iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL
FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 Issue: VI Month of publication: June 2022

DOI: https://doi.org/10.22214/ijraset.2022.43770

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

Design Analysis and Fabrication of Atmospheric Water Generator

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Abstract: **The Atmosphere contains water in the form of water vapor, moisture etc. Within that amount almost 35% of the water is wasted. This amount of water can be used with the help of an Atmospheric Water Generator. This device is capable of converting atmospheric moisture directly into usable and even drinking water. In many countries like India, there are many places which are situated in temperate region; there are desert, rain forest areas and even flooded areas where atmospheric humidity is eminent. But resources of water are limited.**
Keywords: **Condenser, Compressor, Refrigeration and water.**

I. INTRODUCTION

The Atmosphere contains water is in the form of water vapor, moisture etc. Within that amount almost 40% of the water is wasted. This amount of water can use with the help of an Atmospheric Water Generator. This device is capable of convert atmospheric moisture directly into usable and even drinking water. The device uses the principle of latent heat to converts water vapor molecules into water droplets. In many countries like India, there are many places which are situated in temperate region; there are desert, rain forest areas and even flooded areas where atmospheric humidity is eminent in that places. But resources of water are limited. In the past few years ago, some projects have already been done to establish the concept of air condensation as well as generation of water. So, this project will be helping to extend to the applications of such devices further in the near future. According to previous knowledge, we know that the requires to condense water is known as dew point temperature. Here, the goal is to obtain the specific temperature practically or experimentally to condense water with the help of some electronics devices. This project consists of a bicycle-gear arrangement for running a condenser which is use create the environment of water condensing temperature or dew point, indeed conventional compressor and evaporator system could also be use condense water by simply exchanging the latent heat of coolant inside the evaporator. The condensed water will be collected used for drinking purpose and various other uses.

II. METHODOLOGY

Vapor-compression refrigeration is the most widely used method for air-conditioning in today's world. The vapor-compression consists of a circulating liquid refrigerant as the medium which absorbs and removes heat from the space to be cooled and subsequently rejects that heat to the atmosphere. Fig 1 depicts a single-stage vapor-compression system. Basically, the system has four components: a compressor, a condenser, a thermal expansion valve and an evaporator. Circulating refrigerant enters the compressor as saturated vapor and is compressed. This results in high pressure which in turn is responsible for higher temperature. The compressed vapor then comes out as superheated vapor and attains a temperature and pressure at which condensation can take place with the help of cooling water or cooling air. That hot vapor is passed through a condenser where it is cooled and condensed. This is where the circulating refrigerant rejects heat from the system. The condensed liquid refrigerant known as saturated liquid is next passed through an expansion valve where there is a sudden drop in pressure. This results in the adiabatic flash evaporation of the liquid refrigerant. The Joule-Thomson effect as it is called lowers the temperature of the liquid and vapor refrigerant mixture which makes it colder than the temperature to be achieved (temperature of the enclosed space). The cold mixture is passed through the coils in the evaporator. A fan circulates the warm air in the enclosed space across the coils carrying the cold refrigerant liquid and vapor mixture. That warm air evaporates the liquid part of the cold refrigerant and at the same time, the circulating air is cooled

