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# AQUANEBULA: AIR TO WATER GENERATOR

**Gangadhara[1], Hitha S Chowta[2], Naeema Thasneem[3], Savi S Chowta[4], Veekshitha[5]**

[1]Associate Professor, Department of Electronics and Communication,

[2,3,4,5] Students 8th sem, Bachelor of Engineering, Department of Electronics and Communication,

[1,2,3,4,5]Yenepoya Institute of Technology, Moodbidri, Dakshina Kannada, Karnataka

***Abstract:*** Water scarcity is a pressing global challenge. Traditional solutions like desalination are energy-intensive. This project explores a promising alternative: Atmospheric Water Generators (AWGs) that extract water from air using Peltier devices, thermoelectric coolers with minimal energy demands. The Aquanebula project investigates the feasibility of AWGs powered by solar energy for sustainable water production.

**Keywords: Air to water generation; Atmospheric Water Generators (AWGs); Thermo Electric Cooler.**

## I. INTRODUCTION

Water scarcity is a pressing issue worldwide, with conventional methods such as desalination demanding substantial energy input. However, a promising alternative emerges in harnessing the abundant atmospheric reservoir of water vapor. Atmospheric Water Generators (AWGs) capitalize on Peltier technology to extract water from humid air, offering a potentially sustainable solution. Unlike traditional AWGs that rely on energy-intensive vapor compression, Peltier devices provide a more efficient alternative. These solid-state devices utilize electricity to create a temperature difference, enabling water vapor condensation on the cooler side. AWGs equipped with Peltier coolers (TECs) function by drawing in moist air, cooling it with the TEC's cold side, and subsequently condensing the water vapor. This innovative approach holds significant promise for sustainable water generation, particularly when powered by renewable sources like solar energy.

Addressing global water scarcity necessitates innovative solutions. While traditional methods like desalination offer some relief, they come with a high energy cost. Fortunately, an alternative lies in the atmosphere, which harbors vast reserves of water vapor. Atmospheric Water Generators (AWGs) represent a novel technology capable of extracting water from the air. While conventional AWGs often rely on energy-intensive processes for water vapor condensation, recent advancements introduce a more efficient approach. Peltier devices, a type of thermoelectric cooler, are revolutionizing water generation. These solid-state devices utilize electricity to induce a temperature difference, leading to condensation on the cooler side. AWGs equipped with Peltier coolers (TECs) operate by drawing in moist air, chilling it with the TEC's cold side, and condensing the water vapor. This innovative technology offers several advantages, including compactness, efficiency, and reduced energy consumption compared to traditional methods. Moreover, its compatibility with renewable energy sources like solar power renders it a sustainable solution for water production. The Aquanebula Project endeavors to harness the potential of Peltier-based AWGs, aiming to develop an energy-efficient system requiring minimal space, suitable for diverse applications.

The findings of this project have the potential to be transformative, contributing significantly to the development of sustainable and accessible AWG technologies. By offering a solution that is environmentally friendly and can be adapted to various settings, Aquanebula holds the potential to alleviate the burden of water scarcity in underprivileged communities and remote areas, paving the way for a future with improved water security for all.

## II. METHODOLOGY

### 2.1 Theoretical Calculations

To obtain the appropriate dew point temperature, the necessary calculations for water vapor condensation as follows:

$$\gamma(T,RH) = \ln\left(\frac{RH}{100}\right) + \frac{bT}{c+T} \qquad (1)$$

$$T_{dp} = \frac{c\gamma(T,RH)}{b-\gamma(T,RH)} \qquad (2)$$

These equations are given by Magnus formula under varying temperature and relative humidity conditions. Where, b = 17.67 & c = 243.50C and T is in 0 also RH= Relative humidity T= DBT (Dry Bulb Temperature) and

Tdp=Dew point temperature.

Relative humidity is defined as the ratio of water vapor pressure to saturation vapor pressure at certain temperature.

The Saturation pressure value is determined by the equations are formulated as follows:

$$RH = \frac{P_W}{P_s} x100 \qquad (3)$$

$$P_W = \frac{RH}{100} XP_s \qquad (4)$$

$$Humidity\ ratio = 0.622x\frac{P_W}{P_a - P_W} \qquad (5)$$

where $P_a$=constant standard atmosphere (1atm)

Here, determining the humidity ratio is also essential to ascertain the quantity of water present in 1m³ of air.

### Experiment

The Aquanebula project involved building a prototype Atmospheric Water Generator (AWG) and testing its performance in environment. a controlled . The block diagram of AquaNebula can be shown as:

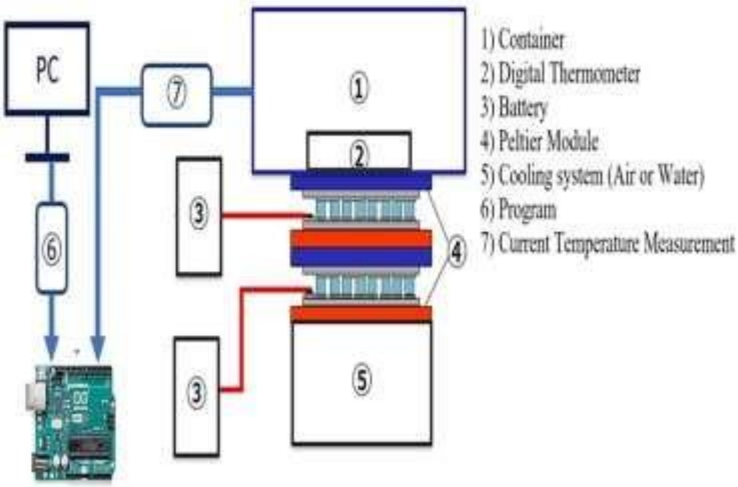


Figure 1: Schematic representation Aquanebula AWG utilizing Peltier technology.

