**Master Thesis**

# Solar apparatus for water distillation

*Study programme:* N0723A270002 Textile Engineering
*Author:* **Kaushal Vipul Shah, B.Tech.**
*Thesis Supervisors:* prof. Ing. Jakub Wiener, Ph.D.
Department of material engineering

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FACULTY OF TEXTILE ENGINEERING TUL

## Master Thesis Assignment Form

# Solar apparatus for water distillation

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| *Name and surname:* | **Kaushal Vipul Shah, B.Tech.** |
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### Rules for Elaboration:

1) Make a literature review focused on water distillation by solar radiation
2) Propose and construct solar water distillation apparatus containing textiles
3) Optimise construction of this apparatus for possible harvesting of drinkable water from wasted water or sea water
4) Quantify yield of this distillation process in comparison with theoretical calculations
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1. Li, X., Li, J., Lu, J., Xu, N., Chen, C., Min, X., Zhu, B., Li, H., Zhou, L., Zhu, S., Zhang, T., & Zhu, J. (2018).Enhancement of Interfacial Solar Vapor Generation by Environmental Energy. Joule, 2(7), 1331– 1338. https://doi.org/10.1016/j.joule.2018.04.004
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L.S.

doc. Ing. Vladimír Bajzík, Ph.D.
Dean

doc. Ing. Jiří Chvojka, Ph.D.
Head of Department

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# Abstract

Solar water distillation is a viable method for creating potable water in locations with limited access to clean water. To produce clean water, the procedure entails heating water with solar radiation and collecting the condensed water vapor. Solar water distillation provides several benefits, such as simplicity, affordability, and sustainability. This abstract focuses on solar-powered water distillation and gives a general description of the method, its advantages, and some of the difficulties involved in putting it into practice. We also talk about the most current developments in solar water distillation technologies, such as the utilization of fabrics and other materials to increase productivity. By combining passive solar tracking systems that optimize the alignment of the distillation unit with the sun and by employing materials like textiles, which can boost the absorption and retention of solar radiation, it is possible to increase the efficiency of solar water distillation. Although solar water distillation is a relatively easy process, there are a number of difficulties with its application, such as the requirement for sufficient sunlight, the danger of the distillation unit overheating or freezing, and the possibility of contamination during storage and handling of the produced water. It is crucial to take into account elements like maintenance, local capacity building, and community involvement in the design and execution of the systems to ensure the long-term sustainability of solar water distillation projects. In many parts of the world, especially in rural and distant locations, solar water distillation has the potential to dramatically increase access to clean water. This method uses the power of the sun to provide clean water that is dependable and sustainable, enhancing social well-being, economic growth, and health. Finally, we draw attention to the possibility of solar water distillation as a remedy for the world's water issue, particularly in poorer nations where obtaining clean water continues to be a significant challenge.



**Keywords:** Sustainability, Potable water distillation, Fabric distillation materials, Affordable water treatment, Productivity advancement.

# Abstrakt

Solární destilace vody je životaschopnou metodou pro výrobu pitné vody v místech s omezeným přístupem k čisté vodě. Postup k výrobě čisté vody zahrnuje ohřev vody slunečním zářením a shromažďování kondenzované vodní páry. Solární destilace vody poskytuje několik výhod, jako je jednoduchost, cenová dostupnost a udržitelnost. Tato práce se zaměřuje na solární destilaci vody a poskytuje obecný popis této metody, její výhody a některé obtíže spojené s jejím uvedením do praxe. Hovoříme také o nejaktuálnějším vývoji v technologiích solární destilace vody, jako je využití tkanin a dalších materiálů ke zvýšení produktivity. Kombinací pasivních solárních sledovacích systémů, které optimalizují vyrovnání destilační jednotky se sluncem, a použitím materiálů, jako jsou textilie, které mohou zvýšit absorpci a zadržování slunečního záření, je možné zvýšit účinnost solární destilace vody. Přestože je solární destilace vody poměrně snadný proces, s její aplikací je spojena řada úskalí, jako je požadavek na dostatek slunečního záření, nebezpečí přehřátí nebo zamrznutí destilační jednotky, možnost kontaminace při skladování a manipulaci s vyrobenou vodou. Je velmi důležité vzít v úvahu prvky, jako je údržba, budování místních kapacit a zapojení komunity do návrhu a realizace systémů, aby byla zajištěna dlouhodobá udržitelnost projektů solární destilace vody. V mnoha částech světa, zejména ve venkovských a vzdálených oblastech, má solární destilace vody potenciál dramaticky zvýšit přístup k čisté vodě. Tato metoda využívá sílu slunce k zajištění čisté vody, která je spolehlivá a udržitelná, což zvyšuje sociální blahobyt, ekonomický růst a zdraví. Nakonec upozorňujeme na možnost solární destilace vody jako léku na světový problém s vodou, zejména v chudších zemích, kde je získávání čisté vody i nadále významnou výzvou.

**Klíčová slova:** Udržitelnost, Destilace pitné vody, Materiály na destilaci látek, Cenově dostupná úprava vody, Zvýšení produktivity.

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## Acknowledgment

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# Preface

Clean and safe drinking water is essential for human development. Unfortunately, many countries still lack clean water. Practical and sustainable potable water solutions are needed to improve millions of lives.

This thesis examines the feasibility of solar water distillation in areas with limited clean water. Solar water distillation uses solar radiation to heat water and collect condensed water vapor, making water purification simple, affordable, and sustainable.

The abstract describes solar-powered water distillation, its benefits, and its challenges. It also discusses the latest solar water distillation technologies, including using fabrics and other innovative materials to boost productivity.

Passive solar tracking systems and materials that optimize solar radiation absorption and retention can boost solar water distillation efficiency. To ensure success, issues like sunlight, distillation unit overheating or freezing, and water contamination during storage and handling must be addressed.

Maintenance, local capacity building, and community involvement in system design and implementation are also crucial to solar water distillation project sustainability. Solar water distillation can transform rural and remote areas without clean water by engaging and empowering local communities.

Solar water distillation could solve the water crisis, especially in impoverished areas with scarce clean water. This method uses solar power to provide clean water, improving social well-being, economic growth, and health.

Solar water distillation could solve the global water crisis, so we must consider its pros and cons. This thesis aims to improve water accessibility and foster a better future by highlighting solar water distillation, especially in developing nations.

# 1. Introduction

Traditional materials utilized in solar distillation systems, such as glass and metal, have a few drawbacks compared to textile materials, which offer a few benefits. Because they are not only lightweight but also flexible and simple to move, textiles are a perfect alternative for usage in regions that are not connected to a grid. In addition to this, they are inexpensive and can readily be adjusted in size to accommodate the requirements of a variety of communities.[1]

One of the most significant challenges that the world is now confronted with is a severe lack of water, which is especially problematic in regions with limited access to potable water. This is particularly true in nations that are still developing. The process of solar distillation begins with the evaporation of water, which is followed by the condensation of the water vapor that has been produced into pure, distilled water. This process is powered by the sun. This approach is one of the potential solutions that is being investigated for the problem that is currently being dealt with. In recent years, researchers have been researching the idea of employing textile materials in solar distillation systems, such as polystyrene nonwoven, in order to improve the performance of the systems and save money on the expenses of doing so. Polystyrene nonwoven is a material that is appropriate for use in solar distillation systems because it is a good option in terms of cost, weight, and absorption capacity. Polystyrene nonwoven is a lightweight material. Polystyrene nonwoven may be used in the design of solar distillation systems to increase the efficiency and efficacy of the systems, making them a more cost-effective solution to the issue of water shortage.

A critical problem that affects millions of people all over the globe is a lack of available fresh water. Despite the fact that the world's water supplies are limited, the demand for potable water is rising at an alarming rate owing to factors such as urbanization, industrialization, and population expansion. The method of solar distillation, which utilizes the sun's energy to evaporate and purify water, has recently come to the forefront as a potential solution to this issue. Traditional methods of solar distillation, on the other hand, suffer from a number of drawbacks, including high prices, poor efficiencies, and fragility. Solar distillation using textiles is a novel method that has the ability to circumvent these restrictions and offer a dependable supply of clean water. In this article, we will take a look at the research that has been done so far on the topic of water distillation using solar radiation from woven materials.[2], [3] Polystyrene nonwoven is a kind of textile material that may be used in solar distillation systems to solve the problem of durability and performance in harsh climatic conditions. These systems are designed to utilize solar energy to produce distilled water. Polystyrene nonwoven is distinguished by its capacity to tolerate high temperatures and ultraviolet radiation without suffering considerable deterioration. This is in contrast to the behavior of certain other textile materials, which may lose part of their effectiveness over time or disintegrate when subjected to similar circumstances. Because of this, its use in solar distillation systems is an appealing choice, as it may contribute to ensuring that the system continues to be successful throughout the course of its lifetime. Solar distillation systems may benefit from the use of polystyrene nonwoven since it is lightweight and has a high absorption capacity. This can bring about an even greater improvement in system performance. As a result, the use of polystyrene nonwoven in solar distillation might be a potentially fruitful solution to the challenge of assuring the durability and efficiency of textile materials in such systems.

During this research, we came to the conclusion that solar distillation systems utilizing polyethylene terephthalate (PET) and polyamide textile materials were not nearly as efficient as those utilizing polystyrene nonwoven. In contrast to a conventional still made of glass, solar still made from PET textile had a lower distillate output and a greater rate of heat loss. In a similar vein, when a solar still was made from polyamide cloth as compared to a glass still, it was found that the polyamide still was not as effective at producing clean water. According to the results of our research, polystyrene nonwoven beats PET and polyamide textiles when used in solar distillation systems. As a result, this material is a more attractive candidate for use in developing solutions to the problem of water shortage. [1], [4][5]

In addition to making solar stills more effective and long-lasting, researchers are investigating the feasibility of incorporating textile-based solar distillation into pre-existing water treatment infrastructure, such as desalination plants and wastewater treatment facilities. This might assist to enhance the overall efficiency and sustainability of these systems, as well as offer populations who are in need of a dependable supply of clean water.[6]

apart from PET and polyamide fabrics. The high absorption capacity of polystyrene nonwoven is what enables it to capture a greater quantity of water vapor as a by-product of distillation. This property is well recognized.

Additionally, it is lightweight and flexible, which makes it simpler to work with and more adaptable to a variety of system designs. In addition, the thermal conductivity of polystyrene nonwoven is lower compared to that of PET and polyamide textiles. This results in less heat being lost from the system, which in turn helps to keep temperatures at a higher level. As a result of these considerations, we have concluded that polystyrene nonwoven is a more appropriate material for use in solar distillation systems. This material provides superior performance, increased efficiency, and a higher potential for tackling the urgent problem of water shortage.

In addition to making solar stills more effective and long-lasting, researchers are investigating the feasibility of incorporating textile-based solar distillation into pre-existing water treatment infrastructure, such as desalination plants and wastewater treatment facilities. This might assist to enhance the overall efficiency and sustainability of these systems, as well as offer populations who are in need of a dependable supply of clean water.[6]

The following are some advantages of solar distillation using textiles:

- In comparison to more conventional solar distillation systems, textile-based solar distillation offers several significant benefits.
- To begin, textiles are convenient for usage in off-grid or remote regions since they are lightweight, flexible, and simple to carry.
- This makes them a perfect alternative.
- Second, textiles are inexpensive and can easily have their production levels increased or decreased to accommodate the requirements of a variety of communities.
- Thirdly, textiles have a wide range of applications and may be tailored to fulfill a variety of needs, including resistance to wear and tear, thermal insulation, and transparency to light.

Problems associated with solar distillation using textiles:

- In textile-based solar distillation, one of the primary issues is ensuring that the textile material can endure extreme climatic conditions, such as high temperatures and UV radiation, without deteriorating or losing its efficacy.
- This is one of the fundamental challenges associated with the process.
- To find a solution to this problem, researchers have been investigating several kinds of textile materials, such as polyester, polyamide, and

polyethylene, as well as creating novel coatings and treatments to improve the durability and performance of these materials.

- Another difficulty is to increase the effectiveness of the solar distillation system that is based on textiles by improving the design of the system.
- In order to increase the efficiency of the system, researchers have been experimenting with a variety of design factors, including the size and shape of the still, the thickness of the textile material, and the angle at which the solar collector is angled.

Integration with the water treatment systems that are already in place:

- In addition to making solar stills more effective and long-lasting, researchers are investigating the feasibility of incorporating textile-based solar distillation into pre-existing water treatment infrastructure, such as desalination plants and wastewater treatment facilities.
- This might assist to enhance the overall efficiency and sustainability of these systems, as well as offer populations who are in need of a dependable supply of clean water.

The following are some advantages of solar distillation using textiles:

- Solar stills made from textiles are both lightweight and portable, making it simple to move them to off-grid or isolated regions that have limited access to clean water.
- Solar stills produced from textiles are considerably inexpensive when compared to more conventional solar stills manufactured from glass or plastic.
- Textile materials may be made to satisfy particular criteria such as durability, thermal insulation, and light transmission. This versatility allows textile materials to be used in a variety of applications.
- Solar stills made from textiles may readily be scaled up or down to fit the requirements of a variety of communities.

## 2. Literature Review

The lack of access to clean water is a critical problem that requires inventive approaches to be addressed on a worldwide scale. Distillation of water using solar energy has recently gained attention as a potentially useful approach to overcoming this obstacle. In this review of the lecture, we will discuss the significance of fresh water, the various pollutants that may be found in water, as well as the characteristics of fresh water. We will investigate the potential for solar water distillation to effectively address these concerns and contribute to sustainable water management.[7]

Water that comes from natural sources like rivers, lakes, and groundwater can frequently contain impurities that make it unfit for human consumption in its purest form. Impurities can come in the form of particles that are suspended in the water, salts that are dissolved in it, minerals, organic compounds, microbes, and even pollutants that are produced by industrial processes. Ingestion of contaminated water can result in diseases that are spread by waterborne organisms as well as long-term health problems. The elimination of these pollutants is essential to provide populations with water that can be consumed safely.[7]

Fresh water is distinguished from other types of water by the presence of a number of critical qualities that make it acceptable for human consumption. To begin, it needs to have a pH level that is neutral, ideally somewhere near 7, so that it can keep a healthy equilibrium in the human body. Second, it must be clear of pathogenic germs like bacteria, viruses, and parasites in order to be safe for consumption. In addition, there should be low concentrations of dissolved salts, minerals, and other pollutants in fresh water. These contaminants can alter the flavor, clarity, and overall quality of the water.[7]

The process of solar water distillation harnesses the energy from the sun to extract contaminants from water through the processes of evaporation and condensation. This process is known as water purification. The fundamental idea is to evaporate impure water by subjecting it to sun radiation, which heats the water to the point where it evaporates and leaves the impurities behind. After that, the generated water vapor is condensed, and the resulting water is collected and filtered. Solar distillation is an efficient method for getting rid of a wide variety of contaminants, such as bacteria, dissolved solids, and even heavy metals.

A potential solution for supplying safe drinking water in places with limited access to clean water is solar-powered water distillation. In this study of the literature, we will look at the present state of solar distillation research and its possible applications in underdeveloped nations.[7]

With the help of sunlight, water is evaporated, and the resultant vapor is subsequently condensed to produce clean, distilled water. In areas with plenty of sunshine and few water resources, this approach has been employed for generations. Recent developments in solar technology have made it possible to boost solar distillation systems' effectiveness, making it more feasible to utilize them in both urban and rural settings.[7]

Solar distillation's capacity to generate clean water without the need of chemicals or power is one of its main advantages. This makes it the perfect option for populations without access to dependable electrical sources or where chemical treatment costs are out of reach. Solar distillation uses renewable energy and doesn't generate any toxic by-products, making it another sustainable alternative.[7]

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The efficiency of solar distillation for creating healthy drinking water has been examined in many research. Solar still may purge tainted water of up to 99.9% of germs and viruses, according to Indian research. Like this, research carried out in Egypt discovered that solar still could successfully remove impurities from sewage, generating clean water that complied with global standards for drinking water quality. [8]

Solar distillation systems are feasible for usage in impoverished nations since they can be built from basic, inexpensive components. In research done in Bangladesh, it was discovered that cheap solar still composed of materials that were readily accessible there could generate clean water for less than one cent per litre. This shows how solar distillation has the potential to provide a low-cost, long-term solution for supplying clean drinking water in locations with few resources.[9]

Solar distillation has advantages, but there are drawbacks that make it difficult to use. The poor efficiency of solar stills, which might restrict the quantity of water that can be generated, is one of the key issues. Researchers are looking at novel materials and design approaches to improve the effectiveness of solar distillation systems to solve this problem. Another difficulty is the need of doing regular maintenance and cleaning on the solar stills to make sure they are operating properly.[10]

## 2.1. Solar Radiation

A promising technology that utilizes solar radiation to purify water and address the difficulties of water scarcity is solar water distillation, which uses solar radiation to do so. The potential of solar radiation water distillation, as well as the financial considerations involved with employing this approach, will be the primary emphasis of this lecture review, in which we will investigate the benefits and drawbacks of adopting this method.[11]

Solar radiation water distillation is a procedure that utilizes the power of the sun to cleanse water. It entails subjecting water that has been tainted with contamination to the radiation of the sun, which heats the water and causes it to evaporate. After that, the generated water vapor is condensed, and the resulting water is collected and filtered. Because this technique is so efficient at removing a wide variety of contaminants, it is well suited for use in regions that have restricted access to sources of clean water and a high demand for potable water.[11]

The following are some of the drawbacks associated with solar radiation water distillation:[11]

**Energy Requirement**

The solar radiation water distillation process is extremely reliant on the availability of sunshine. The system's effectiveness and output may be negatively impacted by weather conditions such as cloudiness, decreased daylight hours, or seasonal shifts. Solar distillation is a sluggish process when compared to other methods of water treatment, which results in a lower production capacity. Solar stills have a limited surface area, so they can only absorb a certain amount of energy. As a result, their production rates are rather modest, and they may not be able to meet the requirements of large-scale water delivery systems.

**Land and Space Requirements**

Systems that use solar radiation to distill water need a large amount of open land for the installation of solar collectors or stills. This land need might be a challenge in areas that have a high population density or locales that have a restricted amount of land available.

**Initial Investment**

The initial cost of establishing solar distillation systems can be relatively significant, especially for large-scale applications. This is especially the case when the system is being used to produce huge quantities of water. The cost accounts for the acquisition and installation of solar collectors, as well as the materials for construction and the initial configuration of the system. In terms of its cost-effectiveness, solar radiation water distillation is not always considered to be an economically viable option when compared to other methods of water treatment. When compared to other systems like filtration or reverse osmosis, its low production rate, large acreage requirements, and high maintenance costs can make it a less cost-effective choice. This is especially true when other options are available.

**Regional Applicability**

The economic viability of solar radiation water distillation is contingent on the geographical location as well as the availability of solar resources. Solar distillation may be economically justifiable in parts of the world that receive an abundance of sunlight but have limited access to other methods of water treatment.

## 2.2 Electronical Solutions for Solar Water Distillation

Distillation of water using solar energy is a process that is both efficient and environmentally friendly for the purification of water. During this review of the lecture, we will investigate the usage of electronic solutions in solar water distillation, talk about the challenges that come with utilizing these solutions, and investigate the financial and ecological impacts that are connected with using these systems.[12]

In recent years, electronic solutions have been created to better the efficiency and management of solar water distillation operations. These improvements have been made possible by recent advances in technology. The introduction of electronic components into the distillation system, such as sensors, pumps, and controllers, is required for these systems to be effective. They hope to improve the monitoring and control capabilities, as well as the overall efficiency of the solar water distillation process, in order to achieve their goals. The following are some of the drawbacks associated with electronic solar water distillation:[12]

**Complexity and Cost**

The addition of electrical components into the solar water distillation system not only adds to the complexity of the system but also results in an increase in the initial investment cost. The upkeep and repair of electronic systems frequently call for the use of specialist knowledge and abilities.

