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Development of Water lift to Harvest Potable Water from Atmospheric Air using Peltier Effect

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Abstract—*Water scarcity is one of the major problems faced by world. Although 70% of earth's surface is covered by water but only 2.5% of it is drinkable. The moisture in atmospheric air can be a good source for drinking water in humid areas like places near sea. This project presents the method to develop the atmospheric water extractor based on Peltier effect. Atmospheric water extractor is device which takes in atmospheric air and cools it below its dew point temperature to condense water from air. This atmospheric water extractor uses the principle of latent heat to convert vapor molecules into water droplets. The formed water from this device is then filtered and can be used for day to day activities. This is not a new concept but is not commonly used in India. This device is portable and can be used in various regions with suitable humidity levels.*

Keywords—Atmospheric Water Extractor, Peltier Module, Water Filter

I. INTRODUCTION

According to 2018 report by government -NITI ayog 21 major cities are going to be run out of groundwater in upcoming year and due to uneven rainfall, this problem can get worse. Atmospheric air contains significant amount of water vapor especially in a humid region such as places near sea. India has 7516.6 km of coastline but most amount of water in atmospheric air gets wasted as the technology based on this concept of extraction of water from atmosphere is not very common in India. in such cases atmospheric water extraction can be a good solution.

Atmospheric water extractor is a device which takes in atmospheric air and cools it below its dew point temperature to condense water from ambient air. There are three main methods which can be used to extract water from the atmospheric air, which are

- Vapour Compression Method
- Liquid Desiccant Method
- Thermoelectric Cooling

II. OBJECTIVES

- To provide an alternative source of clean drinking water.
- To develop a portable and light weight system.
- To extract maximum amount of water from available air
- To manufacture a product which is less harmful to environment
- To manufacture a product which is energy efficient
- To design a cost-effective system.

III. PROPOSED METHODOLOGY

To provide feasible and economical solution for the problem mentioned in the previous chapters, a brief study and research work were carried out by the team and the idea of atmospheric water extractor (water loft) was finalized to fulfill the necessity of potable water.

STEPS IMPLEMENTED:

- Research
- Problem Identification
- Strategy And Planning
- Methods And Calculations

3.1 Research

We studied research papers which were published by different researchers to deal with the same problem from the research work we learnt that there are various methods which can be used to resolve difficulty of potable water availability. Out of the research paper we referred, we noticed that thermoelectric cooling method was simple and effective in operation if planned properly than rest of the processes

.

3.2 Problem Identification

Research work carried out by the researchers helped us to identify the problems which were faced by them during their experimentation. Some of the obstacles were:

- Less amount of water generation due to improper design specifications.
- Improper selection of thermoelectric module.
- Lower efficiency due to incorrect selection of power sources.
- Unfiltered water generation due to absence of filtration system.

3.3 Strategy And Planning

As per the problems we identified, we initiated to build up our own strategies for design and development of a water harvesting system working on the same thermoelectric cooling principle with less limitations and drawbacks. Our strategy includes selection of suitable Peltier module and the processes which lead to adequate amount of water generation.

3.4 Methods And Calculations

3.4.1 Selection Of Thermoelectric Module

TEM module plays an important role in designing of water harvesting system. Selection of a thermoelectric module is mainly based on a maximum cooling capacity (Qmax) that is needed to be achieved. Before selecting any efficient TEM device, the important parameters which should be considered are:

- Qmax (max cooling capacity)
- Temperature difference (ΔT) between hot and cold surfaces of TEM

Design specification for condensing chamber:

- Area =225sq.cm=0. 242sq.ft
- Overall heat transfer coefficient (U factor) for wall of chamber=1.15 BTU (hr. sqft. °F)

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- Ambient temp=32℃= 89.6 °F
- Required dew point temp=15℃= 59 °F
- Watts consumed by fan =1.8W

As per our required heat load conditions, the TEM having maximum cooling capacity greater than 20 W should be selected.

As long as the availability, economical and efficient selection of TEM is concerned Thermoelectric cooling module **TEC1-12706** with max cooling capacity of 33 W is optimal solution.

