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An Investigation of the Use of Peltier Modules in Water Extractors and Dehumidifiers

Dr. Kishore Kumar Sinha[1], Ankur Pandey[2], Nimesh Kumar[3]

Professor[1], Students[2, 3]

Department of Mechanical Engineering

GNIT Guru Nanak Institutions, Mullanaambala

***Corresponding Author's Email:** -ankurpandeyengg@gmail.com[2]*

Abstract

The relative humidity in coastal locations is relatively high, ranging between 70 and 80%. As a result, by installing a dehumidifier unit, the air in coastal areas may be used to meet the people's water needs. Even in coastal places, solar insolation is consistently high throughout the year. As a result, the solar insolation may be used to provide the necessary electricity to operate the dehumidifier unit. The goal of this project is to use solar energy to tackle the drinking water problem in coastal areas. A gadget like this is known as a water extractor and dehumidifier.

Keywords: -*Water Problem, Electricity, Dehumidifier, Water Extractor*

INTRODUCTION

The primary goal of this project is to create a portable device that may be utilised to meet the water needs of coastal families.

This apparatus will condense the water in the atmosphere and then purify it so that it may be consumed.The atmospheric water generator is intended to assure the efficacy of the final project by meeting the three conditions listed below.

They are-

- Portability of Water – The quality of water produced must fit in to the World Health Organization (WHO) drinking water standards.

- Simplicity of Use – The design must be feasible to operate by persons even with unskilled person.

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- Safety – The design of the device must not cause a hazard to users during its regular operation.

The developed model able to meet the several goals such as-

- Utilization of multiple power sources like solar, wind, traditional power grid etc.,
- Maximization of water production per unit energy consumption.
- Low water production cost of both capital and production costs.

Dehumidification is the process of extracting water vapour or humidity from the air while keeping the dry bulb temperature constant. The equipment that can carry out this procedure is known as a "dehumidifier."

This approach is distinguished by a vertical line on the psychrometric chart that begins at the first value of relative humidity and runs downward to the final value of relative humidity. Similarly to the pure humidification process, pure dehumidification is not achievable in real-world conditions since dehumidification is usually accompanied by cooling or heating of the air. "Chilling dehumidification" refers to the process of cooling the air while extracting the water from it. Cooling dehumidification occurs when the air at the specific dry bulb temperature is cooled to a temperature lower than the dew point temperature.

Heating dehumidification refers to the process of heating the air while extracting water from it. This is accomplished by passing air through compounds such as alumina and molecular sieves. These components have an inherent characteristic that allows them to continue emitting heat while simultaneously capturing moisture. These substances are known as "hygroscopic chemicals."

Components: Peltier Module

It is a type of electrical device used to chill items to temperatures lower than the ambient temperature. The Peltier unit is made up of two types of semiconductor components placed between copper substrates. The "Peltier effect" occurs when electricity is transmitted through the unit and electrons flow in one element while positive holes migrate in the other. This permits one side of the substrate to absorb heat while the other side radiates heat, allowing the hot and cold sides to be swapped based on the current direction. It may also be used as a thermoelectric

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power production module by putting a temperature differential on both sides of the Peltier module, which causes a current to flow. In this project, TEC1-12715 and TEC1-12706 are employed, with a maximum voltage of 12 volts and a maximum current of 20 a.



Figure 1: Peltier Module

Switched-Mode Power Supply (SMPS)



Figure 2: SMPS

A switching regulator is used in an electronic power supply system to properly transmit electrical power. A switched-mode power supply (SMPS) is an electrical circuit that changes electricity by using switching devices that turn on and off at high frequencies and storage components like inductors or capacitors to provide power when the switching device is not conducting.

Switching power supplies are extremely efficient and extensively used in a wide range of electronic equipment, including computers and othersensitive equipment that requires a consistent and efficient power supply. A switched-mode power supply, also known as a switch-mode power supply or switching-mode power supply, is a type of power supply that operates on alternating current.

C. Fan



Figure 3: Fan

A device having revolving blades that provides an air current for cooling. The fan's purpose is to cool the bigger heat sink. In current computer systems, a heat sink and fan are frequently employed to keep the processor cool. Without it, the CPU is vulnerable to overheating and damage. As a result, this combination is common in most low- to mid-range computer systems, as well as high-end laptops. However, for PCs and computer systems with more powerful processors, a

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more powerful cooling solution, such as liquid cooling, is necessary.