**Dependence on Energy**

Electronic solutions frequently need for an increase in the amount of available electrical power in order for sensors, pumps, and controllers to function properly. This dependence on electricity might be a barrier in places where the supply of electricity is unstable or is in limited supply.

**Impact on the Environment**

The utilization of electronic components results in the production of more electronic waste in addition to the potential for increased environmental concerns. Disposal of these components in an incorrect manner might result in pollution and cause damage to ecosystems.

**Initial Investment:**

In general, electronic solar water distillation systems have a larger initial investment than non-electronic systems do due to the additional electronic components. The costs include the purchase as well as the installation of equipment such as sensors, pumps, controllers, and other such items.

**Maintenance and Operation**

Electronic components need to be calibrated, maintained, and sometimes replaced on a regular basis. This might result in an increase in the overall operational expenses over time.

**Cost-effectiveness**

It is possible that the use of electronic solutions will not always be the most economically viable option, particularly in applications of a smaller size. It is possible that the benefits will be outweighed by the added complexity and maintenance requirements, which would make classic solar water distillation systems more cost-effective.

**Waste Electronic**

The incorporation of electronic components into solar water distillation systems results in an increase in the quantity of waste electronic products produced. In order to reduce the negative effects on the surrounding environment, appropriate disposal and recycling practices should be put into place.

**Energy Consumption**

Because the operation of electronic components often requires the use of electrical power, this might result in higher energy consumption, which has the potential to cancel out some of the positive effects that solar water distillation has on the environment.

## 2.3 Solar Water Distillation by Thermal Solution

Distillation of water using solar energy in conjunction with a thermal solution is an efficient way to cleanse water using solar energy. In this lecture review, we will investigate the benefits of solar distillation, including its economic viability, environmental issues, and advantages in comparison to other types of distillation, such as electronic and solar radiation distillation.[2]

The following are some of the advantages of distilling water using solar energy:

- Solar water distillation utilizes the power of the sun, which is a renewable and abundant source of energy. This process is both sustainable and renewable. As a result of the fact that it does not depend on non-renewable resources and does not emit harmful emissions, it is a solution that is favorable to the environment.
- In terms of cost-effectiveness, solar water distillation through the use of thermal solutions provides advantages in comparison to other technologies for the purification of water. The systems are not overly complicated, and as a result, they have modest requirements for both maintenance and running costs. They are able to be utilized in inaccessible regions where neither electricity nor fuel sources are available.
- The process of solar water distillation can be modified to work with a wide variety of water sources, including saltwater, brackish water, and groundwater that has been contaminated. It does a good job of removing contaminants, such as salts, minerals, and bacteria, and as a result, it is able to provide a dependable source of clean drinking water.

**Possibility of Financial Success**

**Lower Initial Capital Investment**

In general, solar water distillation systems that utilize thermal solutions demand a lower initial capital investment as compared to large-scale solar radiation distillation plants or complicated electronic systems. Because of this, it is a workable choice for applications on a smaller scale and for communities with restricted access to financial resources.Solar distillation systems offer low operational costs because to their reliance on the sun's natural energy, which means they are becoming increasingly popular. After the system has been installed, the majority of the ongoing costs, which are normally quite affordable, are connected to its upkeep.

**Long-Term Cost**

Stability Solar water distillation systems provide long-term cost stability because their prices are not reliant on the ever-changing prices of fuel. In the long run, this offers a method that is both dependable and environmentally friendly for the filtration of water.

**Environmental Considerations**

Solar water distillation through the use of thermal solutions has a very small carbon footprint because it does not require the use of fossil fuels and it does not result in the production of greenhouse gases throughout the process of operation. It contributes to the reduction of environmental pollution and helps minimize the effects of climate change.

Solar distillation uses very few, if any, chemicals for the treatment of water, which reduces the possible environmental concerns connected with the use of chemicals in conventional water treatment methods.

In comparison to electronic distillation systems, solar water distillation using thermal solutions is typically much easier in both the design and operation of the distillation process. Because it utilizes fewer components and is simpler to maintain and repair, its level of dependability is significantly higher.

**Independence from Electricity**

Unlike electronic distillation systems, solar thermal distillation does not rely on any external sources of electricity to function. Because of this, it is well-suited for use in off-grid and remote settings.

**Higher Energy Efficiency**

When Compared to Solar Radiation Distillation Methods Solar thermal distillation systems have a higher energy efficiency when compared to solar radiation distillation. As a result of the thermal solution's ability to capture and maximize heat transfer, energy usage may be optimized, which in turn leads to improved water production rates.

The thermal solution used in solar water distillation has a number of benefits, including the fact that it is a renewable resource, that it is cost-effective, and that it is versatile. It offers a method of water purification that is not only feasible from a financial standpoint but also reduces the negative effects on the environment. In contrast to other methods of solar distillation, such as electronic and solar radiation distillation, solar thermal distillation stands out due to its ease of use, dependability, and superior energy efficiency. Embracing and increasing the use of solar water distillation by thermal solution has the potential to make a substantial contribution to sustainable water management and meet the difficulties posed by the lack of available water on a worldwide scale.

The use of solar distillation to purify water has been the subject of several investigations. Al-Harahsheh et al.'s research examined the functionality of a solar still in Jordan. They discovered that the solar still was capable of producing high-quality water with nothing in the way of bacteria or total dissolved solids (TDS). [13]

Garg et al. (2020) compared the performance of a solar still with that of a traditional still in another investigation. They discovered that compared to the conventional still, the solar still was able to generate water with reduced levels of TDS, turbidity, and microorganisms. [14]

Nair et al.'s (2019) research investigated the effectiveness of a solar still with a built-in heat exchanger. They discovered that the heat exchanger increased the still's effectiveness and enabled it to generate water with reduced TDS and bacterial levels. [15]

Alam et al.'s (2018) research assessed the effectiveness of a solar still with a built-in storage tank. They discovered that the storage tank increased the still's effectiveness and enabled it to generate water with lower TDS and bacterial levels. [16]

Last but not least, research conducted in 2020 by Choong W. assessed the performance of a solar still with an integrated reflector. They discovered that the reflector increased the still's effectiveness and enabled it to generate water with reduced TDS and bacterial levels. [4]

Saravanavel et al. [17] evaluated the usage of porous material to improve the performance of solar pyramid stills. With a constant saline water height of 0.01 m, the tests were carried out at various times of the day utilizing clay pots and chalk pieces as a porous medium. To reduce heat losses to the surroundings, glass wool was used on the side walls of the solar still. Two solar stills, one customized and the other conventional, were compared under identical environmental circumstances. According to their findings, porous material-based solar panels are 36% more efficient than conventional ones. Using permeable fins, Srivastava and Agrawal [18] improved the solar still. The experiments were conducted on a single-slope solar still with a porous fin made of blackened old cotton rags situated on the basin, as shown in Fig. 1. The glass cover has a 24-degree slope is comparable to the latitude angle. Additionally, they discovered that the distillate water production of the solar still rose with a reduction in the water depth. In May, their system of porous fins produced the most freshwater daily—roughly 7.5 kg/m2.

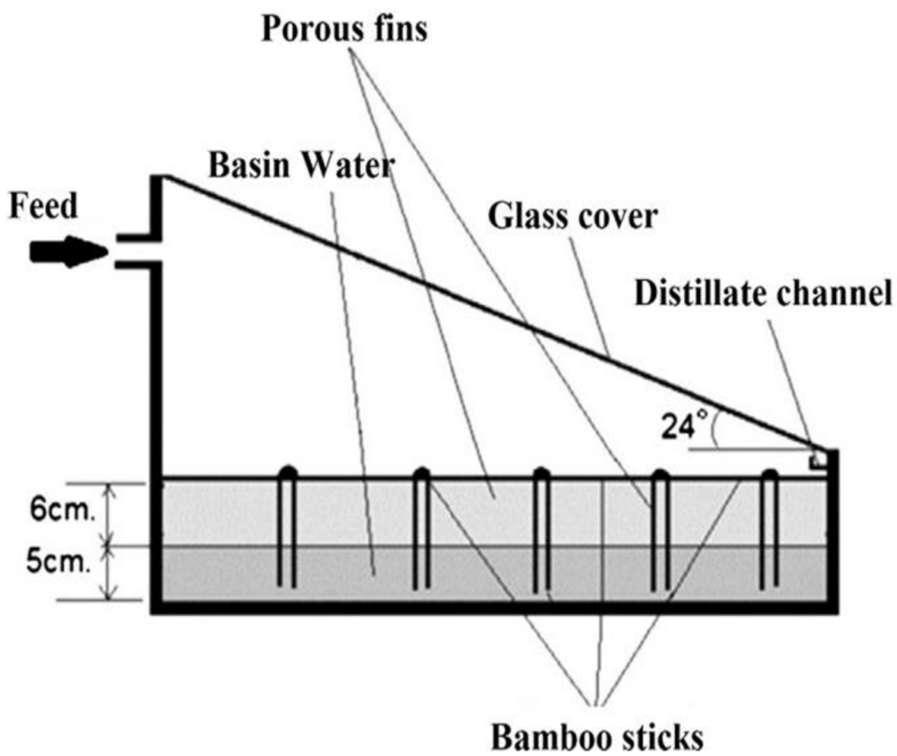



*Figure 1The schematic of the modified still using porous absorber* [19]

According to the findings of P. K. Srivastava and S. K. Agrawal, the purpose of the study is to analyze the performance of a single-sloped basin-type solar still combined with extended porous fins during the winter and summer seasons.[19]

Evaluation of the Solar Still's Performance during the Winter Season This section of the article examines and assesses the performance of the solar still during the winter season. Even in settings with less solar light, the expanded porous fins help improve the effectiveness of heat absorption and heat transfer, which leads to enhanced evaporation rates and water production.[19]

Performance throughout the summer The study also evaluates the performance of the solar still while it is operating during the summertime. The enlarged porous fins contribute to a reduction in the temperature difference between the top cover and the basin, which in turn helps to minimize heat loss and improve the system's overall efficiency. Productivity increase It has been discovered that the addition of expanded porous fins can greatly increase the productivity of a single-sloped basin-type solar still. Because of the enhanced efficiency of the heat transfer, the amount of freshwater that may be produced is also increased.[19]

Validation through experimentation. The research provides experimental data to validate the performance improvement gained by including expanded porous fins into the design of the solar still. The findings of the experiments show a significant increase in both productivity and thermal efficiency when compared to more traditional designs.[19]

The following is a list of some of the things that should be considered according to the paper:[19]

**Complexity and expense have both increased**

The complexity of the system is increased when expanded porous fins are incorporated into the design of a single-sloped basin-type solar still. It is possible that the new components, such as the fins and their installation, will cause an increase in the total cost of the system. This rise will take into account the increased costs associated with the material, manufacture, and maintenance of the system.

**Space requirements**

It's possible that incorporating expanded porous fins into the solar still system may take more area than originally anticipated. Because of the area that the fins take up on the sloped surface and within the basin, the solar still's total capacity or size may be restricted, which may have an effect on the amount of water that it is able to produce.

**Concerning upkeep and long-term use**

It's possible that the enlarged porous fins will need routine maintenance in order to function at their highest potential. Heat transfer efficiency can be negatively impacted by the accumulation of dust, dirt, or scaling on the surface of the fins, which can also impede water production. In addition, for performance that is maintained over time, it is important to take into consideration the fins' long-term endurance as well as their resistance to corrosion, deterioration, and fouling.

**Design limitations**

There may be some constraints placed on the design and layout of the solar still as a result of the use of extended porous fins. It is possible that it is not feasible or appropriate for all kinds of solar stills or applications because of issues like the available space, the geographical location, or the particular requirements.

Mohamed et al. [15] examined the impact of utilizing porous material on the solar still system's production. As porous absorbers, natural stones (black basalt) with varying grain sizes (1 cm, 1.5 cm, and 2 cm) were used. The experiments were conducted at Mansoura, Egypt, under local weather conditions. The fiberglass solar still has a surface area of 1 m2 and a water depth of 30 mm. To improve the absorber, black paint was coated on all of the walls. The results showed that porous media with grain sizes of 1 cm, 1.5 cm, and 2 cm enhanced the daily energy efficiency of systems by 19.09%, 26.84%, and 32.07%, respectively. A picture of porous media and a schematic of the solar still utilized in this investigation are shown in Fig. 2. The use of basalt stones into the solar still as a form of porous and effective absorber is the primary focus of this research. In order to improve the efficiency of the system, the stones serve the function of an additional heat transmission element.[15]

The purpose of this research, which was conducted by A. F. Mohamed, A. A. Hegazi, G. I. Sultan, and E. M. S. El-Said and published in Solar Energy Materials and Solar Cells, is to evaluate the performance increase of a solar still with the use of basalt stones as a porous, sensitive absorber. The purpose of this study is to conduct a thermoeconomic analysis and conduct an experimental study to determine the influence that the absorber has on productivity. [15]

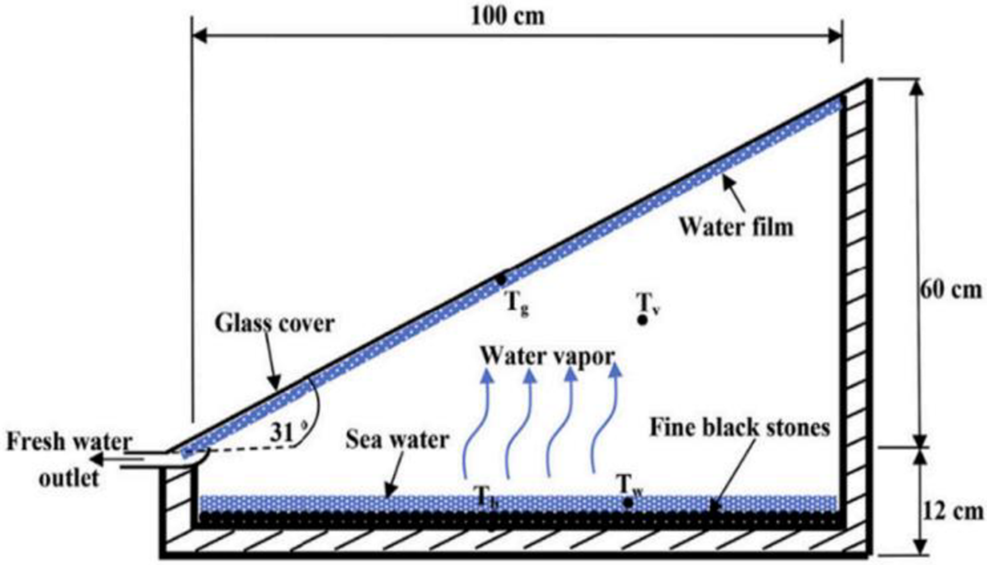



*Figure 2 schematic view of experimental tests to use basalt stones* [15]

The results of the investigation as well as the information presented in Figure 2 show that the performance of the solar still is greatly improved when porous basalt stones are utilized as part of the absorber material. Because of the stones' ability to facilitate heat transfer, raise the effective surface area, and enhance thermal efficiency, the amount of water that can be produced is also increased. [15]

According to the results of the research, using basalt stones as a porous and sensitive absorber in solar still designs may result in significant performance improvements. This improvement has the potential to be useful for practical applications in the desalination or purifying of water, particularly in locations where there is a surplus of solar energy but a shortage of water.[15]

However, there are a few drawbacks to this approach, including the following:[15]

**Practical implementation challenges**

The basalt stone absorber's implementation in real-world solar still systems The research effort focuses on experimental studies and theoretical analysis; however, it is possible that it will not address the issues posed by the basalt stone absorber's application in real-world solar still systems. In order to achieve optimal performance in real-world settings, it is necessary to do additional research into and make improvements to aspects such as system integration, durability, and maintenance requirements.

**Scale-up and cost implications**

The potential scale-up and cost implications of adding basalt stones as a porous sensible absorber are not extensively discussed in the research report. Because the usage of basalt stones could entail additional engineering and manufacturing efforts, this could result in an increase in the system's overall cost. This could potentially limit the general adoption of the system, particularly in applications that are sensitive to cost. The use of basalt stones as a porous and sensible absorber may call for the installation of additional space within the solar still system. Additionally, the amount of water that can be produced may also be limited. This could have an impact on the total capacity or size of the solar still, which could potentially restrict the amount of water that can be produced. It is necessary to do additional research in order to analyze the compromise that must be made between the improved performance and the space needs of the absorber.

**Durability and steadiness over the long term**

Important factors to take into account include the basalt stone absorber's long-term durability as well as its stability, in particular when subjected to severe environmental conditions. The research effort does not provide a comprehensive understanding of the potential deterioration, erosion, or fouling of the stones over time, all of which could have an effect on the system's effectiveness and lifespan.

**Analyses of comparable cases**

Evaluation of the performance improvements gained with the usage of the basalt stone absorber is the primary topic of the research work that is being done. However, a detailed comparative examination against various solar still designs currently available or alternatives that have been enhanced is not adequately examined. To acquire a better understanding of the potential benefits and drawbacks of the technique that has been described, additional research or comparisons to other types of systems would be beneficial.

Murugavel et al. [20] conducted an experimental analysis of the film layer of saline water in the sun desalination. 1.75 square meters of passive solar still were used in this project. Rice husk was used as insulation in the area between the inside and outside of the basin. The studies were conducted in a lab setting using saline water that was at the same depth as in a typical system. We employed porous media such washed natural rock with an average size of 1 cm  0.65 cm and quartzite rock with an average size of 0.65 cm as well as wick media like light cotton cloth, light jute cloth, and sponge plate with a thickness of 0.002 m. A 2000

W heater installed beneath the inner basin was used to replicate sun rays in order to boost production. Their findings demonstrated a clear relationship between water production and the temperature difference between glass and water in a solar still.

Experimental research on a solar still using porous fins as an absorber material was conducted by Panchal and Sathyamurthi [21]. In the climatic conditions of Gujarat, India, they employed 20 porous fins with an absorber surface of 1 m2. The porous fin, which had 10 holes with a diameter of 30 mm and a height of 110 mm, was composed of aluminum. According to the findings, the productivity of modified and conventional solar still utilizing porous fins was about 3.8 L/day and 2.67 L/day, respectively. This showed a 42.3% increase in water production over conventional ones. The article "Desalination: A review on Principles, Methods, and Materials" written by Monnisha Ganesan and Gobi Nallathambi offers a detailed assessment of the methods, principles, and materials that are utilized in the desalination process. The following are some of the most important points made in the paper:[22]

**Techniques for desalination**

In this work, several different desalination processes, such as reverse osmosis (RO), multi-stage flash (MSF) distillation, multi-effect distillation (MED), electrodialysis (ED), and capacitive deionization (CDI), are discussed. RO stands for reverse osmosis.[22] Each approach is broken down into its underlying concepts, detailed operating processes, potential benefits, and potential drawbacks.

**Reverse osmosis (RO)**

Because of its high efficiency and effectiveness in the removal of salts and other contaminants, RO is the method of desalination that is employed the most frequently. The RO process, including the use of a semipermeable membrane to extract salts and pollutants from the water, is discussed in the paper.[22]

**MSF distillation, which stands for multi-stage flash**

The MSF distillation process involves the use of numerous stages to evaporate and condense water, at the end of which salt and other impurities are left behind. The authors go through the basic operating concept, the many parameters of the process, as well as the issues that are related to MSF distillation.

