# Water Extractor and Dehumidifier using Peltier Module

## (Water Generation)

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***Abstract*—The relative humidity in the coastal areas is quite high around 70 to 80%. Therefore, the air in coastal areas can be utilized to fulfil the water required for the people by using a dehumidifier unit. In coastal areas even the solar insolation is also considerably high round the year. Hence this solar insolation can be used to generate the required power to run the dehumidifier unit. This project aims to solve the drinking water problem in the coastal areas from the atmosphere by harnessing solar energy. Such a device is called water extractor and dehumidifier.**

## I. INTRODUCTION

The main objective of this work is to build a portable device that can be used to fulfill the water requirements of a coastal households. This device will first condense the water present in the atmosphere and then purify it so that it can be used for drinking.

The atmospheric water generator is designed to ensure the effectiveness of the final project with the following three requirements.

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.
- 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.

The method by which water vapour in air or humidity is extracted from air maintaining the dry bulb temperature persistent is called dehumidification. The machine that is capable of carrying out this process is called as a "Dehumidifier".

This method is characterized by a vertical line on the psychrometric chart beginning from the first value of relative humidity, ranging downwards and terminating at the final value of the relative humidity. Like for the pure humidification process, in real condition the pure dehumidification is not possible, since the dehumidification is always escorted by cooling or heating of the air". The method in which the air is cooled reasonably and at the same time the water is extracted from it is called cooling dehumidification. Cooling dehumidification is acquired when the air at the particular dry bulb temperature is cooled to a lower point than the dew point temperature.

The method in which the air is heated and at the same time water is extracted from it is called heating dehumidification. This is obtained by passing the air over some chemicals like alumina and molecular sieves. These elements have an intrinsic property due to which they go on discharging the heat and also have the property to captivate the moisture. Those types of chemicals are known as the hygroscopic chemicals"

## II. COMPONENTS

### *A. Peltier Module*

It is electronic devices designed for cooling objects to below the ambient temperature. Peltier unit consists of two types of semiconductor elements arranged in tandem sandwiched between copper substrates. When electricity is passed through the unit, electrons move in one element and positive holes move in the other element, this is called the "Peltier effect." This allows one side of the substrate to absorb heat and the other to radiate heat, so the hot and cold sides to be switched depending on the current direction. It can also be used as a thermoelectric power generation module using the "Seebeck effect" in which a current flow by applying a temperature difference on both sides of the Peltier module. In this project TEC1-12715, TEC1-12706 is used, it says that itwhich runs with maximum voltage of 12V and max current of 20A.

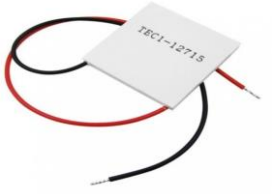



Figure 1: Peltier Module

*B. switched-mode power supply (SMPS)*

SMPS is an electronic power supply system that makes use of a switching regulator to transfer electrical power effectively. A switched-mode power supply (SMPS) is an electronic circuit that converts power using switching devices that are turned on and off at high frequencies, and storage components such as inductors or capacitors to supply power when the switching device is in its non-conduction state.

Switching power supplies have high efficiency and are widely used in a variety of electronic equipment, including computers and other sensitive equipment requiring stable and efficient power supply. A switched-mode power supply is also known as a switch-mode power supply or switching-mode power supply.

Figure 2: SMPS

*C. Fan*

An apparatus with rotating blades that creates a current of air for cooling. The function of the fan is to cool the larger heat sink. A heat sink and fan is often used in modern computer systems to keep the processor cool. Without it, the processor could easily overheat and become damaged. Therefore, this combination is often found in most low- to mid-range computer systems, and even in high-end notebooks. However, for PCs and computer systems that boast a more powerful processor, a more powerful cooling solution is required, such as liquid cooling.

Figure 3: Fan

*D. Heat Sink*

A heat sink is a component that increases the heat flow away from a hot device. It accomplishes this task by increasing the device's working surface area and the amount of low-temperature fluid that moves across its enlarged surface area. We are using 3 heat sinks one is larger heat sink for hot side, and 2 are small heat sink for cold side and thus can eventually be used for collecting water from module.

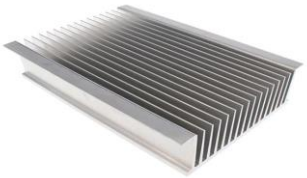


Figure 4: Heat Sink

*E. Thermal paste*

Thermal paste (also called thermal compound, thermal grease, thermal interface material (TIM), thermal gel, heat paste, heat sink compound, heat sink paste or CPU grease) is a thermally conductive (but usually electrically insulating) chemical compound, which is commonly used as an interface between heat sinks and heat sources such as high-power semiconductor devices. The main role of thermal paste is to eliminate air gaps or spaces (which act as thermal insulation) from the interface area in order to maximize heat transfer and dissipation. Thermal paste is an example of a thermal interface material. As opposed to thermal adhesive, thermal paste does not add mechanical strength to the bond between heat source and heat sink. It has to be coupled with a mechanical fixation mechanism such as screws to hold the heat sink in place and to apply pressure, spreading and thinning the thermal paste.

