

## Solar Distillatory

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### ABSTRACT

The solar distillatory design is a project which born of the social point of view, keeping in mind that hundreds of water liters are wasted every year, this project is developed with the purpose of obtain distilled liquid for the chemistry lab and help the students with their activities in the Universidad Tecnológica de Tlaxcala. Therefore, the stages, in which the evaporation and condensation under the thermodynamics were performed, are described in general terms. The Sun makes it a removable source, playing a very important role in the system warming, the types of energy transference implicated such as radiation, convection and conduction were analyzed. The main components of a distillatory are covers and tray, they must be put through an energetic test during the design final stage. This calculation is also applied to the fluid, which is going to be analyze, the amount of heat that is absorbed and how much water is wasted throughout the project also. A system function analysis was conducted and with it and using variables like temperature, radiation, time, initial and final volume, compare the theoretic data with the real data obtained during the prototype function, this determines the efficiency of the mechanism and the amount of liquid coming out clean per day. The distilled water is composed by two hydrogen atoms and one oxygen atom, which molecule is represented chemically by the formula H<sub>2</sub>O. The liquid component has been put through a distillation process in which impurities and the origin water ions were eliminated.

**Keywords:** Distillatory; radiation; thermodynamics

### INTRODUCTION

The Universidad Tecnológica de Tlaxcala (UTT) students use the thermodynamics laboratory where the water is a necessary supply for the realization of practices and experiments. This supply must be pure for the correct realization of them.

Nevertheless, this supply care is necessary. In this sense, using rainwater es a good option. However, choosing this source the purification turns mandatory. This can be done by different ways. In this sense, a solar distillatory has been picked to use, same that is looked forward to improving, being this the main objective of the present work.

The solar distillery is a system that uses the captured solar energy to purify the rainwater. The distillation process purifies the water by eliminating salt, bacteria, fungus, viruses, and any other kind of pollutants.

Between the improvements made to the distiller, the distiller glass was replaced for one with 9 mm thickness.

Afterwards a 3 mm thick glass is integrated, this glass allows to capture solar rays better and makes the condensation faster producing a greater amount of distilled water. The inclination is increased to enhance the caption and the liquid condensation. Once the distiller has condensed water it is collected in the corresponding ducts and finally, is conducted to the collector gallons for being used by the students of the (UTT).

Another improvement made is the colocation of a lock in the glass outline, due to the constant movement of the distiller, causing a low water caption. Finally, a better conduct is added for eliminate filtrations causing purified water losses.

## METHODOLOGY

This prototype consists in a metal base, which overload a wooden box and on top of this box the tray containing the rainwater tray this tray is made of stainless steel, is 15 cm depth, 58 cm width and 83 cm long. This tray is sealed with a glass of 3 mm thickness, for capture the solar rays.

For the distiller tray inclination, a tool called Goniometer is used for determined the correct angle for its optimal function. Next, in figure 1.3 the result of 6.7° inclination angle is shown.



**FIGURE 1:** Goniometer Measurement.  
*Source:* Own, year 2023.

The solar distillation is a simple way of water distillation, using the solar heat for generating evaporation from the humid soil or ambient air for condense it over a surface, the impure water is gathered out of the collector, where it is store.

In nature, the distillation is a process produced within the water cycle, through solar warming, this kind of distillation is simulated in the solar distillation project on a minimal scale.

### Solar distillery parts

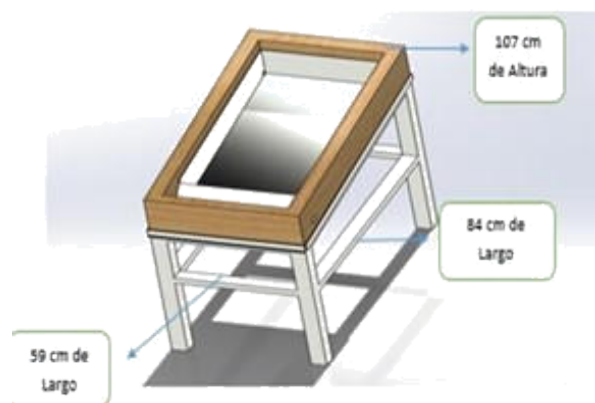
**Solar collector:** Is a stainless-steel container where the water to be treated is stored, this container must have the physic characteristics for the thermal absorption and to avoid stain and corrosion. An insulating is required on the base for avoiding heat loss. The collector tank has the appropriate covering to endurance the high temperatures and chemic attack.

**Evaporator:** The water Surface acts like evaporator, where the temperature for the evaporation process is reached, rising the water vapor pressure. The direct radiation for gathering the evaporation influences.

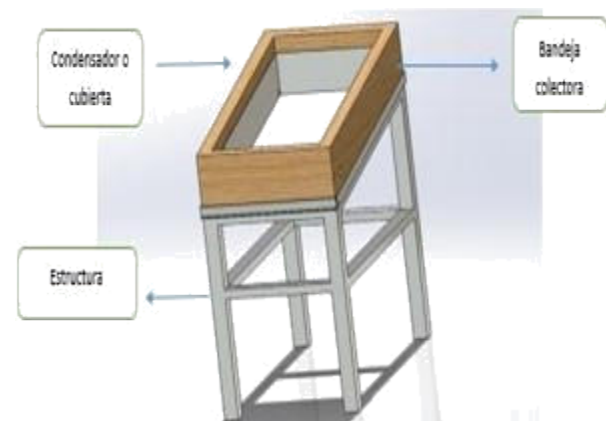
**Cover:** Is the exterior part of the distillatory, which must be of a translucent material allowing solar rays to pass without retain high temperatures because it must have lower temperature than the rest of the distillery, especially lower than the evaporator with enough distance to generate vapor, the temperature difference between the parts is what produces the vapor change to liquid, getting the condensed.

