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Atmospheric Water Generator: Air Drops

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***Abstract*— World desperately needs alternative "water cultivation" methods and producing water from air is one of the most viable and sound solutions presented as the world's fresh water needs increase daily. This technology has ability to meet and fill the growing demand for economical, safe, great tasting drinking water in a clean drinking water is to health and wellness for people everywhere. We have designed and developed a prototype system for removing clean (potable) drinking water from air using a traditional power grid. Use a traditional power grid to generate electricity; use electricity to cool air (or increase pressure) resulting in condensation of water; capture water vapor from air that condenses into water to obtain 99% pure and safe drinking water from the moisture in the air. Implementation of process using most efficient and cost effective method is also an important concern in the project**

***Index Terms*— Atmospheric water generator, Humidity, Desiccation Cycle, Refrigeration Cycle, filtration**

I. Introduction

During the 20th century the global human population increased fourfold to more than 6 billion, while, withdraw from natural freshwater ecosystems increased eightfold during the same period. As global population increase the possibility of severe water supply shortages in many areas of the globe increase too, therefore, social planners and governments are exploring strategies for managing water resources in a sustainable way. Water scarcity will have a special negative impact on poor people as it leads to a decrease of water quality and consecutively to an increase of diseases, plus, it has a huge negative impact on food's production that depend strongly upon water sources.

Another major problem regarding water sources management is the groundwater depletion.Some of the most populated and developing countries of the world (India, China, Middle East countries, etc) have been using groundwater resources in an incontrollable way during the pasts two decades, which has been leading to the depletion of these sources.These negative consequences are basically the rapid decrease of fresh water aquifers and the increase of saline and solid water, as well as, other toxic components that increase the pollution of these aquifers. The problem of groundwater depletion threats food security in the 21st century.The water scarcity problematic that Earth faces in the present century and the urgency in find a balance between human demands and ecosystems requirements to achieve sustainability enhance the potential and strategic value that AWG technology – an environmental friendly technology, that makes water from the air, protecting water resources – may have in the present century. Therefore, by taking in account this scenario, it can be answered more properly and realistically to the research question.

Severe water shortages are currently experienced by 470 million people and it is projected that by 2025, the number of people living in water-stressed countries will increase to 3 billion. It is also estimated that 2.4 billion people in the world lack access to safe drinking water and that there are about 1.7 million deaths per year worldwide because of diseases found in poor water quality.

Atmospheric water generating systems harvest fresh great tasting water from air. Most people have no idea how much water is readily available in Earth's atmosphere – there is over 3,100 cubic miles of water, or more than 3.4 quadrillion gallons at any one time in our atmosphere. The hydrologic cycle ensures that billions of gallons of water are evaporating into or raining out of the atmosphere every day. This creates a never ending continuous supply of fresh water that is available and accessible almost everywhere in the world. Atmospheric water generator produces water similar to the way rain is made and is an environmentally friendly water dispensing system.

An atmospheric water generator is a device that extracts water from humid ambient air. Water vapor in the air is condensed

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by cooling the air below its dew point, exposing the air to desiccants, or pressurizing the air. AWGs are very useful in locations where pure drinking water is difficult or impossible to obtain, as there is almost always a small amount of water in the air. The two primary techniques in use are cooling water vapor and using desiccants. In the initial stage we are trying to obtain one to two liters of water in 2 hours with relative humidity of 70%.Within this period, it consumed 1 kilowatt-hours of energy per liter of water generated. Atmospheric water generator technologies can address the need for clean water without any health or environment concerns. They are already available in locations that have grid power and public waterworks.

II. SCOPEANDOBJECTIVES

[1] Flexibility in Power Source - The design should be able to utilize a variety of power sources, including (but not limited to) solar, wind, and the traditional power grid.

[2] 1 Liter of Water Production per Day - The design should produce at least one liter of drinkable water per day.

[3] Maximize Efficiency - The design should maximize the water produced per unit energy.

[4] Minimize Maintenance - The system should be designed for long-term operation, requiring only low-cost and minimally intensive repairs.

[5] Minimize Cost - The design should minimize the cost per unit water production.

[6] The project can be implemented in the areas where the humidity is above 40% throughout the year.

[7] Alternative for existing process - We can implement this project in coastal areas. This will reduce the cost of implementing the desalination process as maximum efforts are made to obtain drinking water from sea water and also cost of maintaining desalination systems is very high.

III. BASIC LAWS AND DEFINITIONS

[1] Energy can neither be created nor can be destroyed. It can be only converted from one form to another. Thus total amount of energy in the universe remains constant.

[2] Heat always flows from the material at higher temperature to the material at lower temperature.

[3] Saturation Vapor Pressure

Amount of water vapor that air can hold at given temperature is saturation vapor pressure OR Maximum amount of water vapor that air can hold.

[4] Vapor Pressure

Actual amount of water vapor in the air is vapor pressure.

[5] Dew Point

It is temperature at which relative humidity reaches 100%. At this point air is so full of moisture that it cannot hold any more water.