Figure 5: Thermal paste

*F. Acrylic Sheet*

Acrylic, also known as Plexiglass, is a versatile plastic material with a variety of purposes and benefits, available in a spectrum of colors and opacities. Acrylic plastic was first produced in 1928 and brought to the market by Rohm and Hass Company around 1933. It was initially used during World War ll for products such as airplane windows, canopies, and turrets. Today, acrylic is most commonly sold in sheets of various thicknesses but can also be found in forms such as rods or tubes, and styles such as frosted, mirrored, or non-glare. Not only is acrylic available in many shapes and sizes, they can also be molded and colored to fit specific applications. No matter what option best suits your needs, acrylic will provide a cost-effective, durable material for the project.

Figure 6: Acrylic Sheet

## III. MACHINING

Machining is a process in which a material (often metal) is cut to a desired final shape and size by a controlled material-removal process. The processes that have this common theme are collectively called subtractive manufacturing, which utilizes machine tools, in contrast to additive manufacturing (3D printing), which uses controlled addition of material. Machining is a part of the manufacture of many metal products, but it can also be used on other materials such as wood, plastic, ceramic, and composite material. A person who specializes in machining is called a machinist. A room, building, or company where machining is done is called a machine shop. Much of modern-day machining is carried out by computer numerical control (CNC), in which computers are used to control the movement and operation of the mills, lathes, and other cutting machines. This increases efficiency, as the CNC machine runs unmanned therefore reducing labor costs for machine shops. We have started with firstly joined the acrylic sheets into a rectangular box open from 2 sides. Then we have marked the dimensions of fans and already decided with the location of heat sink and marked correspondingly. We started with drilling the holes using a pneumatic driller where it was done via the method of centering and then drilled completely, finally delivering a finishing over the surface. Then we repeat the procedure for the 2nd fan. The special precaution taken during the machining process were Safety gears like gloves, goggles, minimum distance from the tools.


Figure 7-Air compressor rig

Then we reduced the size of the nuts in order to fit as per our requirement. We then started drilling the holes using the air compressor test rig for the nuts fitting then we started drilling using the same equipment for nuts fitting. We then start fitting the heat sink on the acrylic arrangement as per the markings made.

Figure 8: Drilling the holes

## IV. CONSTRUCTION STEPS AND DIMENSION

The constructional setup of the water extractor is as follows:

1. Firstly the thermal paste is applied on both the sides of the peltier module and then it is pasted to the heat sinks one side being attached to the lager heat sink and other side onto the smaller heat sink, hence eventually resulting one side being hotter and other side being the colder one.
2. Now repeat the procedure for the second peltier with one side still attached to the larger heat sink and the other side to the another smaller heat sink.
3. Then we find an acrylic sheet of appropriate dimension. Then these sheets are joined together to give a form of rectangular box which is opened from 2 sides.
4. Then diameters of fans are noted down and the drills of the same dimension are drilled on the acrylic sheet.
5. Now the arrangement of peltier and heat sink is attached to the acrylic sheet via the nuts and bolts arrangement and is eventually placed with some gap at the bottom for the water accumulation in any container.
6. Then these fans are mounted over the drilled holes.
7. Then we mount the SMPS on the acrylic sheet i.e. one is on the top while the other one is attached on either side of the acrylic sheet.
8. Then the necessary electrical connections are made from the peltier and fans to their corresponding SMPS.
9. Using the alligator pins the connection is made firm and easier to attach and detach.
10. The container is placed at bottom of the colder heat sink to collect the water in it and utilize it for various purposes once the device is turned on.

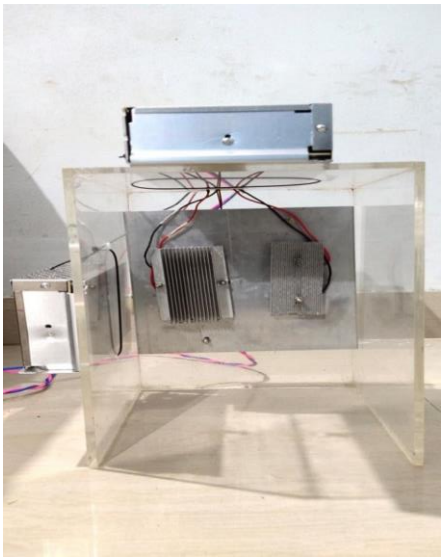


Figure 9: Model

PROJECT DIMENSION:

Total Length of the device=242 mm

Total Breadth of the device=225 mm

Total Height of the device=345 mm

| Heat Sink | Length (mm) | Breadth (mm) | Thickness (mm) | No Of Fins |
|---|---|---|---|---|
| **Larger heat sink** | 200 | 180 | 18 | 25 |
| **Smaller heat sink** | 140 | 40 | 23 | 14 |
| **Smallest heat sink** | 100 | 40 | 5 | 26 |

## V. APPLICATION AND ADVANTAGES

- It's Cheap and Easy to Maintain

One of the biggest advantages of Atmospheric Water Generators are the cost efficiency of the device. While the immediate cost may outweigh the price of purchasing portable water from a retailer at first, the overall value improves, and a net gain is seen within a short time period. Another benefit of this method of water retrieval is no additional operating expenses, and because the atmospheric water generator is autonomous, there are no electric bills.