**Multi-effect distillation (MED)**

The Multiple Evaporator and Condenser (MED) Desalination Process is Yet Another Method of Thermal Desalination That Utilizes a Series of Evaporators and Condensers to Separate Salts from Water.

The document provides an explanation of the configurations, operating principles, and benefits of MED. ED and CDI stand for electrodialysis and capacitive deionization, respectively. The authors discuss the new desalination technologies of ED and CDI, both of which utilize electrical fields to remove ions and salts from water in the desalination process. They go over the fundamentals of how ED and CDI function, the components that make them up, and the potential uses for both. Recent breakthroughs in membrane materials, energy efficiency, and hybrid processes are some of the aspects of desalination technology that are highlighted by the writers. Desalination presents a number of issues, including fouling, scalability, excessive energy usage, and environmental concerns, which are all addressed by these solutions.[22]

A study on the development of multifunctional textiles coated with Ag3PO4-rGO for the purpose of clean water production is presented in the research paper "Multifunctional Ag3PO4-rGO Coated Textiles for Clean Water Production by Solar-Driven Evaporation, Photocatalysis, and Disinfection" by Laila Noureen et al., which will be published in ACS Applied Materials & Interfaces in the year 2020. The purpose of this study is to create a multipurpose system based on textiles that is capable of utilizing solar energy for the production of clean water through the processes of evaporation, photocatalysis, and disinfection.[23]

**Solar-driven water evaporation**

It was discovered that coated fabrics had high solar absorption and thermal insulation capabilities, which made solar-driven water evaporation more effective. The process of evaporation contributes to the separation of clean water from various pollutants, salts, and other impurities in the water.[23]

**Photocatalysis**

Under the influence of solar radiation, the Ag3PO4-rGO coating exhibited highly effective photocatalytic activity. It made it possible for dangerous compounds in the water to be removed while also facilitating the breakdown of organic contaminants.[23]

**Disinfection:**

Textiles that have been treated with Ag3PO4-rGO displayed considerable antibacterial characteristics. The coating was successful in killing bacteria when subjected to solar radiation, which provided a disinfection mechanism that could be used for the purification of water.[23]

**Purification of the water that is improved**

When compared to uncoated textiles, the multifunctional textiles showed significantly improved performance in the process of water purification. The coating's capacity for solar-driven evaporation, photocatalysis, and disinfection all contributed in a complementary manner to the creation of clean water.[23]

**Consistency and the ability to be reused**

After testing the durability and reusability of the coated textiles, the researchers discovered that the textiles were able to keep their effectiveness even after being put through many rounds of water filtration. Because of the coatings' excellent durability and reusability, they were ideally suited for various applications in the real world. In addition to these benefits, there are a few drawbacks that were glossed over in the paper.

**Scalability issues are present:**

The capacity to scale up the coated textile-based technology for large-scale water filtration is still something that needs to be worked on. The research work largely focuses on the demonstration at the laboratory scale, and additional optimization and engineering efforts may be required to efficiently scale up the process.[23]

**Reliance on the radiation from the sun**

Because the process is powered by the sun, its success is heavily reliant on there being enough amount of sunshine. Cloudy or overcast weather conditions can have a substantial impact on the system's efficiency and effectiveness. The procedure might not be as dependable or fruitful in places where the amount of available sunshine is low or varies greatly.[23]

**Effective use of energy**

The total energy efficiency of the procedure is not thoroughly examined, even though the research work does note the excellent solar absorption and thermal insulation capabilities of the coated fabrics. In order to create a solution that is both environmentally friendly and profitable from a financial standpoint, it is critical to analyze and improve the energy requirements as well as the conversion efficiency.[23]

**Both in terms of longevity and durability**

For practical applications, it is vital to take into consideration the coating's long-term endurance as well as its stability. The coating consists of Ag3PO4-rGO. The research that was done did not provide any specific information regarding the durability of the coating or its resistance to deterioration over prolonged periods of use or exposure to different environmental conditions.[23]

**Taking into account the costs**

In the research effort, the subject of the cost that is related with the manufacturing of Ag3PO4-rGO coatings on textiles is not specifically mentioned. Because the usage of materials based on silver and graphene oxide can be quite expensive, this may limit both the affordability of the method and its general use, particularly in locations where resources are in short supply.[23]

**Disposal and environmental impact:**

It is important to take into consideration both the potential environmental impact of the Ag3PO4-rGO coating as well as its disposal at the end of its lifecycle. The scientific effort does not provide any specific insights on the implications for the environment or the measures that should be used to properly dispose of coated textiles.[23]

The performance of the solar stills made of porous materials is compared in Table 1. The results show that, in comparison to conventional ones, the productivity of the solar still with porous aluminum fins improved by roughly 42.3%. Additionally, the freshwater production and energy efficiency of the system employing black basalt porous absorbers are directly impacted by the water height of the system. Additionally, the system incorporating porous activated carbon medium improved its energy efficiency by 94.14%.

Due to the one-of-a-kind qualities that carbon materials possess, such as graphene, carbon nanotubes, and activated carbon, solar-powered seawater desalination using carbon-based materials has showed some signs of promise.[1]

Because of their great surface area, superior thermal conductivity, and chemical stability, the carbon compounds being discussed here are appropriate for use in efficient processes involving the conversion of solar energy and the desalination of water. Several different methods of desalination, such as solar stills, solar evaporators, and membrane distillation, can all benefit from the use of carbon-based nanomaterials, which can improve both the methods' overall performance and their overall energy efficiency.[1]

The utilization of carbon materials in solar-powered desalination systems has the potential to assist in the reduction of energy consumption, the improvement of water production rates, and the enhancement of the desalination process's overall sustainability. In the process of desalination, carbon-based materials can be manipulated and given new functions to enhance their inherent features, such as hydrophilicity, which increases the amount of water that can be transported and separated more effectively.[1]

The integration of carbon materials with renewable energy sources, such as solar photovoltaics, enables a method of seawater desalination that is both self-sustaining and kind to the environment. Ongoing research is focusing on the development of new carbon materials and the optimization of their features in order to further improve the performance of solar-powered saltwater desalination systems as well as the cost-effectiveness of these systems.[1]

A single-basin solar still is a device that can use solar energy to transform salty or contaminated water into freshwater. Typically, it is made out of a basin that is used to store the water, a cover that is see-through, and an inclined surface that is used to collect the freshwater that has condensed.[21]

The research investigates the long-term effects of drought on the amount of nitrate that is leached out of a temperate mixed forest. The term "legacy effects" refers to the long-term repercussions that actions or circumstances in the past continue to have on subsequent processes or results. Alterations brought on by the drought: The purpose of this study is to investigate how different levels of dryness can influence the natural processes of nitrate leaching in a forest environment. Dry conditions can have an effect on the moisture content of soil, the availability of nutrients, the activity of microbes, and the dynamics of plants, all of which can have an effect on nitrate leaching. [6]

Leaching of nitrates is the process by which nitrates, which are a type of nitrogen, are transferred through the layers of soil and have the potential to enter groundwater or surface water. An excessive amount of nitrate can seep into the groundwater, which can then pollute the water and have other negative effects on the environment. It is possible that field monitoring and data collection were carried out. [6]

*Table 1 Comparison of solar still made of textile materials*

| References | Climatic condition | Max. solar radiation ($W/m^2$) | Porous material | Type of solar still | Study Parameter | Result |
|---|---|---|---|---|---|---|
| [14] | – | – | Clay pot and chalk | Pyramid | Conventional | Thermal efficiency of solar still → 36% ↑ |
| [18] | Rewa, India | ≈ 900 | Cotton rags | Single slope | Porous fins, Conventional | Water productivity of solar still →7.5 kg/ m2 |
| [15] | Mansoura, Egypt | 534 | Black basalt (Natural fine stone) | Single slope | Conventional | Water productivity of solar still (1 cm) → 0.901 L/$m^2$<br>Water productivity of solar still (1.5 cm) → 1.005 L/$m^2$<br>Water productivity of solar still (2 cm) → 1.075 L/$m^2$ |
| [20] | Kovilpatti, India | 775 (Simulated solar radiation) | Washed natural rock | Double slope | Wick material (Sponge, cotton cloth) | The porous material increased the temperature of water. |
| [24] | Mansoura, Egypt | ≈ 600 | Black basalt (Natural fine stone) | Single slope | Conventional | Exergy efficiency of solar still (1 cm) → 65%↑<br>Exergy efficiency of solar still (1.5 cm) → 104.4% ↑<br>Exergy efficiency of solar still (2 cm) → 123%↑ |
| [25] | Horeen village, Egypt | ≈ 1000 | Activated carbon tube | Single slope | Conventional | Exergy efficiency of solar still →164.29% ↑ Energy efficiency of solar still →94.14%↑ |
| [15] | Semnan, Iran | ≈ 950 | Black sponge rubber | Single slope | Conventional | The highest daily freshwater generation of solar still → 17.35% ↑<br>The highest hourly freshwater generation of solar still (13:00 PM) → 33.7% ↑ |
| [26] | Chennai, India | 857 | Carbon impregnated foam | Single slope | bubble-wrap (BW) insulation | Water productivity of solar still (by porous media and BW) → 3.1 L/$m^2$<br>Freshwater output of solar still (by BW) → 1.9 L/$m^2$ |
| [21] | Gujarat, India | ≈ 900 | Aluminum fins with holes | Single slope | Wick material | Water productivity of solar still → 42.3% ↑ |

It is essential to understand the legacy effects of drought on nitrate leaching in temperate mixed forests on karst in order to properly evaluate the effects of forest ecosystems on the environment and ensure their long-term viability. The findings may have repercussions for the administration of water resources, the preservation of forests, and the planning of land use. This research may provide some insights into prospective mitigation measures or management approaches that can limit nitrate leaching and its ecological implications in drought-prone forest ecosystems.[6]

Solar stills often use a technology called porous fins, which is a form of heat transfer improvement technique. These fins are constructed out of porous materials, which allow for effective heat transfer and contribute to an overall rise in the solar still's level of output. The researchers most likely carried out a series of experiments in order to assess the performance and efficiency of a single-basin solar still that was outfitted with porous fins. It's possible that they took readings of things like solar radiation, water temperature, evaporation rate, condensation rate, and freshwater productivity.[21]

The research work may have been focused on testing the performance of the solar still with porous fins under varied operating settings, such as varying solar radiation levels, water depths, and fin designs. This was done in order to determine whether or not the solar still was effective in producing water from sunlight. It's possible that the researchers evaluated the solar still's performance by going through the data they gathered from the experiments and finding out how effective it was.[21]

Both the quantity and quality of the water may have been investigated in this study. Perhaps the solar still equipped with porous fins would have been used to determine the amount of freshwater produced. In addition, it is possible that the researchers assessed the quality of the produced freshwater to determine whether or not it is suitable for a variety of applications, including drinking and irrigation, among others. The study effort may have included comparing the performance of the solar still with porous fins to that of other types of solar stills or to approaches that promote heat transmission. It's possible that the objective was to determine the benefits, drawbacks, and prospective areas for optimization or enhancement in the system.[21]

This research report describes the results of an experimental investigation that was carried out to evaluate the performance and efficiency of solar desalination in a tropical climate by making use of a Fresnel lens. In order to complete the research, you most likely had to construct a solar desalination system and carry out a series of experiments in which you measured and analyzed a variety of parameters. As a means of concentrating the sun's rays for use in power generation, the research project makes use of a Fresnel lens. A Fresnel lens is a type of lens that is both thin and flat, and its surface is grooved in a series of concentric rings. It is intended to concentrate the sun's rays on a particular spot or region, which will result in the production of high temperatures and heat fluxes. [4]

Utilizing the concentrated solar power that is produced by the Fresnel lens in order to desalinate water is the primary focus of the study being conducted. The process of transforming salty or brackish water into freshwater through the use of solar energy is referred to as solar desalination. The experimental study is carried out in a specific setting that has a tropical environment. The high temperatures, plentiful sunshine, and typical high humidity are the defining characteristics of this climate. The selection of a tropical climate makes it possible to evaluate the efficacy of solar desalination under the particular environmental conditions that are being studied here.[4]

Evaluation of the performance of the solar desalination system using various metrics such as solar energy conversion efficiency, water production rate, thermal efficiency, and overall system performance is likely to be included in the scope of the research activity to be carried out. The information that was gathered from the trials is assessed to determine the efficiency and practicability of employing a Fresnel lens for the purpose of solar desalination in a climate that is classified as tropical. A technological and economic examination of the solar desalination system might also be incorporated into the research. In the course of this analysis, we will evaluate the cost-effectiveness, practicality, and potential scalability of the system in relation to applications in the real world that take place in tropical areas.[4]

In the research paper, it is possible to discuss the prospective applications and benefits of solar desalination in tropical regions by making use of a Fresnel lens. It is possible that it will investigate how such systems can offer a sustainable and ecologically friendly alternative for the production of freshwater in places that are characterized by high levels of solar radiation and low water availability.[4]

## 2.4 Previous construction device

From fig. 3, in solar stills, the use of porous materials like activated carbon tubes may have a considerable effect on the amount of liquid that can be extracted from the system. The activated carbon tubes perform the function of a porous medium that improves the process of heat transmission, ultimately leading to an increase in the system's overall output.[2]

The performance of the solar still system was analyzed in the research, with consideration given to energy and exergy metrics, as well as economic and CO2 mitigation considerations. The investigation revealed that the use of activated carbon tubes resulted in a significant rise in the quantity of freshwater produced, which was around 5850 mL/m2 in total.[2]

In addition, the system's energy and exergy efficiency saw considerable increases of 94.14% and 164.29%, respectively, as compared to a typical solar still that did not include the activated carbon tubes. This enhancement may be ascribed to the increased heat transfer area and the accelerated evaporation process that are both brought about by the use of the porous medium.

The use of activated carbon tubes as a porous medium in solar stills has the potential to considerably enhance both the productivity and efficiency of the stills, so making them more suitable for use in practical settings. In addition, this technology has advantages that are beneficial to both the economy and the environment, which makes it an appealing choice for the production of freshwater that is both sustainable and effective.[2]

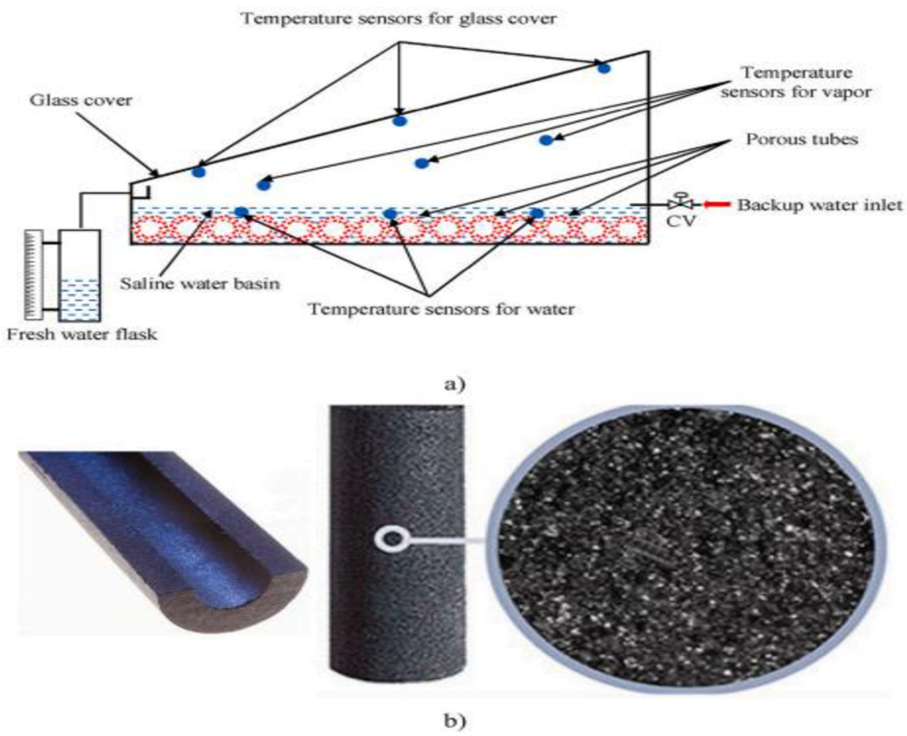



*Figure 3 a) Device Construction and b) activated carbon tube*[2]

The purpose of this work is to report the findings of an experimental investigation that was carried out to assess the efficiency of a solar desalination system that utilized activated carbon as the porous absorber. The study comprises taking readings on the water's temperature, the rate of evaporation, the rate of condensation, and the total amount of water produced. The outcomes of this research show that using activated carbon as a porous absorber into solar desalination systems can greatly boost the performance of those systems. Because of the activated carbon's ability to facilitate heat transfer and increase effective surface area, both evaporation rates and the amount of water produced are increased. The research effort includes an assessment of the system's impact on the environment, particularly with regard to the use of activated carbon. In comparison to more traditional approaches to desalination, this study evaluates the potential environmental benefits, such as lower levels of carbon emissions and overall energy use. In this work, an exergy analysis of the solar desalination system is presented. The analysis takes into account both the quality of the energy and the efficiency with which it is used within the system. The exergy analysis is a useful tool for evaluating the performance of the system and locating areas that could be improved. An economic study of the solar desalination system utilizing activated carbon is included in the research work that was carried out. The economic viability and cost-effectiveness of the system is evaluated by taking into account a variety of parameters, including the cost of the materials, the cost of the installation, and the possible savings in energy or freshwater production.According to the findings of the study, using activated carbon as a porous absorber into solar desalination systems has the potential to result in considerable increases in the systems' levels of performance. This method has potential uses in the desalination or purification of water, and it offers the possibility of benefits in the form of increased productivity, decreased energy consumption, and cost savings.[2]

From fig. 3, carbon-impregnated foam, also known as CIF, was used as a floating absorber in solar stills to raise the level of surface area available for evaporation. In addition, insulation made of bubble wrap (BW) was used in both the basin and the thermal storage in order to reduce the amount of heat that was lost and to speed up the pace of evaporation.[5]

Computational fluid dynamics was used in the process of designing and analysing three solar stills, each of which included a unique configuration, in order to test the performance of these materials. According to the findings, the solar still that had CIF and BW insulation had the maximum production, generating around

3,100 mL/m2 of freshwater each and every day. In contrast, the solar still that did not have BW insulation had productivity that was only 1900 mL/m2.day, but the solar still that did have BW insulation had a productivity that was 2300 mL/m2.day.[5]

The findings of the predicted temperature distribution were similarly in excellent agreement with the data from the experiments. It seems from this that the incorporation of CIF as a floating absorber and BW insulation into the solar still has the potential to considerably increase the productivity and efficiency of the solar still.[5]

In general, the use of porous materials like CIF and insulation like BW in solar stills may enhance the performance of the stills and increase the amount of freshwater that they produce. This technique may be used in regions that have restricted access to fresh water, therefore giving a solution that is both sustainable and effective to produce fresh water.[5]