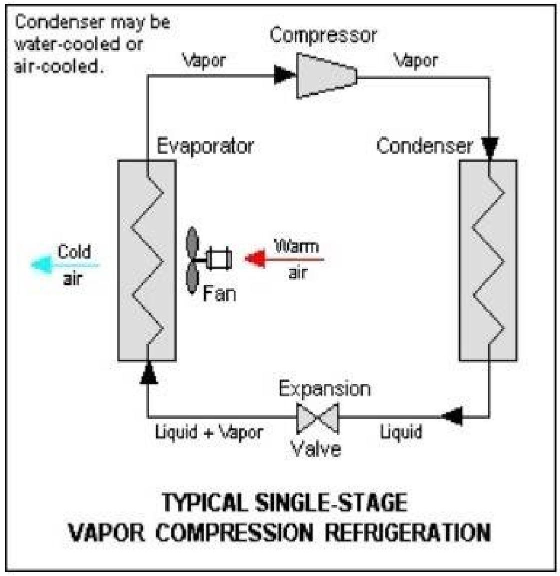

Fig. 1. Vapor Compression Refrigeration

and as a result, it lowers the temperature of the enclosed space to the temperature to be achieved. The circulating refrigerant absorbs and removes heat from the evaporator which is then rejected in the condenser and transferred by the water or air used in the condenser. For the completion of the refrigeration cycle, the refrigerant vapor coming out of the evaporator which is again a saturated vapor is returned back into the compressor.

III. COMPONENT DETAILS

A. Compressor

The compressor is the "heart" of a refrigerator. It circulates the refrigerant throughout the system and adds pressure to the warm part of the circuit, and makes the refrigerant hot. It's similar to when you are pumping air into a bicycle tube - you can sense a heat increase in the pump while you compress the air. The compressors are one of the most important parts of the refrigeration cycle. The compressor compresses the refrigerant, which flows to the condenser, where it gets cooled. It then moves to the expansion valve, and the evaporator and it is finally sucked by the compressor again. For the proper functioning of the refrigeration cycle, the refrigerant must be compressed to the pressure corresponding to the saturation temperature higher than the temperature of the naturally available air or water. It is the crucial function that is performed by the compressor. Compression of the refrigerant to the suitable pressure ensures its proper condensation and circulation throughout the cycle.

Fig. 2. Compressor

Specifications:

Application : LBP
Refrigerant : R134a

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Compressor Cooling	: Static
Displacement (cc)	: 4
Evaporating Temperature	: 7.2 degrees
Condensing Temperature	: 55 degrees
Liquid Sub Cooling Temp	: 32.2 degrees
Power / Current	: 94 Watts / 0.8 Amps
Rated Voltage	: 230V – 50HZ

B. Refrigerant

Refrigerant is a cooling agent that absorbs heat and leaves cool air behind when passed through a compressor and evaporator.

1) R-134a Refrigerant

Components: Hydrofluorocarbon (HFC)
Uses: Refrigerators, Car Air Conditioning
ODP: 0
GWP: 1430 (Medium)
Eco-Friendly: Somewhat
Flammable: No

C. Condenser

The condenser removes heat from the hot refrigerant vapor gas vapor until it condenses into a saturated liquid state condensation. After condensing, the refrigerant is a high-pressure, low-temperature liquid, at which point it's routed to the loop's expansion device.

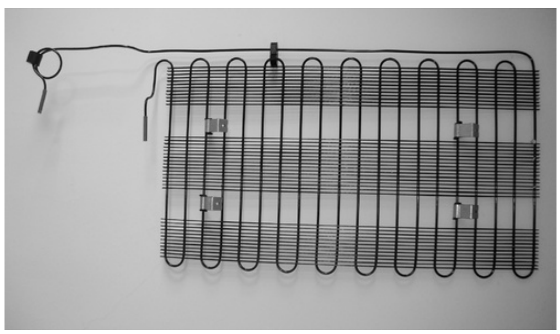

Fig. 3. Condenser

D. Evaporator

The function of the evaporator is to absorb the heat from the space or surrounding medium which is to be cooled by means of refrigeration. The process of heat removal from the substance to be cooled or refrigerated is done in the evaporator. The liquid refrigerant is vaporized inside the evaporator (coil or shell) in order to remove heat from a fluid such as air, water etc.

Fig. 4. Evaporator

E. Expansion Valve

An expansion valve or thermostatic expansion valve is a component in vapor-compression refrigeration and air conditioning systems that controls the amount of refrigerant released into the evaporator and is intended to regulate the superheat of the

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refrigerant that flows out of the evaporator to a steady value. Although often described as a "thermostatic" valve, an expansion valve isn't able to regulate the evaporator's temperature to a precise value. The evaporator's temperature will only vary with the evaporating pressure, which will have to be regulated through other means (such as by adjusting the compressor's capacity).