D. Heat Sink

A heat sink is a device that directs heat away from a hot device. This is accomplished by expanding the device's working surface area as well as the amount of low-temperature fluid that travels through its expanded surface area.

We are employing three heat sinks, one large one for the hot side and two tiny ones for the cold side, which will eventually be used to collect water from the module.



Figure 4: Heat Sink

Thermal paste

Thermal paste is a thermally conductive (but generally electrically insulating) chemical substance that is often employed as a contact between heat sinks and heat sources such as high-power semiconductor devices. Thermal paste's primary function is to remove air gaps or voids (which act as thermal insulation) from the contact region in order to enhance heat transfer and dissipation.

A thermal interface substance is something like thermal paste. Thermal paste, unlike thermal glue, does not contribute mechanical strength to the link between the heat source and the heat sink. It must be combined with a mechanical fixation device, such as screws, to secure the heat sink and apply pressure, spreading and thinning the thermal paste.



Figure 5: Thermal paste

Acrylic Sheet

Acrylic, commonly known as Plexiglass, is a flexible plastic substance that comes in a range of colours and opacities and may be used for a number of purposes and benefits. Acrylic plastic was invented in 1928 and introduced to the market by the Rohm and Haas Company in about 1933. It was first utilised in World War I for items such as aeroplane windows, canopies, and turrets. Today, acrylic is most typically marketed as sheets of various thicknesses, although it can also be obtained in rods or tubes and in frosted, mirrored, or non-glare finishes. Acrylic is not only available in a variety of forms and

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sizes, but it can also be moulded and tinted to suit specific needs. Whatever solution best meets your requirements, acrylic will be a cost-effective and long-lasting material for the project.



Figure 6: Acrylic Sheet

Machining

Machining is the controlled removal of material from a substance (usually metal) to achieve the desired final shape and size. The procedures that share this theme are referred to as "subtractive manufacturing," which uses machine tools as opposed to "additive manufacturing hare this theme are referred to as "subtractive manufacturing," which uses machine tools as opposed to "additive manufacturing," which employs controlled material addition. Machining is utilised in the production of numerous metal items, but it may also be used on wood, plastic, ceramic, and composite materials.

A machinist is someone who specialises in machining. A machine shop is a room, building, or enterprise where machining is done. Much modern machining is done using computer numerical control (CNC), which uses computers to control the movement and functioning of mills, lathes, and other cutting equipment.This improves efficiency because the CNC machine runs unsupervised, lowering labour expenses for manufacturing businesses.

We began by assembling the acrylic sheets into a rectangle box with two sides open. Then we marked the fan sizes and agreed on the position of the heat sink, which we also marked. We began by drilling the holes with a pneumatic drill, centering them, and then drilling entirely, eventually offering a finish over the surface.

The method is then repeated for the second fan. Safety equipment such as gloves, goggles, and keeping a safe distance from the tools were used during the machining operation.The nuts were then decreased in size to match our specifications. We then began drilling the holes for the nut fittings using the air compressor test rig, and then we began drilling using the same equipment.

The heat sink is then installed on the acrylic arrangement according to the markings.

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Figure 7-Air Compressor Rig



Figure 8: Drilling the holes

Construction Steps and Dimension

The constructional setup of the water extractor is as follows:

1. First, the thermal paste is applied to both sides of the peltier module, and then it is pasted to the heat sinks, with one side attached to the larger heat sink and the other side attached to the smaller heat sink, resulting in one side being hotter and the other side being cooler.

2. Repeat the technique with the second peltier, this time with one side still linked to the bigger heat sink and the other side to the smaller heat sink.

3. Next, we locate an acrylic sheet with the proper dimensions. The sheets are then put together to form a rectangular box with two sides that open.

4. The diameters of the fans are then recorded, and holes of the same size are bored in the acrylic sheet.

5. The peltier and heat sink combination is now joined to the acrylic sheet using nuts and bolts and will eventually be

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put in with some gap at the bottom for water buildup in any container.

6. The fans are then installed over the drilled holes.
7. Then we put the SMPS on the acrylic sheet, one on top and the other on either side of the acrylic sheet.
8. The electrical connections from the peltier and fans to their respective SMPS are then established.
9. The alligator pins strengthen the connection and make it easier to install and disengage.
10. When the device is turned on, the container is positioned at the bottom of the cooler heat sink to collect the water and use it for various reasons.