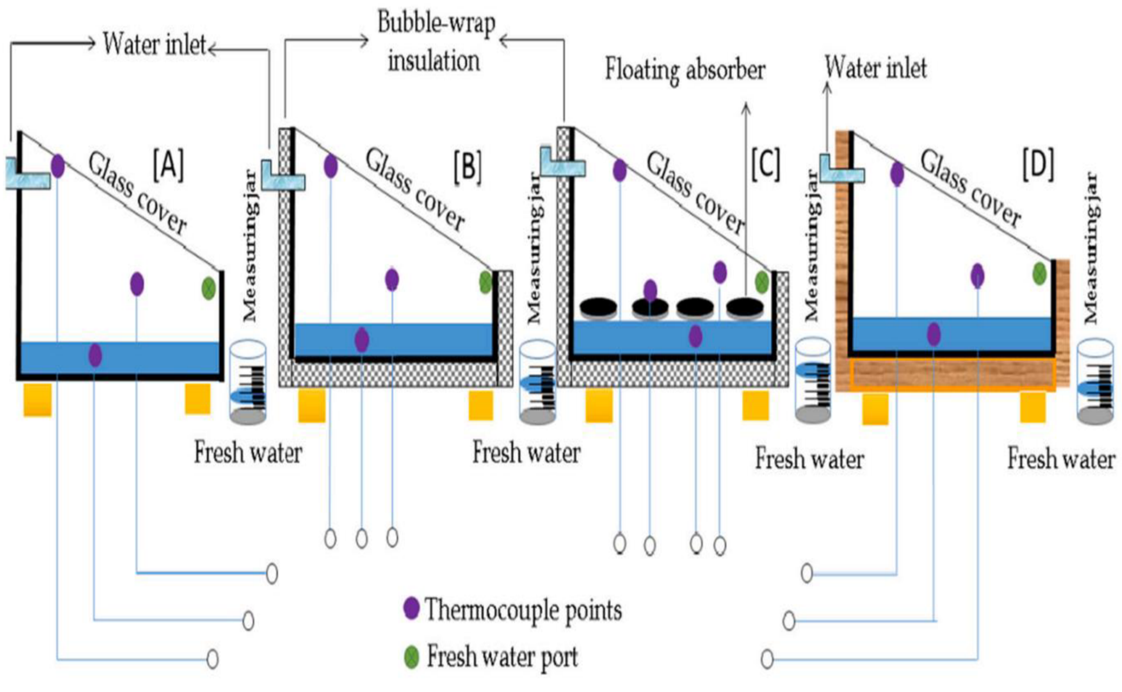



*Figure 4 The schematic of [A] solar still without insulation, [B] solar still with BW insulation, [C] solar still -CIF with BW insulation, and [D] Conventional solar*

When it comes to solar water desalination, the usage of nano/PCM and porous media might potentially have a substantial influence on the performance of the system. For the purpose of this research, anthracite porous absorber materials with a grain size of 1.3 mm and CuO/PCM were used in order to accelerate the pace at which the system evaporates.[27]

A conventional solar still with a water height of 15 millimeters was contrasted with the solar still that had these alterations made to it. According to the findings, the redesigned solar still resulted in a 41.94% increase in the amount of water produced. This enhancement may be ascribed to the accelerated evaporation process that is brought about as a result of the increased surface area supplied by the porous media and the thermal energy storage capabilities of the porous crystalline material (PCM).[27]

Based on figure 5, the practicability and prospective advantages of integrating solar district heating with solar desalination, making use of energy storage materials for the production of household hot water and drinking water are discussed. It examines not just the economic but also the environmental aspects of the problem. The solar district heating systems are depicted in Figure 5. These systems utilize solar energy for heating purposes on a bigger scale than the ones shown. This study investigates the possibility of incorporating solar desalination into the district heating system, thereby broadening the system's potential applications to include the generation of water.

Solar stills that make use of anthracite porous absorber materials and CuO/PCM might offer a method that is both environmentally friendly and very effective for the generation of freshwater. The higher rate of evaporation and water production may have major economic and environmental advantages, especially in regions with limited access to freshwater. This is particularly the case in locations where there is little availability to freshwater.[27]

The use of porous media and PCM in solar stills has the potential to considerably enhance their performance and increase the amount of freshwater they produce, so making them a viable technology for the production of sustainable freshwater. The fig. 5 that has been presented illustrates the various configurations of solar stills with porous absorbers that were used in this research project.[27]

The application of solar thermal or solar photovoltaic technologies in desalination systems and their potential for delivering domestic hot water and drinking water is discussed in the use of solar energy for desalination operations, which may be found in figure 5. In the solar district heating system, the exploitation of energy storage materials for the purpose of efficient storage and consumption of thermal energy. These materials have the potential to help close the gap between energy production and demand, thereby guaranteeing a stable and consistent supply of energy.

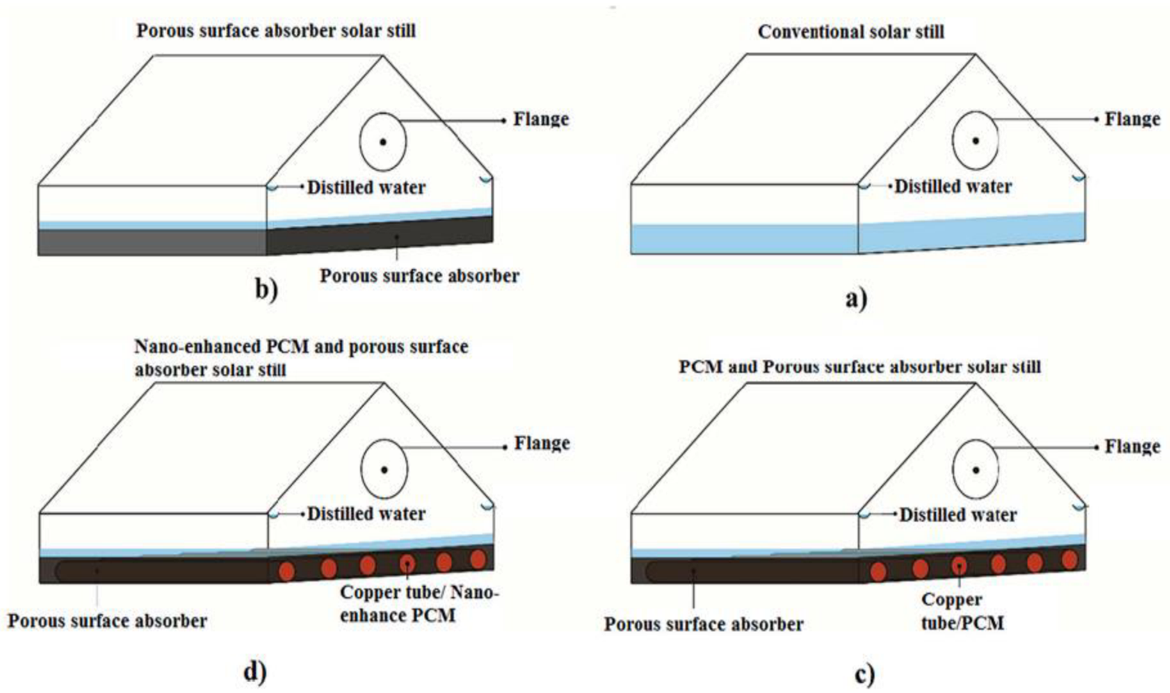



*Figure 5 Sketch of solar still with a) Traditional, b) Porous media, c) PCM and porous media and d) Nano/PCM and porous media*[27]

The environmental impact of the combined solar district heating and desalination system is evaluated as part of the environmental assessment, as is the system's long-term viability. In comparison to more traditional approaches to heating and desalination, it investigates issues like as carbon emissions, energy usage, and the potential positive effects on the surrounding environment. An economic analysis that assesses the economic viability of the solar district heating and desalination system as well as the cost-effectiveness of using the system. When determining whether or not the system can be economically viable, it takes into account a number of criteria including payback period, possible energy savings, installation costs, and operational costs. The potential benefits of integrating the heating and desalination processes into a single system, including lower carbon emissions, greater savings on energy, and improved financial standing in comparison to using two separate systems. It places an emphasis on the significance of taking into account economic concerns in addition to environmental factors while developing sustainable energy initiatives.

The effectiveness of solar still that makes use of a membrane porous medium was analyzed via the process of air gap membrane distillation in this particular research. The impact that time-dependent solar fluxes, air velocity, and ambient temperature have on the operation of the system was investigated using a mathematical model that was constructed for the purpose.[28]

The performance of a solar still that used a permeable hydrophobic (PTFE) porous membrane was evaluated and contrasted with the performance of a solar still that did not utilize any porous media. As shown in Figure 10, the findings revealed that the water production of the solar still equipped with the hydrophobic porous membrane resulted in an increase of between 40 and 70 percent when compared to the water production of the solar still that did not include any porous media.[28]

Utilizing a porous membrane in the solar still offers a number of advantages, including greater surface area for evaporation, improved heat transmission, and less heat loss. Only water vapor is able to travel through the membrane because of its hydrophobic nature, which stops liquid from entering the porous medium and only lets water vapor through. As a consequence, the amount of water produced by the solar still increases, and its overall effectiveness also improves.[28]

The use of a membrane that is also a porous medium in solar stills has the potential to considerably enhance both the performance of the stills and the amount of freshwater they produce. This technique has the potential to provide a long-term and cost-effective solution for the generation of freshwater, especially in regions that have restricted access to such a resource.[28]

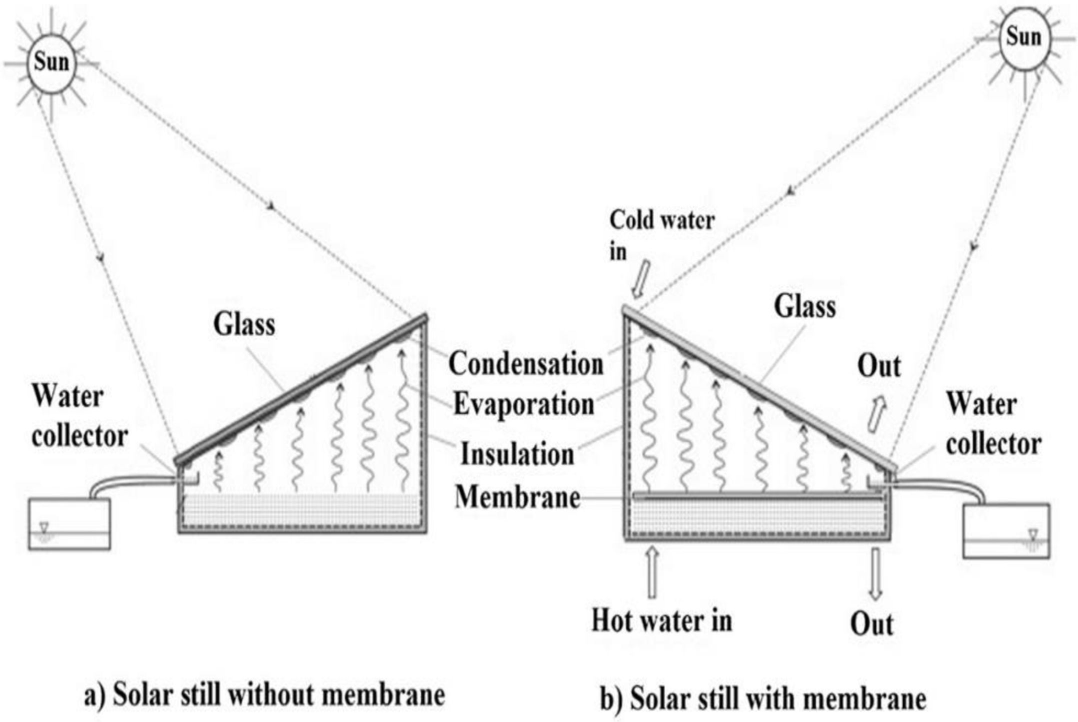



*Figure 6 Sketch of solar still desalination a) without and b) With membrane*[28]

Distillation using a membrane that is resistant to water There is a possibility that this concept of distillation using a hydrophobic membrane will be discussed in the publication. A hydrophobic membrane is used in the process of membrane distillation, which is a type of separation that is used to remove water vapor from a saline solution.[28]

A hybrid technique for desalinating seawater can be created by using solar electricity in conjunction with membrane distillation, as shown in figure 6. Solar energy can be utilized to provide the necessary heat for the distillation process. This makes solar energy an alternative that is better for the environment and more cost-effective. Solar energy may also be harnessed to supply the necessary heat for a variety of other industrial activities.[28]

Configuration of the air gap that can be changed. The variable air gap membrane distillation technique, which is one facet of membrane distillation, has the potential to be the primary focus of the article. Using this method, which involves adjusting the distance that separates the membrane from the condensation surface and the air gap that exists there, is one way to increase the performance and efficiency of the process. This method involves modifying the distance that separates the membrane from the condensation surface.[28]

The researchers are going to discuss the experimental setup that was used to evaluate the hybrid solar desalination system that was constructed. This discussion is going to take place after they have presented their findings. This could include information regarding the solar collector, the membrane, and any other components that are essential for the procedure. In this part of the investigation, the results of the experiments that were carried out in order to evaluate the effectiveness of the variable air gap membrane distillation system could be provided. This could include information on characteristics like as the efficiency and productivity of the desalination process, the quantity of energy that is required, and the quality of the water that is produced after the process.

The investigation may consist of a comparison analysis, in which the efficiency of the variable air gap membrane distillation system is measured against that of several alternative desalination systems. This will highlight the positives as well as the downsides of the methodology that was presented.[28]

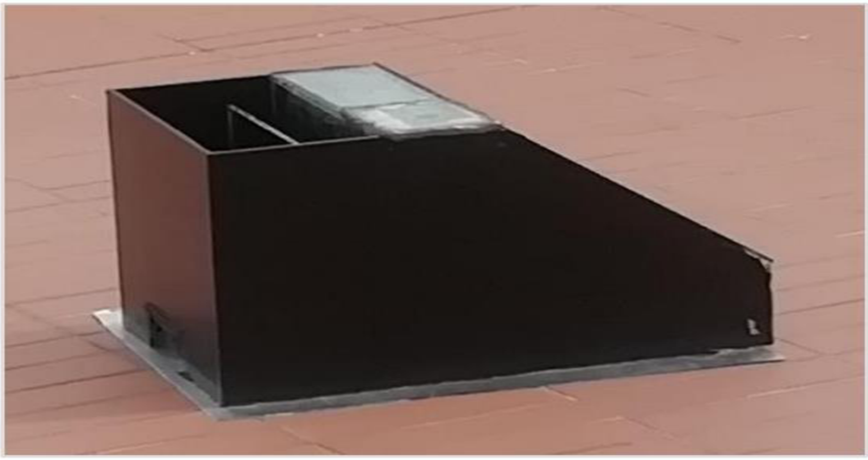


*Figure 7 Solar Still Side. The solar still is 0.50 m long and 0.30 m wide, respectively.* It is covered with black adhesive paper to improve the absorptivity of solar radiation and increase the internal heat of the solar still.[29]

*Figure 8 Solar Still used in field trail front view. The wall of the solar still ere build in glass with a thickness of 5 mm and the water basin was in metal.*[29]

The research study's purpose is to evaluate the performance of a solar still under the climatic circumstances of the Gulf of Mexico coast and analyze the influence of design and operational parameters, as shown in figures 7 and 8. The ability of a mathematical model to accurately simulate the conditions that are seen in real fields is also evaluated. The landscape and climate in Mexico are both extremely varied. The climate in the southeast is humid, in contrast to the dry or semi-dry conditions of the northwest and center. There are geographical differences within the nation, but on average, the country receives 740 millimeters (mm) of precipitation year. In some locations, such as the Valley of Mexico and the more densely populated parts of Veracruz, water stress and scarcity are problems that need to be addressed.[29]

The field tests were carried out in La Guadalupe, which may be found in the state of Tecolutla-Veracruz in Mexico; the precise coordinates are provided. Over the course of a single year, Tecolutla has a climate that is marked by significant fluctuations in humidity, temperature, and precipitation. These changes can be spectacular. While the warmest part of the year lasts for 9.6 months, the driest part of the year only lasts for 4.4 months. The research effort made use of a prototype solar still, which had a base area of 0.054 square meters and was manufactured out of glass that had a dark plastic film coated on it to increase the amount of heat that was retained. In order to evaluate the solar still's energy balance, a mathematical model that was primarily inspired by Dunkle's model was utilized. The energy balance was studied using Dunkle's model, which determines the heat transfer coefficients via convection and evaporation. Dunkle's model also defines the heat transfer coefficients. The mathematical model took into account a variety of assumptions, including that there were no steam leaks, that the water mass was constant, that there was negligible loss due to evaporation, and that there was insignificant temperature differential along the water depth. Among the other assumptions that were taken into consideration was that there were no steam leaks. The equation for the energy balance of the solar still takes into account incident thermal radiation, the amount of energy that is stored, as well as the amount of energy that is lost through to convection, evaporation, and radiation. In addition, the quantity of energy that is stored is factored into the equation. The investigation resulted in the development of equations that could predict the heat transfer coefficients that occurred between the water mass and the glass cover through the processes of natural convection, radiation, and evaporation. We utilized a wide range of statistical metrics, such as absolute error, percent relative error, correlation coefficient, determination coefficient, and mean absolute percent error, in order to evaluate the accuracy of the mathematical model. The performance of the model was assessed by comparing the data from the experiment with the data from the prediction, with the intention of achieving a high level of correlation and a good fit between the two different kinds of information.[29]

It is possible to run a single-slope solar still in the region known as "La Guadalupe" on the coast of the Gulf of Mexico since the climate there is conducive to doing so. The performance of the solar still was hindered by the low solar radiation and considerable variability of cloud cover that occurred during the test days. This was primarily caused by the presence of Hurricane Grace in the area where the tests were conducted. The Dunkle model, which is valid for operating temperatures around 50 degrees Celsius, exhibited an excellent fit and approximation with regard to the experimentally recorded water temperature values (Tw). This is because the Dunkle model is valid for operating temperatures around 50 degrees Celsius. The poor production and performance rates (M' and ) achieved in the solar still were attributable to the climatic parameters that were indicated, even falling below the rates that were observed in other regions of the world. The effluent water from the solar still is of superior quality and might be put to good use in regions that are experiencing a severe shortage of water. For the purpose of determining whether or not the water is safe for human consumption, more complementary research on the water's physicochemical quality needs to be carried out. Solar stills offer a workable solution on a small scale to alleviate freshwater shortages in vulnerable populations located in coastal areas, notably in tropical and developing countries. Solar stills can be used to distill water using the sun's energy.[29]

# 3 Experiment Part

The experimental portion of this study focuses on two crucial aspects: roller cover fabric selection and machine construction. These factors are essential for determining the overall performance and efficacy of the experimental setup. Fabric selection for the roller cover entails selecting the most appropriate material to ensure optimal experiment functionality. When selecting the fabric, absorbency, durability, and compatibility with the experimental conditions must be considered. In addition, the machine's construction plays a crucial role in facilitating the experimental procedure. The design and construction must be robust, efficient, and able to accommodate the experiment's specific requirements. The machine must be capable of providing precise and controlled movement of the roller cover in order to produce consistent and reliable results. Through careful fabric selection for the roller cover and meticulous machine construction, this experiment intends to produce a dependable and efficient setup for the subsequent testing and analysis.

## 3.1 Fabric Selection for the roller cover

The architecture of a solar device's fabric has a significant impact on how well it performs its function. The solar device in question makes use of a variety of different materials, each of which has its own unique structure and set of characteristics. The purpose of this paper is to investigate the usage of fabric in the building of the solar device, including the many kinds of fabric that were used and the benefits that each offered. In addition to this, the study will emphasize how significant an impact the structure of the fabric has on the effectiveness as well as the general performance of the solar device.

