3600*677.46

= 1.37%

Daily Efficiency of still

= 1*1.8*2267505.564/3600* 634.99

= 1.78%

Daily Efficiency of still

= 1*1.4*2167245.146/3600* 630.24

= 1.33%

Daily Efficiency of still

= 1*1.5*2129731.495/3600*643.76

= 1.37%

Daily Efficiency of still

= 1*1.6*2186301.122/3600*623.18

= 1.55%

Daily Efficiency of still

= 1*1.4*2240843.417/3600*628.25

= 1.36%

Daily Efficiency of still

=1*1.6*2132198.141/3600*611.83

=1.54%

Formulas

$$A = a^2 + 2a\sqrt{a^2/4 + h^2}$$

Area of basin

Efficiency of still without absorbing material with 5cm water depth

Ŋ =APH/3600G

A-collecting surface area in m^2

G-solar radiation in w/m^2

H-latent heat of water, P-collecting water in liter

Efficiency of still using black paint with 5cm water depth

ꞑ =APH/3600G

Daily Thermal Efficiency

$$\eta_D = \left(\frac{\sum m\cdot_d \times \lambda_{fg}}{A_{ab} \times \sum I_r \times 3600} \right)$$

Where, m.d = Distillate Productivity

h_{fg} = Latent heat of vaporization

Ir = Solar Radiation

Aab = Absorber Area

CHAPTER 5
RESULT AND DISCUSSION

5.1 Result and Discussion on Graphs

Active 27/12/2021 Winter 5CM Reading **Without Absorbing Material**

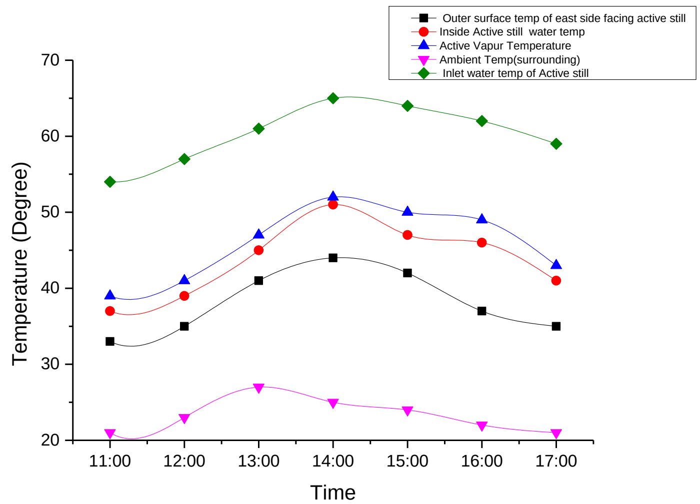

Fig 14. Hourly variations in temperature without absorber plate of active still at 5cm depth in winter season

28/12/2021 Iron Rod **Active temperature** **Winter 5CM Reading**

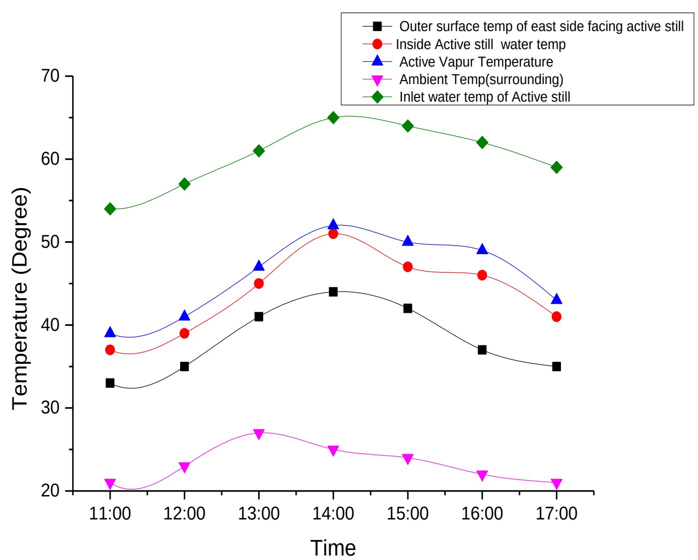

Fig 15. Hourly variations in temperature with iron rod in absorber plate of active still at 5cm depth in winter season

Active 29/12/2021 Winter 5CM Reading Limestone

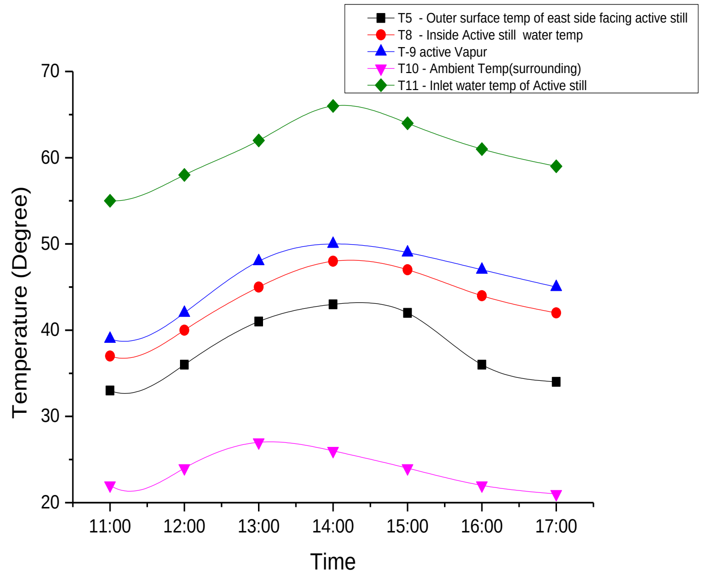

Fig 16. Hourly variations in temperature with lime stone in absorber plate of active still at 5cm depth in winter season

Active 30/12/2021 Winter 5CM Reading Black Paint

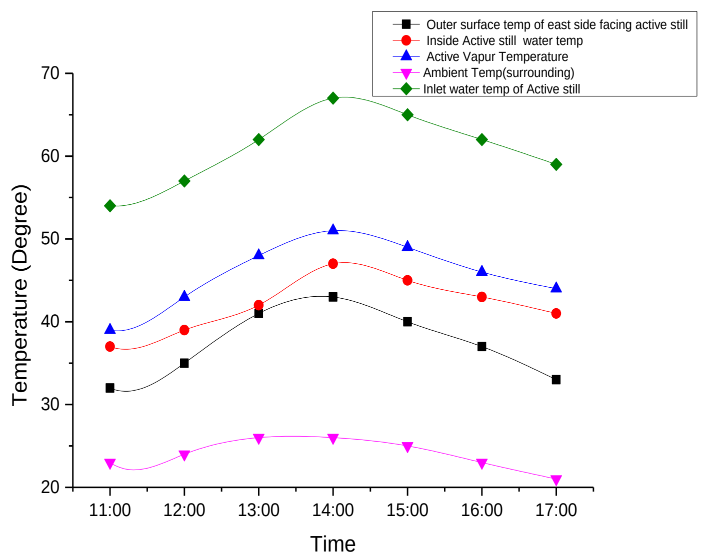

Fig 17. Hourly variations in temperature with black paint in absorber plate of active still at 5cm depth in winter season

Active 31/12/2022 winter 5CM Reading Sand

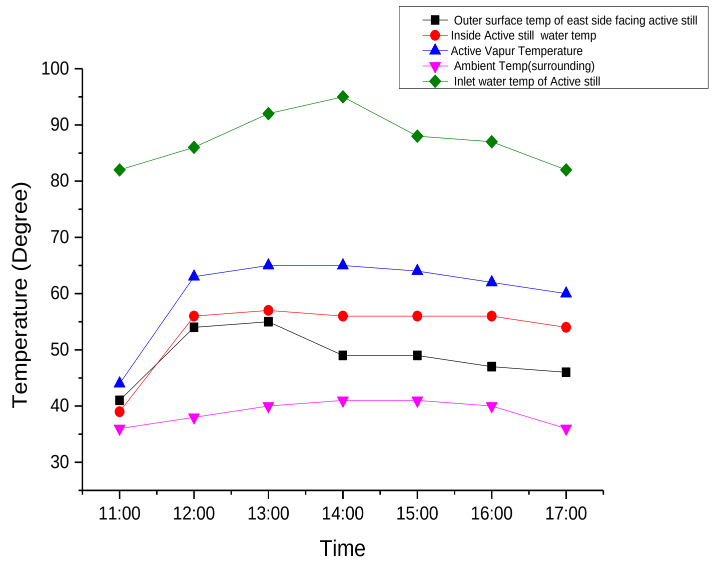

Fig 18. Hourly variations in temperature with sand in absorber plate of active still at 5cm depth in winter season

Active 03/01/2022 Winter 5 cm Reading Tiles

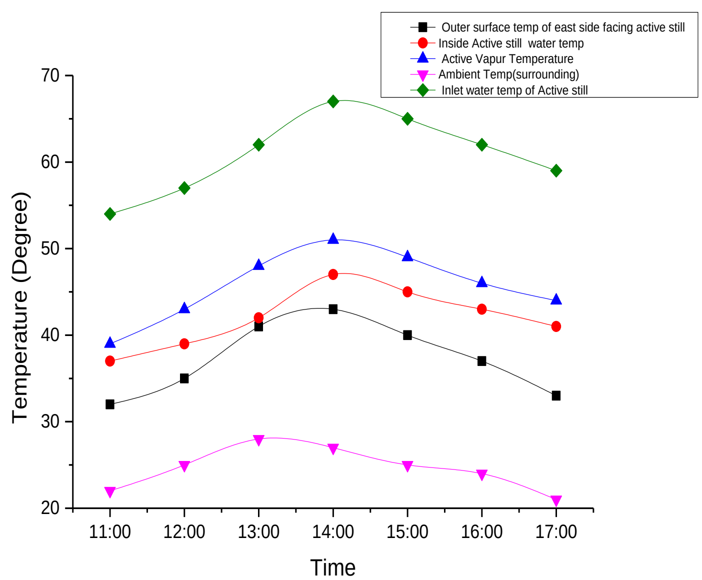

Fig 19. Hourly variations in temperature with tiles in absorber plate of active still at 5cm depth in winter season

Active 04/01/2022 Winter 5CM Reading **River Stone**

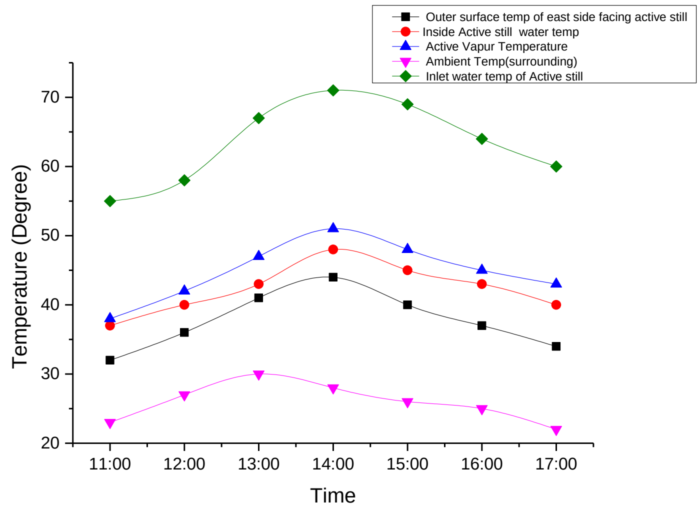

Fig 20. Hourly variations in temperature with river stone in absorber plate of active still at 5cm depth in winter season

05/01/2022 Winter 2CM Reading **Without Absorbing Material**

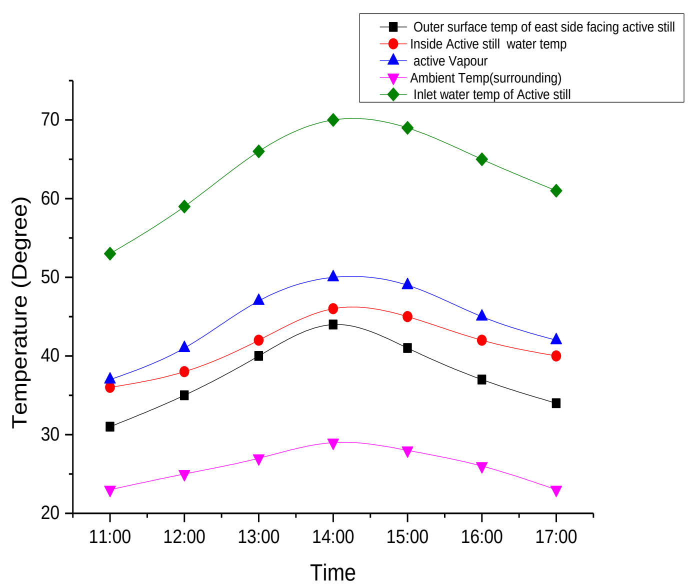

Fig 21. Hourly variations in temperature with Without Absorbing Material in absorber plate of active still at 2cm depth in winter season

Active 06/01/2022 Winter 2CM Reading Iron Rod

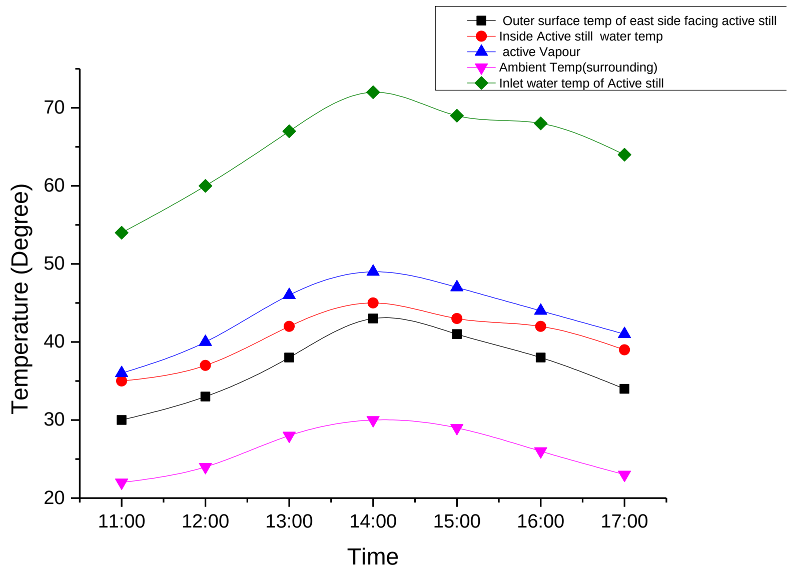

Fig 22. Hourly variations in temperature with iron rod in absorber plate of active still at 2cm depth in winter season

