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PORTABLE ATMOSPHERIC WATER GENERATOR

Sajil V.P[1], Ameer E.A[2], Anfal P[3] Aswin Vas C[4], Binshad Ibnu Masood[5], Faris Ahamad[6], Vivek V.N[7]

[1]*Lecturer, Department Of Mechanical Engineering, Orphanage Polytechnic College, Edavanna, Kerala, India.*
[2,3,4,5,6,7] *Diploma students, Department Of Mechanical Engineering, Orphanage Polytechnic College, Edavanna, Kerala, India*

Abstract - *In many countries like India it is difficult to obtain fresh water resources for drinking and other purposes. For this, Device like atmospheric water generator can be used. It is a condensation device where air is directly condensed to water, which uses the principle of latent heat to convert molecules of water vapour into water droplets. For taking away the latent heat from the water vapour we use a thermoelectric cooler works based on peltier effect. It is not very common in India. This paper also describes the experimental results and the performance of the system.*

Key Words: Water condensation, Thermoelectric peltier, Dew condensation (latent heat)

1.INTRODUCTION

The atmospheric water generator using peltier effect is a device used to generate the water from the humid air In our atmosphere much amount of humid air is available it contains large amount of water this amount of water can be used by implementing a device like Atmospheric Water Generator. It uses the principle of converting the latent vapour molecule into water droplets. The temperature regions such as deserts, rain forest areas and flooded areas where the rate of humidity is high and many countries are situated in very high temperature regions. In past years several projects have done to introduce the concept of condensation and also the generation of water from the water vapour by the peltier effect. From the previous available projects we come to know that the temperature required to condense the water is known as dew point temperature. The main objective of this project is making a portable water generator. Also in this project we use the peltier module and it reduces the usage of compressor and condenser. It also leads to reduction of space and size of the device which makes it to transport easily.

1.1 Principle of Peltier Device

The peltier thermoelectric device has two sides (A p-type and an n-type semiconductor), and when DC current flows through the device, it brings heat from one side to other, so that one side gets cooler while the opposite one gets hotter. This is called Peltier effect and electron hole theory. Peltier coolers consist of a Peltier element and a powerful heat sink/fan combination. Peltier elements come in various forms and shapes. Typically, they consist of a larger amount of thermocouples arranged in rectangular form and packaged between two thin ceramic plates. This type of device is so powerful that it can freeze good amount of the water within several minutes. A conventional cooling system contains three fundamental parts-the evaporator, compressor and condenser. A TEC also has some analogous parts. Energy (heat) is absorbed by electrons at the cold junction, as they pass from a low energy level in the p-type semiconductor element, to a higher energy level in the n-type semiconductor element. It is the power supply that provides the energy to make those electrons to move through the system. At the hot junction, energy is expelled to a heat sink as electrons move from a high energy level element (n-type) to a lower energy level element (p-type)

1.2 Advantages of This Device over Conventional Device

- No moving part, so maintenance is required less frequently
- No use of chlorofluorocarbons.
- Temperature control within fractions of degrees can be maintained
- Can be used in environments that are smaller or more severe than conventional refrigeration.
- Has a long life, Flexible shape
- Controllable via changing the input voltage/current very easily.
- Draw comparatively low current than a compressor based refrigeration system

3. CALCULATION

1.1 Dew Point Temperature Calculation

This calculation forms an important part of this project as this helps us to determine at temperature the Peltier device must be maintained in order to condense the humidity present in air at the given atmospheric condition.

What is Dew Point Temperature?

Dew-point temperature is the temperature at which humidity in the air starts condensing at the same rate at which it is evaporating at a given constant barometric pressure.