Fig. 5. Expansion Valve

F. D.C. Motor

A single-phase D.C motor is an electrically-powered rotary machine that can turn electric energy into mechanical energy. It works by using a single-phase power supply.

1) Product Description:

Usage/Application – Cooler Motor
Voltage – 220 to 240V
Phase – Single Phase
Commutation – Brush
Speed – 500 to 1500 RPM
Mounting Style – Case Bolt Mount
Frequency - 15 to 20 Hz
Efficiency – 90%
Body Material – Mild Steel

Fig. 6. D.C Motor

G. Air Blower Fan

Fans can create airflow with low pressure but in large volumes and hence they are usually used in big air coolers. But blowers create high pressure airflow from the cooling system with higher speed and air throw.

1) Product Specifications:

Motor Rating – 0 to 1 HP
Fan Speed – 500 to 600 rpm
Material – Stainless Steel
Blade Material – Plastic

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Product Type – Air Blower

Power Source Type – Electric

Fig. 7. Air Blower Fan

H. Lead Acid Battery

The sealed lead-acid battery consists of six cells mounted side by side in a single case. The cells are coupled together, and each 2.0V cells adds up to the overall 12.0V of the battery. A completely charged lead-acid battery is made up of a stack of alternating lead oxide electrodes, isolated from each other by layers of porous separators. All these parts are placed in a concentrated solution of sulfuric acid, intercell connectors connect the positive end of one cell the negative end of the next cell hence the six cells are in series.

1) Product Details:

Voltage – 12 Volts
Current – 8 Ah
Battery Cell Composition – Sealed Lead Acid
Dimensions L*W*H – 11.8 * 11.4 * 11.3 Centimeters
Number of Cells – 6

Fig. 8. Lead Acid Battery

IV. WORKING PRINCIPLE

The Atmospheric Water Generator works on the same principle as a Refrigerator and Air Conditioner. Refrigerators and air conditioners both work on the principle of cooling through evaporation. The refrigeration process begins with the compressor. Ammonia gas is compressed until it becomes very hot from the increased pressure. This heated gas flows through the coils behind the refrigerator, which allow excess heat to be released into the surrounding air. Eventually the ammonia cools down to the point where it becomes a liquid. This liquid form of ammonia is then forced through a device called an expansion valve. Since this evaporation occurs at -27 degrees F (-32 degrees Celsius), the ammonia draws heat from the surrounding area. Cold material, such as the evaporating ammonia gas tend to take heat from warmer materials. As the evaporating ammonia gas absorbs more heat, its temperature rises. Coils surrounding the lower refrigerator compartment are not as compact. The rate at which water can be produced depends on relative humidity and ambient air temperature and size of the compressor. Atmospheric water generators become more effective as relative humidity and air temperature increase. As a rule of thumb, cooling condensation atmospheric water generators do not work efficiently when the temperature falls below 18.3°C (65°F) or the relative humidity drops below 30%. This means they are relatively inefficient when located inside air-conditioned offices. The cost-effectiveness of an AWG depends on the capacity of the machine, local humidity and temperature conditions and the cost to power the unit. Water is often condensed from the air in the air conditioners when the ambient air is humid and hot in coastal tropical regions. This water can be conveniently used for drinking purpose. The amount of water vapor at any time is

usually less than that required to saturate the air. The Relative Humidity is a percent of saturation humidity shown in Fig. 9.
Here condenser is placed on roof of the frame. That is connected to the silica gel and evaporate, and compressor. The condenser is connected all the side of the frame by pin joint. The assembly of various components like Condenser, Compressor, Evaporator, D.C Motor, Air Blower Fan, Battery, Water Collecting Tank. Shown in Fig. 10.

