Design of a Cost Effective Water Generating System through thin air

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Abstract: *Water scarcity is one of the burning issues of today's world. Though water covers more than two third (about 70%) of the Earth's surface but still fresh water which can be used for drinking and carrying out everyday chores remains scarce (only about 2.5%). The acute problem of water shortage, is mainly faced by the countries with long coastlines and the island nations, which do not have adequate fresh water sources like rivers and ponds. An atmospheric water generator (AWG) is a device that extracts water from humid ambient air. This paper aims to solve this problem. In the coastal areas the relative humidity is quite high (around 70-80%). So, the air in coastal areas can be used to meet the water needs of people by using a dehumidifier unit. Further the solar insolation is quite high in these areas round the year. This can be used to provide necessary power to the dehumidifier unit. Thus drinking water can be obtained from the atmosphere by harnessing solar energy. Such a device is called Atmospheric Water Generator. Water vapor in the air can be extracted by condensation - cooling the air below its dew point, exposing the air to desiccants, or pressurizing the air. Unlike a dehumidifier, an AWG is designed to render the water potable. AWGs are useful where pure drinking water is difficult or impossible to obtain, because there is almost always a small amount of water in the air that can be extracted. The two primary techniques in use are cooling and desiccants. The extraction of atmospheric water can require a significant input of energy. Some AWG methods are completely passive, relying on natural temperature differences, and requiring no external energy source.*

Index Terms *- Atmospheric Water Generator, Desalination, Relative humidity, Dehumidifier unit.*

I. INTRODUCTION

While designing the atmospheric water generator it was identified that three requirements were necessary to ensure that the final project would effectively fulfil its intended purpose. They are-

1) Portability of Water - Water produced by the design must conform to the World Health Organization (WHO) drinking water quality standards.

2) Simplicity of Use - Design must be operable by persons of limited technical experience.

3) Safety - Design must not pose a hazard to users at any point during its normal operation.

We developed several goals that the design should be able to meet.

They are-

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) Maximize Efficiency - The design should maximize the water produced per unit energy.

3) Minimize Cost - The design should minimize the cost per unit water production for both capital cost and production cost.

An Atmospheric Water Generator (AWG) is a device that extracts water from humid ambient air. Water vapor in the air can be extracted by condensation - cooling the air below its dew point, exposing the air to desiccants, or pressurizing the air.

Unlike a de-humidifier, an AWG is designed to render the water potable.

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Water scarcity will be a top priority in the upcoming decade. This design project involves the development of a working Atmospheric Water Generator (AWG) prototype to produce an adequate supply of drinking water for an average person. This is a device which produces drinkable water from humid air with an emphasis on energy.

II. BLOCK DIAGRAM

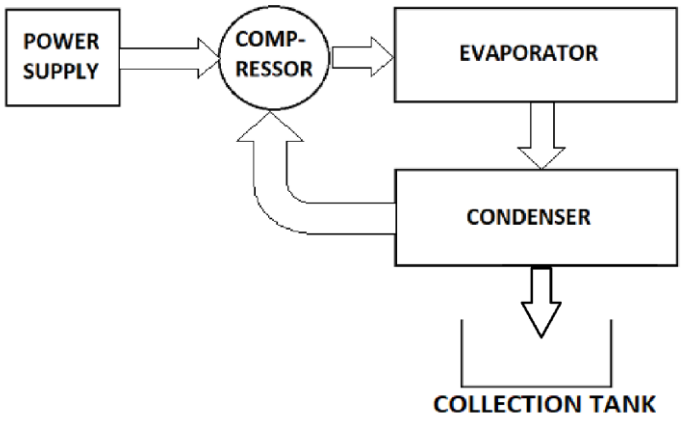


Figure 1: Block Diagram of AWG

III. HARDWARE DESCRIPTION

Sr. No	Components	Quantity
1	Compressor	1
2	Condenser	1
3	Capillary Tube	1
4	Evaporator	1
5	Fan	1
6	Capacitor	1

Table 1: Components used

A. COMPONENTS'S DESCRIPTION

1. COMPRESSOR

A compressor is a mechanical device that increases the pressure of a refrigerant by reducing its volume. Both temperature and pressure of refrigerant increases to very high value. An air compressor is a specific type of gas compressor

Figure 2: Compressor

2. CONDENSER

The condenser removes the heat from refrigerant carried from evaporators and added by compressor and converts the vapour refrigerant into liquid refrigerant. It is a heat exchanger in which heat transfer takes place from high temperature vapour to low temperature of air or water which is used as cooling medium.

Figure 3: Condenser

3. EVAPORATOR

An evaporator is a device used to turn the liquid form of a refrigerant into its gaseous form. The liquid is evaporated, or vaporized, into a gas. An evaporator is used in an air-conditioning system to allow a compressed cooling chemical, such as R22 to evaporate from liquid to gas while absorbing heat in the process.

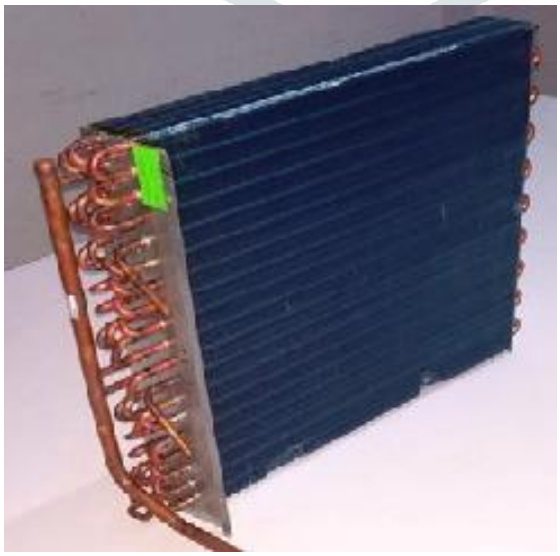


Figure 4: Evaporator

4. CAPILLARY TUBE

When the refrigerant leaves the condenser and enters the capillary tube its pressure drops down suddenly due to very small diameter of the capillary. The decrease in pressure of the refrigerant through the capillary depends on the diameter of the capillary and the length of the capillary. Smaller is the diameter and more is the length of the capillary more is the drop-in pressure of the refrigerant as it passes through it.