Active 07/01/2022 winter 2CM Reading Limestone

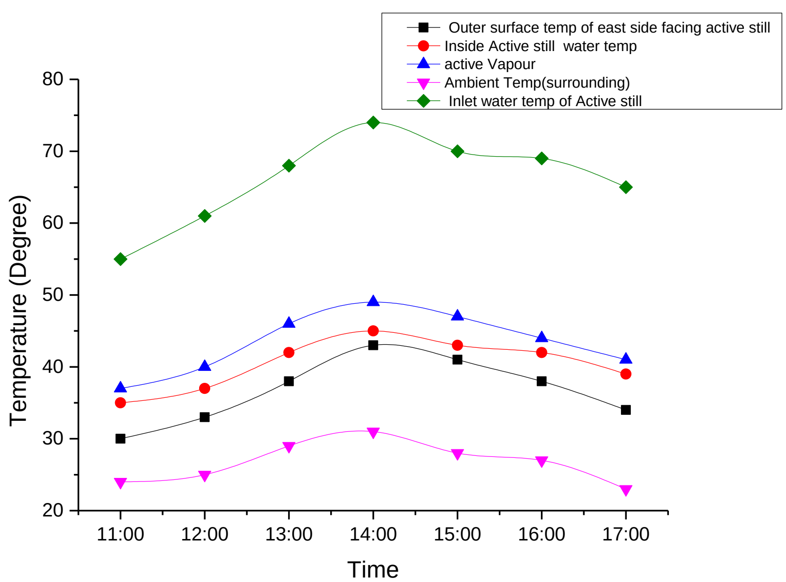

Fig 23. Hourly variations in temperature with lime stone in absorber plate of active still at 2cm depth in winter season

Active 08/01/2022 Winter 2CM Reading Black paint

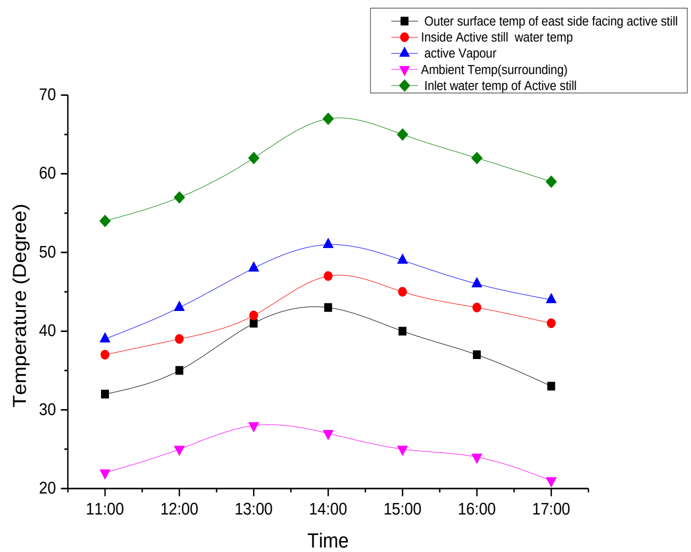

Fig 24. Hourly variations in temperature with black paint in absorber plate of active still at 2cm depth in winter season

Active 10/01/2022 winter 2cm Reading Sand

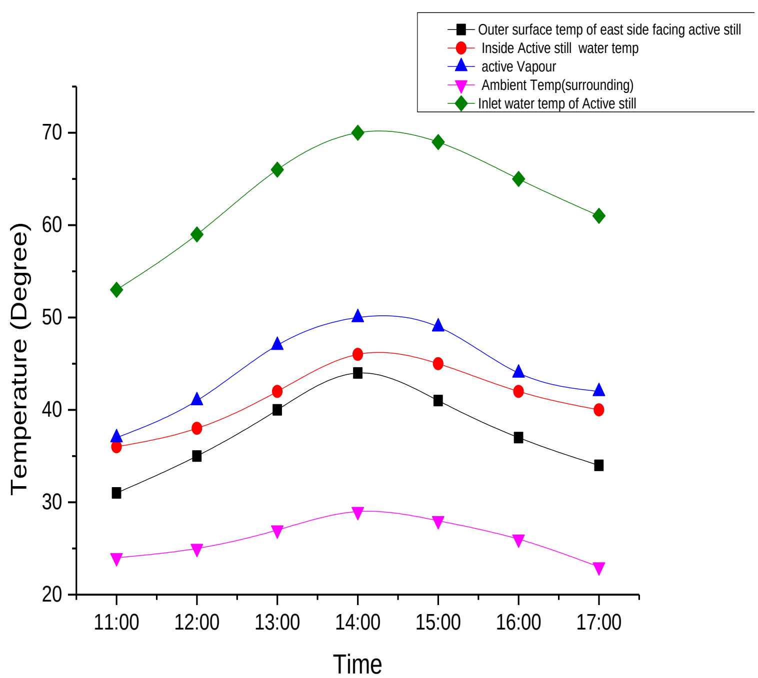

Fig 25. Hourly variations in temperature with sand in absorber plate of active still at 2cm depth in winter season

Active 11/01/2022 Winter 2CM Reading Tiles

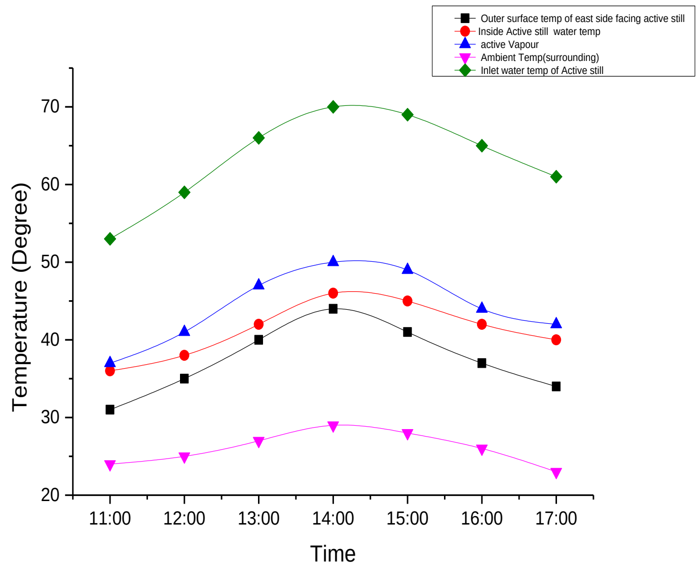

Fig 26. Hourly variations in temperature with tiles in absorber plate of active still at 2cm depth in winter season

Active 12/01/2022 Winter 2CM Reading River stone

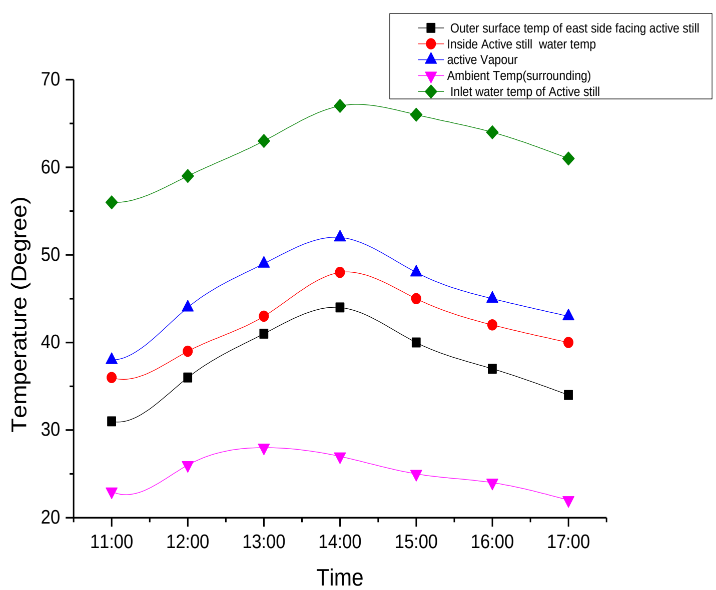

Fig 27. Hourly variations in temperature with river stone in absorber plate of active still at 2cm depth

26/03/2022 Summer 5CM Reading **Without Absorbing Material**

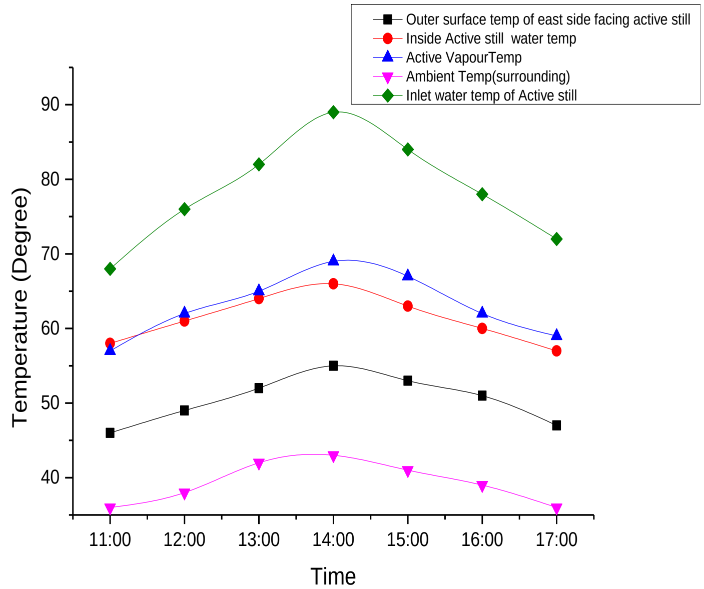

Fig 28. Hourly variations in temperature without absorber plate of active still at 5cm depth in summer season

28/03/2022 Summer 5CM Reading **Iron Rod**

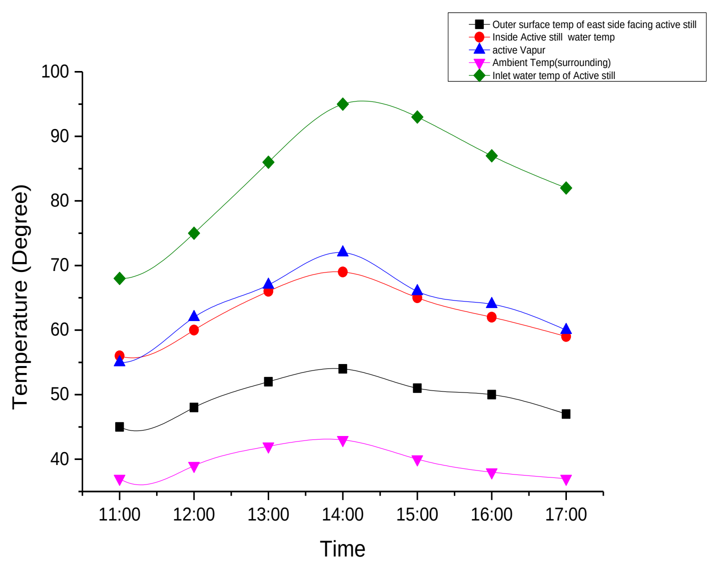

Fig 29. Hourly variations in temperature with iron rod in absorber plate of active still at 5cm depth in summer season

Active **29/03/2022 Summer 5CM Reading** **Limestone**

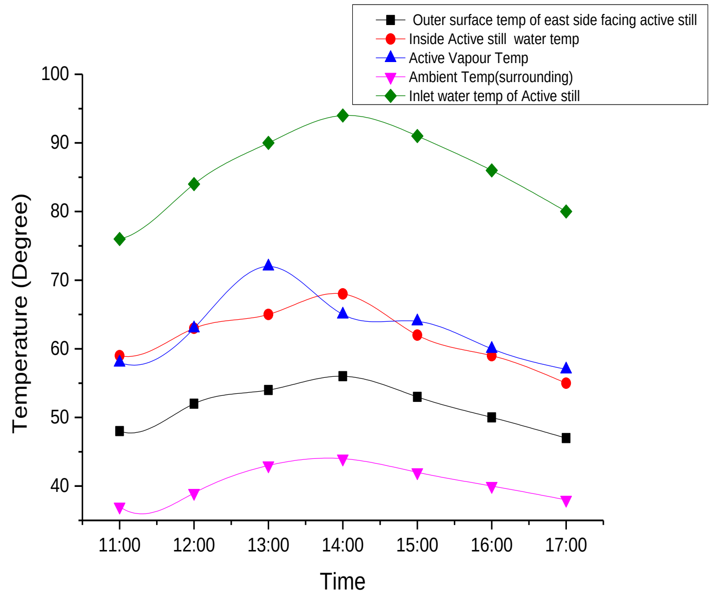

Fig 30. Hourly variations in temperature with lime stone in absorber plate of active still at 5cm depth in summer season

30/03/2022 Summer 5CM Reading **Black paint**

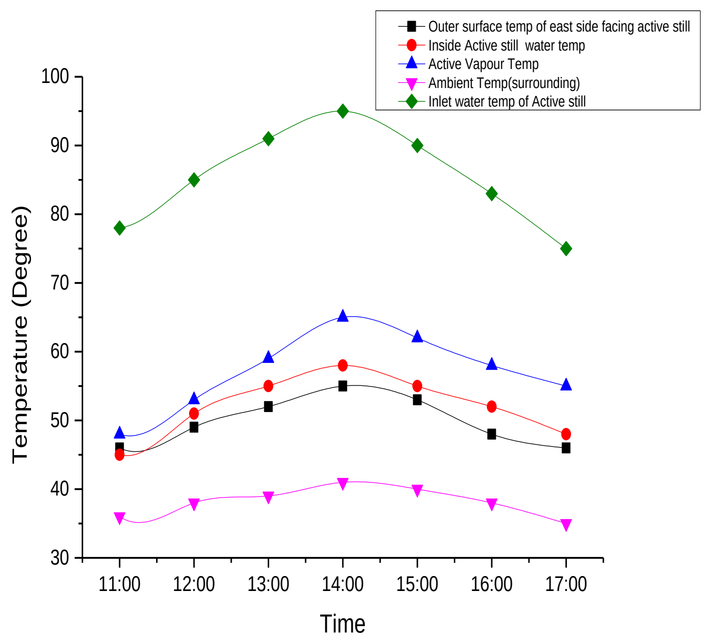

Fig 31. Hourly variations in temperature with black paint in absorber plate of active still at 5cm depth in summer season