[6] $$\text{Relative Humidity} = \frac{\text{Actual Humidity}}{\text{Maximum Humidity}}$$

[7] $$\text{Relative Humidity} = \frac{\text{Vapor Pressure}}{\text{Saturation Vapor pressure}}$$

[8] Formula for obtaining maximum amount of water absorbed using desiccants

$$\text{Water absorbed} = \frac{(\text{Start }\%)}{(\text{End }\%)} - 1$$

Where,

Water absorbed = water absorbed per pound of $CaCl2$

Start% = starting concentration of $CaCl2$

End% = ending concentration of $CaCl2$.

[9] Coefficient of Performance in Refrigeration cycle is given by

$$COP = \frac{Temp_{evap.}}{Temp_{cond.} - Temp_{evap.}}$$

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COP= Coefficient of performance

$Temp_{evap}$=Temperature of Evaporator

$Temp_{cond}$= Temperature of Condensor

IV. BASIC BLOCK DIAGRAM

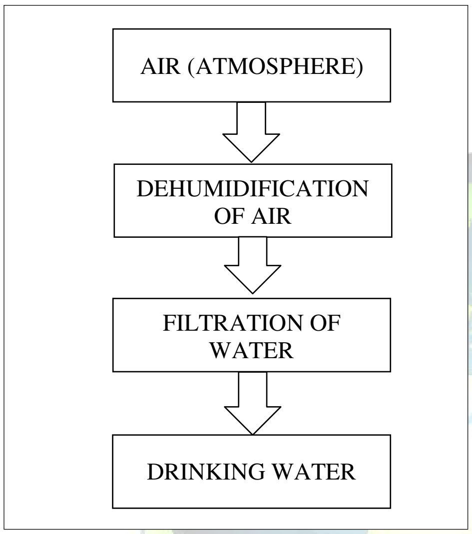

Figure 1: Basic Block Diagram of Prototype

Water vapor in the air is condensed by cooling the air below its dew point, exposing the air to desiccants, or dehumidifying the air. The two primary techniques in use are cooling and desiccants. Air is passed over a cooled coil, causing water to condense. The rate of water production depends on the ambient temperature, humidity, the volume of air passing over the coil, and the machine's capacity to cool the coil. These systems reduce air temperature, which in turn reduces the air's capacity to carry water vapor. An alternative available technology uses liquid or "wet" desiccants such as Calcium Chloride or lithium bromide to pull water from the air via hygroscopic processes.

[A] FILTRATION

Filtration takes place at two points in this prototype: air intake and water output. This is important for the cleanliness of the water and the safety of those consuming it.

Air Intake

Air filtration is required to eliminate large particulates, which will cause problems in the dehumidification apparatus. The biggest concerns in the air stream filtration are the maximum particulate size that can make it through the filter and the filter lifetime/cost. Maximum particulate size is more critical for the desiccation and pressure dehumidification schemes. There are several possible filtration technologies: paper filters, electrostatic filters, and oil bath air cleaners. Paper filters are the best option because they are effective, simple, relatively cheap, and requireno extra power input and will be implemented into the design. Christo Ananth et al.[4] presented a brief outline on Electronic Devices and Circuits which forms the basis of the Clampers and Diodes.

Water Output

Water treatment is crucial to ensuring drinking water quality. The process inherently produces relatively clean water; water treatment is thus implemented to guarantee quality. We investigated UV sterilization, carbon filters, and ceramic filters. Of these, UV sterilization is the most costly in terms of price and energy, and it only focuses on the microbial aspect. We have used RO+UV system to ensure and meet the safety measures.

[B] REFRIGERATION

Refrigeration cycle dehumidification is the most prevalent method for generating water from atmospheric humidity. This method circulates air over cooling coils connected in a refrigeration cycle to bring the water in the air below its dew point. The dew point of the water is dependent on the vapor pressure and humidity and tends to be a relatively low temperature compared to the ambient conditions. To reach the dew point the air running through the unit will have to be cooled a considerable amount. This process requires a constant energy supply that is used as the maximum allowable energy demand for the system. Liquids absorb heat when changed from liquid to gas. Gases give off heat when changed from gas to liquid. Christo Ananth et al. [3] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller.This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased. For our system to operate with economy, the refrigerant must be used repeatedly. For this reason, we used refrigeration cycle of compression, condensation, expansion, and evaporation in a closed circuit. The same refrigerant is used to move the heat from one area, to cool this area, and to expel this heat in another area.The refrigerant comes into the compressor as a low-pressure gas, it is compressed and then moves out of the compressor as a high-pressure gas. The gas then flows to the condenser. Here the gas condenses to a liquid, and gives off its heat to the outside air. The liquid then moves to the expansion valve under high pressure. This valve restricts the flow of the fluid, and lowers its pressure as it leaves the expansion valve. The low-pressure liquid then moves to the evaporator, where heat from the inside air is absorbed and changes it from a liquid to a gas. As a hot low-pressure gas, the refrigerant moves to the compressor where the entire cycle is repeated.