### Project Layouts

Computer design in 3D software was used for doing a high detailed distillatory simulation.



**FIGURE 2:** Measurements of the distiller parts.  
*Source:* Own, year 2023.



**FIGURE 3:** The distiller parts.  
*Source:* Own, year 2023.

## RESULTS

The construction of the modified distillatory table was a success, adapting it to receive the most solar radiation most of the time during a day with its inclination angle, the table has an excellent amount of inlet solar radiation through the glass because the process of the water cycle takes place through solar radiation, in other words, the distillation table heats the water until it eliminates all impurities, condensing it. This water vapor doesn't escape from the table atmosphere, on contraire, it gets stored in the glass that returns it to its liquid state sliding to the deposit.

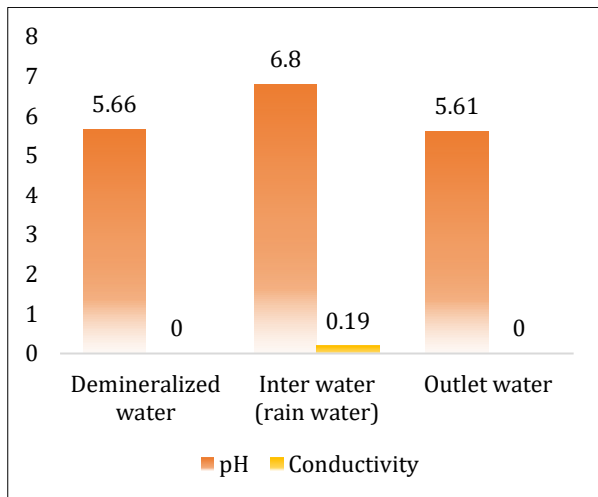
For the distillation tests 5 liters of water were introduced obtaining a total of 3.7 liters of distilled water in a period of 8 days with an ambient temperature from 22°C to 30°C.

**Hydrogen potential and conductivity tests**

After conducting the inlet and outlet water pH and conductivity tests with a HP-meter and a conductometer, these tools were used to compare the unmineralized water with the outlet water (distilled) and the results were similar in pH and conductivity, in other words, the distillation table is effective for distillate water because it eliminated all impurities. In the next chart the results of pH and conductivity are shown.

**TABLE 1:** pH and conductivity samples.

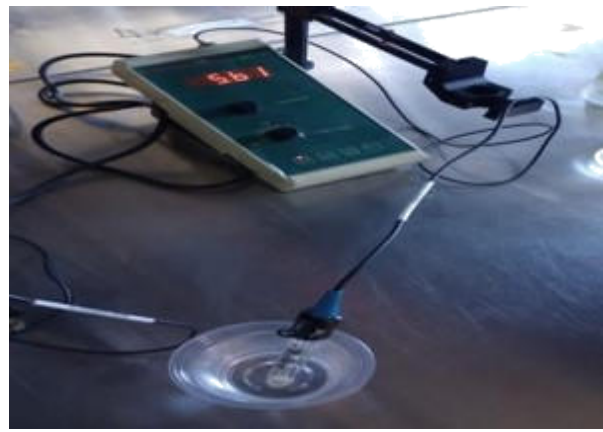
	pH	Conductivity
Demineralized water	5.66	0 Mspc
Inter water (rain water)	6.80	0.19
Outlet water	5.61	0 Mspc



**FIGURE 4:** Inlet water pH (Graph).  
Source: Own, year 2023.



**FIGURE 5:** Inlet water pH.  
Source: Own, year 2023.



**FIGURE 6:** Outlet water pH.  
Source: Own, year 2023.



**FIGURE 7:** Inlet water conductivity.  
Source: Own, year 2023.



**FIGURE 8:** Outlet water conductivity.  
Source: Own, year 2023.



**FIGURE 9:** Front finished prototype.  
Source: Own, year 2023.





**FIGURE 10:** Side finished prototype.  
*Source:* Own, year 2023.

### CONCLUSIONS

The distillation table design identification entitles economic and practical advantages, above all, it prevents pollution and reduces the use of lab materials, in addition, the space saving is notorious.

The performance of the project required a try and guess phase during the construction, and thanks to it is possible to improve and adapt it to the land conditions, from the design to the assembly it can be modified, change material, dimensions, and its capacity to restructuration in its implementation.

About the prototype, the objective of the distillation table was achieved given that was possible to eliminate all the impurities.

### REFERENCES

- [1] Reunión V, Mundial DEE. El agua y su análisis desde la perspectiva económica: una aplicación para el crecimiento económico 2006; 1-21.
- [2] Por Alimentos, Emergentes Virus. COLABORACIÓN ESPECIAL. 2005; 253 – 69.
- [3] Europeo P, Directiva E. Estadísticas e indicadores del agua. 2008.
- [4] Marcos FV. EDITORIAL. 2005; 117-27.
- [5] Sanabria, Giovanni. Una propuesta para la enseñanza de los Elementos de Análisis Combinatorio. Memorias del Primer.
- [6] Encuentro Nacional en la Enseñanza de la Probabilidad y la Estadística (1° ENEPE), Puebla – México del 16 al 18 de junio del 2010.
- [7] Sanabria, Giovanni. Comprendiendo la Estadística Inferencial. Editorial Tecnológica de Costa Rica: Cartago, Costa Rica. 2011.
- [8] Walpole, Ronald; Myers, Raymond; Myers, Sharon. Probabilidad y estadística para ingenieros, Sexta edición. PrenticeHall Hispanoamericana. S.A: México. 1999.
- [9] Vallecillos, A., y Batanero, C. Análisis del aprendizaje de conceptos clave en el contraste de hipótesis estadísticas mediante el estudio.