31/03/2022 Summer 5CM Reading **Tiles**

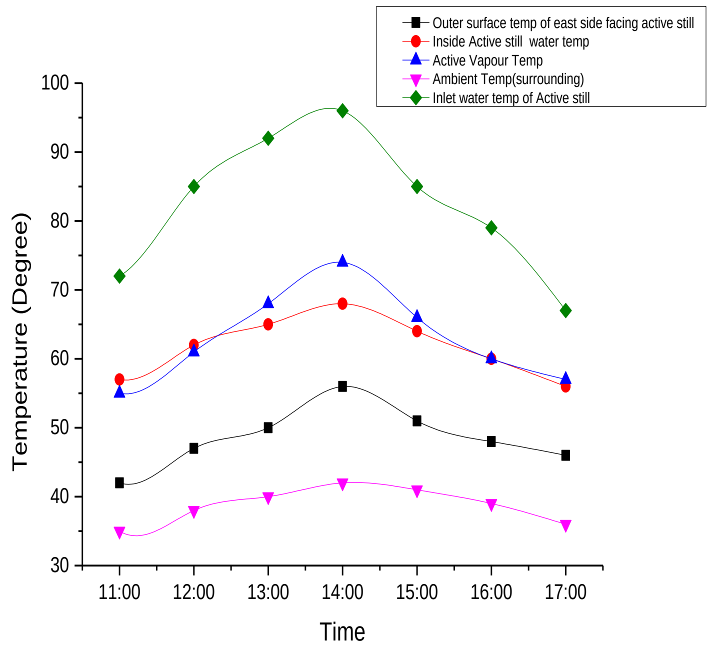

Fig 32. Hourly variations in temperature with tiles in absorber plate of active still at 5cm depth in summer season

Active 01/04/2022 Summer 5CM Reading **Sand**

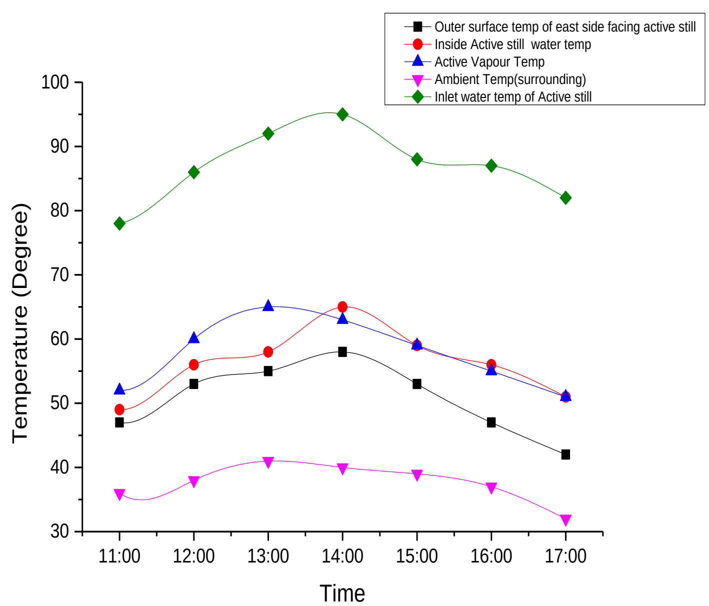

Fig 33. Hourly variations in temperature with sand in absorber plate of active still at 5cm depth in summer season

04/04/2022 Summer 5CM Reading **River stone**

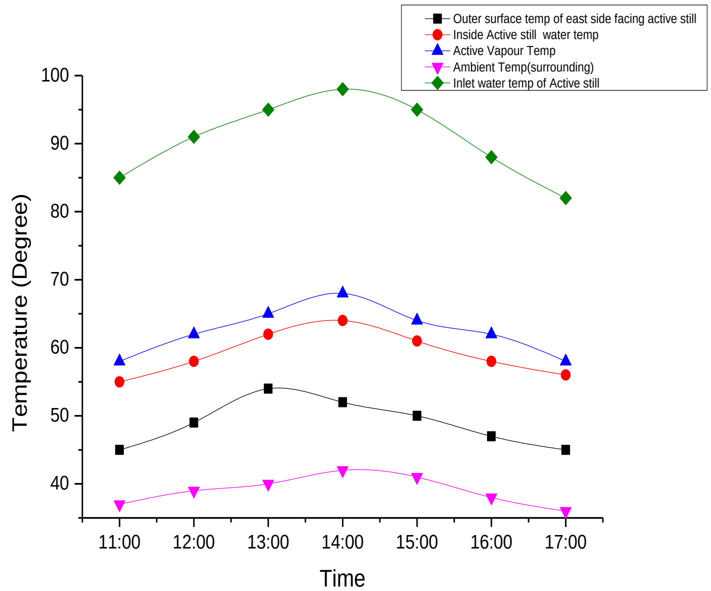

Fig 34. Hourly variations in temperature with river stone in absorber plate of active still at 5cm depth in summer season

Active 05/04/2022 summer 2CM Reading **Without Absorbing Material**

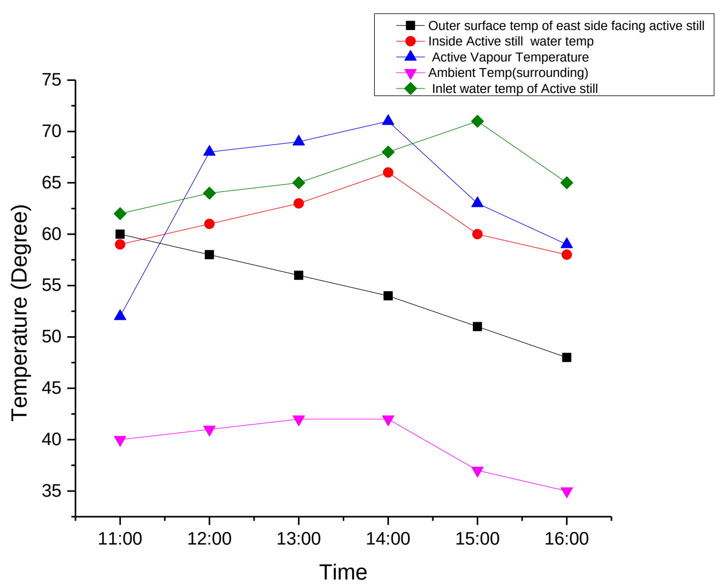

Fig 35. Hourly variations in temperature without absorber plate of active still at 2cm depth in summer season

Active 06/04/2022 summer 2CM Reading Iron Rod

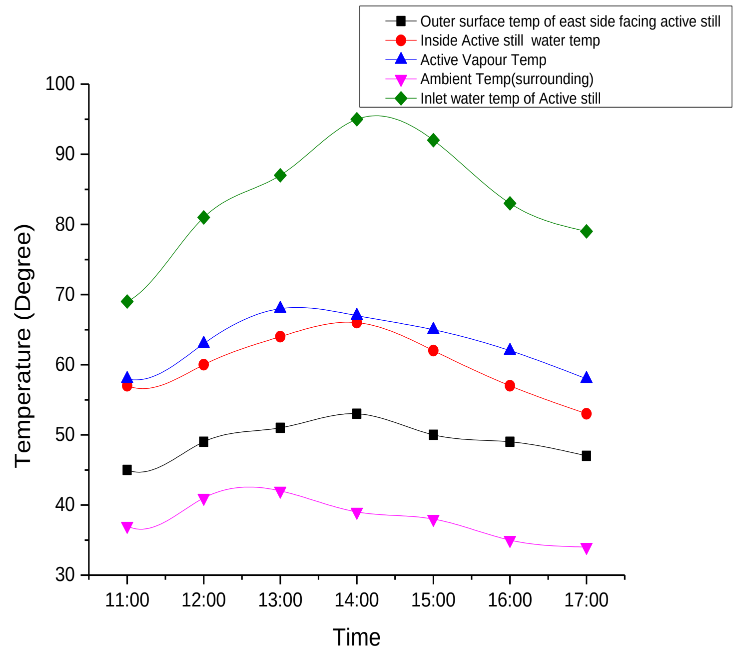

Fig 36. Hourly variations in temperature with iron rod in absorber plate of active still at 2cm depth in summer season

Active 07/04/2022 summer 2CM Reading Limestone

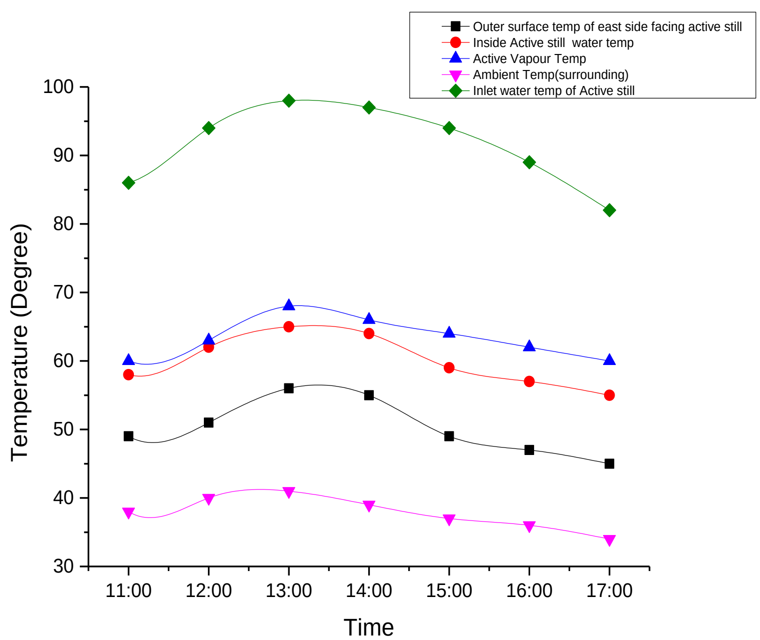

Fig 37. Hourly variations in temperature with lime stone in absorber plate of active still at 2cm depth in summer season

Active 08/04/2022 summer 2CM Reading **Black Paint**

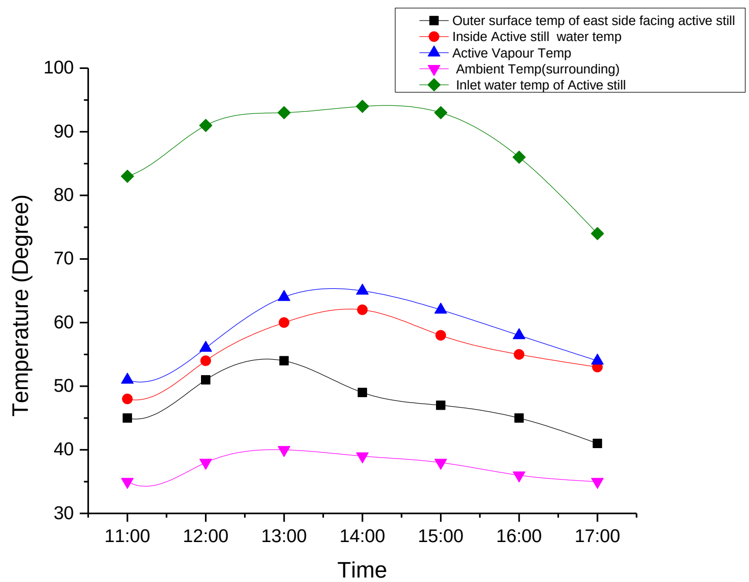

Fig 38. Hourly variations in temperature with black paint in absorber plate of active still at 2cm depth in summer season

Active 11/04/2022 summer 2CM Reading **Tiles**

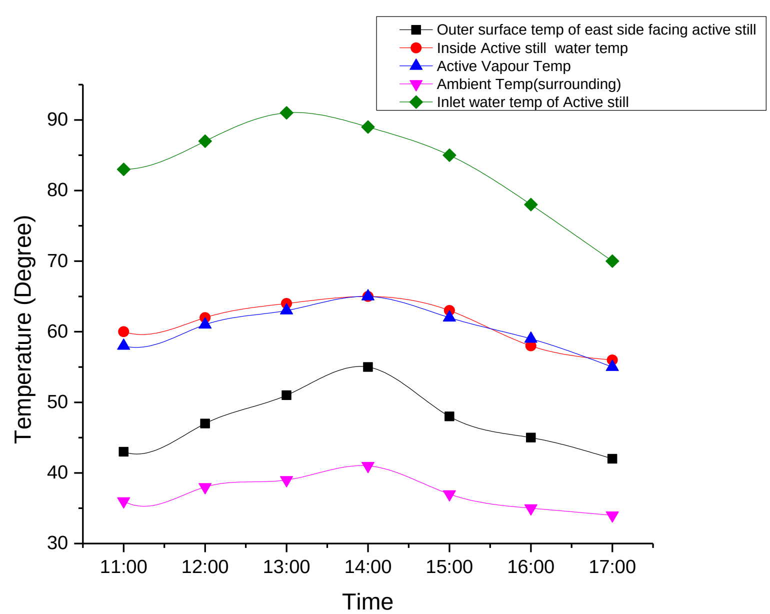

Fig 39. Hourly variations in temperature with tiles in absorber plate of active still at 2cm depth in summer season

Active 12/04/2022 summer 2CM Reading Sand

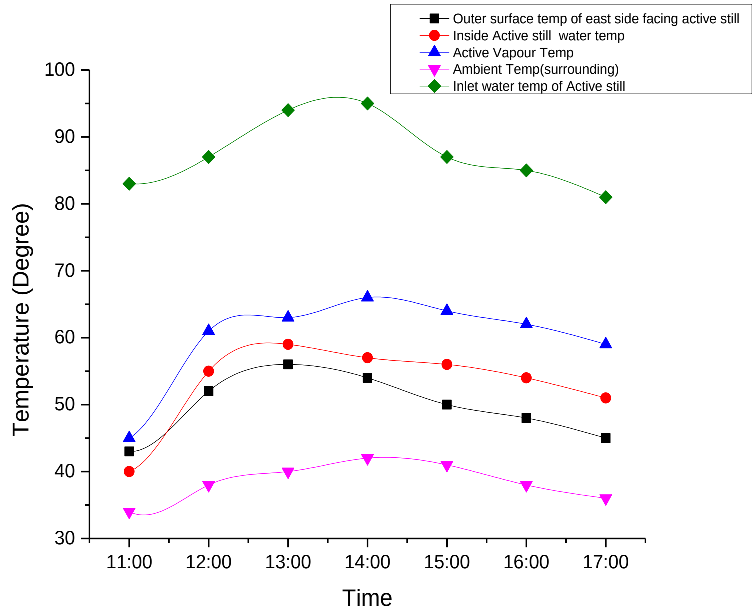

Fig 40. Hourly variations in temperature with sand in absorber plate of active still at 2cm depth in summer season