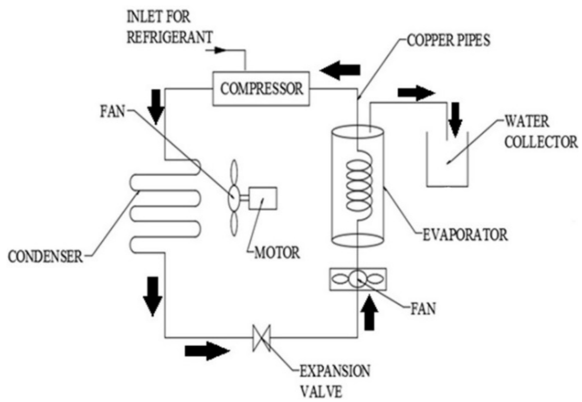

Fig. 4.1. Block Diagram

Fig. 4.2. Assembled Atmospheric
Water Generator

V. TESTING PROCEDURE

The tests were conducted between April 21st and May 13th, 2022. And used monitoring devices such as a clamp type multimeter to measure current and voltage, an anemometer to measure airflow inlet and outlet, a thermocouple to measure airflow temperature, and a hygrograph to measure airflow humidity. Table. l shows the testing positions for temperature, airflow rate, and relative humidity. The measured data and generated water were recorded once every hour.

Apparatuses	Unit		Accuracy		Range	Purpose
Clapometer	A	V	±(2.5%+15d)	±(1.0%+5d)	400/600	Current and voltage testing
Anemometer	m/s		±0.0015		0.4-30.0	Air flow rate testing
Thermocouple	c		±0.1		-200-1300	Temperature testing
Hygrograph	%		±3		0~99	Air humidity testing
Graduated cylinder	ml		±5		50-500	Water generated testing

Table. 1. The specifications of experimental apparatuses used

VI. APPLICATIONS

There are hardly any chances to refuse that this device is portable for its simple design and endurance capability. So, the

Atmospheric Water Generator is the device which can be implemented for extreme situation, to use during flood, in desert areas, and in rural areas. It has great advantages as it works like a renewable source of atmosphere water and doesn't need a heavy power source. It can be implemented for Industrial development where the water is a matter of crisis.

VII. ADVANTAGES

1. High Performance: Delivers consistent low dew-point temperatures.
2. High Efficiency: Precools incoming air, cuts operating costs up to 50%.
3. Simple Technology: Simple technology, familiar to HVAC contractors and technicians.
4. Reliable: No moving parts in the airstream, except direct drive fan.
5. Low Maintenance: Direct drive Fans, no belts or pulleys to adjust.
6. Sanitary: Full draining, no standing water.
7. Lower capital costs, competitively priced.
8. Versatile: Available using chilled water or refrigerant.

VIII. CONCLUSION

New weather patterns appeared in our world in the past century, and that caused lots of confusion for humans who used to expect only one weather pattern per season in certain areas. However, this is not the case in the current days, which means that people have to change their behaviors in so many ways if they want to have a good life quality for the future generations. However, it is obvious that finding sustainable alternatives of the traditional natural sources is one of the most important issues that should be studied and developed, whether for energy source, or water sources. Applying this system in a highly humid region almost 300 Milliliter of condensed water can be produced per hour during the day light, this is a promising result. Finally, in this report we talked about way of harvesting water from thin air, and these ideas mentioned above can solve the poorer arid areas water problems with cheap prices inventions that they can buy or maybe produce their selves. We can produce an unlimited supply of water without environmental pollution for the current water scarcity problem. Air water is a renewable source of water so the technology is a secured source for the future.

IX. FUTURE WORK

There have been many things we missed out on enabling our system to be very effective and efficient with the production of water. However, since it is still in a prototype stage, there are is lot of room for improvements. One of which is, to properly optimize the system which facilitate the production of water in case of conditions where humidity can be decreased too low. Secondly, there should also be a need to properly insulate the heat sink to avoid leakage of current and heat which will eventually improve the efficiency of the whole system. Also, there would be a need of heat sink wall modification to avoid resting on it and instead is passed straight towards the water container.