A well-known approximation used to calculate the dew point, Tdp, given just the actual ("dry bulb") air temperature, T and relative humidity (in percent), RH, is the "Magnus formula".

$$\gamma(T, RH) = \ln(RH/100) + Bt/c + T$$

$$Tdp = c\gamma(T, RH)/b - \gamma(T, RH)$$

(Where, b = 17.67 & c = 243.50C and T is in 0C)

The above formulas is used to calculate the dew point temperature for different atmospheric conditions at which the device may be subjected to operate. With the help of Microsoft excel the operating parameters are calculated and tabulated.

Sample Calculations

$$\gamma = \ln(57/100) + 17.67*33/243.5*33 = 1.546$$

$$Tdp = (243.5*1.546)/(17.67-1.546)$$

$$= 23.35\ °C$$

The table for the dew point temperature calculation for different atmospheric conditions is as follows.

DBT	30	31	32	33	34	35	36
RH	DEW POINT TEMERATURE (Tdp)						
50	18.4	19.3	20.3	21.2	22.1	23	23.9
51	18.7	19.7	20.6	21.5	22.4	23.3	24.2
52	19.1	20.0	20.9	21.8	22.7	23.6	24.6
53	19.7	20.3	21.2	22.1	23.0	24.0	24.9
54	20.0	20.6	21.5	22.4	23.4	24.3	25.2
55	20.2	20.9	21.8	22.7	23.7	24.6	25.5
56	20.5	21.2	22.1	23.0	24.0	24.9	25.8
57	20.8	21.5	22.4	23.3	24.3	25.2	26.1
58	21.1	21.7	22.7	23.6	24.5	25.5	26.4
59	21.4	22	23.0	23.9	24.8	25.8	26.7
60	21.7	22.3	23.2	24.2	25.1	26	27.0

1.2 Amount of water (in L) present in 1m3 of air

Humidity Ratio gives the volume of water (in m3) present in 1m3 of air.

$$\text{Partial Pressure of water (Pw)} = RH \div 100 \times P$$

$$\text{Humidity Ratio} = 0.622 \times Pw \div Pa - Pw$$

(Where Pa is the atmospheric pressure i.e. Pa=1.01325 bar)

Humidity ratio gives the amount of water (in m3) present in 1m3 of air. Also we know that 1m3 is equal to 1000 litres. Thus multiplying humidity ratio by 1000 gives the maximum amount of water (in litres) that is present in 1m3 of air.

Sample Calculations

(For atmospheric temperature 30°C and relative humidity 50%)
Saturation Pressure of water vapour (Pw) at 30°C is obtained from steam table as 0.04241 bar.

$$Pw = (50 \div 100) \times 0.04241 = 0.021205\text{bar}$$

$$\text{Humidity Ratio} = 0.622 \times 0.021205 \div (1.01325 - 0.021205) = 0.013295273$$

Therefore amount of water (in litres) present in 1m3 of atmospheric air= Humidity ratio × 1000
= 0.013295273× 1000 = 13.2952739 litres

2. WORKING

Based on the CAD model a device was built. The outer casing of the device is made up of acrylic sheet which is light and cheap material and easy to work with. Four Peltier devices (TEC12706) are fitted as shown in figure. The draft fans for cooling the Peltier device were attached top of the device in order to increase the efficiency of cooling as shown in figure. On running the device, initially condensation started and water droplets were formed on the cold surface of the Peltier device. But subsequently due to the deposition of these water droplets the thermal conductivity of the region decreased as water is not a good thermal conductor. Hence the condensation process slowed down subsequently. So in order to increase the output a wiping mechanism is include in the device so as to increase the condensation rate for the wiping mechanism. Here we using a 60 Rpm motor attached at the top of the device and two wipers were connected in motor for four peltiers. Two inlet draft fan was also attached at the side of the device which will draw the humid atmospheric air for condensation.