Active 13/04/2022 summer 2CM Reading River stone

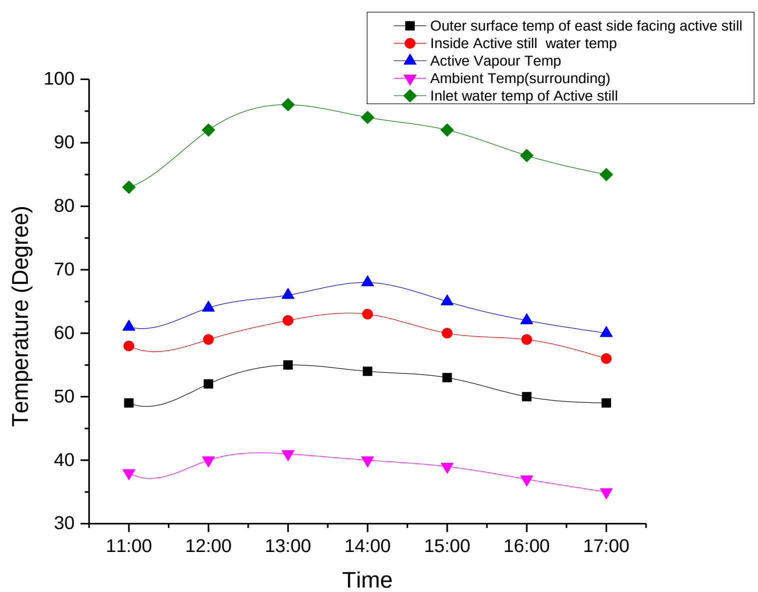

Fig 41. Hourly variations in temperature with river stone in absorber plate of active still at 2cm depth in summer season

Passive 27/12/2021 winter 5CM Reading

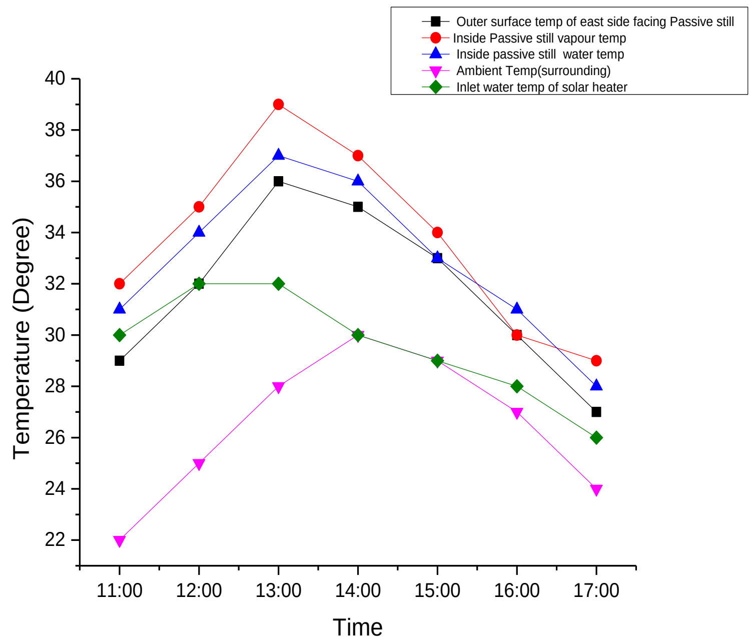

Fig 42. Hourly variations in temperature of passive still at 5cm depth in Winter season

Passive 28/12/2021 winter 5CM Reading

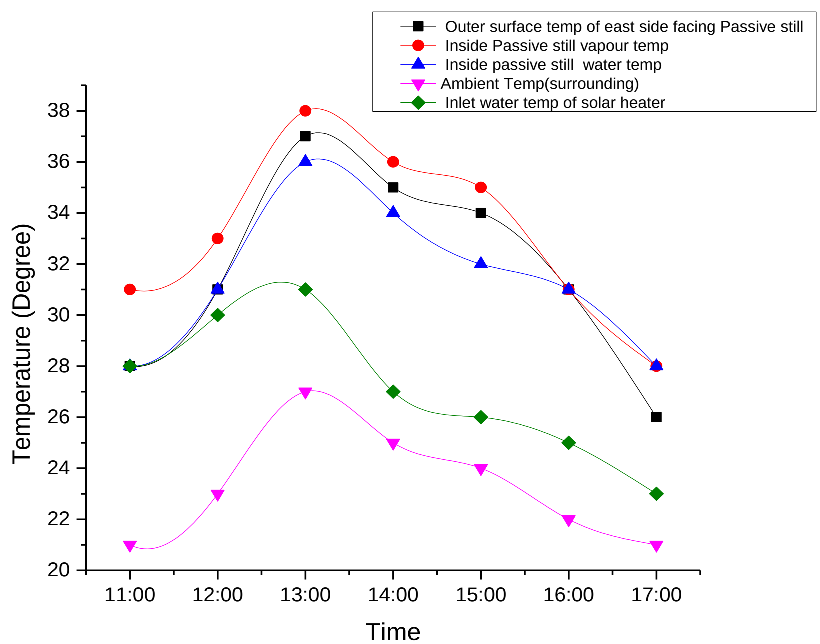

Fig 43. Hourly variations in temperature of passive still at 5cm depth in winter season

Passive 29/12/2021 winter 5cm Reading

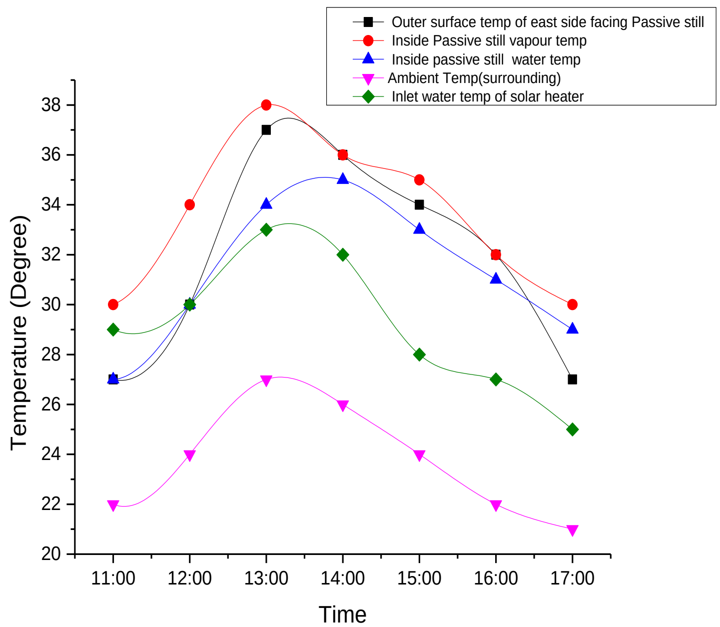

Fig 44. Hourly variations in temperature of passive still at 5cm depth in winter season

Passive 30/12/2021 winter 5CM Reading

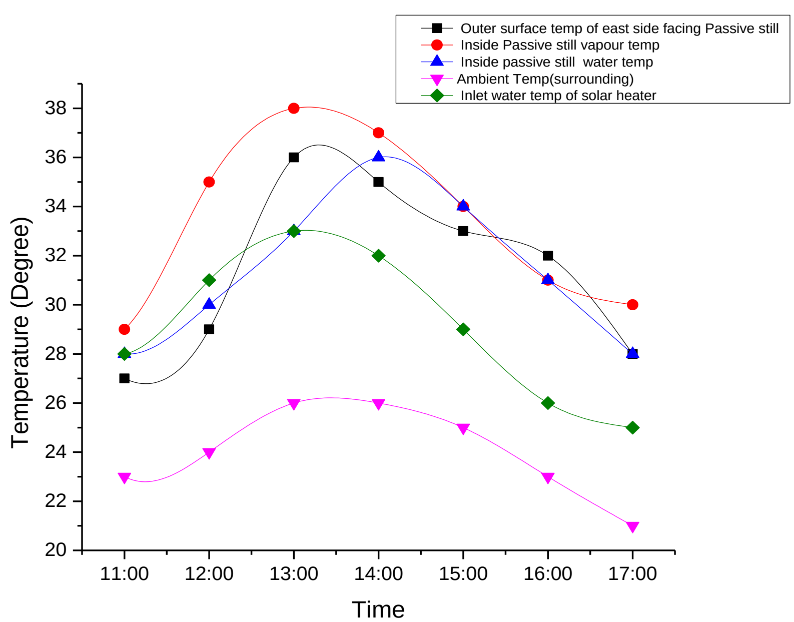

Fig 45. Hourly variations in temperature of passive still at 5cm depth in winter season

Passive 31/12/2022 winter 5CM Reading

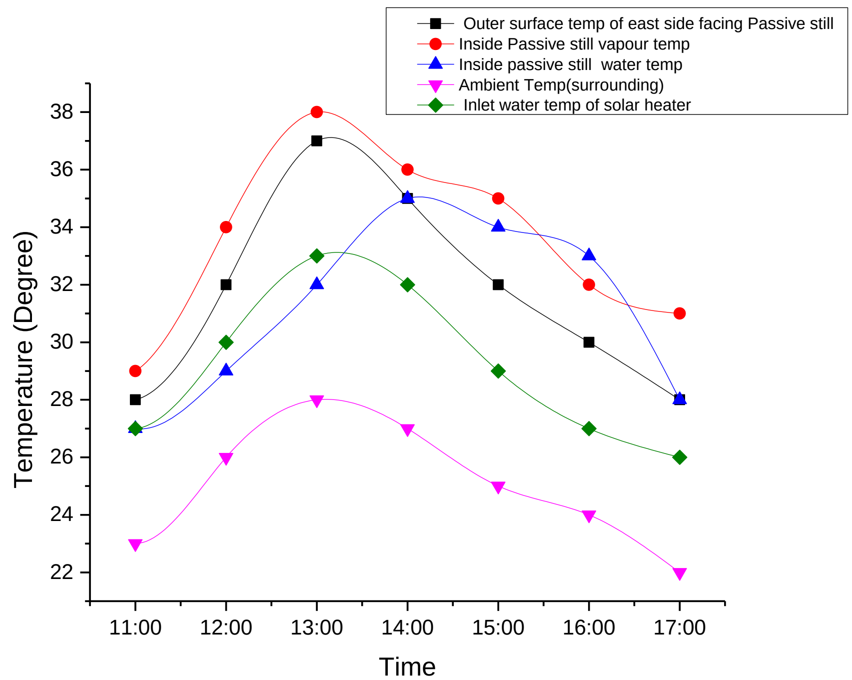

Fig 46. Hourly variations in temperature of passive still at 5cm depth in winter season

Passive 03/01/2022 winter 5CM Reading

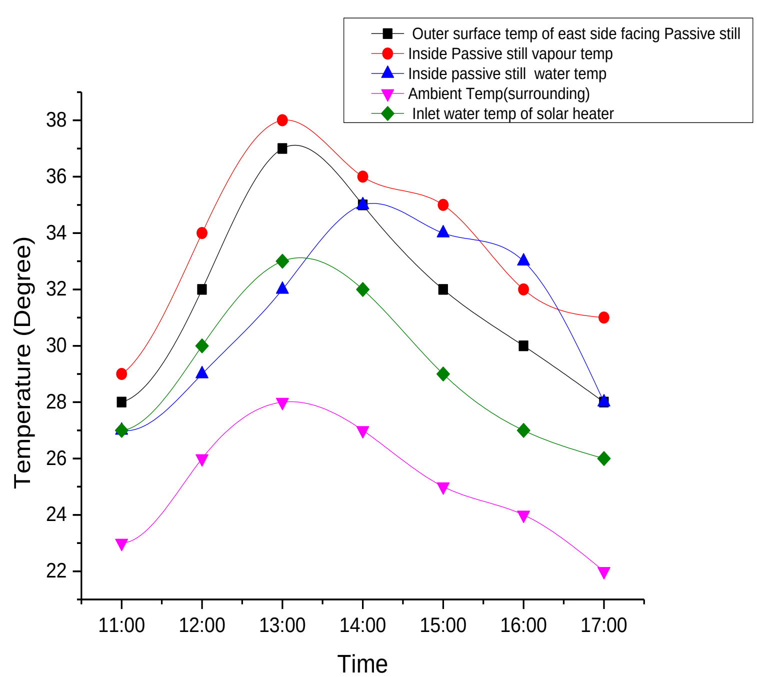

Fig 47. Hourly variations in temperature of passive still at 5cm depth in winter season

Passive 04/01/2022 winter 5CM Reading

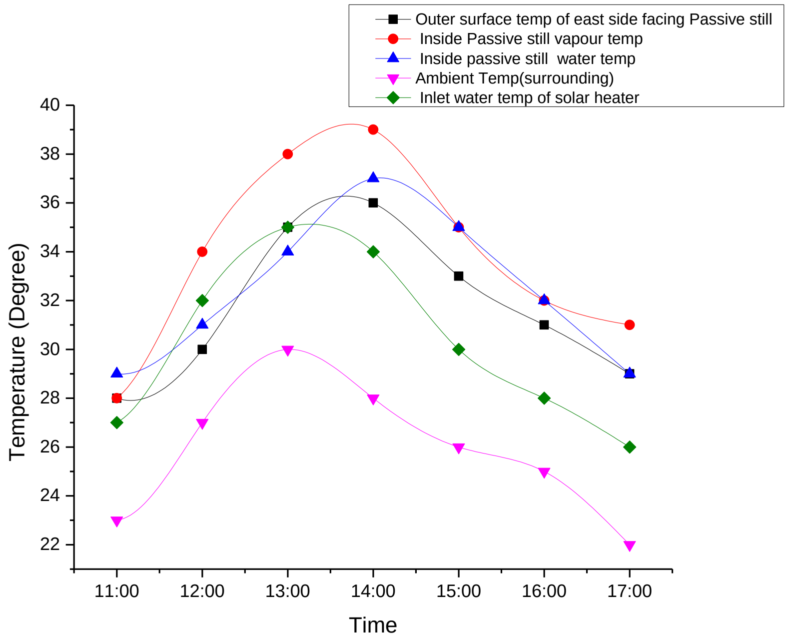

Fig 48. Hourly variations in temperature of passive still at 5cm depth in winter season