- Emergency Water Solution

Finally, a major reason to implement an atmospheric water generator is for emergency and medical purpose. Having one of these units handy during recovery efforts can help source drinkable water for families, store supplies, medicine and blood, alongside other necessities. Whether you are living in a remote area, or your job is taking you to a place where living conditions are less than favourable, we've got you covered when it comes to clean drinking water.

- Live Off-Grid

Off-grid living is sometimes a result of inconvenient circumstances, but other times it is purely by choice. To escape the costs and politics of living on public utilities, many families choose to use alternative methods of energy and water collection.

- Water To Go

Industries which require travel, such as the military, can use an atmospheric water generator to create water when resources run low. Setting up camp in a desert, or a region where there is little safe drinking water is much simpler when you have a device like ours to continuously supply hydration.

- Less Weight

People will think then there will be problem related to weight but its not like that the weight will be very less , due to which it is very easy to carry which will be helpful for everyone.

## VI. TEST, OBSERVATION AND RESULT

- The first tests was conducted on 16/12/2021 the tests was conducted inside the room being 24*C and tests was conducted around 3:00 p.m.
- The device was left running for half an hour and the water collected was around 5 ml.
- The performance of the device was not satisfactory and we have increased the number of peltier and increased the surface area of the larger heat sink. The results of the updated prototype is shared in the next slide.
- As the project is based on trial and error method hence we have performed the experiment in different places and result of those runs are shown below.

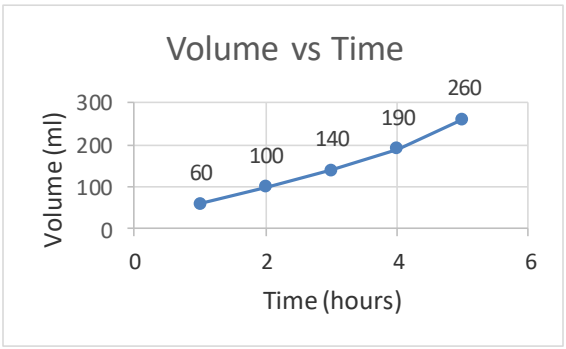
  Tests were conducted in various temperature and humidity level for 1 hour and the following results were obtained that are tabulated and shown below.

  Conducted 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.

| WATER OBTAINED (ml) | TEMPERATURE (DEGREE CELCIUS) | HUMIDITY (%) | PLACE |
|---|---|---|---|
| 17 | 25 | 79 | Acharya College |
| 23 | 21 | 92 | Cottage |
| 21 | 24 | 86 | Acharya hostel |
| 19 | 19 | 78 | Sapthgiri |
| 15 | 27 | 64 | Chikkabanavara |

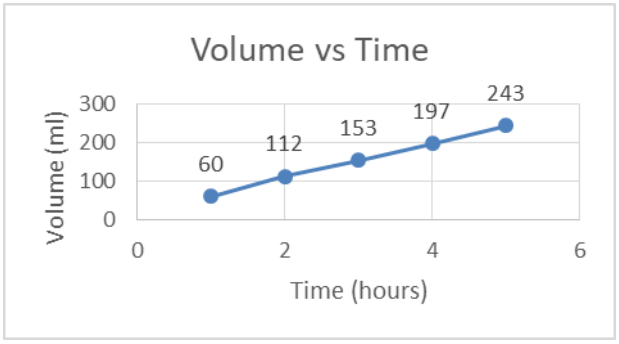
RESULT :

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%.

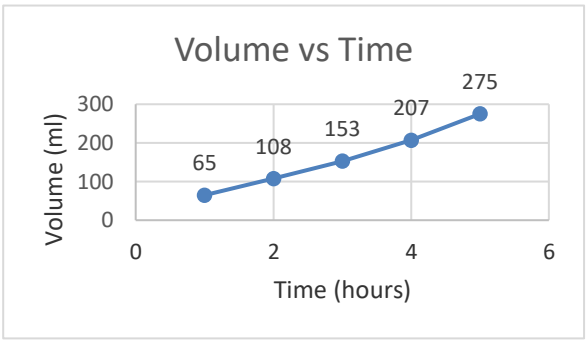
Test Run 2:-




**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%.

## VII. CONCLUSION

This project model was tested in Bangalore and found that the output water from the device was not adequate. After thorough study and it was noticed that the following reasons may be accountable for the low water output:

1. Due to low humidity in Bangalore region.
2. For proper functioning of the device a region must contain humidity above 50%. So it is expected, if the device is tested in coastal areas, the water output will be more.
3. The water droplets were formed with initially condensation on the cold surface of the Peltier device. Due to water droplets deposition the thermal conductivity region decreases. Therefore, the condensation process decelerated consequently. In order to increase the output water, a wiping mechanism may be incorporated in the unit.
4. With increase in Peltier devices the water output may be increased.
5. The model may be designed to run with solar power source in place of the AC power source for environmental friendly.

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