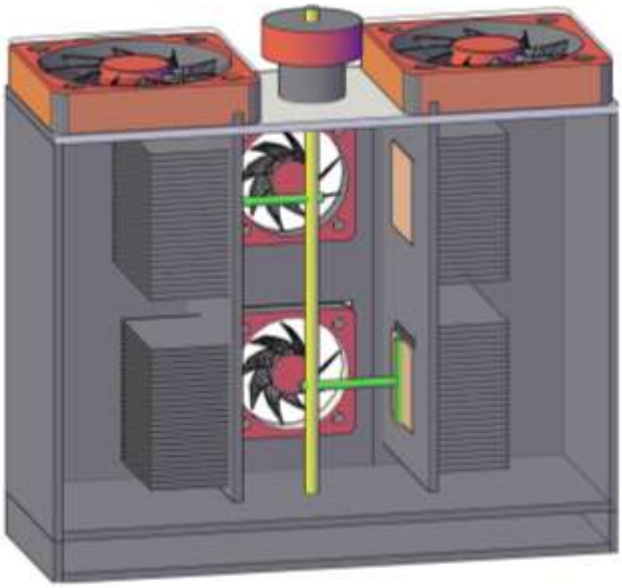

Fig 1.1

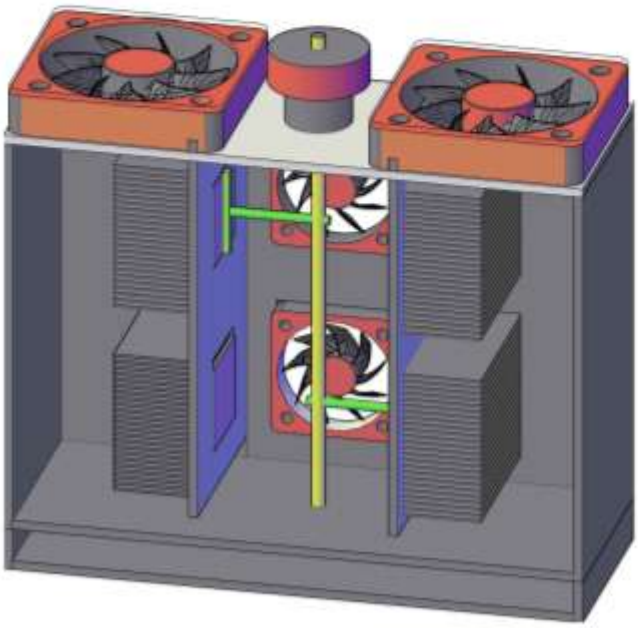

Fig 1.2

N (Air Remover)

N (Air in Taker)

ng System

r

otor

at Sink

3. CONCLUSIONS

The device we made is tested and it was found that the water output from the device was at least 5ml/hour. After diligent study and research we found that the following reasons may be responsible for the low water output of the device.

1. As such the cold surface area of the Peltier device is very less (4cm*4cm). So we used a copper plate in contact with the cooling surface of the Peltier device because of its high conductivity expecting that the cold surface area will increase thereby increasing the condensation area. But finally in the prototype when we used the copper plate proper thermal contact between the cold Peltier surface and the copper plate could not be achieved. This maybe the possible reason for low efficiency.

2. One of the most important limitations is the peltier device itself. The peltier we have found in market is not that much effective in producing water. While experimenting with the local available peltier device we have observed that these devises lose their ability frequently and doesn't work perfectly

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BIOGRAPHIES

Sajil V.P
Lecturer
Dept.of mechanical engineering
O.P.T.C edavanna
Malappuram, Kerala

Ameer E.A
Edakkadamban (H)
Nampooripotty (P.O)
Malappuram, Kerala

Anfal P
Palayakodan (H)
Pookkottumpadam (P.O)
Malappuram, Kerala

Aswin Vas C
Choondiyengal (H)
Anakkayam(P.O)
Malappuram, Kerala

Binshad Ibnu Masood
Pulath (H)
Erumamunda(P.O)
Malappuram, Kerala

Faris Ahamad
Komullil thodi (H)
Thelakkad(P.O)
Malappuram, Kerala

Vivek V.N
Vadakkethil(H)
Theyyathumpadam(P.O)
Malappuram, Kerala