Passive 05/01/2022 Winter 2CM Reading

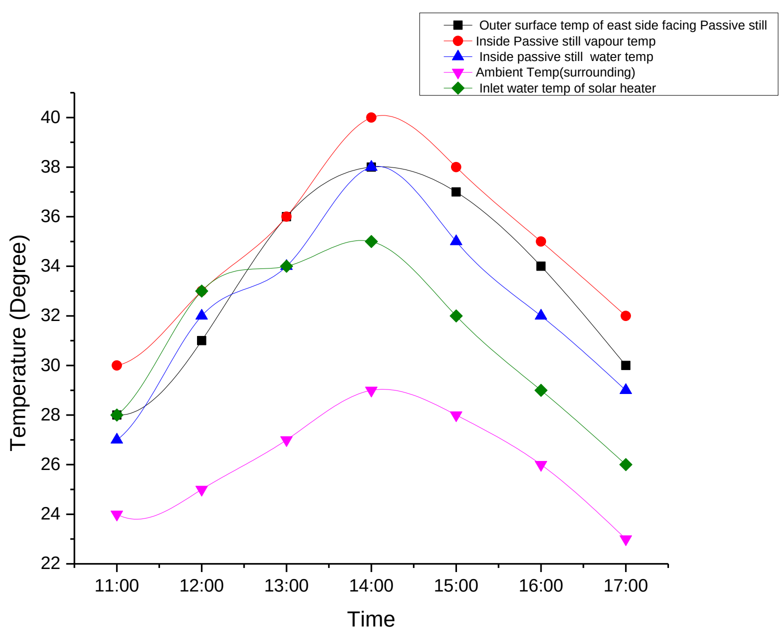

Fig 49. Hourly variations in temperature of passive still at 2cm depth in winter season

Passive 06/01/2022 winter 2CM Reading

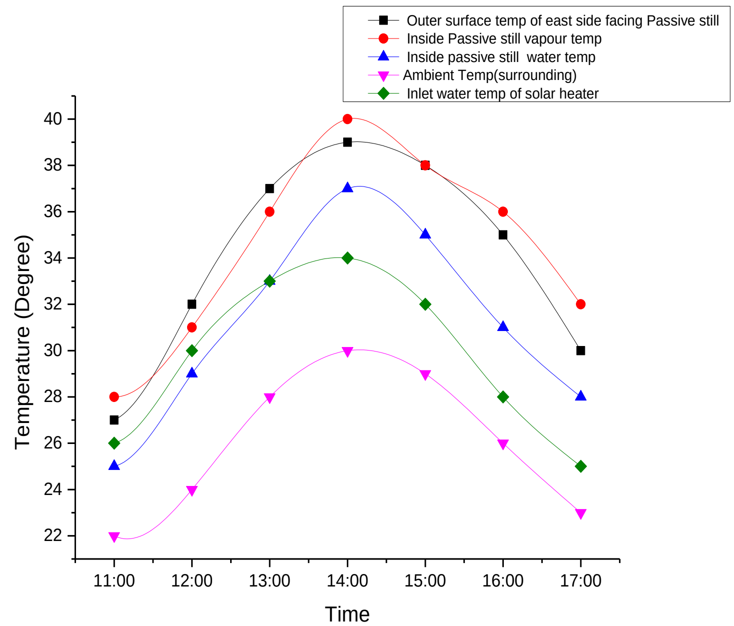

Fig 50. Hourly variations in temperature of passive still at 2cm depth in winter season

Passive 07/01/2022 Winter 2CM Reading

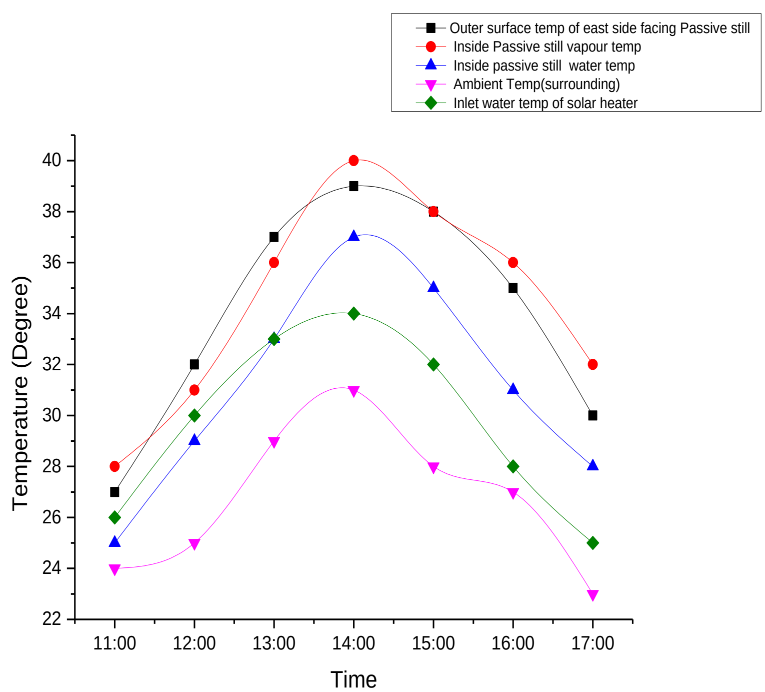

Fig 51. Hourly variations in temperature of passive still at 2cm depth in winter season

Passive 08/01/2022 Winter 2CM Reading

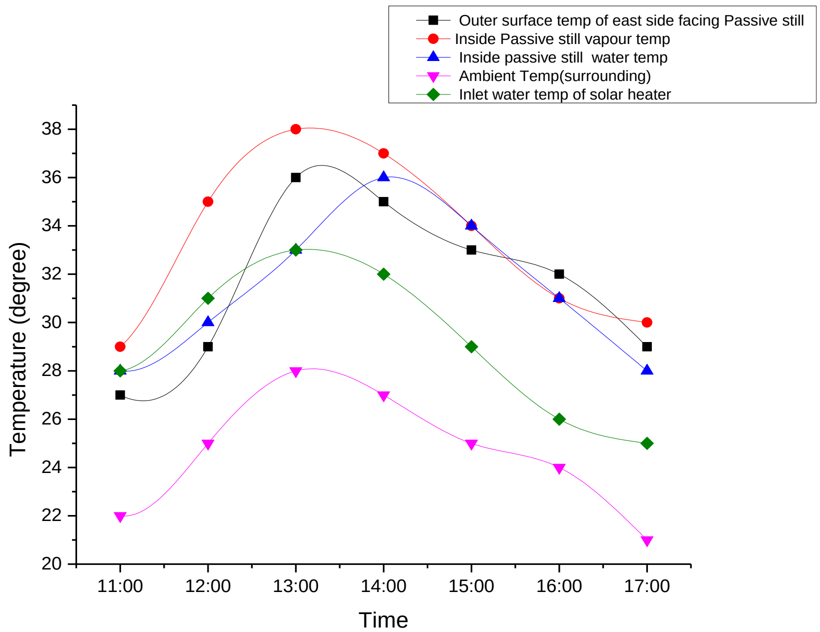

Fig 52. Hourly variations in temperature of passive still at 2cm depth in winter season

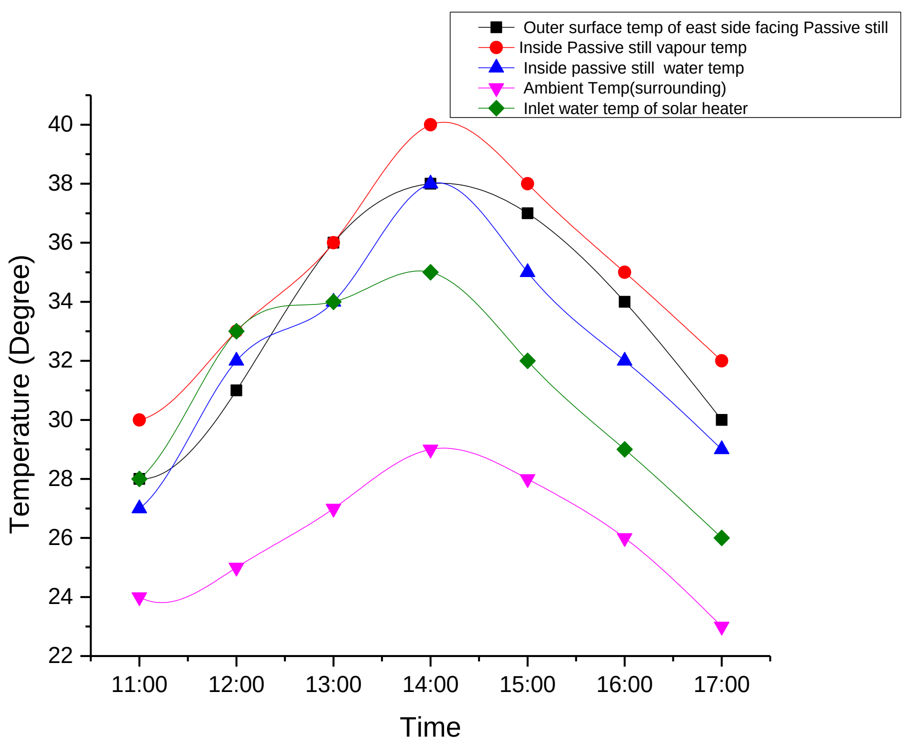

Fig 53. Hourly variations in temperature of passive still at 2cm depth in winter season

Passive 10/01/2022 Winter 2CM Reading

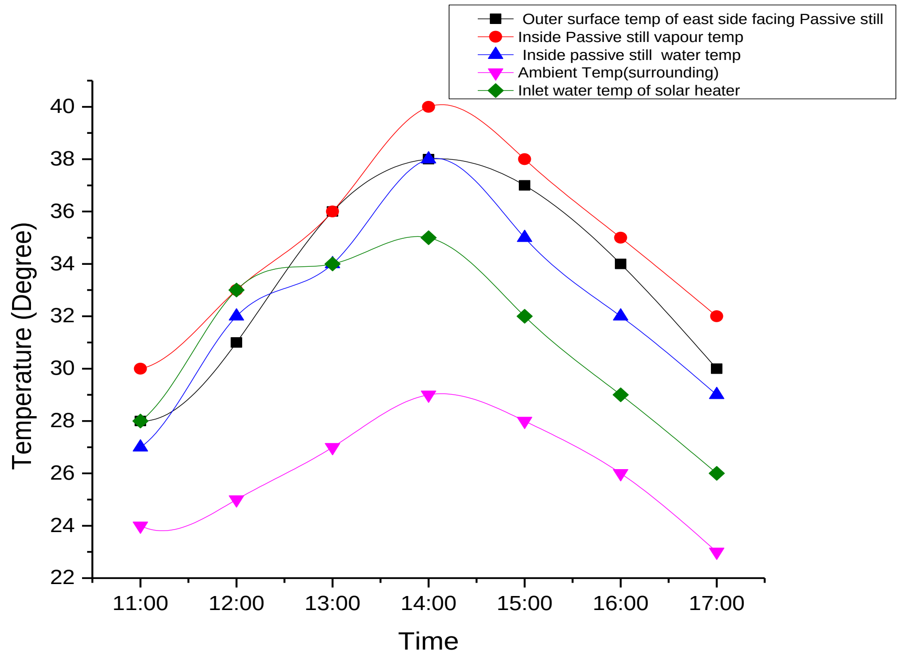

Fig 54. Hourly variations in temperature of passive still at 2cm depth in winter season

Passive 11/01/2022 Winter 2CM Reading

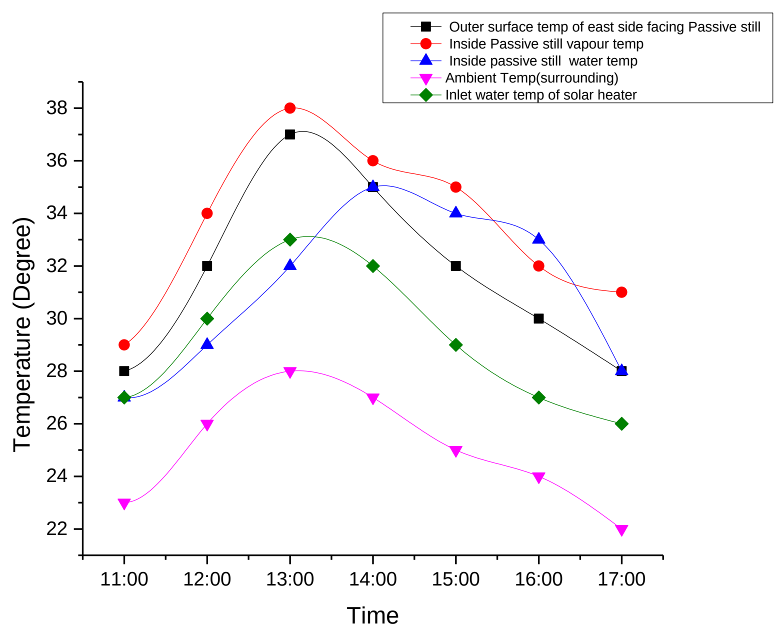

Fig 55. Hourly variations in temperature of passive still at 2cm depth in winter season