At the core of our system lies the Peltier module, serving as its primary component. This module plays a pivotal role in driving the system's fundamental functionality, enabling the conversion of air into water through the application of thermoelectric principles. It serves as the cornerstone of our project, providing the necessary temperature differentials essential for this conversion process to occur effectively and efficiently.

Surrounding the Peltier module is a robust container, serving as the protective enclosure for the system's internal components. Within this container, various elements work in concert to achieve the system's objectives. One such component is the digital thermometer, meticulously designed to measure and monitor temperature levels with precision. This monitoring ensures meticulous control over the conversion process, optimizing performance and efficiency.

In close proximity to the Peltier module resides the battery, strategically positioned to provide uninterrupted power supply to the system. This ensures continuous operation, irrespective of external power sources, thereby enhancing thereliability and autonomy of the conversion process.

To regulate temperature and manage heat dissipation effectively, a sophisticated cooling system is seamlessly integrated into the system design. Indicated by blue and red arrows, this cooling mechanism employs either air or water to maintain optimal operating conditions within the container. By mitigating heat buildup, it facilitates efficient conversion while ensuring system integrity.

Driving the operation of the system is the program component, which orchestrates various functions such as temperature regulation, data processing, and communication with external devices. This software backbone ensures seamless coordination among system components, optimizing performance and efficiency throughout the conversion process.

At the forefront of monitoring and control is the current temperature measurement component, providing real-time feedback on temperature conditions within the container. This component plays a crucial role in continuous monitoring and adjustment, ensuring precise control and optimization of the conversion process to meet desired objectives effectively and reliably.

## III. RESULTS AND DISCUSSION

The results and discussion section outline the Theoretical Calculations, Flowchart and Result. The details are as follows;

### 3.1 Theoretical Calculation

The necessary dew point temperature was derived utilizing data from the World Weather and Climate Information. Below Figure illustrates the The quantity of water contained within 1 cubic meter of air varies depending on the temperature and humidity levels. This variation is significant for understanding atmospheric moisture content. At different temperature and humidity combinations, the amount of water vapor present in the air differs. This information is crucial for various applications, including environmental monitoring and industrial processes. Understanding these variations allows for better management of water resources and optimization of processes dependent on atmospheric moisture levels.

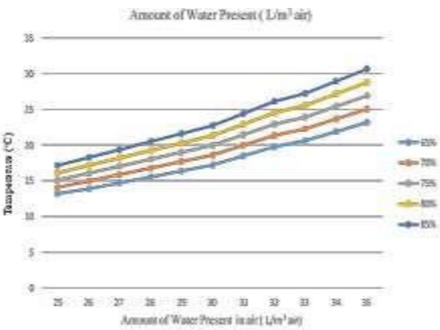


Figure 2: Water content in air variations

According to the figure, an increase in humidity and temperature leads to a corresponding increase in the water content in the air. This implies regions with higher humidity and temperature is more conducive to the condensation of water vapor from the Peltier set.

### 3.2 Flowchart

The AquaNebula project's flowchart visually represents the sequential steps of the atmospheric water generation process, illustrating the intake of ambient air, thermoelectric cooling powered by solar energy, condensationof water vapor, and the collection and filtration stages, offering a clear and concise overview of the innovative water production system.

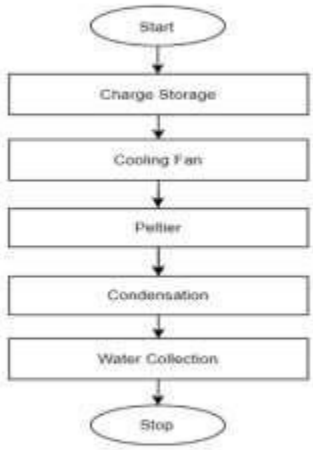


Figure 3: Flowchart of AquaNebula

### 3.3 Result

Through this project, a significant achievement is evident in the successful generation of water from atmospheric moisture. Utilizing an innovative approach to convert air into water, facilitated by the thermoelectric principles of the Peltier module, the system demonstrates its capability to produce a valuable resource. Through meticulous regulation of temperature and effective management of heat dissipation, the system optimizes conditions for water vapor condensation, resulting in a reliable output of clean, potable water. This offers a sustainable solution to address water scarcity challenges, with the potential for various applications, including supporting communities withlimited access to traditional water sources and providing emergency relief in disaster-stricken areas. Overall, the project's success in water generation represents a significant step towards achieving water security and sustainability.

## IV. CONCLUSION

Employing thermoelectric cooling technology, the implementation of the atmospheric water generator, AquaNebula, showcases a notable achievement in water generation. Through meticulous construction and strategic integration of components, the system has proven its capability to extract water from atmospheric moisture efficiently. This successful demonstration underscores the potential for further advancements aimed at enhancing water production capacity, thereby meeting larger-scale demands. The AquaNebula project represents a significant milestone in sustainablewater generation technologies, offering a promising solution to address water scarcity challenges. With continued research and development efforts, the system holds the potential to evolve into a vital resource for communities facing water shortages, contributing to a more water-secure future.

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