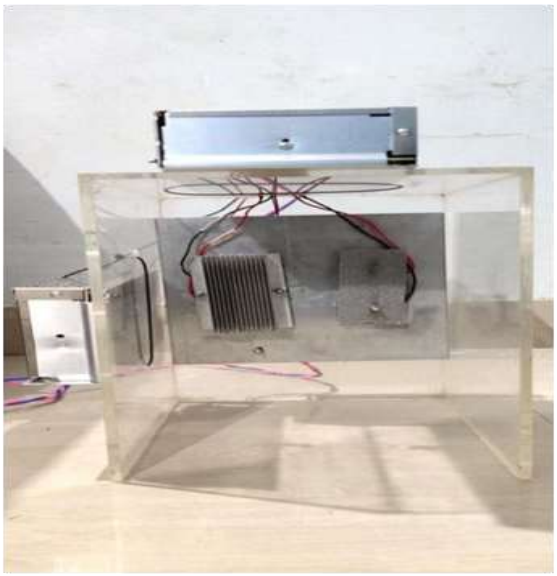


Figure 9: Model

PROJECT DIMENSION

Total Length of the device=242 mm Total Breadth of the device=225 mm Total Height of the device=345 mm

Table 1:

HeatSink	Length(mm)	Breadth(mm)	Thickness(mm)	No OfFins
Largerheat sink	200	180	18	25
Smaller heatsink	140	40	23	14
Smallestheatsink	100	40	5	26

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APPLICATION AND ADVANTAGES

- **It's Cheap and Easy to Maintain**

One of the most significant advantages of atmospheric water generators is their low cost. While the initial cost may be greater than the cost of purchasing portable water from a retailer, the overall value improves, and a net gain is realised within a short time period. Another advantage of this method of water retrieval is that there are no additional operating costs, and because the atmospheric water generator is self-contained, there are no electric bills.

- **Emergency Water Solution**

Finally, one of the most important reasons to install an atmospheric water generator is for emergency and medicinal purposes. Having one of these units on hand during recovery operations may help people get drinking water, store supplies, medication, and blood, among other things. We have you covered when it comes to safe drinking water, whether you live in a distant region or your profession takes you to a place where living circumstances are less than ideal.

- **Live Off-Grid**

Off-grid life is occasionally necessary due to unforeseen events, but it is also entirely voluntary. Many families adopt alternative energy and water collection methods to avoid the price and politics of depending on public utilities.

- **Water To Go**

When supplies run low, industries that demand mobility, such as the military, can employ an atmospheric water generator to generate water. Setting up camp in a desert or other area with limited safe drinking water is much easier with a device like ours to provide continuous hydration.

- **Less Weight**

People will assume that there will be weight issues, but this is not the case. The weight will be quite light, making it very easy to transport and useful to everyone.

Test, Observation and Result

- The initial experiments were done on December 16, 2021, in a chamber that was 24 degrees Celsius at approximately 3:00 p.m.

- The gadget was left running for 30 minutes, and the water collected was approximately 5 ml.

- Because the device's performance was inadequate, we increased the number of peltiers and the surface area of the

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bigger heat sink. The findings of the modified prototype are shown in the following slide.

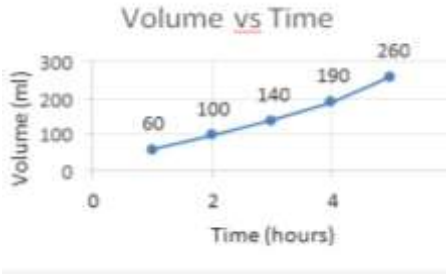
- Because the project is built on trial and error, we conducted the experiment in many locations, and the results of those runs are displayed below.

Tests were conducted in various temperature and humidity level for 1 hour and the following results were obtained that are tabulated and shown belowConducted total of 5 iterations in various location near college vicinity such as Acharya cottage, Acharya hostel, Acharya college, Sapthagiri and chikkabanwara. Obtained different water level in each of the locations depending of the time of operation conducted, humidity and temperature levels of the corresponding zones.

Table 2:

WaterObtained(Ml)	Temperature(DegreeCelcius)	HumiditY(%)	Place
17	25	79	AcharyaCollege
23	21	92	Cottage
21	24	86	Acharyahostel
19	19	78	Sapthgiri
15	27	64	Chikkabanavara

Result :



Test Run 1:-

Test specifications:

Location: Bangalore.