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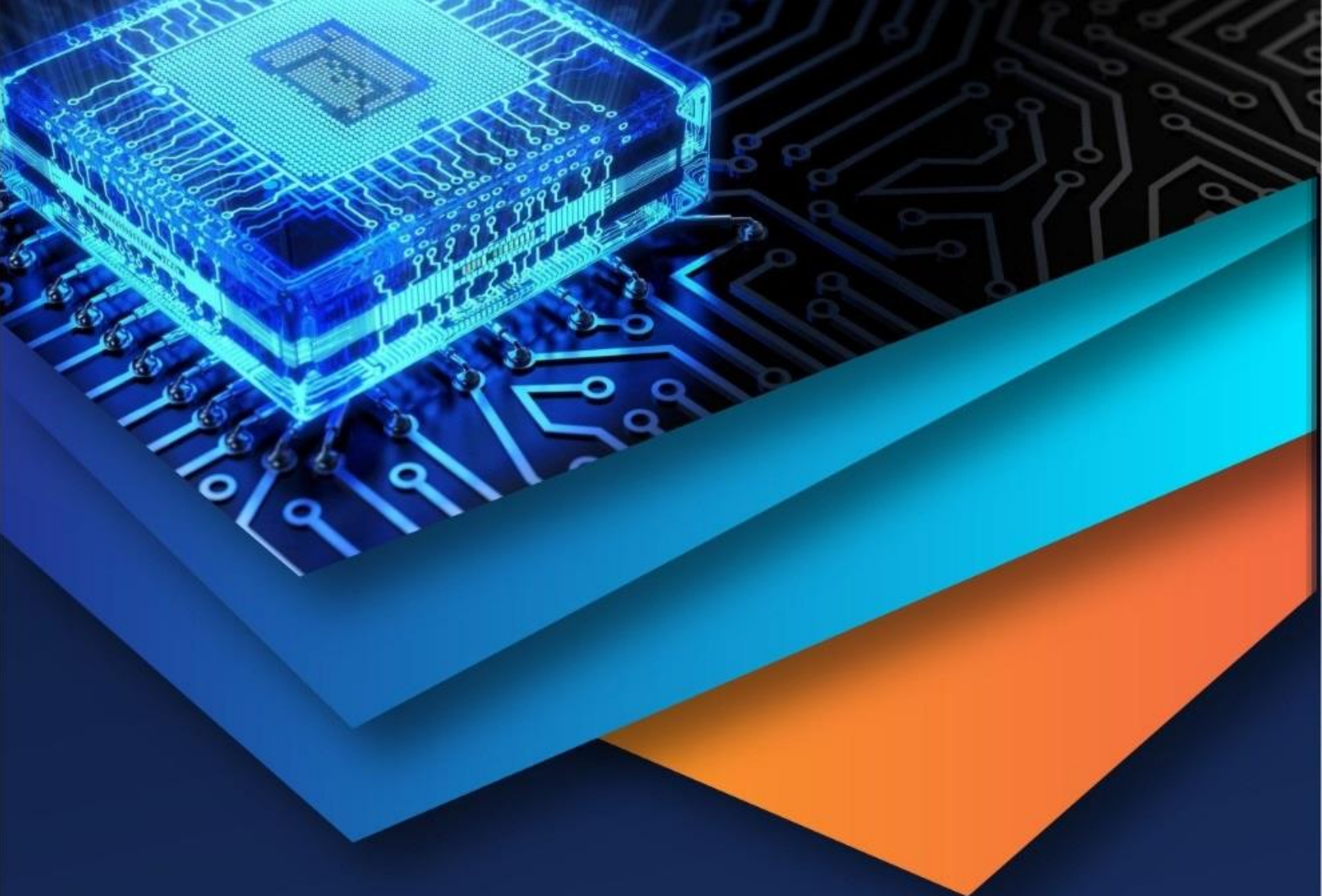

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