Passive 12/01/2022 Winter 2CM Reading

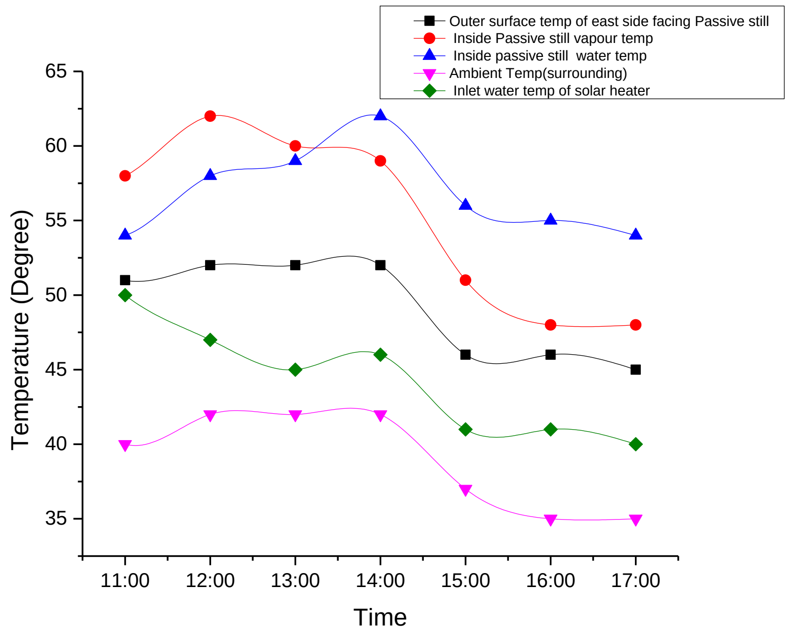

Fig 56. Hourly variations in temperature of passive still at 2cm depth in winter season

Passive 26/03/2022 Summer 5CM Reading

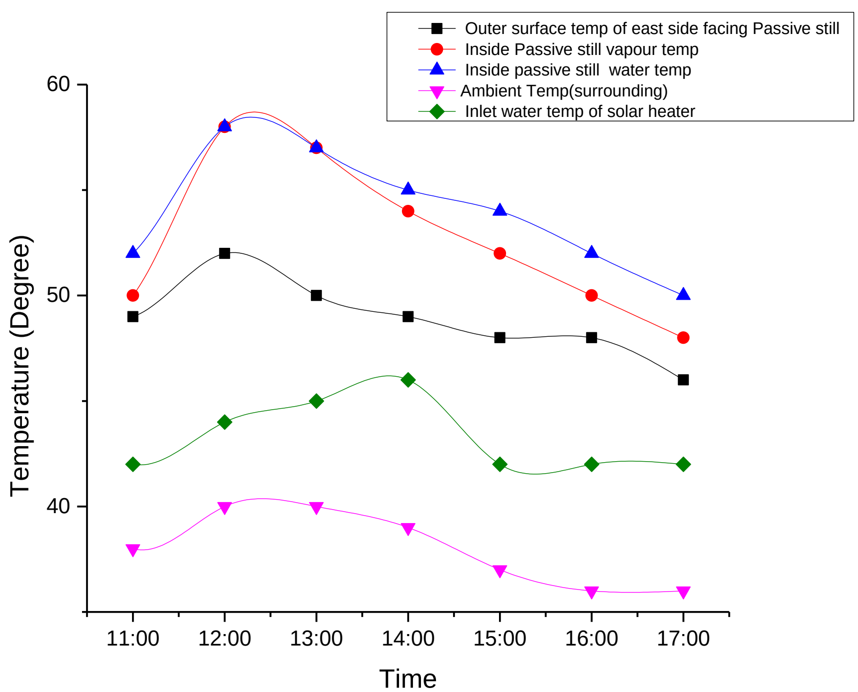

Fig 57. Hourly variations in temperature of passive still at 5cm depth in summer season

Passive 28/03/2022 Summer 5CM Reading

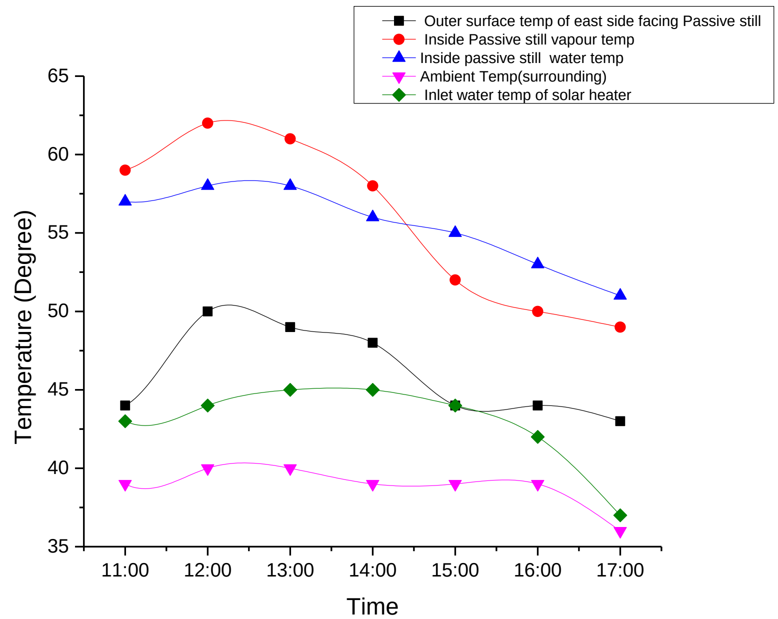

Fig 58. Hourly variations in temperature of passive still at 5cm depth in summer season

Passive 29/03/2022 Summer 5CM Reading

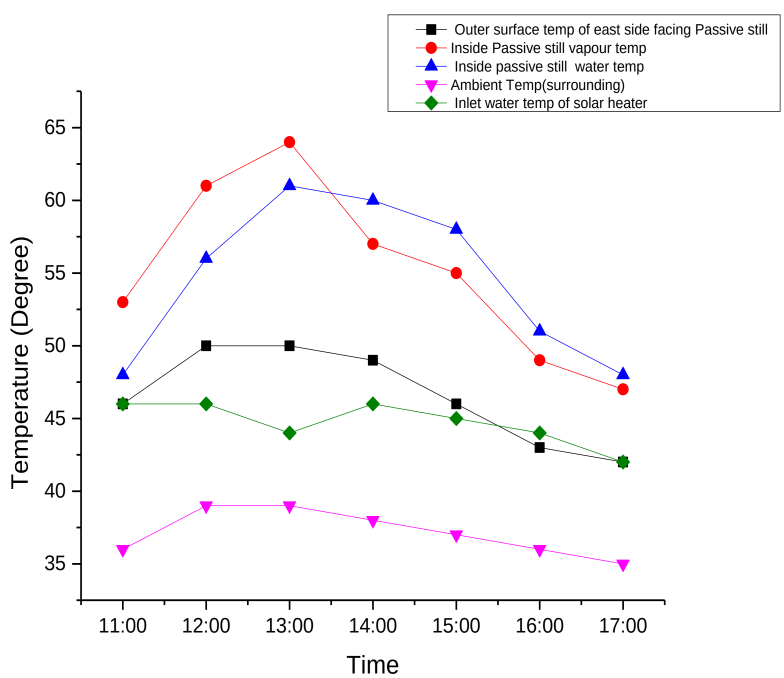

Fig 59. Hourly variations in temperature of passive still at 5cm depth in summer season

Passive 30/03/2022 Summer 5CM Reading

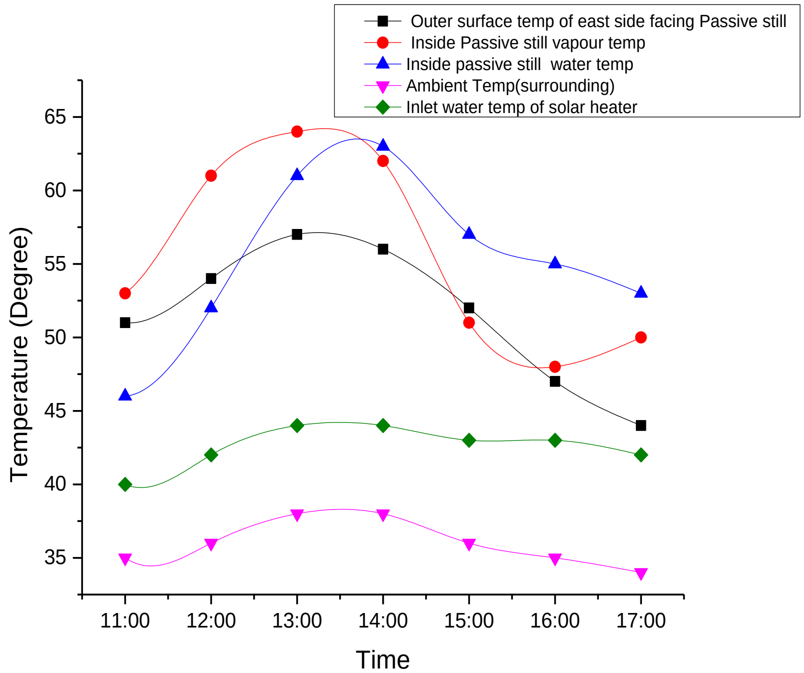

Fig 60. Hourly variations in temperature of passive still at 5cm depth in summer season

Passive 31/03/2022 Summer 5CM Reading

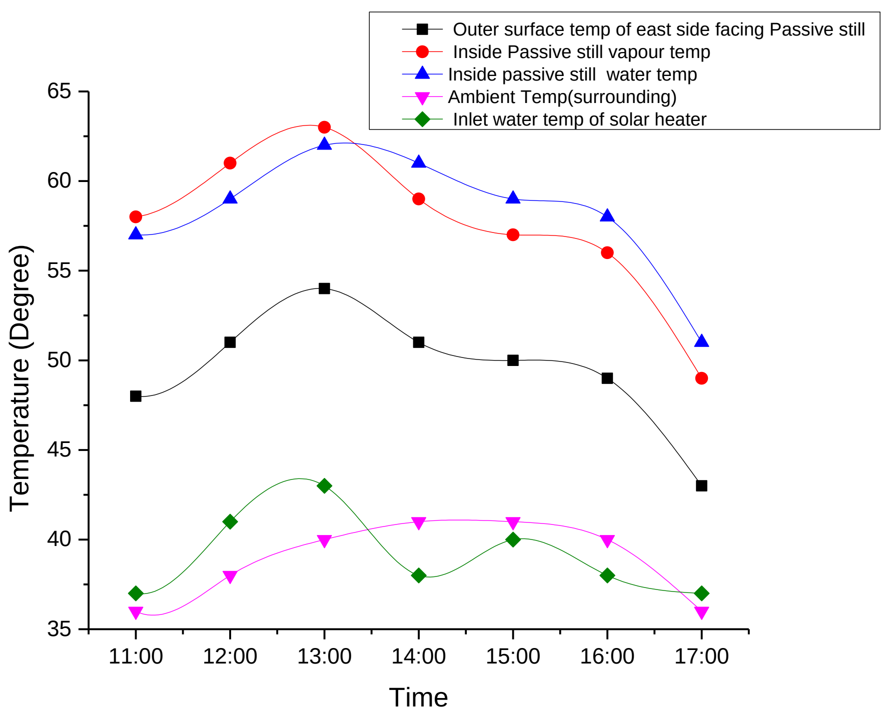

Fig 61. Hourly variations in temperature of passive still at 5cm depth in summer season

Passive 01/04/2022 Summer 5CM Reading

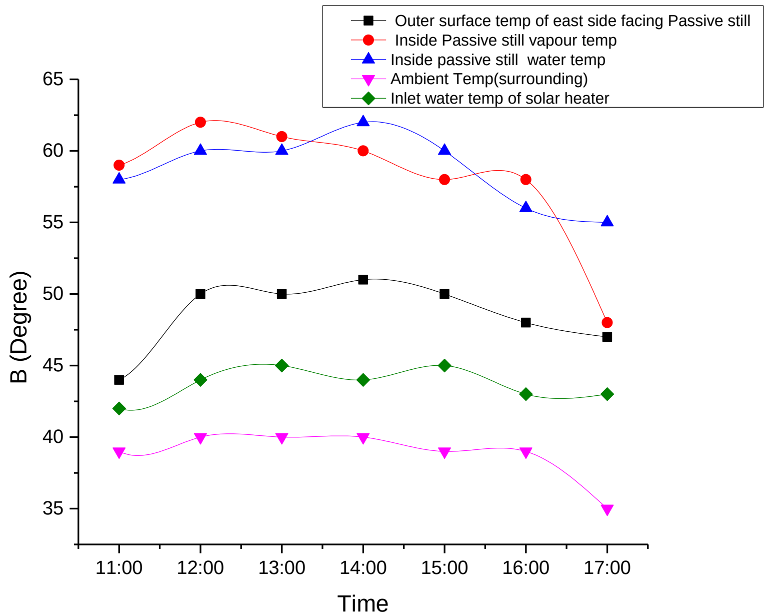

Fig 62. Hourly variations in temperature of passive still at 5cm depth in summer season

Passive 04/04/2022 Summer 5CM Reading

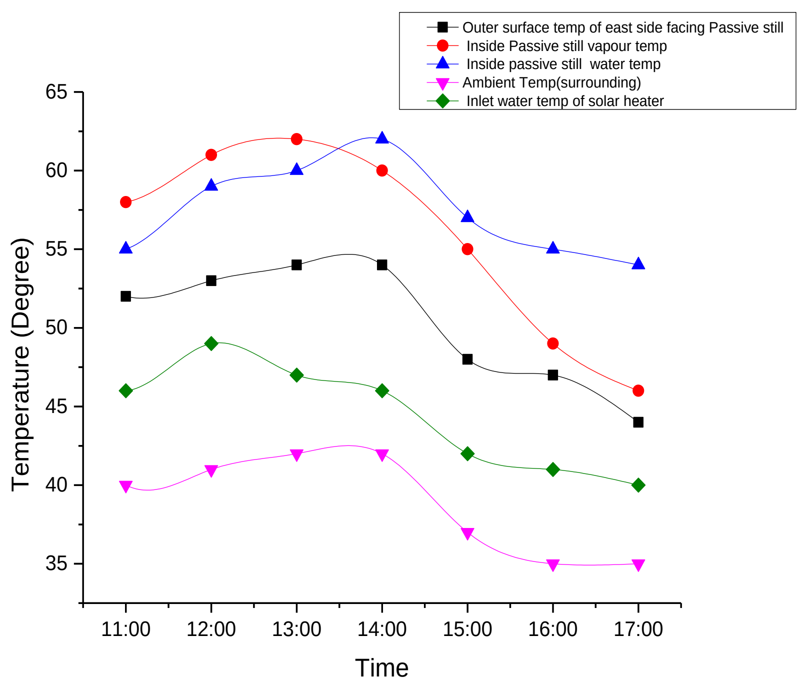

Fig 63. Hourly variations in temperature of passive still at 5cm depth in summer season