During our continuing investigation into how solar distillation systems may be made more effective in terms of their capacity for water collection, we discovered that the use of a polyurethane foam roller is very necessary. Because of its many one-of-a-kind qualities, polyurethane foam is an excellent candidate for the role of a material that may improve the functionality of solar stills. Its high absorption capacity enables it to capture and hold more water vapor than standard textile materials, while its vast surface area enhances the exposure of the water vapor to the energy of the sun, resulting in quicker and more effective evaporation. This combination of properties makes it superior to traditional textile materials. In addition, polyurethane foam has a low thermal conductivity, which helps to reduce the amount of heat that is lost during the distillation process and thus improves the operation's overall effectiveness. According to the findings of our investigation, implementing polyurethane foam rollers into solar distillation systems may lead to considerable increases in water collection as well as energy efficiency. As a result, this material can be considered an essential component for the continuation of research and development efforts. We can work towards a more sustainable future by giving access to clean, safe water in locations where it is limited by employing polyurethane foam in solar distillation systems. This will allow us to strive towards a more sustainable future.

The solar apparatus makes use of a variety of textiles, each of which has its own unique structure and set of characteristics. The woven material that is utilized in the construction of this equipment is composed of cotton and has a plain weave structure. A plain weave structure refers to an over-under pattern of interlacing threads and is the most fundamental kind of weave. Because of their longevity, breathability, and resistance to ripping, woven textiles are the material of choice for use in solar gear.

The knitted material that is used in the device is constructed out of jersey textiles that are knitted using a single-knit stitch. This breathable material is elastic and open-structured, which promotes increased airflow and facilitates quicker evaporation. Spunbond nonwoven is the kind of nonwoven fabric that was employed, and it features a random arrangement of fibers that enables the surface area to be exposed to air to the greatest possible degree. When compared to the other two kinds of cloth, the rate of evaporation caused by this factor is the quickest.

**Influence on Level of Performance**

In a solar device, the selection of the fabric structure to use is of the utmost importance since it has a considerable influence on both the system's performance and its efficiency. It is possible that there will be less air movement and slower evaporation without the use of knitted textiles, which will result in a lowered level of efficiency in the solar equipment. In a similar fashion, if nonwoven textiles were not used, there is a possibility that there would be a decrease in the amount of surface area exposed to air. This, in turn, might lead to slower evaporation and a drop in the effectiveness of the solar apparatus.

**Advantages of Fabrics That Are Woven**

The absence of knitted or nonwoven materials in a solar apparatus may result in less air flow and slower evaporation, which eventually affects the system's overall efficiency and performance. Woven fabrics, on the other hand, can be tear-resistant, robust, and breathable. Woven fabrics can also be resistant to ripping.

textiles that are woven have a tight and flat structure that is generated by interlacing threads in a basic over-under pattern. This gives woven textiles the ability to resist stretching or deformation because of their relatively stable structure. This may be useful in solar equipment, where the fabric must be able to keep its form over an extended period of time, while being subjected to a variety of environmental variables.

Woven textiles, in comparison to other kinds of fabrics, are often more breathable than the others because they let air pass through them with greater ease. This is advantageous in a solar apparatus since proper air movement is required for successful evaporation and the solar apparatus may benefit from this. Additionally, in comparison to other kinds of textiles, woven fabrics often have a higher resistance to ripping, which contributes to their increased durability and longevity.

The structure of the fabric is an extremely important factor in the overall performance and efficiency of a solar device. The solar device in question makes use of a variety of materials, including woven, knitted, and nonwoven fabrics, among others. The absence of knitted and nonwoven materials, each of which has its own distinct benefits, may lead to decreased air movement and slower evaporation, which, in turn, can have a negative impact on the system's ability to function effectively and efficiently as a whole. Because of their longevity, breathability, and resistance to ripping, woven textiles are used in solar equipment. This is because woven fabrics are a typical option for usage in solar apparatus.

Use of cotton fabric in solar distillation

- Covering the polyurethane foam roller with a black dye cotton fabric not only improves water collection and energy efficiency, but it also boosts the roller's longevity and resistance to environmental degradation, which may result in an increase in the amount of time that solar distillation systems are able to function effectively.
- Solar distillation systems may be made more accessible and economical for communities that are in need of clean water if we make use of materials that are both low-cost and widely available. Some examples of such materials are polyurethane foam and cotton fabric.
- Additional study is required to investigate not only the most effective design and configuration of solar distillation systems that use polyurethane

foam rollers and cotton fabric covers but also the performance of these systems in a variety of different environmental conditions.

- In the context of solar distillation systems, the use of polyurethane foam rollers and cotton fabric coverings has the potential to play a major role in the fight against the depletion of the world's water supply and the promotion of sustainable development.
- Cotton is an appealing material for use in solar stills because of the fact that it can absorb solar energy well while being relatively inexpensive. It is also widely available. In addition, cotton is quite amenable to being altered or coated to increase its performance as a solar distillation material.
- Cotton fabric was utilized as the evaporator in a sun still for the purpose of a research project that was carried out in India. The solar still was able to generate clean water at a rate of 2.2 liters of distillate per day. [30]
- In other research, researchers have investigated the possibility of modifying cotton material in order to increase its efficiency for solar distillation. For instance, researchers in Iran produced a hybrid solar still that increased the efficiency of water production by using a cotton fabric that was covered with a titanium dioxide nanofilm. This improved the fabric's ability to absorb solar radiation and increased the yield of water. [6]
- In order to construct hybrid systems that are capable of producing clean water in a more effective manner, cotton-based solar stills have been integrated with other types of renewable energy sources, including as wind turbines. For instance, a research project that was carried out in Turkey paired a cotton-based solar still with a vertical-axis wind turbine, and the results showed that the system was able to generate clean water at a rate that was more productive than conventional solar still. [31]
- Cotton-based solar stills, on the other hand, may also have certain inherent limits. According to the findings of one piece of research, the effectiveness of cotton-based solar still may be influenced by external elements like as the velocity of the wind, temperature, and humidity. In addition, cotton fabric has to be protected against the damage caused by UV radiation, which, over time, may cause it to lose some of its efficiency.

Solution associated with solar distillation using textiles:

- The capacity of textile materials to survive adverse climatic conditions, such as high temperatures and UV radiation, without deteriorating or losing their efficiency is what we mean when we talk about durability.

- The design of the textile-based solar still must be adjusted so that it can produce the purest water while also achieving the highest possible level of efficiency.

## 3.2 Machine Construction

As in the previous research areas solar water distillation is too complex and it can't carry from one place to another this is the problem, to solve the problem here we constructed, solar water distillation with the use of textile materials which is a straightforward and efficient method of water purification. Here, we are making solar distillation without the use of any energy and a naturally activated process without involving human interference. Building a solar water distillation system out of textiles contains polystyrene nonwoven, two chambers with different angles, insulating rollers which are made of polyurethane foam that cover with textile black fabric, a transparent lid, and a cooling system.

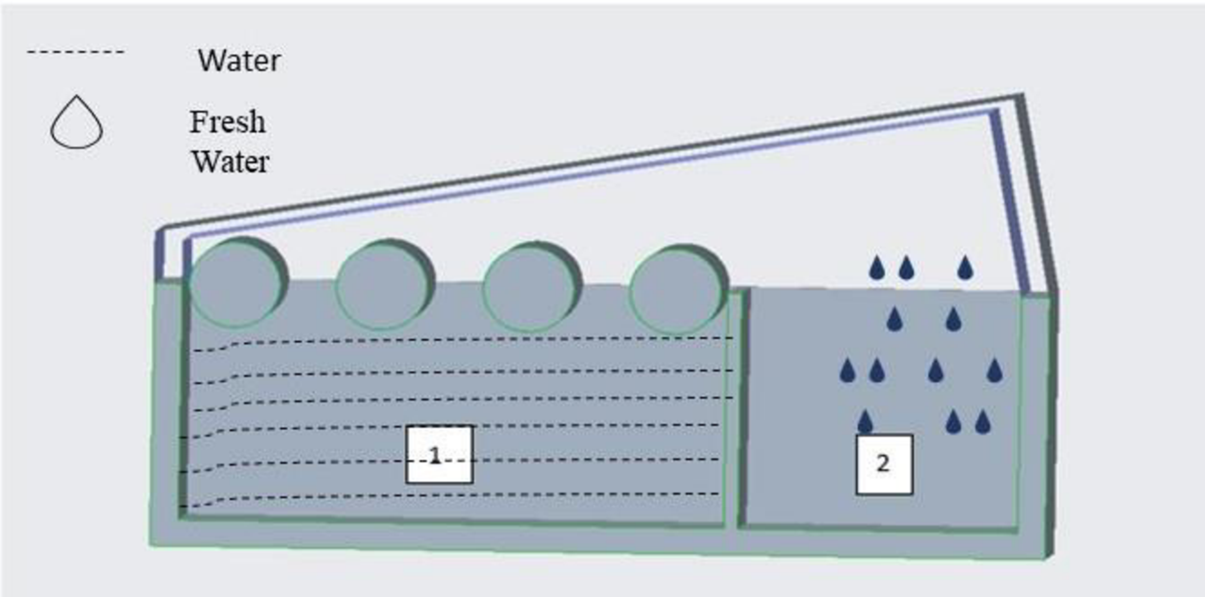



*Figure 9 Two chamber in machine 1. Dirty water and 2. Fresh Water.*

### 1. Transparent Lid:

The solar water distillation system features a cover made of transparent material. This lid serves a number of functions, including providing a protective cover for the chambers, permitting sunlight to pass through while also preventing heat loss, and allowing sunlight to pass through.

### 2. Cooling System:

A cooling system is built into the machine, and its primary function is to maintain a consistent temperature throughout the system. In order to keep the conditions of operation in their optimal state, this system makes certain that the water that has been distilled condenses and is collected while also removing any excess heat.

**3. Insulating Rollers is Cover with Black Woven Fabric:**

The rollers are constructed out of polyurethane foam, which is an insulating material. This insulation helps the system maintain the temperature that is needed for effective water distillation, which is made possible by the system. The apparatus consists of four rollers, each of which performs an important function in the distillation process. These rollers have a dark woven fabric covering them, which helps them absorb more of the heat that is generated by the sun's rays.

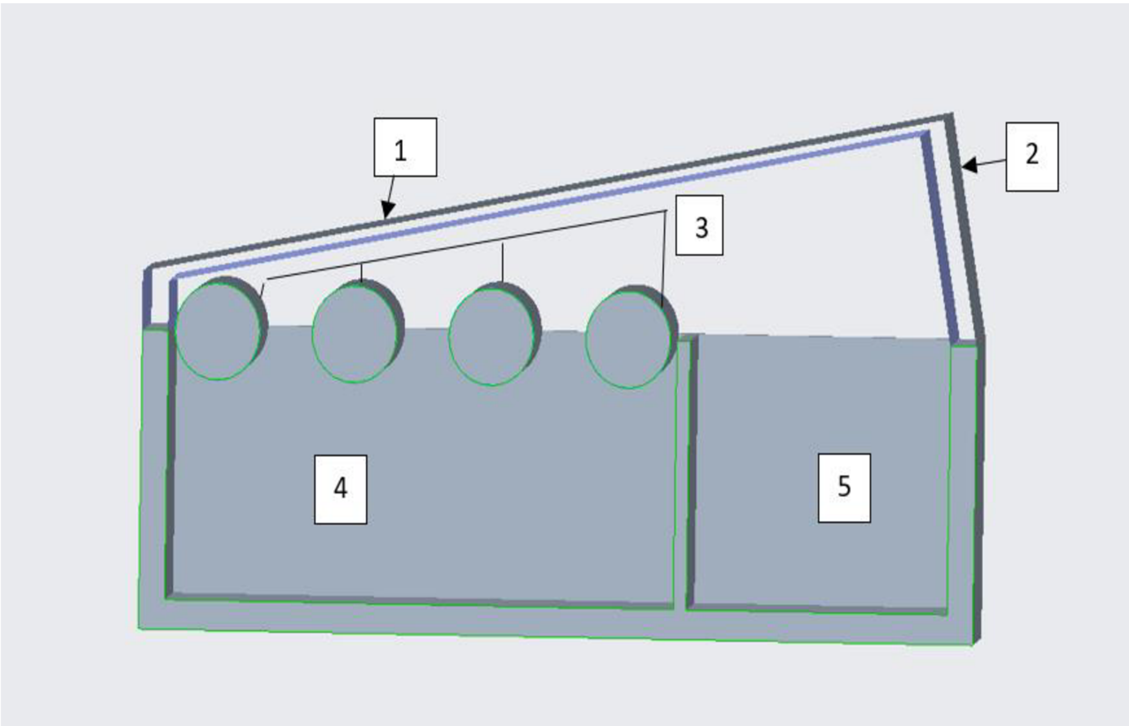



*Figure 10 Machine Construction with four roller cover with black woven fabric and having two chamber 4 and 5 and having 1. Transpernt Lid, 2. Cooling System and 3. Insulating Roller cover with black woven fabric.*

In the first step, the whole chamber is covered with an angled transparent lid that allows solar heat to enter and creates vapor from the polluted water owing to the partial pressure difference. This takes place in the initial phase of the process. Because of the difference in temperature and partial pressure, water vapor forms on an inclined transparent lid and then travels to a second chamber that is linked to the first chamber. In this case, the angle of inclination might be anywhere from 30 degrees. The cavity that exists between the water's surface and the glass cover determines the volume of the optimal inclination angle that should be used. Because of this, it takes a great deal more time for the air to get saturated, which in turn delays the beginning of production. In addition to this, there is a correlation between an increase in the inclination angle and solar energy losses caused by the reflection of the glass cover. From this vantage point, the angle of tilt ought to be as near as it can go to being the same as the angle of latitude. The sole advantage of having a steeper slope is that after condensation begins, the water that is on the inside of the glass cover will drain into the collecting channel more quickly if the slope is steeper. Therefore, the droplet might expand to the point where the mass drag it exerts is greater than the tension at the top, which would result in it falling into the pool. Taking into consideration the fact that the location of the experiment was thirty degrees north of the equator and that it was suggested that the water be dumped into the lake. Because the test site was located at a latitude angle of 30 degrees and other research indicated that an angle of 15 degrees was optimal, the roof of the structure was sloped at an angle of 15 degrees to the horizontal, as shown in Figure 7.

A proposed solar water distillation system purifies water using textiles and various components. This machine distills water without external energy or human intervention. The machine has four black-woven rollers. These rollers absorb solar radiation to maximize distillation heat transfer. Two chambers with different angles help distill water and remove impurities. These chambers improve system performance and purification. Polyurethane foam rollers maintain system temperature. These rollers trap heat to prevent distillation-compromising temperature fluctuations. Solar water distillation systems benefit from transparent lids. The lid protects the chambers while maximizing solar energy absorption. It prevents heat loss, maximizing system performance. The machine has a cooling system to maintain optimal operating conditions. This system condenses and collects distilled water while dissipating heat, producing high-quality purified water. These components solve traditional solar water distillation's portability and complexity issues. This system's textile materials and design allow natural and energy-efficient water purification, making it a sustainable solution for various applications.

**1. First Chamber:**

The vapor that is produced on the transparent lid that is inclined moves to a second chamber that is connected to the first chamber. The optimal volume of the cavity between the water's surface and the glass cover is used to determine the angle of inclination of the lid in the first chamber. This angle is determined by the angle of the lid's tilt. The angle of inclination can range from 30 degrees to anything else. In the first step, the entire cavity is covered with a lid that is angled and made of transparent material. Because of the difference in pressure between the two chambers, this lid lets solar heat into the system, which in turn causes polluted water to evaporate into the air.

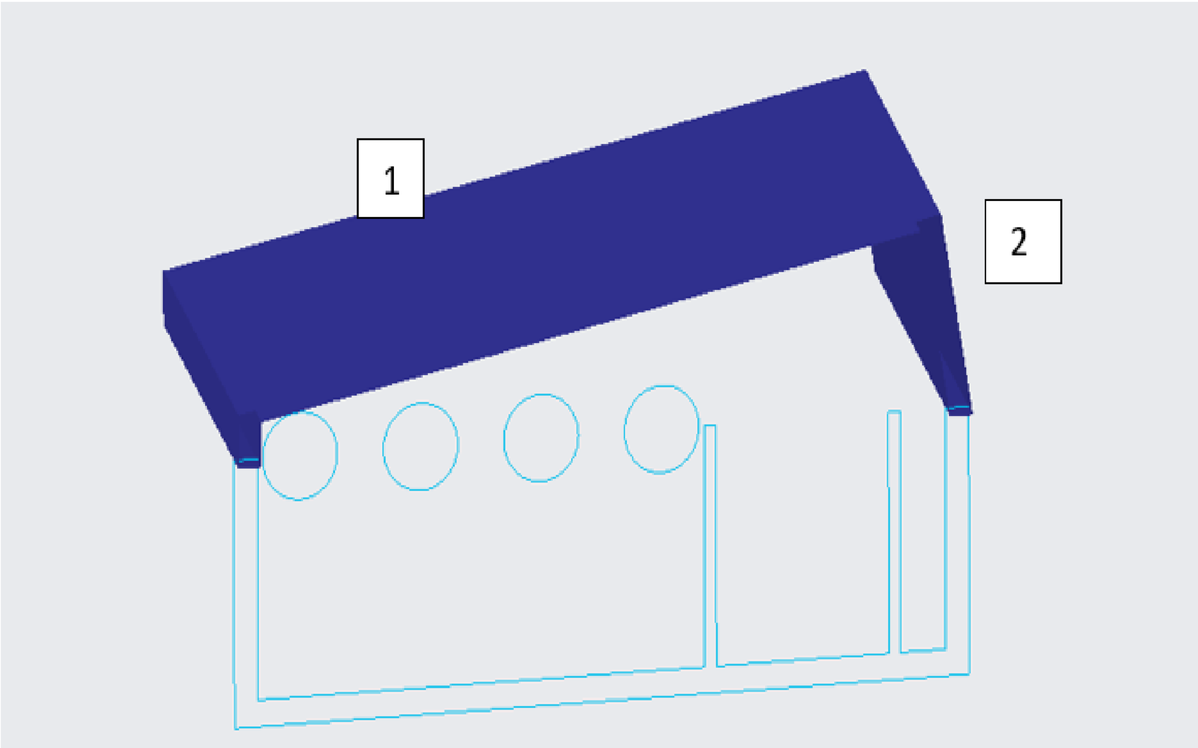



*Figure 11 Machine Construction slope view 1.First Chamber 2. Collecting Chamber*

**2. Collecting Chamber:**

Condensed water droplets gather in the machine's collecting channel, which can be seen in the sloping view of the device. A more precipitous slope makes it easier and more expedient for water to drain from the interior of the glass cover and into the collecting channel. The steeper slope makes it easier for the droplets to grow to the point where their increased mass makes it possible for them to descend into the pool under the influence of gravity.

We started by putting a polyurethane foam roller in the first chamber. This roller had a cotton fabric that had been black-dyed affixed to it, and it was rolled on polyurethane foam. Because of the way the roller was positioned, it was able to collect the water diets that had condensed onto the fabric as a result of the air passing over it. Because of the way the system was set up, it was feasible to collect water in a more efficient manner. Cotton fabric was used in this experiment, and its construction consisted of a simple weave, which allowed water vapor to condense on the surface of the fabric more easily. Because the cloth was dyed with a dark pigment, it was able to absorb solar energy, which led to an increase in temperature within the chamber. This, in turn, facilitated the formation of water droplets by creating an environment favorable to their growth. The addition of the polyurethane foam roller that was wrapped in a fabric that had been cotton that had been black dyed helped to increase the overall performance of the solar distillation system by making it easier to collect more clean water.