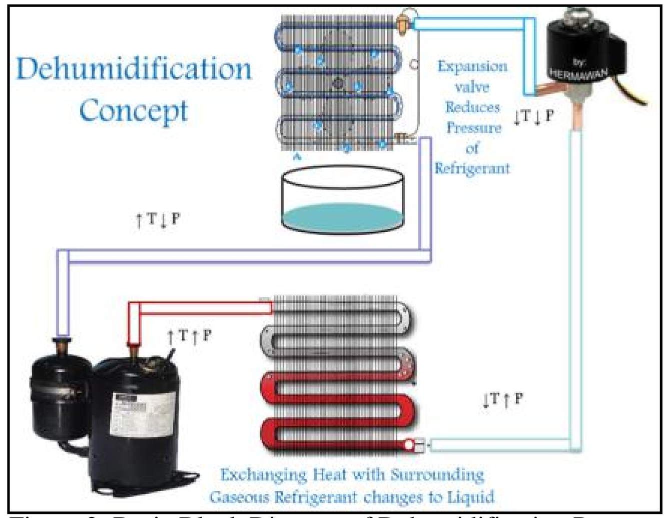

Figure 2: Basic Block Diagram of Dehumidification Process in Water generation system

[C] CONTROL MECHANISM

We need control mechanism to trigger on the system in suitable conditions. For this we have integrated system with Temperature and Humidity sensor. The controller satisfies the basic condition to switch on the system. Apart from this whenever system is keep in open there are chances of Pest dwelling in moist conditions hence we have used PIC microcontroller as frequency generator which acts as pest repellent. We have integrated water level sensor to indicate the level of water stored. We also can have another sensors like dust sensors to enhance the productivity of product.

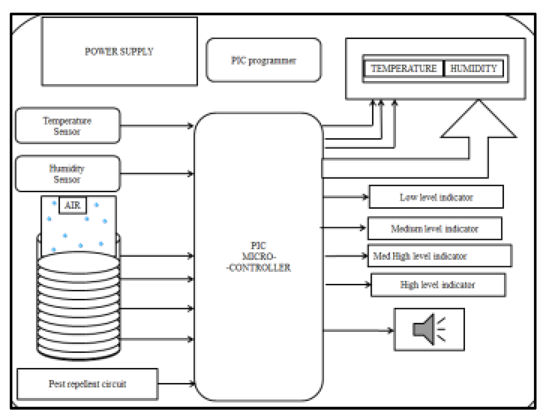

Figure 3: Block diagram of Control Circuitry of Prototype

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Below mentioned figure represent the simulation of entire control mechanism in the system in Proteus software. We have used PIC microcontroller to interface multiple sensors for control mechanism of Prototype.

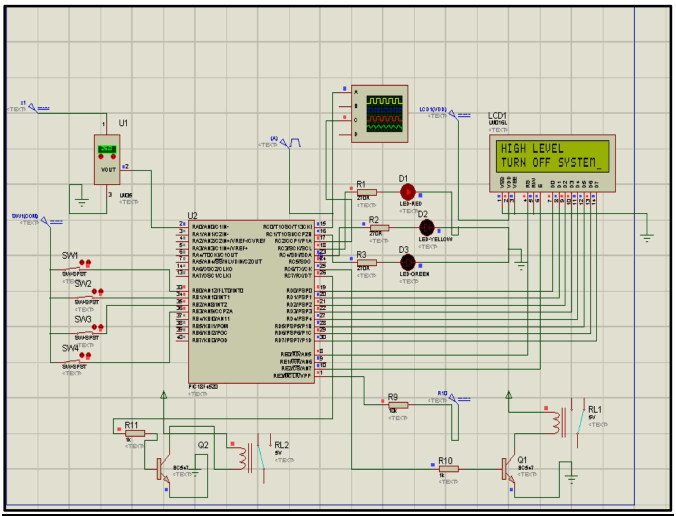

Figure 4: Simulation of Control Circuitry using Proteus

We have obtained the results for three important parameters from the testing water sample that is water obtained from the air -TDS (Total Dissolved Solids), pH value, Hardness. Water produced from the Prototype was tested in Laboratory and meet the WHO drinking standards.

V. CONCLUSION

We have implemented of two process wet desiccation method and refrigeration method. We have found refrigeration method having higher productivity when relative humidity is high and desiccation method can enhance the productivity of prototype when relative humidity is low. We also have done some test for both the process and obtained satisfactory results for the same.

In the initial stage we have successfully obtained one to two liters of water in 1 hour with relative humidity of 70%.Within this period, it consumed 1 kilowatt-hours of energy per liter of water generated using refrigeration process. Our aim would be extracting humidity from the air and then purifying it into the highest quality drinking water by sending the collected condensation through a series of ultra-high quality filters that kills all germs, bacteria and viruses that could be present in the water. The end result is the cleanest, purest water. The water is absolutely pure, safe and clean, as well as great tasting.

VI. ACKNOWLEDGEMENT

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