Date: 20-05-2022.

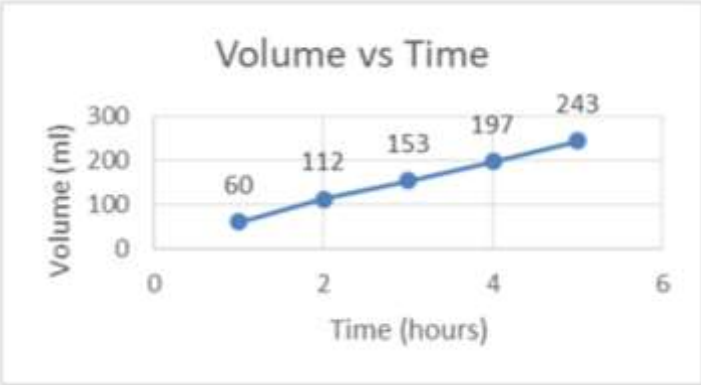
Start time: 10:00 a.m.

Temperature range: 23-28 *C.

Average Humidity: 77%.

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Test Run 2:-



Test specifications:

Location: Chikkamangaluru.

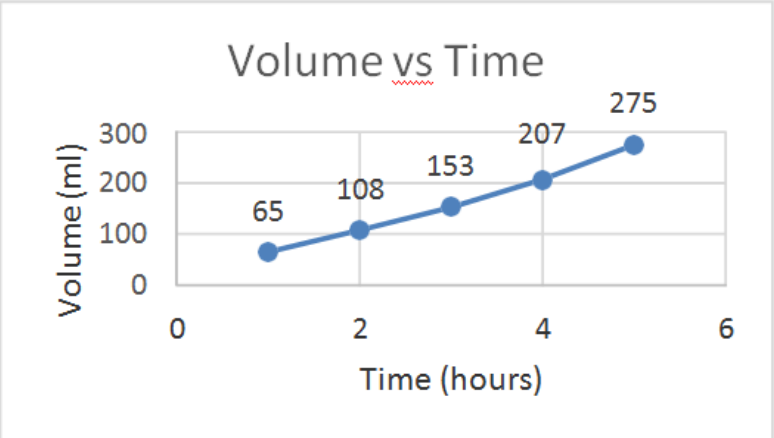
Date: 22-05-2022.

Start time: 10:00 a.m.

Temperature range: 18-22 *C**.***

Average Humidity: 81%.

Test Run 3:-



Test specifications:

Location: Mysore.

Date: 27-05-2022.

Start time: 10:00 a.m.

Temperature range: 20-25 *C.

Average Humidity: 83%.

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CONCLUSION

This project model was tested in Bangalore, and it was discovered that the device's output water was insufficient. Following a comprehensive investigation, it was discovered that the following factors may be to blame for the poor water output:

1. Because of the low humidity in the Bangalore region.

2. A location with humidity above 50% is required for the gadget to work properly. As a result, it is believed that if the device is tested in coastal locations, the water production would be greater.

3. The water droplets were generated by condensation on the Peltier device's chilly surface. The thermal conductivity area falls as a result of water droplet deposition.

4. As a result, the condensation process slowed down. A wiping mechanism may be included in the unit to increase the output of water.

5. The water production may increase as the number of Peltier devices increases.

6. For environmental reasons, the model might be constructed to run on solar power instead of AC electricity.

REFERENCES

1. Brown, D.R., Fernandez N., Dirks J.A., Stout T.B. "The Prospects of Alternatives to Vapor Compression Technology for Space Cooling and Food Refrigeration Applications". Pacific Northwest National Laboratory (PNL). U.S. Department of Energy, 2010.
2. Vinay, M. V., A. Suman, and R. Shadakshari. "Dehumidification of atmospheric air for water production." International Journal of Innovative Research in Science, Engineering and Technology 7.4 (2018): 3808-13.
3. Perry R.H and Green D.W. “Perry's Chemical Engineers” Handbook. McGraw-Hill, 1984.
4. Anbarasu T., Pavithra S. “Vapour Compression Refrigeration System Generating Fresh Water from Humidity in the Air”, 2011.
5. Niewenhuis B., Shepperly C., Beek R.V., Kooten E.V. “Water generator water from air using liquid desiccant method”, 2012.

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