The second chamber is known as the "cooling chamber," and it is where the water vapor that was produced in the first chamber is allowed to condense. The inclination of the angle was increased to $80^0$ in this location so that the water vapor could readily settle down without the need for power. The design that we have produced for the solar distillation system incorporates a cover that is made of cotton fabric. The inclusion of this cover was done with the intention of assisting in boosting the performance of the cooling chamber. Plain weave is the construction of cotton fabric, which not only allows for an adequate quantity of ventilation but also avoids an excessive amount of heat build-up. The cooling chamber has to be shielded from direct sunlight in order to fulfill its function as the cover's primary objective. If the condensation process is slowed down, the overall efficiency of the system will suffer. Additionally, the cloth cover serves to manage the temperature within the chamber, preventing it from becoming excessively cold and possibly freezing the condensed water. This is accomplished by preventing the chamber from becoming too cold. This is achieved by maintaining a temperature in the chamber that is just below freezing. If we use this approach, which is not only straightforward but also effective, we won't need to rely on any other forms of energy or complicated processes to boost the overall effectiveness and efficiency of the solar distillation system.

Vapor from the inclined transparent lid enters a second chamber connected to the first. The first chamber transports vapor from the lid to the second slope. The machine has a second slope connected to the first chamber. The steeper second slope helps water collection. The increased slope allows condensed water droplets on the transparent lid to quickly drain into a collecting channel. Gravity drops droplets into the pool.

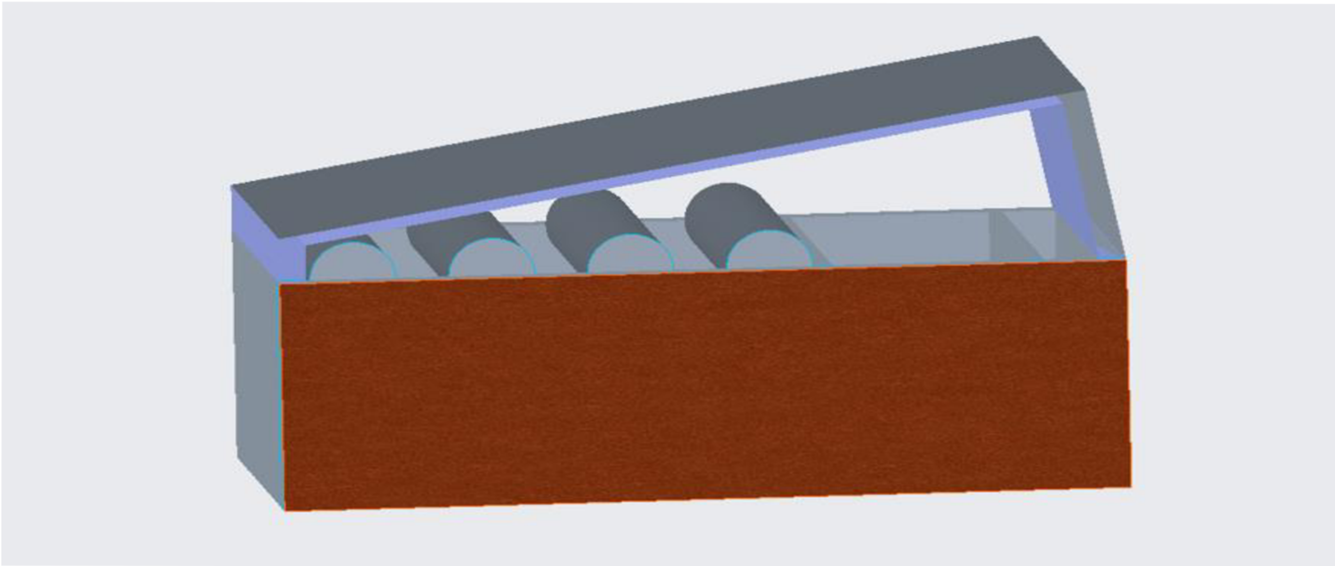


*Figure 12 Machine Construction final view*

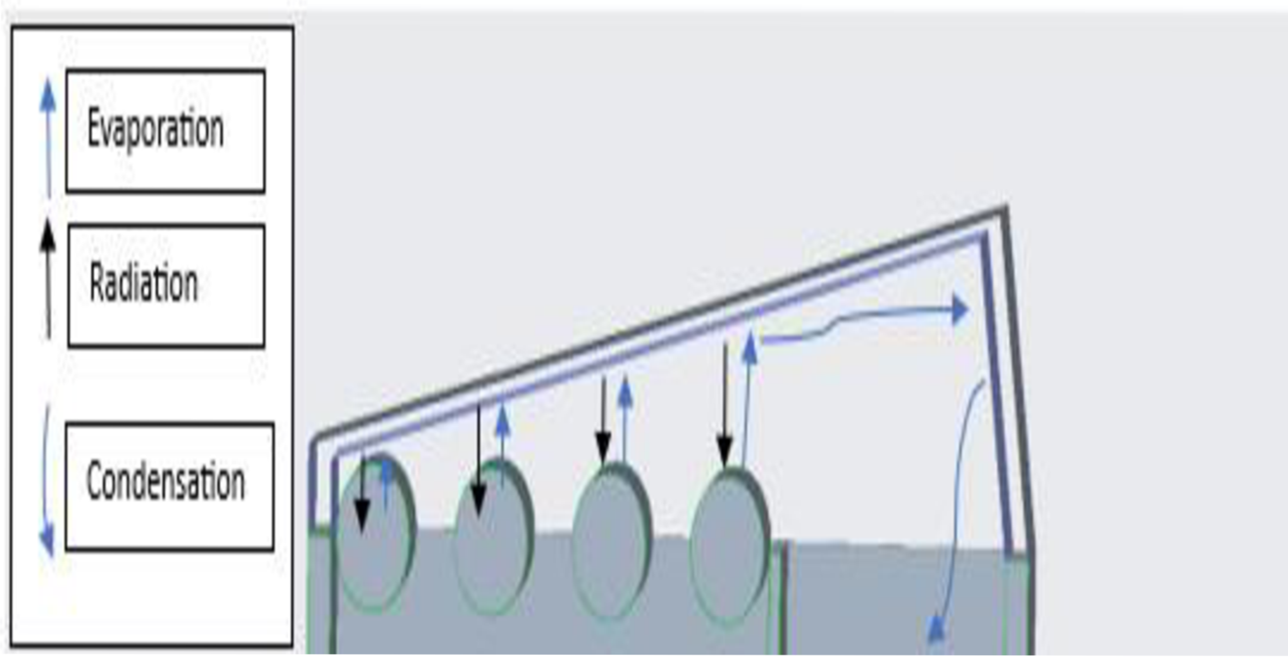



*Figure 13 Working Model of machine*

# 4 Testing

Evaluation of the performance and viability of various systems and processes requires testing. Several tests are performed to evaluate the efficiency, effectiveness, and economic viability of the solar apparatus in the context of water distillation using black dye textile material. In this article, we will discuss four important testing techniques: the evaporation test, the wicking test, the rate of the solar apparatus for water distillation using black dye textile material, thermal efficiency, production rate, and economic viability. These tests provide valuable information regarding the system's evaporation rate, water wicking capacity, distillation rate, thermal efficiency, production capacity, and overall economic viability. By analyzing these factors, we can determine the efficiency of the system and identify potential improvement areas.

## 4.1 Wicking Test

In a wicking test, a tiny rectangular sample of the fabric is put vertically into a dish containing water or another liquid, with a marked line showing the beginning location of the liquid level. The line also indicates how high the liquid level was when the test began. After a predetermined length of time, which ranges from 10 to 30 seconds on average, the cloth is removed, and the height that the liquid has risen on the fabric while being absorbed is measured. This distance provides an indication of the wicking capacity of the fabric, which refers to the rate and effectiveness with which it can absorb and move liquids. The observation of the above experiment is given in the observation section.

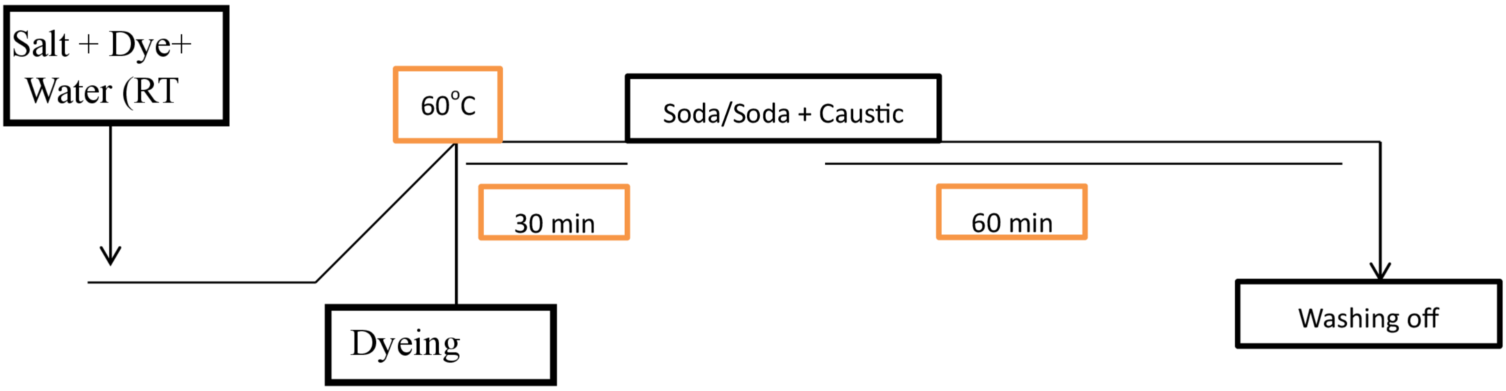
## 4.2 Evaporation Test

The rate of evaporation may vary for different textiles depending on a number of parameters including the kind of weave, the thickness, and the composition. The rate of evaporation was found to vary depending on the kind of textile material used during testing that was carried out at 54 centimeters using polyurethane rollers that were coated with nonwoven, knitted, and woven textile materials. During the experiment, the temperature of the room was kept at $22.8^0$ Celsius, and the humidity was maintained at 28%; both factors had an impact on the evaporation rates. It was owing to IR Light that the temperature on the testing side was $40^0$ Celsius, while the humidity was 58%. The observation of the above experiment is given in the observation section.


*Figure 14 Measurement of Evaporation Test*

### 4.3 Rate of a Solar Apparatus for Water Distillation Using Black Dye Textile Material

Using a textile material that can absorb the most solar radiation is essential for maximizing the thermal efficiency and production rate of a solar apparatus used for solar water distillation. Fabrics dyed with black, which are known to have a high absorptivity of solar radiation, may be used for solar water distillation. As more solar energy is absorbed by the black dye and transferred to the water, the thermal efficiency of the distillation process is improved when employed in a solar apparatus. This raises the water's temperature, which in turn increases the pace at which distilled water may be produced. Since the black dye is less susceptible to fading or degradation from exposure to solar radiation over time, its usage may also aid to enhance the endurance of the textile material. We had to use the following two as per availability in the laboratory they are Satarnova Cern A B5528 and Ostacolor A.S. The procedure for dyeing the cotton is same for the both dyes that are as follows:




## 4.4 Thermal Efficiency

The following procedures may be performed in a laboratory to determine the thermal efficiency of a solar apparatus that is being used for solar water distillation utilizing infrared light. Install the solar equipment in a laboratory that has carefully monitored and managed temperature and humidity levels. Fill the water container of the solar distillation equipment with an amount of water that can be accurately measured, such as one litter of water.

To determine the thermal efficiency of a solar device used for solar water distillation with infrared light, the following procedures may be performed in a laboratory. Install the solar equipment in a laboratory where the temperature and humidity levels have been carefully monitored and controlled. Fill the water container of the solar distillation equipment with a precisely measurable quantity of water, such as one liter. Use a thermometer to obtain an accurate reading of the water's temperature and record the initial temperature. Place the device directly beneath the IR light source, and ensure that the water container is also positioned directly beneath the light source. In this case, two hours, turn on the IR light source and let the machine run for the specified amount of time. Turn off the IR light source and remeasure the water's temperature after two hours. Perform the calculation used to determine the difference in temperature between the initial and final temperatures in order to determine the amount of heat acquired by the water during the testing period. To calculate the latent heat of vaporization, divide the heat energy gained by the water's mass using the formula:

$$Latent\ Heat\ Vaporization = \frac{Energy}{Mass}$$

Use a thermometer to get an accurate reading of the temperature of the water and make a note of the starting temperature. Position the device so that it is immediately under the IR light source, and make sure the water container is positioned so that it is directly beneath the light source as well. Turn on the IR light source, and then let the machine run for a certain amount of time, such as two hour. After the allotted amount of time has passed, the IR light source should be turned off before taking another reading of the water's temperature. Calculate the amount of heat acquired by the water throughout the testing time by performing the calculation that is used to calculate the difference in temperature between the beginning temperature and the end temperature. To get the thermal efficiency of the solar device, multiply the amount of heat gained by the amount of input energy using the formula:

$$Thermal\ Efficiency = \frac{Fresh\ Water\ x\ Latent\ Heat\ Vapourization}{IR\ Radiation\ x\ Running\ Time}$$

The quantity of energy that was put into the machine over the course of the test may be used to determine the input energy, which can then be computed. This may be accomplished by determining the wattage of the IR light source, then multiplying that number by the amount of time spent testing, which is expressed in hours. The outcome of the thermal efficiency test will provide an indication of how well the solar equipment performs the task of transforming input energy from the IR light source into thermal energy that can be used for water distillation. The higher the thermal efficiency ratings, the more effectively the solar equipment can transform the input energy into heat for the distillation of water.

The results of the thermal efficiency test will reveal how effectively the solar equipment converts input energy from the IR light source into thermal energy for water distillation over the course of the two-hour test.

## 4.5 Production Rate

The following procedures may be carried out in a laboratory in order to test the manufacturing of a solar apparatus that is used for solar water distillation employing IR light. Install the solar equipment in a laboratory that has carefully monitored and managed temperature and humidity levels. Fill the water container of the solar distillation equipment with an amount of water that can be accurately measured, such as one liter of water. Use a thermometer to get an accurate reading of the temperature of the water, and make a note of the starting temperature. Position the device so that it is immediately under the IR light source, and make sure the water container is positioned so that it is directly beneath the light source as well. Turn on the IR light source, and then let the machine run for a certain amount of time, such as an hour. After the allotted amount of time has passed, the IR light source should be turned off before taking another reading of the water's temperature. Calculate the amount of heat acquired by the water throughout the testing time by performing the calculation that is used to calculate the difference in temperature between the beginning temperature and the end temperature. During the course of the exam, you should take note of the total amount of water that the solar system generates. To calculate the production rate of the solar device, divide the total volume of water generated by the amount of time in hours that was spent doing the test.

$$Productivity\ Rate = \frac{Volume\ of\ Water\ Produced}{Time}$$

The performance of the solar equipment in generating distilled water utilizing the IR light source will be shown by the outcome of the production test. When the production rate is higher, it indicates that the solar system is capable of producing a greater quantity of distilled water in the allotted amount of time. It is essential to keep in mind that the pace of production may be influenced by a number of different parameters, including the intensity of the IR light source, the starting temperature of the water, and the ambient conditions present in the laboratory.

$$Production = Productivity\ Rate\ x\ Thermal\ Efficiency\ x\ 340\ day/year$$

Production Rate is the rate at which the solar apparatus produces distilled water in liters per hour (L/h). The volume of Water Produced is the total volume of water distilled by the solar apparatus during the testing period, measured in liters (L). Time is the duration of the testing period in hours (h).

For example, if a solar apparatus produces 2 liters of distilled water during a 1-hour testing period, the production rate can be calculated as follows:

Production Rate = Volume of Water Produced / Time

Production Rate = 2 L / 1 h

Production Rate = 2 L/h

Therefore, the production rate of the solar apparatus is 2 liters per hour.

## 4.6 Economic Feasibility

In order to evaluate an in-lab solar apparatus for solar water distillation using IR light in terms of its potential to generate a profit, the following elements will need to be taken into consideration. The cost of the solar apparatus takes into account the expense of purchasing all of the components that are necessary to construct the solar apparatus, such as the water container, the IR light source, and any other essential pieces of gear. Operating expenses are comprised of the cost of the energy that is necessary to operate the IR light source as well as any maintenance costs that are related to the solar device. The quantity of water that is generated by the solar system in each length of time is referred to as the water production rate. This value is significant in deciding whether or not the equipment is feasible from a financial standpoint. Demand for water is a term that refers to the quantity of water that is needed by the user on a daily or weekly basis. This value is significant in deciding whether or not the equipment is feasible from a financial standpoint. The cost of the water that must be used in the process of distillation using the solar apparatus is referred to here as the "water cost." This value is significant in deciding whether or not the equipment is feasible from a financial standpoint. The cost of energy is the amount of money needed to pay for the electricity that is used to power the infrared light source. This value is significant in deciding whether the equipment is feasible from a financial standpoint.

The cost of the solar apparatus as well as the expenses of running the apparatus need to be weighed against the quantity of water that is generated and the demand for water in order to evaluate whether or not the solar apparatus is economically viable. If the whole cost of the solar equipment, including installation and maintenance, is less than what it would cost to buy water, then using the solar apparatus might be considered economically viable. If the cost of the solar apparatus as well as the running expenses are more than the cost of acquiring water, then it is possible that the solar apparatus is not economically viable.

$$Annual\ Cost = Fix\ Cost + Operating\ Cost$$

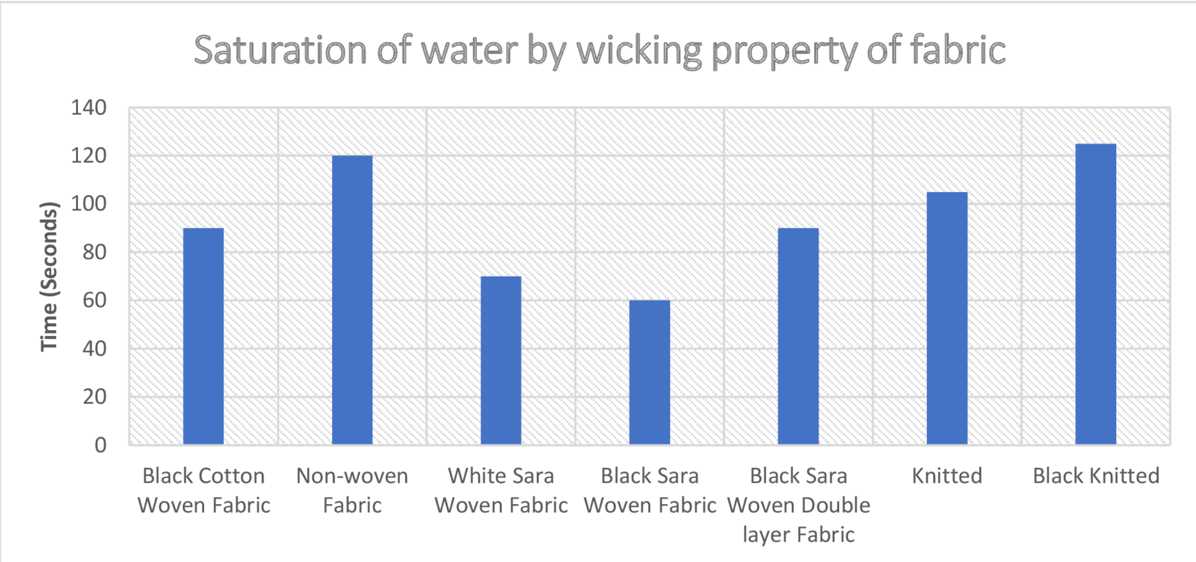
$$Cost\ of\ Fresh\ Water = \frac{Annual\ Cost}{Production}$$

## 5 Result and Discussion:

The evaluation of the efficiency and practicability of numerous systems and processes requires extensive use of observation and calculation as two of the most important tools. In the context of a solar apparatus for the distillation of water using black dye textile material, a number of important aspects are observed and calculated in order to evaluate the apparatus's efficiency, effectiveness, and economic viability. The evaporation test, the wicking test, the rate of the solar apparatus for water distillation using black dye textile material, the thermal efficiency, the production rate, and the economic feasibility will be discussed in the following paragraph. By carrying out the evaporation test, one is able to ascertain the rate at which water is lost from the apparatus as a result of evaporation. The ability of a textile material to draw water through capillary action is one of the qualities that can be evaluated using the wicking test. The speed at which distilled water is produced can be determined by examining the rate at which the solar apparatus for water distillation using black dye textile material operates. The thermal efficiency of a system is the measure of how effectively heat is transferred within the system. The production rate is an evaluation of the amount of distilled water that is generated over a specific time period. In the final step, economic feasibility calculations investigate whether or not it is feasible and cost-effective to put the system into action. We are able to gain valuable insights into the performance of the system and identify areas in which it can be improved if we carefully observe and calculate these factors.