Passive 05/04/2022 Summer 2CM Reading

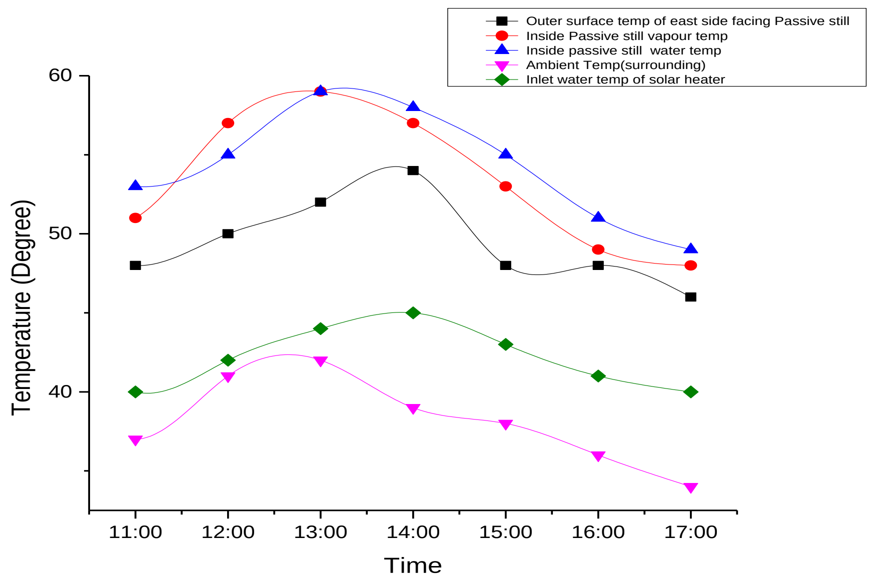

Fig 64. Hourly variations in temperature of passive still at 2cm depth in summer season

Passive 06/04/2022 Summer 2CM Reading

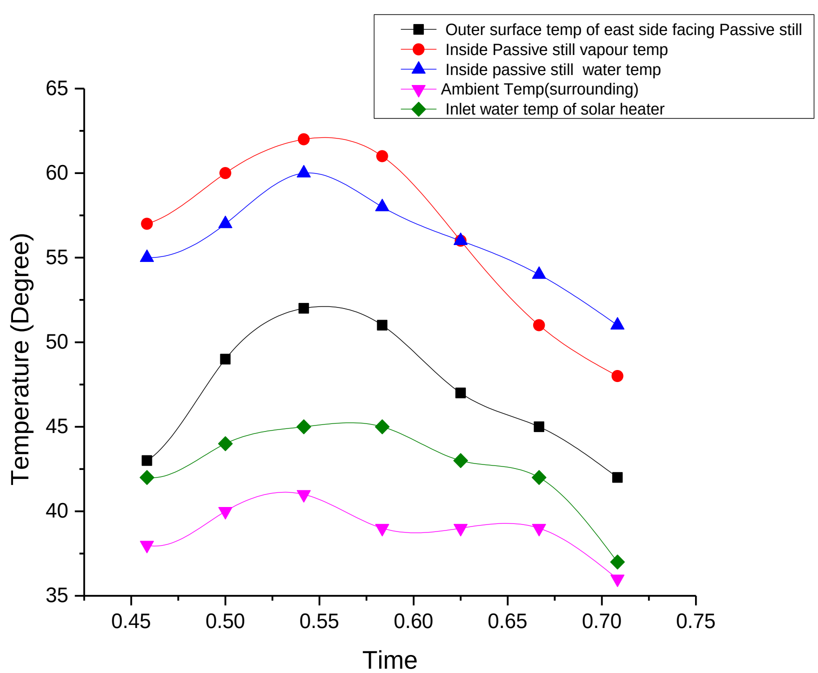

Fig 65. Hourly variations in temperature of passive still at 2cm depth in summer season

Passive 08/04/2022 Summer 2CM Reading

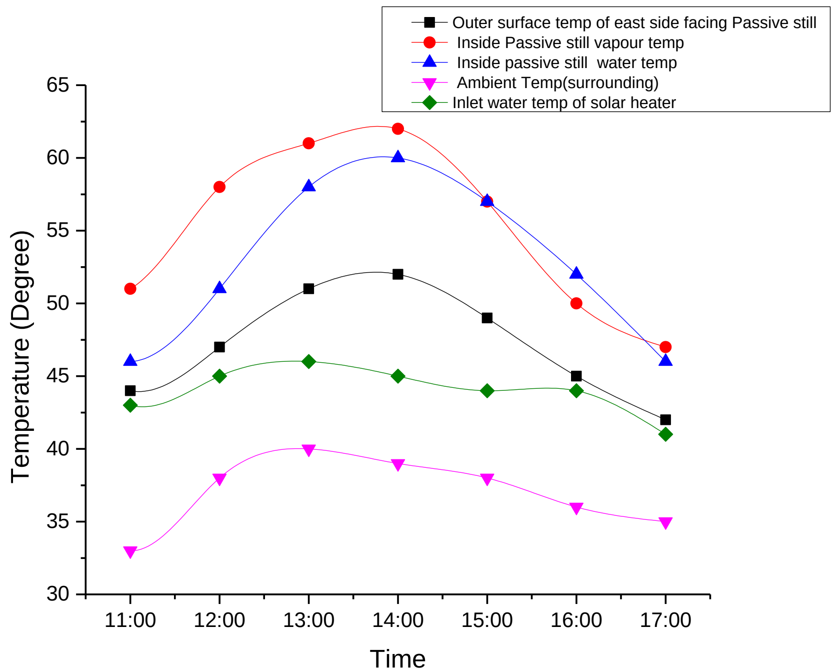

Fig 66. Hourly variations in temperature of passive still at 2cm depth in summer season

Passive 11/04/2022 Summer 2CM Reading

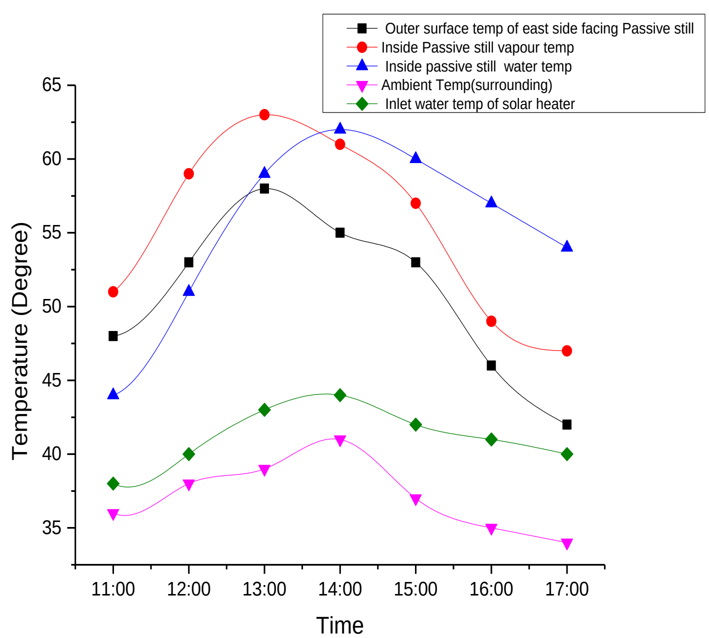

Fig 67. Hourly variations in temperature of passive still at 2cm depth in summer season

Passive 12/04/2022 Summer 2CM Reading

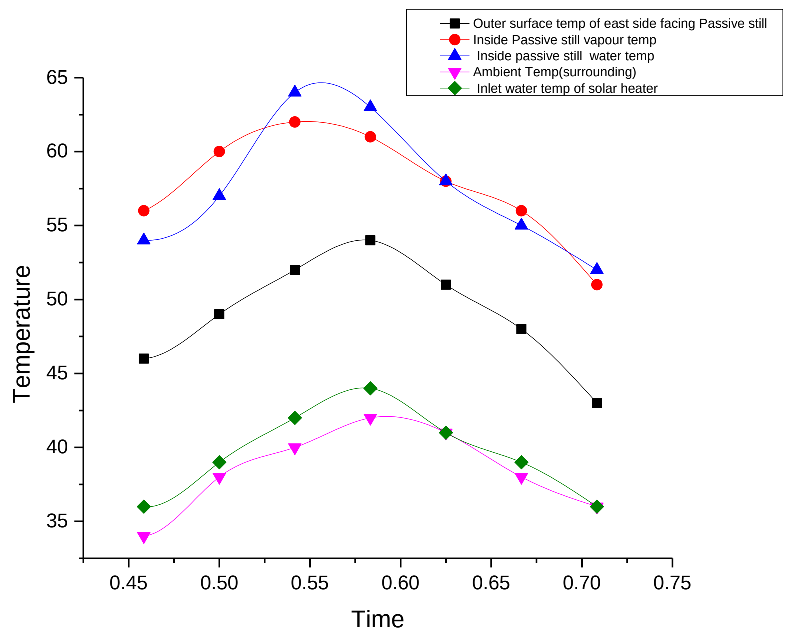

Fig 68. Hourly variations in temperature of passive still at 2cm depth in summer season

Passive 13/04/2022 Summer 2CM Reading

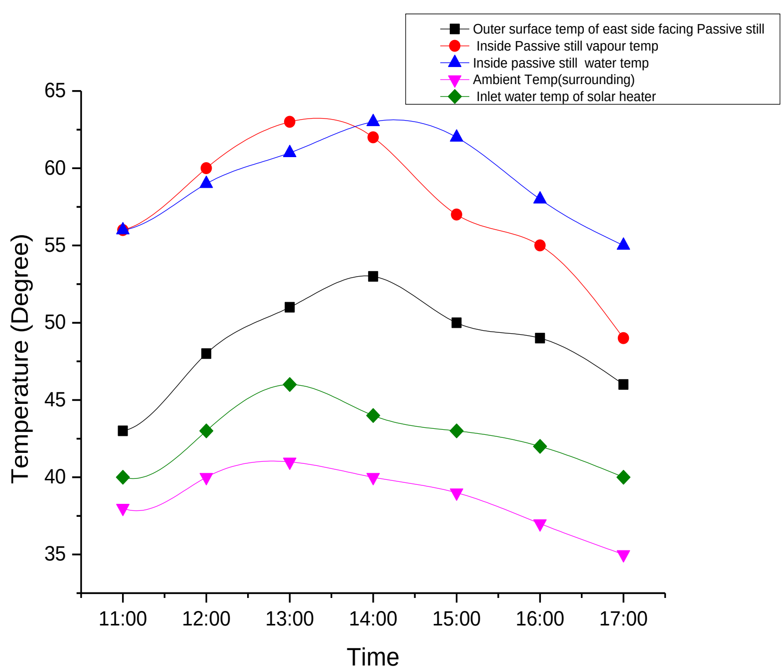

Fig 69. Hourly variations in temperature of passive still at 2cm depth in summer season

5.2 Explanation of showing Result in Graphs

Table No. 59 Explanation of showing Result in Graphs for All 2cm Depth Cases

ABSORBING MATERIALS	ACTIVE WINTER 2CM	PASSIVE WINTER 2CM	ACTIVE SUMMER 2CM	PASSIVE SUMMER 2CM
WITHOUT ABSORBER PLATE	Case 2 Fig no .1 of material(without absorbing plate) for winter season 2cm represent that in daily experimentation it is found that for case 2 in winter season 2cm depth for material (without absorbing plate) the graph shows that the productivity is 3.2 l and exergy is 73.96	Case 2 Fig no. for winter season 2cm represent that in daily experimentation it is found that for case 2 in winter season 2cm depth the graph shows that the productivity is 1.3l and exergy is 19.65	Case 4 Fig no .1 of material(without absorbing plate) for summer season 2cm represent that in daily experimentation it is found that for case 4 in summer season 2cm depth for material (without absorbing plate) the graph shows that the productivity is 6.8 l and exergy is 118.09	Case 4 Fig no .for summer season 2cm represent that in daily experimentation it is found that for case 4 in summer season 2cm depth the graph shows that the productivity is 1.5 l and exergy is 32.84
IRON ROD	Case 2 Fig no .2 of iron rod for winter season 2cm depth represent that in daily experimentation it is found that for case 2 in winter season 2 cm depth for iron rod the graph shows that the productivity is 2.6 l and exergy is 49.25	Case 2 Fig no .for winter season 2cm depth represent that in daily experimentation it is found that for case 2 in winter season 2 cm depth the graph shows that the productivity is 1.12l and exergy is 20.63	Case 4 Fig no .2 of iron rod for summer season 2cm depth represent that in daily experimentation it is found that for case 4 in summer season 2cm depth for iron rod the graph shows that the productivity is 5.8 l and exergy is 101.59	Case 4 Fig no .for summer season 2cm depth represent that in daily experimentation it is found that for case 4 in summer season 2cm depth the graph shows that the productivity is 1.8 l and exergy is 36.19
LIME STONE	Case 2 Fig no .3 of lime stone for winter season 2cm depth represent that in daily experimentation it is found that for case 2 in winter season 2cm depth for lime stone the graph shows that the productivity is 2.6 l and exergy is 45.66	Case 2 Fig no. for winter season 2cm depth represent that in daily experimentation it is found that for case 2 in winter season 2cm depth the graph shows that the productivity is 1.4l and exergy is 17.67	Case 4 Fig no .3 of lime stone for summer season 2cm depth represent that in daily experimentation it is found that for case 4 in summer season 2cm depth for lime stone the graph shows that the productivity is 5 l and exergy is 99.66	Case 4 Fig no. for summer season 2cm depth represent that in daily experimentation it is found that for case 4 in summer season 2cm depth the graph shows that the productivity is 1.4 l and exergy is 29.22