Figure 5: Capillary Tube

5. FAN

It is used to drive out hot air from evaporator. or to reduce temperature of evaporator coil.

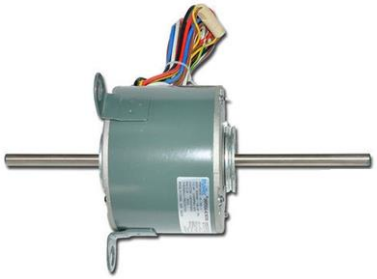


Figure 6: Fan

6. R22 GAS

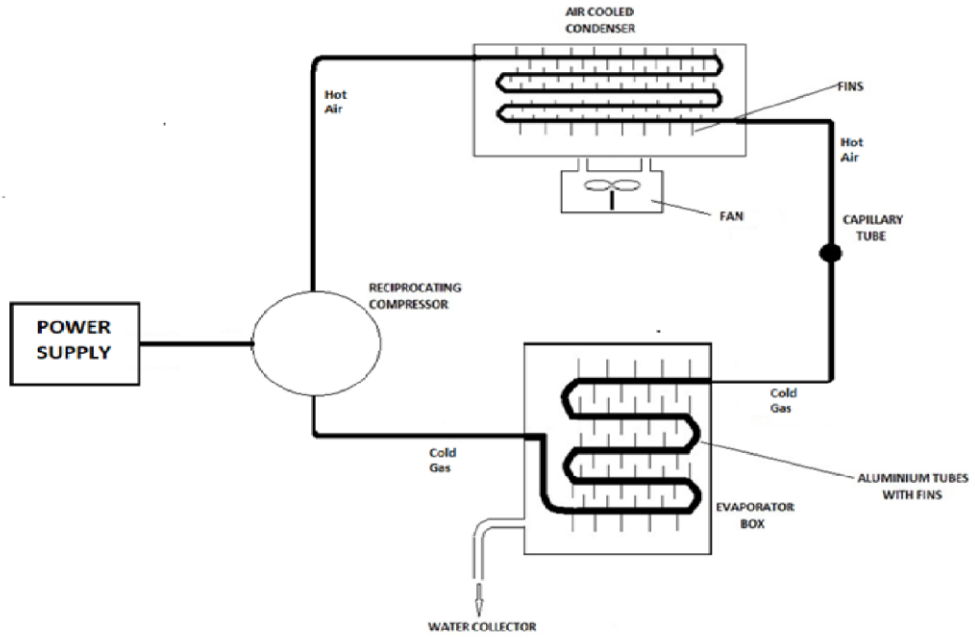
R22 is a gas used in the compressor as a refrigerant**.**

Figure 7: R22 Gas

IV. WORKING

The working of AWG starts from the heart of the AWG, that is the compressor which has R22 gas as a refrigerant. We already know that the compressor has a property of pressurizing the agent present in it to convert into other form.
So, this R22 gas is compressed and is converted into liquid form, and due to compression, the temperature increases and becomes very high. Now, this liquid enters the condenser via copper tube, and as it is very hot, it needs to be cooled down to a bit to process it further. Now, to reduce the temperature, we are using fan to push air into the condenser to reduce its temperature as shown in the schematic diagram, now due to the air which is pushed by the fan. The temperature of the hot liquid reduces to a bit. And now this hot liquid enters the capillary tube which has a property of changing the temperature from hot to cold and cold to hot. Also, due to sudden pressure drop, the state of the agent changes too, here it is in liquid form. So, after entering the tube, it converts into Gas. So, the agent which is entering the evaporator is now in Cold Gas form. Now, when this cold gas enters the evaporator, due to its low temperature, we can observe that ice is being formed on the fins and on the tubes of evaporator.

So, due to very low temperature of gas and the tube, it's not possible to melt when the system is in working condition.
So, we need to switch off the system to melt the ice which is formed on the fins and tubes. After the system is turned off, the ice melts due to the outer temperature and converts it into water. This water which is produced by the system is distilled



water because it is produced by condensation of vapor. Hence, we can use it for drinking after adding minerals into it.

V. CONCLUSION & RESULTS

After testing it was found that AWG can produce 1.129Ltr of water in one day. Amount of water generated depends on Temperature, Relative humidity of outdoor air, velocity of Air passed over coil and coil surface temperature. By increasing efficiency of compressor, velocity of air we can get more amount of water in same hour of operation. It will be more cost effective. This system's efficiency totally depends upon humidity and the temperature, if the humidity is high then the system will produce more water due to high humidity, if low the efficiency will be low too. Applying this system in a highly humid region can almost produce two to three liters of condensed water per day, this is promising result. A more enhanced system can be designed that used power solar cells and also has the facility to store excess energy during day time that is to be used at night. It is an ecological, economical answer to world's ever-increasing water crisis. We believe that this technology can have a positive effect on world water issue as we move forward into the future.

RESULTS

Sr No.	HUMIDITY (%)	WATER PRODUCED (ml)
1	13%	760ml
2	26%	1431ml
3	52%	2140ml

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