### 5.1 Saturation of water by wicking Test

A wicking test was carried out on polyurethane foam rollers that were coated with a variety of textiles, such as woven fabrics, knitted fabrics, and nonwoven fabrics, in order to determine how well they would function in a solar device. In this test, a tiny rectangular sample of each fabric was inserted vertically into a dish holding water. The dish served as a test chamber. A marked line showed where the level of the liquid had begun, and the line also indicated where the level of the liquid had ended. The ability of a cloth to wick liquid gives an indicator of its wicking capacity when the distance that liquid travels up the fabric is measured. In addition to measuring the height to which the liquid had risen on each fabric sample, the wicking test gave a chance to study the behavior of each fabric when it comes into contact with liquid. This was done by measuring the height to which the liquid had risen. For instance, some types of fabric may have a high rate of absorption of liquid, but they may also keep the liquid on their surface for a longer period of time, which may result in a reduced rate of evaporation. On the other hand, materials that absorb liquid more slowly may be more efficient in releasing the liquid, which may lead to quicker rates of evaporation. The rate of evaporation has a direct impact on both the effectiveness and functionality of the system, thus it is essential to take these aspects into account when determining whether or not a material is appropriate for use in a solar device. This assisted in determining which fabric would be the most suitable to employ in a solar device. An observation table was used to record the findings, and those findings were then evaluated to discover which kind of cloth structure is most suited for a solar device. The results of this test provide significant information into the performance of the materials under a variety of situations.




*Graph 1 Saturation of water by Wicking Property of different fabric*

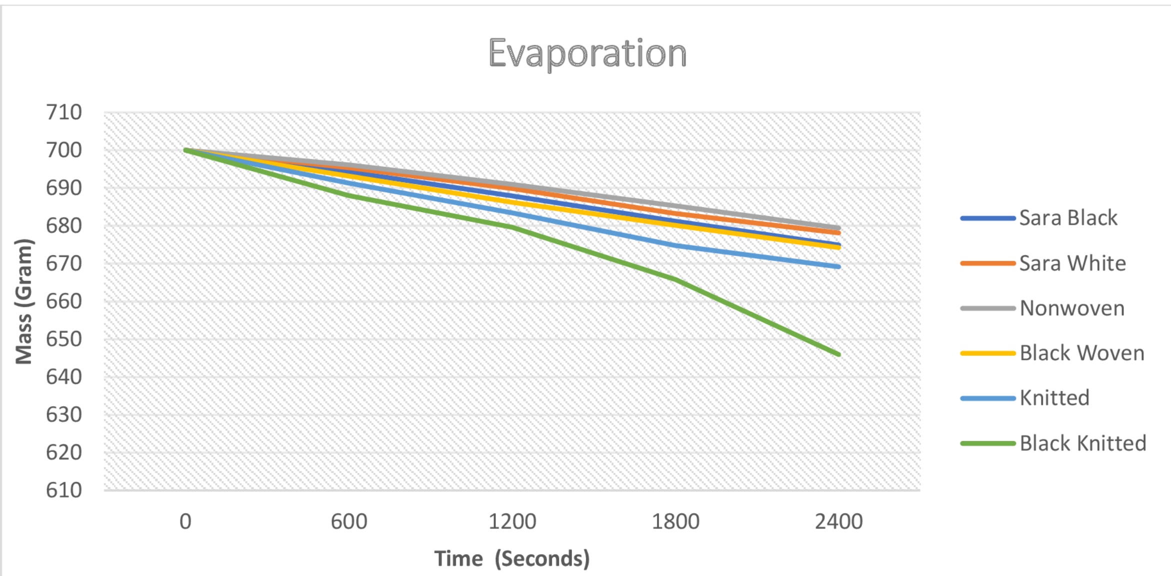
## 5.2 Evaporation Test:

The system of solar water distillation that is described in the study that was referred to uses a combination of components that were carefully selected in order to achieve effective water purification utilizing textile materials. By conducting an evaporation test, the purpose of this study was to evaluate the performance of polyurethane foam rollers coated with woven, knitted, and nonwoven textiles. The results of this evaluation were intended to provide useful insights into the rollers' overall effectiveness.

In this experiment, we measured the mass of the polyurethane foam roller at a variety of different time intervals, including 0 seconds, 600 seconds, 1200 seconds, 1800 seconds, and 2400 seconds. Several environmental parameters were carefully monitored and controlled in order to guarantee that the results would be accurate and reliable. The temperature, humidity, and sun exposure of each roller were kept constant to simulate real-world solar device use.In order to verify the findings and establish the reliability of the results, the study also included a number of different tests for each kind of fabric. In order to provide empirical data to support the effectiveness of various textile materials when used in a solar device, the evaporation test played a crucial role. The observational portion of the research project included compiling detailed documentation of the testing procedure and the findings. This was done to ensure that the study was both transparent and capable of being repeated.

In light of the results of the evaporation test, the machine has been designed to make use of the textile material-coated polyurethane foam rollers that have proven to be the most efficient in order to maximize heat absorption and transfer during the distillation process. The challenges associated with portability and complexity that are frequently encountered in traditional methods are addressed by the solar water distillation system, which combines these components to create a natural and energy-efficient method of water purification.

This innovative system, with its specific design features and utilization of textile materials, presents a sustainable solution for various applications. It provides a straightforward and efficient approach to water purification without the need for external energy sources or human intervention in any of the purification.




*Graph 2 Evaporation Time*

## 5.3 Thermal Efficiency

The goal of the thermal efficiency test was to determine how well the solar equipment converts input energy from an infrared light source into heat energy that can be used for water distillation. The results from the tests include characteristics such as the initial and final water temperatures, the quantity of water, the amount of time the device was operational, the wattage of the IR light source, and the computed thermal efficiency of the solar device. When calculating thermal efficiency, it is necessary to take into account the latent heat of vaporization, also known as the heat required for a liquid to change into a gas at a temperature that remains the same. The ability of the solar device to convert the energy it receives into heat that can be used for water distillation is reflected in the rating it receives for its thermal efficiency. The investigation is carried out in a laboratory setting that is under strict supervision so that correct results can be obtained. In this setting, environmental factors such as temperature and humidity can be properly regulated.

When determining the thermal efficiency of the solar device, the area of the cylinders that are involved is one of the factors that is considered. This component makes a contribution to the overall assessment of how effectively the solar equipment converts the energy received from the IR light source into heat energy that can be utilized for the process of water distillation. The test results provide insights into the performance of the solar device by examining the wattage of the IR light source, operational time, water quantity, initial and final water temperatures, and the computed thermal efficiency. All of these variables may be found in the water. In order to guarantee precise measurements and trustworthy evaluations of the solar device's capacity to generate thermal energy, it is absolutely necessary to carry out such experiments in a laboratory that is under strict scientific control. To use the formula, the results of the supplied thermal efficiency test must first be transformed into the correct units. The amount of specified potable water comes in grams, but it has to be translated to liters before it can be included in the formula, which is written in liters. A total of 26.8 grams of water is comparable to about 0.0268 liters of water. In addition, we need to determine the entire amount of time that the program has been running, which is 120 minutes, which is equivalent to 2 hours. when converting the data, the formula may be used to compute the thermal efficiency by replacing the old values with the new ones when the conversion has been completed.

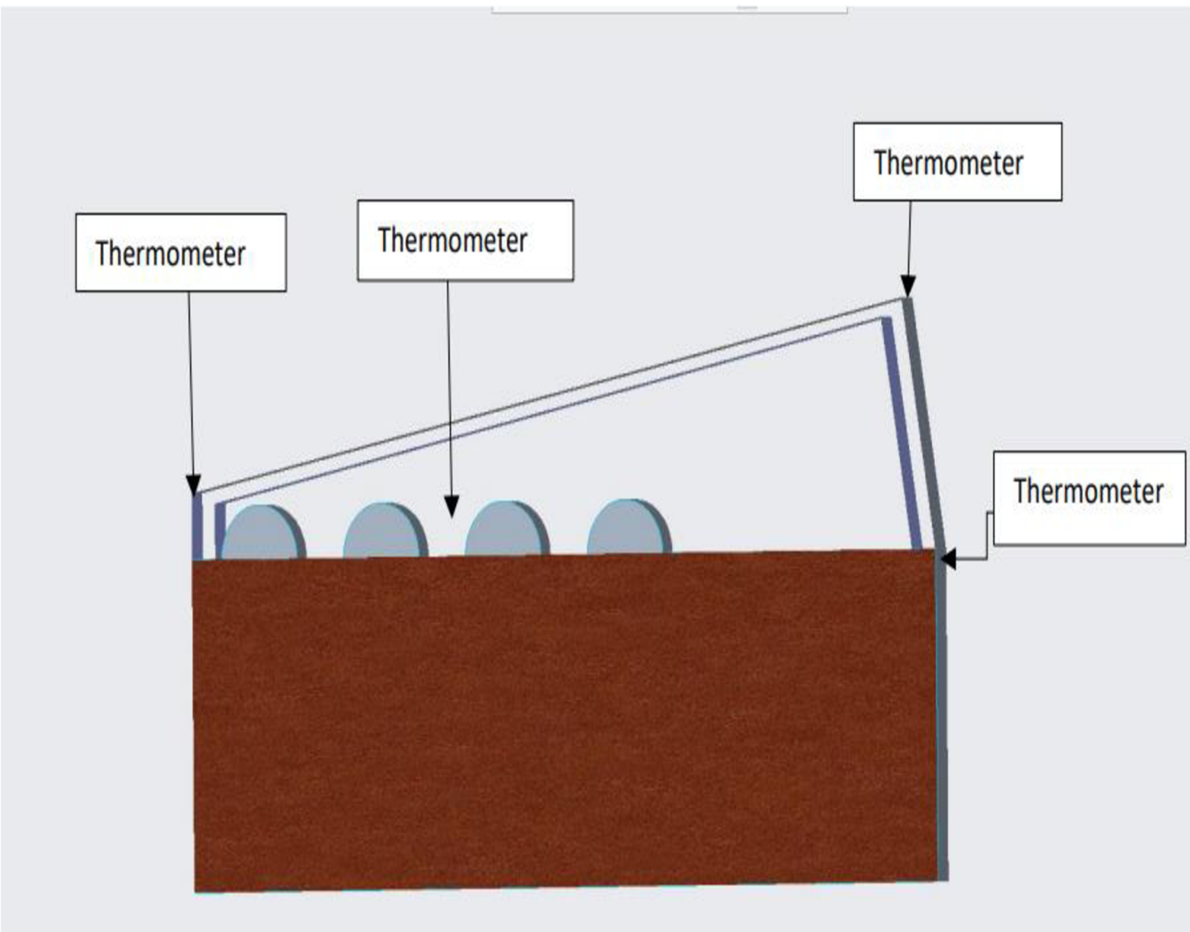



*Figure 15 Place where thermometer is placed to measure Thermal Efficiency*

Thermal Efficiency is calculated as follows:

If a device needs 1200 Watts to function in an area that is 2.5 $m^2$, then it will need approximately 22.27 Watts to function in an area that is 462 $cm^2$. This calculation is predicated on the idea of power density, which refers to the amount of power that is produced per unit of area. We can determine the amount of power that will be necessary for the new area by comparing the power densities of the existing area to those of the new area. In this particular instance, the power density was determined by dividing the total amount of power, 1200 Watts, by the total area, which was initially 2.5 $m^2$. When you multiply this power density by the area of the smaller area, which is 462 $cm^2$, we get an approximate power requirement of 22 Watts for the smaller area.

To calculate the latent heat of vaporization, we need to consider the initial and final mass of the water, as well as the energy required to vaporize the water during the distillation process. Given the following data:

Initial mass of water = 1000 grams

Initial temperature of water = 23.48°C

Final mass of remaining water = 574 grams

We can use the following formula to calculate the latent heat of vaporization:

First, let's calculate the energy used to vaporize the water:

$$Energy = (Initial\ Mass - Final\ Mass) * Specific\ Hear * Temperature\ Change$$

Specific Heat of Water = 4.186 J/g°C (approximately)

Temperature Change = Boiling Point - Initial Temperature

Boiling Point of Water = 100°C

Temperature Change = 100 - 23.48 = 76.52°C

Energy = (1000 - 574) * 4.186 * 76.52

Next, we calculate the latent heat of vaporization:

$$Latent\ Heat\ Vaporization = \frac{426816.9248}{574}$$

Therefore, the latent heat of vaporization is approximately 744.05 J/g

Let's substitute the given values in the formula:

Volume of water (V) = 26.8 gm / 1000 = 0.0268 L

Latent heat of vaporization (Lv) = 744.05 J/g

Density of water (ρ) = 1 kg/L

IR radiation (I) = 22 Watts

Running time (t) = 120 min / 60 = 2 hours

$$Thermal\ Efficiency = \frac{\left(0.0268\ L\ x\ 744.05\ \frac{J}{g}\right)}{(22\ W\ x\ 2\ hours)}$$

The thermal efficiency that has been determined using these figures comes out to around 0.4376 or 43.76%

We performed the very same set of measurements several times inside the exact same laboratory settings, and we arranged the solar equipment in precisely the same way each time in order to guarantee that the thermal efficiency would be accurately measured. In order to offer a more accurate and comprehensive assessment of the solar device's capacity to generate thermal energy, we came to the conclusion that it would be best to take the average of the data.

## 5.4 Production Rate

The production rate is a crucial measurement that may be used to determine the efficiency and efficacy of a solar device that is utilized for solar water distillation using IR light. During the course of the evaluation, it gives an indication of the volume of water that is distilled by the solar device in terms of liters per hour (L/h). When the production rate is correctly measured, it is possible to assess whether or not the solar equipment is operating at its optimum level and whether or not there are any modifications that need to be made in order to boost its productivity. The rate of production may be measured by first ensuring that the laboratory's temperature and humidity levels are stable, then filling the water container with a specified quantity of water, then set the device so that it is in direct line with the IR light source, and finally allowing the device to operate for an allotted period of time. Calculating the production rate involves making a note of the entire quantity of water produced and then dividing that sum by the length of time spent doing the test. It is essential to bear in mind that the production rate may be affected by a variety of variables, some of which include the intensity of the IR light source, the temperature at which the water was first heated, and the environmental conditions that were present in the laboratory.

To calculate the production rate, we first need to convert the volume of water produced from grams to liters.

26 grams of water is equivalent to 0.026 liters of water. Then we can use the formula:

$$Productivity\ Rate = \frac{0.026L}{2\ hr}$$

Productivity Rate = 0.013 L/h

Next, we can use the thermal efficiency given in the paragraph, which is 43.76%. We also know the dimensions of the solar apparatus: length 37 cm and width 25 cm.

Length = 37 cm

Width = 25 cm

$$Area = Length\ x\ Width$$

Area = 925 $cm^2$.

Now we can calculate the production rate:

Production = Productivity Rate x Thermal Efficiency x 340 day/year x Area

Production = 0.013 L/h x 0.4376 x 340 day/year x 925 $cm^2$

Production = 1789 L/year.

Therefore, the production rate of the solar apparatus is 5 L/day.

## 5.5 Economic Feasibility

The term "fixed cost" refers to the one-time charges that are involved with obtaining and installing the equipment. These expenses include the cost of buying the equipment, the cost of installation fees, and any other initial setup expenses.. In the setup, the fix cost is polystyrene nonwoven, Construction of two chambers with different angles, insulating rollers which are made of polyurethane foam, a transparent lid. And operational cost is of cooling system, black fabric that cover polyurethane foam.So cost of following item is in such a way that:

*Table 2 Cost of Material use for preparing machine*

| Material Use | Cost for Provided Length | Material Provided Length | Material Length | Actual Material Usage |
|---|---|---|---|---|
| Polystyrene | 132 CZK | 1 $m^2$ | 0.0925 $m^2$ | 12 CZK |
| Polyurethane Form Roller | 59 CZK | 2 m | 0.8 m | 23 CZK |
| Clear Lid | 217 CZK | 1 $m^2$ | 0.0625 $m^2$ | 14 CZK |
| Collector for Condensing Water | - | - | - | 125 CZK |
| Black Fabric | 200 CZK | 2 $m^2$ | 0.3 $m^2$ | 30 CZK |

So, now to calculate the Annual cost is to sum fixed cost and operational cost which is 204 czk.

Now, we can calculate the cost of Freshwater as we know the annual cost of the setup is 204 czk and production is of 5 L/day. For the setup which has an area 925 $cm^2$ by using the below formula:

$$Cost\ of\ Fresh\ Water = \frac{Annual\ Cost}{Production}$$

The availability of freshwater, which is required for life but is becoming more difficult to come by in many places of the globe, is a fundamental need. There are several issues, such as pollution, droughts, and growing demand, that are contributing to the rise in the price of freshwater in many parts of the world. Traditional ways of generating freshwater, such as desalination, are sometimes prohibitively expensive and demanding of significant amounts of energy. However, it is feasible to manufacture freshwater in a way that is both friendlier to the environment and more wallet-friendly if solar devices are used in the process. Textile technology is now being used in the development of solar apparatuses in order to make these devices more robust, lightweight, and transportable. These solar water distillation systems may create high-quality freshwater at a minimal cost by harnessing the power of the sun. Because of this, they are an economically attractive choice for communities that need dependable access to clean water. In contrast to typical market water, which may be costly and is often of dubious quality, solar devices can offer an inexpensive and trustworthy technique of producing freshwater that is not only economically viable but also an ecologically sustainable option. So, the cost of fresh water is 0.2 CZK with the production of 1789 liters per year.

## 5.6 Solar Apparatus use in field trial

The process of purifying water by evaporating it and then allowing it to condense back into its original form is referred to as solar water distillation. This approach is useful in locations with limited access to clean drinking water or water that is contaminated. The experiment was carried out over the course of four days, with an identical process being followed on each of those days. At the beginning of each day, readings were taken of the temperature and humidity of the surrounding environment, and then three liters of water were added to the solar setup. After then, the solar device was exposed to sunlight for a period of six hours. During this period, the inside temperature, as well as the relative humidity, were tracked, and at the conclusion of the six hours, the total amount of freshwater that had been gathered was tallied.