ABSORBING MATERIALS	ACTIVE WINTER 2CM	PASSIVE WINTER 2CM	ACTIVE SUMMER 2CM	PASSIVE SUMMER 2CM
BLACK PAINT	Case 2 Fig no .4 of black paint for winter season 2cm depth represent that in daily experimentation it is found that for case 2 in winter season 2cm depth for black paint the graph shows that the productivity is 2.3 l and exergy is 39.55	Case 2 Fig no. for winter season 2cm depth represent that in daily experimentation it is found that for case 2 in winter season 2cm depth the graph shows that the productivity is 1.2l and exergy is 21.07	Case 4 Fig no .4 of black paint for summer season 2cm depth represent that in daily experimentation it is found that for case 4 in summer season 2cm depth for black paint the graph shows that the productivity is 5.5 l and exergy is 116.09	Case 4 Fig no .for summer season 2cm depth represent that in daily experimentation it is found that for case 4 in summer season 2cm depth the graph shows that the productivity is 1.5 l and exergy is 30.65
SAND	Case 2 Fig no .5 of sand for winter season 2cm depth represent that in daily experimentation it is found that for case 2 in winter season 2cm depth for sand the graph shows that the productivity is 2.2 l and exergy is 47.29	Case 2 Fig no for winter season 2cm depth represent that in daily experimentation it is found that for case 2 in winter season 2cm depth the graph shows that the productivity is 1.6l and exergy is 20.95	Case 4 Fig no .5 of sand for summer season 2cm depth represent that in daily experimentation it is found that for case 4 in summer season 2cm depth for sand the graph shows that the productivity is 5.6 l and exergy is 119.69	Case 4 Fig no. for summer season 2cm depth represent that in daily experimentation it is found that for case 4 in summer season 2cm depth the graph shows that the productivity is 1.4 l and exergy is 24.61
TILES	Case 2 Fig no .6 of tiles for winter season 2cm depth represent that in daily experimentation it is found that for case 2 in winter season 2cm depth for tiles the graph shows that the productivity is 2.4 l and exergy is 54.50	Case 2 Fig no. for winter season 2cm depth represent that in daily experimentation it is found that for case 2 in winter season 2cm depth the graph shows that the productivity is 1.5 l and exergy is 20.108	Case 4 Fig no .6 of tiles for summer season 2cm depth represent that in daily experimentation it is found that for case 4 in summer season 2cm depth for tiles the graph shows that the productivity is 5 l and exergy is 110.59	Case 4 Fig no. for summer season 2cm depth represent that in daily experimentation it is found that for case 4 in summer season 2cm depth the graph shows that the productivity is 1.6 l and exergy is 35.25

ABSORBING MATERIALS	ACTIVE WINTER 2CM	PASSIVE WINTER 2CM	ACTIVE SUMMER 2CM	PASSIVE SUMMER 2CM
RIVER STONE	Case 2 Fig no .7 of river stone for winter season 2cm depth represent that in daily experimentation it is found that for case 2 in winter season 2cm depth for river stone the graph shows that the productivity is 2.3 l and exergy is 44.26	Case 2 Fig no. for winter season 2cm depth represent that in daily experimentation it is found that for case 2 in winter season 2cm depth the graph shows that the productivity is 1.4l and exergy is 21.68	Case 4 Fig no .7 of river stone for summer season 2cm depth represent that in daily experimentation it is found that for case 4 in summer season 2cm depth for river stone the graph shows that the productivity is 5.5 l and exergy is 116.69	Case 4 Fig no. for summer season 2cm depth represent that in daily experimentation it is found that for case 4 in summer season 2cm depth the graph shows that the productivity is 1.6 l and exergy is 34.22

Table No. 60 Explanation of showing Result in Graphs for All 5cm Depth Cases

ABSORBING MATERIAL	ACTIVE WINTER 5CM	PASSIVE WINTER 5CM	ACTIVE SUMMER 5 CM	PASSIVE SUMMER 5 CM
WITHOUT ABSORBER PLATE	Case 1 Fig no .1 of material(without absorbing plate) for winter season 5cm represent that in daily experimentation it is found that for case 1 in winter season 5cm depth for material (without absorbing plate) the graph shows that the productivity is 2.2 l and exergy is 33.98	Case 1 Fig no. for winter season 5cm represent that in daily experimentation it is found that for case 1 in winter season 5cm depth the graph shows that the productivity is 0.8l and exergy is 14.11	Case 3 Fig no .1 of material(without absorbing plate) for summer season 5cm represent that in daily experimentation it is found that for case 3 in summer season 5cm depth for material (without absorbing plate) the graph shows that the productivity is 5.5 l and exergy is 105.29	Case 3 Fig no. for summer season 5cm represent that in daily experimentation it is found that for case 3 in summer season 5cm depth the graph shows that the productivity is 1.2l and exergy is 19.16

ABSORBING MATERIAL	ACTIVE WINTER 5CM	PASSIVE WINTER 5CM	ACTIVE SUMMER 5 CM	PASSIVE SUMMER 5 CM
IRON ROD	Case 1 Fig no .2 of iron rod for winter season 5cm depth represent that in daily experimentation it is found that for case 1 in winter season 5cm depth for iron rod the graph shows that the productivity is 1.8l and exergy is 22.91	Case 1 Fig no. for winter season 5cm depth represent that in daily experimentation it is found that for case 1 in winter season 5cm depth the graph shows that the productivity is 0.75 l and exergy is 15.78	Case 3 Fig no .2 of iron rod for summer season 5 cm depth represent that in daily experimentation it is found that for case 3 in summer season 5cm depth for iron rod the graph shows that the productivity is 4.6l and exergy is 87.28	Case 3 Fig no. for summer season 5 cm depth represent that in daily experimentation it is found that for case 3 in summer season 5cm depth the graph shows that the productivity is 1.4l and exergy is 15.88
LIME STONE	Case 1 Fig no .3 of lime stone for winter season 5cm depth represent that in daily experimentation it is found that for case 1 in winter season 5cm depth for lime stone the graph shows that the productivity is 1.6l and exergy is 22.79	Case 1 Fig no. for winter season 5cm depth represent that in daily experimentation it is found that for case 1 in winter season 5cm depth the graph shows that the productivity is 0.6l and exergy is 12.17	Case 3 Fig no .3 of lime stone for summer season 5cm depth represent that in daily experimentation it is found that for case 3 in summer season 5cm depth for lime stone the graph shows that the productivity is 4 l and exergy is 85.28	Case 3 Fig no. for summer season 5cm depth represent that in daily experimentation it is found that for case 3 in summer season 5cm depth the graph shows that the productivity is 1.2l and exergy is 18.82
BLACK PAINT	Case 1 Fig no .4 of black paint for winter season 5cm depth represent that in daily experimentation it is found that for case 1 in winter season 5cm depth for black paint the graph shows that the productivity is 1.4l and exergy is 24.79	Case 1 Fig no. for winter season 5cm depth represent that in daily experimentation it is found that for case 1 in winter season 5cm depth the graph shows that the productivity is 0.5 l and exergy is 9.60	Case 3 Fig no .4 of black paint for summer season 5cm depth represent that in daily experimentation it is found that for case 3 in summer season 5cm depth for black paint the graph shows that the productivity is 4.3 l and exergy is 87.79	Case 3 Fig no. for summer season 5cm depth represent that in daily experimentation it is found that for case 3 in summer season 5cm depth the graph shows that the productivity is 1.2l and exergy is 20.53

ABSORBING MATERIAL	ACTIVE WINTER 5CM	PASSIVE WINTER 5CM	ACTIVE SUMMER 5 CM	PASSIVE SUMMER 5 CM
SAND	Case 1 Fig no .5 of sand for winter season 5cm depth represent that in daily experimentation it is found that for case 1 in winter season 5cm depth for sand the graph shows that the productivity is 1.7 l and exergy is 30.62	Case 1 Fig no .for winter season 5cm depth represent that in daily experimentation it is found that for case 1 in winter season 5cm depth the graph shows that the productivity is 0.8l and exergy is 13.68	Case 3 Fig no .5 of sand for summer season 5cm depth represent that in daily experimentation it is found that for case 3 in summer season 5cm depth for sand the graph shows that the productivity is 4.5l and exergy is 93.06	Case 3 Fig no. for summer season 5cm depth represent that in daily experimentation it is found that for case 3 in summer season 5cm depth the graph shows that the productivity is 1.25l and exergy is 23.59
TILES	Case 1 Fig no .6 of tiles for winter season 5cm depth represent that in daily experimentation it is found that for case 1 in winter season 5cm depth for tiles the graph shows that the productivity is 1.6l and exergy is 27.59	Case 1 Fig no. for winter season 5cm depth represent that in daily experimentation it is found that for case 1 in winter season 5cm depth the graph shows that the productivity is 1.1l and exergy is 15.11	Case 3 Fig no .6 of tiles for summer season 5cm depth represent that in daily experimentation it is found that for case 3 in summer season 5cm depth for tiles the graph shows that the productivity is 4.6 l and exergy is 88.06	Case 3 Fig no. for summer season 5cm depth represent that in daily experimentation it is found that for case 3 in summer season 5cm depth the graph shows that the productivity is 1.3l and exergy is 20.97
RIVER STONE	Case 1 Fig no .7 of river stone for winter season 5cm depth represent that in daily experimentation it is found that for case 1 in winter season 5cm depth for river stone the graph shows that the productivity is 1.6l and exergy is 26.69	Case 1 Fig no. for winter season 5cm depth represent that in daily experimentation it is found that for case 1 in winter season 5cm depth the graph shows that the productivity is 0.92l and exergy is 13.17	Case 3 Fig no .7 of river stone for summer season 5cm depth represent that in daily experimentation it is found that for case 3 in summer season 5cm depth for river stone the graph shows that the productivity is 4.2l and exergy is 90.5	Case 3 Fig no. for summer season 5cm depth represent that in daily experimentation it is found that for case 3 in summer season 5cm depth the graph shows that the productivity is 1.2l and exergy is 20.76

5.3 Limitation

- Low distillate output per unit area.
- Productivity decreases with time for a variety of reasons.
- Cost per unit output is very high.
- Installation requires the use of a new hot water cylinder.
- Additional roof top space is required to install the solar heater.
- It will not be very helpful in rainy season or foggy days.

CHAPTER 6
CONCLUSION

6.1 Conclusion

After the Experimentation of PSS using solar water heater for both active and passive modes, following are the observation and conclusion of the experimental analysis,

- Performance and Productivity of Pyramid solar still is increase as compared to conventional solar still methodology using Passive & Active Technique by integrating the solar water heater.
- Purify the water and increase the success rate of solar still much better than other methods of water purification without using any costlier source of energy.
- Improve the efficiency and distillate productivity of solar still using Passive & Active Technique.
- Use of Solar water heater has improved the efficiency of Solar Still.
- Improved the Quality of water in low cost.
- The productivity found in winter season with 2 cm depth of active still is 3.2 l, 2.6 l, 2.6 l, 2.3 l, 2.2 l, 2.4 l, 2.3 l (liter) and exergy is 73.96, 49.25, 45.66, 39.55, 47.29, and 54.50.
- The productivity found in winter season with 2 cm depth of passive still is 1.3 l, 1.12 l, 1.4 l, 1.2, l, 1.6 l, 1.5 l, 1.4 l (liter) And exergy is 19.65 20.63, 17.67, 21.07, 20.95, 20.108, 21.68.
- The productivity found in summer season with 2 cm depth of active still is 6.8 l, 5.8 l, 5 l, 5.5 l, 5.6 l, 5 l, 5.5 l (liter) and exergy is 118.09, 101.59, 99.66, 116.09, 119.69, 110.59, and 166.69.
- The productivity found in summer season with 2 cm depth of passive still is 1.5 l, 1.8 l, 1.4 l, 1.5 l, 1.4 l, 1.6 l, 1.6 l (liter) and exergy is 32.84, 36.19, 29.22, 30.65, 24.61, 35.25, and 34.22
- The productivity found in winter season with 5 cm depth of active still is 2.2 l, 1.8 l, 1.6 l, 1.4 l, 1.7 l, 1.6 l, 1.6 l (liter) and exergy is 33.98, 22.19, 22.79, 24.79, 30.62, 27.59, and 26.69.
- The productivity found in winter season with 5 cm depth of passive still is 0.8 l, 0.75 l, 0.6 l, 0.5 l, 0.8 l, 1.1 l, 0.92 l (liter) and exergy is 33.98, 22.91, 22.79, 24.79, 30.62, 27.59, and 26.69.
- The productivity found in summer season with 5 cm depth of active still is 5.5 l, 4.6 l, 4 l, 4.3 l, 4.5 l, 4.6 l, 4.2 l (liter) and exergy is 105.29, 87.28, 85.28, 87.79, 93.06, 88.06, and 90.5.
- The productivity found in summer season with 5 cm depth of passive still is 1.2 l, 1.4 l, 1.2 l, 1.2 l, 1.25 l, 1.3 l, 1.2 l (liter) and exergy is 19.16, 15.88, 18.82, 20.53, 23.59, 20.97, and 20.76.

6.2 Cost Analysis

Table No. 61 Cost Analysis of Experimental Setup

Sr. No.	**Heads of Expenditure**	**Quantity**	**Rate**	**Amount in Rs.**
A	**Fabrication**			
1	Tank 1m*1m*0.2m	02	3250	7500
2	MS Stand	02	900	1800
3	Tough and Glass 4mm	08	1187	9496
4	Absorber Plate	02	1000	2000
B	**Installation and other charges**			
1	Accessories	-	6000	6000
2	Temperature Indicator with Thermocouples	-	3830	3830
3	Solar Water Heater	01	13500	13500
			Grand Total (A+B)	**44,126 /-**

CHAPTER 7
LITRATURE CITED

7.1 Literature Cited

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CHAPTER 8
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LIST OF PUBLICATIONS:

Sr. No.	Authors	Title of Paper	Name of International Journals / International Conference	Place and date of Publication with **Citation** Index
01	Kaushik C. Kirpade, Saiprasad I. Shellikeri, Sahil D. Kolhe, Yash D. Meshram Rohini Gutte	Investigation of PSS using Solar Water Heater for Active and Passive Modes	International Conference on Tech Trends in Science & Engineering, Sponsored by AICTE, & ISTE Approved at SCOET Nagpur from 25th-26th Feb 2022	NA

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LIST OF PARTICIPATION:

Sr. No.	Name of Participants	Name of Activity	Place and Date of Activity	Position if any
01	Kaushik C. Kirpade, Saiprasad I. Shellikeri, Sahil D. Kolhe, Yash D. Meshram	Project Competition Under National Level Technical Fest i.e. TECHKRUNCH”	G H Raisoni Institute of Engineering and Technology Nagpur, 21-23 April 2022	Secured 2nd Position
02	Kaushik C. Kirpade, Saiprasad I. Shellikeri, Sahil D. Kolhe, Yash D. Meshram	Poster Competition Under National Level Technical Fest i.e. TECHKRUNCH”	G H Raisoni Institute of Engineering and Technology Nagpur, 21-23 April 2022	NA

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and secured 2nd position in National Level

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Dr. Manish Gupta, Robotics Club Incharge
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