3.4.2 Selection Of Heat Sink For Heat Dissipation

The thermoelectric cooling modules requireproper heat dissipation from its hot surface when power is supplied, so that it can achieve minimum dew point temperature at its cold surface. Heat sink can be classified as:

- Air Cooled heat sink
- water Cooled heat sink

Fig.1 Peltier Module WithAluminium Heat Sink

Heat sink made of highly thermal conductivity material works more effectively therefore heat sinks made up of materials like Copper, Aluminium are preferred widely. Since, on comparing thermal conductivities of copper and aluminium it is found that Copper is having higher thermal conductivity but at the same time aluminium is lighter than copper, so we have decided to use the aluminium heat sink to work efficiently.

3.4.3 Selection Of Power Source

Power source provides an electric supply to the thermoelectric module so that high and low temperatures are maintained on opposite sides of module. For a system with high efficiency and less size of the device the power should be small in size and give desired output supply.

To make portable water harvesting device the available power source options are:

Power source	Size	Cost	Weight
Li-Ion Battery	Moderate	Moderate	Low
Li-Acid Battery	Large	Low	High
Li-Po Battery	Small	High	Low

Table 1. Various Power Sources

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As per the specification of the above options available for the power sources we selected **Li-Ion battery** as it fulfills our requirements of power source. Although the system can also work on ac to dc adapter's power supply but the main drawback is, it can't be portable for use.

3.4.4 Selection Of Filter For Water Purification

Water filtration process makes the condensed water potable. As the water is generated from the air it may contain some impurities which need to be filtered. As the water generated needs to meet the potable drinking water standards set by WHO, we decided to do the process in 3 stages.

- Fiber meshing.
- UV lights.
- Mineral candle.

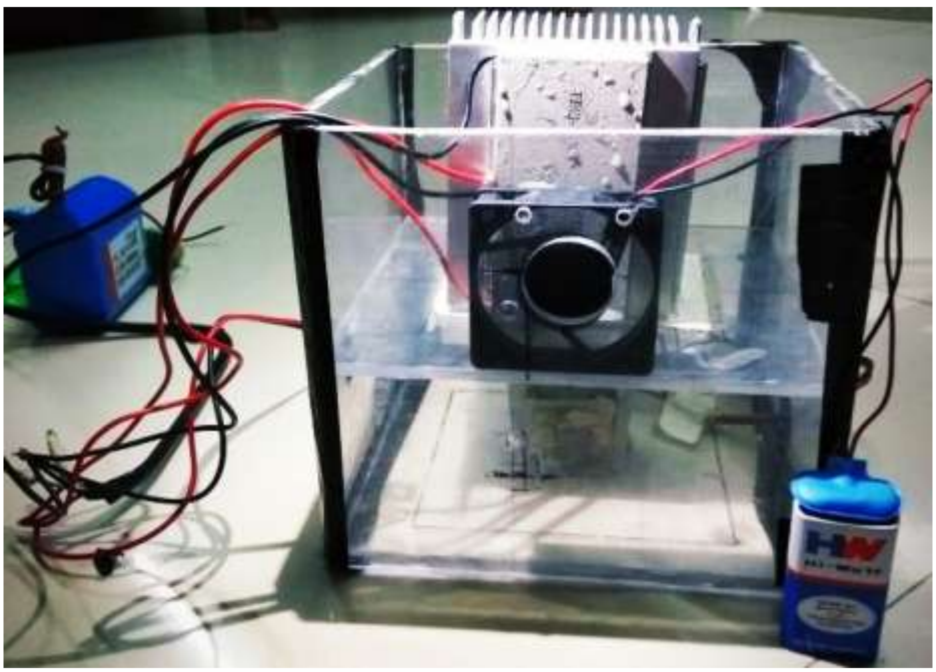

FIGURE.2 working model prototype

IV. RESULTS AND DISCUSSION

The analysis of the machine is done on a normal condition were the operating parameters are perfect. As per experimental study as the relative humidity in air increases water productivity increases and power consumption decreases. The machine requires less space as compared to the machines available in the market and can also be carried anywhere. The filtration system used ensures the water formed is potable as per standards.

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V. CONCLUSION

The literature, research work and ideas represented in this study draw our attention to the crucial topic of drinking water scarcity. This waterloft project is a complete package to avail pure and clean drinking water at low cost. The various problems faced like inadequate water quantity, poor design, insufficient power source etc. were overcome.

As the waterloft incorporates all the required aspects of an optimum product it can be used by anyone, anytime, anywhere. This is a more flexible and handier model as compared to many other products presently available. If proposed methodology is planned well, the remarkable improvements in the water productivity can be achieved. The concept of this project can also be used as a better alternative in refrigeration science against conventional systems.

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