*Figure 16 Machine Instillation*

The results show that the temperature was $23^0$C and the humidity was 32% on the first day. The solar equipment had a temperature of $30^0$C on the inside, and the relative humidity was 82%. After a period of six hours, a total of 5 millilitres of pure water was gathered.

On day 2, the temperature outside was $20^0$C, and the humidity was 28%. The solar equipment had a temperature of $27^0$C on the inside, and the relative humidity was 84%. After a period of six hours, 4 millilitres of pure water was obtained for collection.

On day three, the temperature outside was $17.2^0$C, and the humidity was 41%. The solar device had a temperature of $29^0$C on the inside and a humidity level of 92%. After a period of six hours, 4 milliliters of pure water were obtained for collection.

On day 4, the temperature outside was $24^0$C, and the humidity was 37%. The solar equipment had a temperature of $36^0$C on the inside, and the relative humidity was 89%. After a period of six hours, 10 milliliters of pure water were obtained for collection.

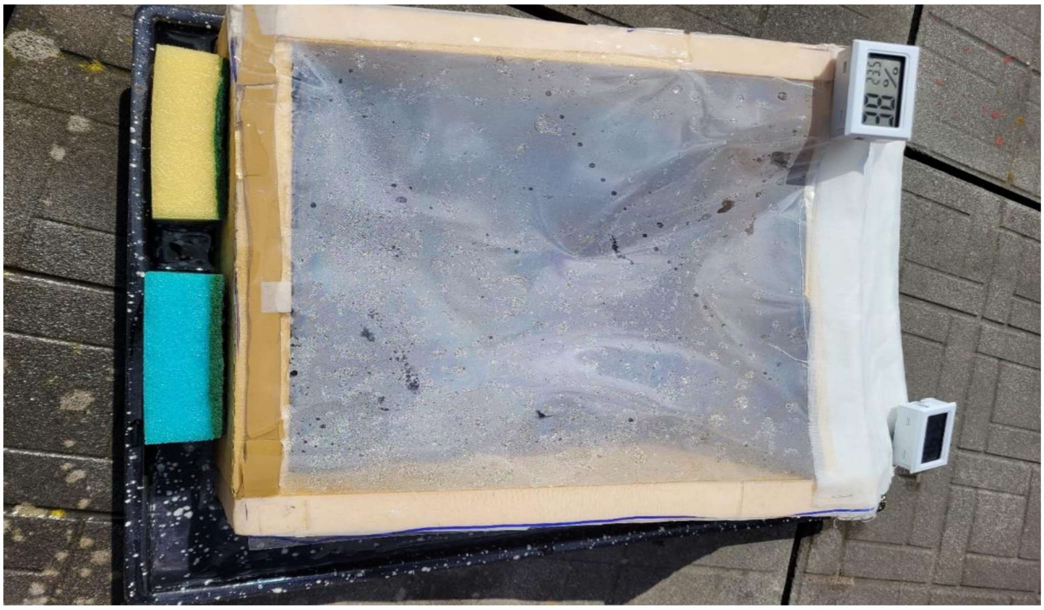


*Figure 17 Evaporation of water outside photo*

*Figure 18 Inside photo of evaporation of water*

The experiment's findings indicate that the amount of freshwater collected rose as the temperature around the participants increased. This is because greater temperatures result in an increased amount of evaporation, which in turn leads to increased condensation and an increased amount of pure water. However, another factor to consider is the level of humidity. Because the air already contains a high moisture content, it is more difficult for water to evaporate and condense as the humidity level rises. As a result, the amount of freshwater that can be collected drops as a result.

Distillation of water using the sun is an efficient method for cleaning water, particularly in locations with limited access to clean drinking water or water that has been contaminated. The findings of this experiment indicate that the amount of freshwater collected is impacted by both the temperature and the humidity of the surrounding environment. It is possible to gather more fresh water as the temperature rises; however, the humidity level must be maintained at a low level in order to get the most out of the sun distillation process.

Solar distillation has been demonstrated to be an effective technique for the purification of water, particularly in regions where clean drinking water is either in little supply or is contaminated. The experiment sheds light on the ways in which temperature and humidity can impact the amount of freshwater that can be collected. Higher temperatures encourage more evaporation and condensation, but lower humidity levels are essential for optimizing the solar distillation process and maximizing water collection. Higher temperatures promote greater evaporation and condensation.

## 5.7 Comparison between Production rate in Laboratories and Environmental Condition for Solar Water Distillation Process:

The production rate in the laboratory is a measurement of the efficiency of a solar device that is used for solar water distillation with infrared light. This measurement is referred to as the production rate in the laboratory. It is a measurement of the amount of water that the solar device is capable of distilling in a given amount of time, and it is typically expressed in liters per hour (L/h). The production rate is used as a metric to evaluate the performance of the device and determine where there may be opportunities for improvement in order to increase productivity. The rate of production can be affected by a variety of factors, including the intensity of the IR light source, the initial temperature of the water, and the conditions of the surrounding environment. The amount of water that is distilled by the solar device on a daily basis was calculated to be approximately 5 L/day based on the information provided in the context in which the calculation was performed.

Conditions in the Environment The conditions in the environment are essential factors that have an impact on the process of solar water distillation. The process of using solar energy to evaporate water, which then returns to its original state as it condenses back into its original form, resulting in purified water, is referred to as solar water distillation. This method is especially helpful in locations where there is insufficient access to clean drinking water or where the water itself is contaminated.

*Table 3 Production Rate in Laboratory*

| Measurement | Description |
|---|---|
| Production Rate | Volume of water distilled by the solar device per unit of time |
| Measurement Unit | Liters per hour (L/h) |
| Factors Influencing | Intensity of the IR light source, initial water temperature, and environmental conditions |
| Calculation | Approximately 5 L/day |
| Purpose | Evaluate device performance, identify modifications to enhance productivity |

In the experiment that was described, the environmental conditions were tracked over the course of a period of four days. Readings of temperature and humidity were taken first thing in the morning of each day in order to gain a better understanding of the environment.

The solar setup was given daily exposure to sunlight for a total of six hours, during which time three liters of water were added to the system. During the time that the solar device was exposed to the light, measurements were taken of the temperature as well as the relative humidity. After the six hours had passed, an account was taken of the total volume of freshwater that had been gathered.

*Table 4 Enviormental Condition*

| Day | Temperature (°C) | Humidity (%) | Inside Device Temperature (°C) | Inside Device Humidity (%) | Freshwater Collected (milliliters) |
|---|---|---|---|---|---|
| 1 | 23 | 32 | 30 | 82 | 5 |
| 2 | 20 | 28 | 27 | 84 | 4 |
| 3 | 17.2 | 41 | 29 | 92 | 4 |
| 4 | 24 | 37 | 36 | 89 | 10 |

The results of the experiment suggest that temperature and humidity are two factors that are extremely important in the process of solar water distillation. Throughout the course of the experiment, daily readings of the temperature and humidity were taken, in addition to noting the total volume of freshwater that was gathered. It was found that increasing the temperature led to an increase in the amount of water that evaporated and condensed, as well as a subsequent increase in the amount of pure water that was collected.

Nevertheless, another factor that had an impact on the process was the humidity. As the relative humidity in the air rose, it became increasingly difficult for water to evaporate and then condense, which resulted in a reduction in the amount of freshwater that was collected. The experiment highlights how important temperature and humidity are for solar distillation as a method for water purification using the sun. Even though higher temperatures lead to an increase in the amount of water collected through evaporation and condensation, it is essential to keep the humidity levels at a lower level in order to optimize the process and get the most water out of it. Distillation of water using the sun has been shown to be an efficient method for water purification, particularly in areas of the world where clean drinking water is either in short supply or is contaminated.

# 6 Conclusion

In conclusion, the experiment that was carried out in order to assess the efficiency of polyurethane foam rollers covered with various types of textiles by means of an evaporation test was successful in selecting the fabric structure that would be most suited for a solar device. The findings of the tests indicated that the knitted cloth was the most efficient at absorbing and evaporating water, both of which are necessary for the successful operation of a solar device. In order to assure the reliability and validity of the results, the experiment was carried out in an environment that was carefully monitored and managed, and each kind of fabric was examined and evaluated a number of times. Actual data to back up the findings that were obtained from the experiment are given in the form of an observation table that is included in the research. When compared to the other kinds of fabric, the black weave dyed cloth was shown to be the most successful in terms of evaporation time, especially when measured at a duration of 2400 seconds. This shows that the black woven colored fabric may be a better option than the knitted textile in some conditions, especially if quick water evaporation is necessary. In addition, this suggests that the knitted fabric may be a superior choice overall. It is important to note that the knitted fabric continued to function better than the black cloth that had been woven and dyed, even at the other time intervals. This suggests that the choice of fabric should be based on the particular needs as well as the environmental circumstances.

The results of the research have substantial implications for the development of solar devices, especially in places where water shortage is a major problem. These implications are particularly relevant in regions where water scarcity is a major concern. The experiment was successful in determining which kind of fabric structure would be most suited for a solar device. The knitted textile and the black weave dyed cloth were found to be the most efficient at absorbing water and evaporating it, respectively. It is important that the choice of fabric be based on certain needs as well as the characteristics of the surrounding environment. Additionally, future research in this field may benefit from the complete documentation of the testing procedure and observation methodologies offered by this research study.

In summary, the wicking test that was carried out on a variety of textiles that had been coated onto polyurethane foam rollers yielded very helpful information on the appropriateness of certain materials for use in solar devices. The findings of the experiment show that a black woven cotton fabric surpasses other materials with regard to its wicking characteristics. It only takes 90 seconds for the cloth to pull water up to a particular height. This is vital for ensuring that a solar device operates well since it makes the evaporation process easier, which is necessary for maximum performance. The experiment also revealed that the knitted fabric was less effective in absorbing and evaporating water. It took anywhere from 105 to 125 seconds for the cloth to wick up water. These discoveries have important repercussions for the research and development of solar technologies in areas of the world where there is a considerable shortage of water. Therefore, it is possible to draw the conclusion that applying a coating made of black woven cotton fabric made of polyurethane foam rollers in solar devices using the black woven cotton fabric might increase the performance and efficiency of the solar devices. These discoveries could be useful for future study and development of solar technologies that are both more efficient and more environmentally friendly.

It was noted that the black woven cotton fabric had the most efficient wicking capabilities among all of the textiles that were tested, as it had the lowest wicking time of just 90 seconds. The reasoning for this observation is based on the findings of the wicking test. In comparison to other types of cloth, this one has a significantly increased capacity to both absorb and transport water. The capacity of the black woven cotton fabric to rapidly absorb and release water is another reason why it is an excellent option for a solar device. This ability is essential for ensuring that the system maintains the right temperature and humidity levels.

In addition to this, the use of a dark woven cotton cloth in a solar device may also assist in the prevention of the loss of heat. Because of the dark hue of the material, more sunlight is absorbed by it, which results in an increase in the temperature of the system. Because of this, the rate of evaporation is accelerated, and the system is able to function more effectively. In addition, the use of cotton material in a solar device is favourable owing to the fact that it is long-lasting and inexpensive.

The results of the wicking test, which was performed on a variety of different kinds of fabrics, offered useful information on the appropriateness of certain textiles for use in solar devices. Due to its good wicking capabilities, heat absorption, durability, and affordable nature, the black woven cotton fabric was discovered to be the most suitable fabric for a solar device. These discoveries have the potential to have substantial ramifications for the development of solar systems that are both more efficient and more environmentally friendly, especially in regions that have problems with water shortages.

In summary, the thermal efficiency test that was performed on solar equipment for water distillation in order to determine its ability to convert input energy into heat energy has supplied us with important information regarding its capacity to do so. The device is only capable of converting a tiny percentage of the input energy from the IR light source into heat energy that can be utilized for water distillation, as shown by the estimated thermal efficiency value of 43.76%. But despite this being a good beginning point, there is still potential for growth.

It is important to point out that the evaluation of the device's thermal efficiency took place in a laboratory under strict conditions, and that the device itself was evaluated on a very modest scale, covering an area of 462 $cm^2$. It is likely that the thermal efficiency of the device may be increased if it were tested on a bigger scale, such as in a commercial application or in an environment that is more representative of the real world. It is anticipated that the thermal efficiency will improve along with the area of the solar device as it continues to expand.

If the average thermal efficiency gained from numerous tests is 43.76%, one may get the following conclusion: with a surface area of 462 $cm^2$, this is the best thermal efficiency that can be reached with the solar equipment that was used in the experiment: this is the best thermal efficiency that can be achieved with the solar equipment that was used in the experiment. It is important to note, however, that this efficiency may change based on a number of different parameters, including the quality of the solar equipment, the strength of the IR radiation source, the kind and quantity of water that is utilized, as well as the external temperature and humidity conditions.

In addition, the thermal efficiency may theoretically improve if this solar equipment were to be utilized in a greater area because of the higher absorption of solar radiation. This would be the case if it were employed in a bigger region. However, in order to guarantee that the heat is distributed evenly across the whole space, this would need the use of a power source that is more powerful. In addition, the kind of materials and the thickness of those materials that are used in the construction of solar equipment may also have an influence on the efficiency of the system when applied to bigger regions.

When determining whether or not solar equipment is useful for water distillation, in addition to the thermal efficiency of the equipment, there are a number of additional factors to take into account. It is essential to keep in mind both of these aspects. For example, the cost of the equipment, the cost of its upkeep, the simplicity with which it may be used, and its scalability are all crucial considerations to take into consideration.

In general, the thermal efficiency test that was performed on the solar equipment revealed a thermal efficiency of 43.76%for an area that was 462 $cm^2$ in size. The efficacy of the solar equipment for water distillation may be evaluated according to this efficiency, which, despite the fact that it may vary based on a variety of conditions, serves as a benchmark for doing so. It is possible that more testing and upgrades to the equipment may lead to better thermal efficiency and a system that is more efficient for the distillation of water.

In overall, the thermal efficiency test offers useful insight into the capacity of the solar equipment to produce thermal energy. Even though the thermal efficiency of 43.76% may not seem like much, it is essential to bear in mind that this is only the beginning. It is feasible to enhance the solar device so that it has higher thermal efficiency and becomes a more practical choice for water distillation. This may be done by testing it on a wider scale and adding changes to the device. The findings of this test provide a constructive foundation upon which to build future exploration and innovation in the field of solar energy technology.

In general, the rate of production is an essential criterion to consider when assessing the effectiveness of solar water distillation systems that make use of IR light. It is possible to verify whether the solar equipment is running at its ideal level and identify any required adjustments to increase its productivity by monitoring the rate of water production in liters per hour. This allows the equipment to be optimized for maximum output. The pace of production is susceptible to being altered by many variables, including the temperature, the intensity of the IR light source, and the ambient conditions that prevail in the laboratory. Therefore, to acquire reliable results from the test, it is very important to make sure that these factors remain constant.

We were able to determine that a solar device had a rate of production of 5 L/day by using the formula that was presented within the given context. This rate was calculated using an area of 925 $cm^2$, a thermal efficiency of 43.76%, and the assumption that the device is in operation for 340 days out of the year. It is essential to keep in mind that the production rate may be different from one solar device to another based on factors such as its dimensions, construction, and the surrounding environment.

In addition, the rate of output may be increased by expanding the surface area of the solar device that is being used. Because there is more water available to be heated and evaporated, the production rate is increased when there is a bigger surface area. This may be accomplished in one of two ways: either by expanding the size of the solar device or by using a multi-layer design that enhances the surface area while simultaneously lowering the footprint of the device.

It is also essential to keep in mind that the rates of production might change based on climatic circumstances, which include the levels of temperature and humidity, the amount of solar irradiation, and the speed of the wind. For this reason, it is very necessary to carry out production rate measurements in a variety of various environmental circumstances to get a more precise depiction of the device's performance.

In conclusion, the rate of production is an essential criterion to consider when assessing the effectiveness of systems that use solar energy to distill water. By carefully monitoring the rate at which water is produced, we can identify areas in which improvements are needed and optimize the solar equipment so that it produces the most amount of water possible. Solar water distillation technology has the potential to play a key role in solving the issue of water scarcity on a worldwide scale and increasing access to potable water if additional research and development are conducted in this area.

In addition, a cost analysis was carried out in order to evaluate the apparatus for solar-powered water distillation in terms of its potential for generating a profit. According to the findings, the production of 1789 liters of fresh water would incur a total cost of only 0.2 Czech korunas. This represents a significant saving. In this calculation, we assume that the machine will be in operation for 340 days and will have an overall production efficiency of 0.013 liters per hour. Because of its low cost of 0.2 CZK, this solar-powered device is an appealing choice for communities that are struggling with the challenges of expensive freshwater or limited water supplies. By utilizing contemporary textile technology and drawing power from the sun, this strategy not only reduces costs but also contributes to the preservation of the natural environment. In addition, the water that is produced by the solar distillation system is of very high quality and is appropriate for a wide variety of uses, including hydration and the use of water in agriculture. The convenience of the device's portability and the fact that it is lightweight make it ideal for use in regions that have limited access to clean water and, as a result, frequently face water shortages. Therefore, this apparatus for solar-powered water distillation offers a reliable and sustainable solution to address the growing problem of water shortage by utilizing sunlight and textile technology. In order to achieve this goal, it collects the water vapor that is produced during the distillation process.

In summing up, the research delivered important takeaways and suggestions that may help advance the development of solar-powered products. In the first experiment, which concentrated on the wicking properties of various textiles sprayed onto polyurethane foam rollers, it was discovered that black woven cotton fabric was the most effective for collecting and evaporating water. This finding was supported by the fact that the fabric had a higher surface area. This cloth was discovered to be helpful in a number of different ways, including its capacity to absorb heat, its durability, and its cost. The second research studied the thermal efficiency of a solar device for water distillation and found that it was only capable of converting a tiny fraction of the input energy into heat energy. This finding contradicts the findings of the first study, which claimed that the solar device had high thermal efficiency. Nevertheless, the findings of this study may serve as a foundation for further research and development on a more extensive scale. Both studies underscore the need of considering the selection of materials as well as environmental concerns when designing and developing solar systems, with the ultimate objective of producing technologies that are both more effective and less harmful to the environment.

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# Appendices

*Table 5 Change of mass by evaporation from textile samples.*

| Time (Seconds) | Different Fabric Mass in Gram | | | | | |
|---|---|---|---|---|---|---|
| | Sara Black | Sara White | Nonwoven | Black Woven | Knitted | Black Knitted |
| 0 | 700 | 700 | 700 | 700 | 700 | 700 |
| 600 | 694.25 | 695.34 | 696.14 | 693.14 | 691.28 | 687.98 |
| 1200 | 687.89 | 689.87 | 690.93 | 686.24 | 683.45 | 679.58 |
| 1800 | 681.24 | 683.27 | 685.26 | 680.13 | 674.78 | 665.78 |
| 2400 | 674.93 | 678.13 | 679.43 | 674.24 | 669.16 | 645.96 |

*Table 6 Saturation of water by Wicking Property of different fabric*

| Fabric | Time (Seconds) |
|---|---|
| Black Cotton Woven Fabric | 90 |
| Non-woven Fabric | 120 |
| White Sara Woven Fabric | 70 |
| Black Sara Woven Fabric | 60 |
| Black Sara Woven Double layer Fabric | 90 |
| Knitted | 105 |
| Black Knitted | 125 |