AIR CONDENSATION: A FRESH WATER SOURCE.

MR. SHIVRAY V. MANE[1] , MR. ANKUSH L. MHETTAR[1] , MR. H A SARAIKAR[2]

[1]U. G. Students, Assistant Professor, Department of Mechanical Engineering,
[2] Ashokrao Mane Group of Institutions Vathar Tarf Vadgoan

ABSTRACT ***:*** *Fresh water is an important for human being for their survival. Till now only rain is considered as a main source of water. but rain is only for about four months a year. so, due to this uncertainty , it is required to go for another alternative source of fresh water. In recent year the different methods of obtaining fresh water from the atmosphere has received more attention and this source of fresh water can be recovered for general domestic use. Fog and Dew are some important sources of water. Dew is common in relatively humid climates with clear sky conditions whereas fog is common in locations like mountains and coastal areas . Generally the fresh water is obtained from atmosphere is expected to be soft neutral water of good quality with a very low contents of mineral and metal. The formation of dew require for cold surface and cloudiness , surface temperature , air humidity and wind speed influence the dew formation .This research seeks and endless source of fresh water as dew from the atmosphere . An experimental setup is developed by using refrigeration system components , in which copper plates act as evaporator. Here copper plate is maintained below dew point temperature of atmospheric air, due to its direct contact with air water drops are formed on plate and collected . The dew collection is analyzed as per various parameters which include , relative humidity , atmospheric temperature . The experimental results show that the performance of a system changes with change in relative humidity and atmospheric temperature. The collected water was tested and the results were positive i.e.the water is potable. Thus this can be very useful water resource for human beings.*

Key words: Condensation, Humidity conversion, Vapour compression Refrigeration etc.

1.INTRODUCTION

1.1 Need of Alternative Sources of Water

"Water conservation should not be considered an option any longer. Current circumstances require our full attention if we hope to thrive as a civilization." It these statements sound dramatic, it is because much of the world is currently suffering due to a lack of clean water. Demands are increasing every year for water while resources are becoming more and more limited Statistics around reveal that our fresh water supply is practically nonexistent that is why it is so important to seek out find and start using all the innovative water conservation solutions and methods that are available today. Whether you live in Australia or India or The USA, it is time to wake up and take responsibility. It is easy to practice water conservation in the home, but there is more to be done. Our world needs help on a commercial level to introduce new sources of fresh water With increasing industrialization and population, the world's water supplies are being taxed to their capacity. There is already an acute shortage of potable water in developing countries. This shortage has necessitated the use of desalination as a means of providing fresh water for drinking purposes. All of the existing desalination plants in the world use scarce and costly fossil to fire them. Consequently, the majority of these plants are located in Mid East countries. However, the majority of the developing countries cannot get the costly fuel to run the desalination plants, thus pointing out the need of using alternative desalination technology.

1.2 Atmospheric water vapour

We have very extensive water reserves that we have difficulty in exploiting. The atmosphere contains 12,900km³ of fresh water, composed of 98% water vapor and 2% condensed water (clouds), a figure comparable to the renewable liquid water resources of inhabited lands (12,500km³). The sums are easy, but being able (and knowing how) to obtain this water in liquid form is crucial. The first, fundamentally important, problem has been solved, but extracting liquid water from the atmosphere economically is another matter.

1.3 DEW: A New Source of Water

Dew is atmospheric water vapor which condenses on a surface (wind shields, blades of grass) which has been cooled below the dew point temperature of the surrounding air by losing heat to the sky via radiation. Moisture from dew is an important means of survival for plants, arthropods and other organisms in water scarce semi-arid and arid environments. However, dew is not considered to be an important source of water for humans because of the small quantities produced and its infrequent occurrence. This is true in general but there are areas where dew occurs frequently and in appreciable quantities which could be of significance to humans. The potable water shortage in the area is widespread and chronic. More than 150 villages near the coast have no water source and the villagers survive on water hauled daily from long distance by trucks. In such a context dew water could provide a small but critical water source for humans if efficiently harvested. Although dew water may have bacteriological contaminants added by air dust, the dew water in the study was tested and found to be potable. After filtering (where needed), dew water may be safely pasteurized. Another useful feature of the dew phenomena was that unlike the rains which are concentrated over 15-20 days in a season of four months, and in some years may be negligible, dew occurrence (103 nights) was more uniformly distributed over the season of seven months. Another important note is that the two seasons, rainy and dew are complementary. Condensation occurred frequently on the greenhouse roof because it cooled to the dew point temperature of surrounding air at night by radiating heat to sky. A search of the literature reveals a maximum potential of 0.8 mm/day, or 0.8 liter/m, of dew water can be condensed under radiation cooling. This is based on the available cooling power (25–100 W/m in various regions with respect to the latent heat of condensation (2.26 kJ/g). Peak collection from the greenhouse roof (200 µm of clear polyethylene) on a night was only 0.362 mm or 0.362 liter/m. This indicated that by employing a more efficient radiator material and with proper engineering, a larger amount of dew water could be harvested. The greenhouse roof and the classing were not specifically meant for dew harvesting.

1.4 Current Scenario:

The assertion that water has always been the essence of life is nothing new. Water comes in many forms: spring water, sea and river water, rainwater, and fog and dew water. Yet water is becoming scarce and this scarcity is becoming a very real worry, proving to be one of the main obstacles to the economic development of countries lacking fresh water. Potable water is a serious problem we are facing nowadays in various regions. So it is necessary to find out alternative recourses to get relief from this problem. Efforts are on to augment potable water resources in various ways. But one potential resource dew has remained unnoticed. It was discovered in the year 2001, in the course of greenhouse work in village Kothara. Its roof (124 m^2 plastic) surface attracted condensation frequently, more in summer. Yearlong daily measurements showed that condensation occurred over a continuous eight-month season (October - May). Dew occurred for 103 nights in the season. The collection from the roof was an equivalent of 10 mm over this season. The peak collection in a night in April was 39 litres [Sharan and Prakash 2003]. Measurement at Kothara was followed by measurements at two other locations along the coast - Panandhro and Mithapur. Research on dew has been very limited in India. Raman (1973) measured dewfall at sixty locations to assess its possible contribution to root zone moisture in dry periods. Subramaniam and Rao (1983) studied dew fall in the north-west India in the context of afforesting sand dunes. There is no report of studies for possible use by humans. The earliest efforts to condense dew for human use were made by the Greeks. More such efforts were made in the early part of last century. Some of these have been carefully studied by contemporary scientists (Milimouk and Beysens 2005). Efforts were mostly unsuccessful. Massive structures often did not cool to dew point. Interest in accessing dew water has emerged again in the recent years. The new approaches are fundamentally different from the old ones. Researchers in Sweden and France (Nilsson et al. 1994, Nilsson 1996, Nikolayev et al 1996, Beysens et al 2003) developed correct theoretical basis to build efficient radiative condensers. They developed light weight, radiative foils that gave higher yields. In the present work a similar approach was adopted. It was decided to build condensers using materials that have appropriate properties and are readily available (roofing sheets for instance) or can be easily produced by the local industry.

2.Air Condensation Unit

As mentioned above the objective of our project, we construct a set up as shown in figure below which includes Refrigeration system components like Compressor, Condenser, Evaporative plate, Expansion device etc. We used copper plate on which evaporative coil is wound to give refrigerating effect.

2.2 Components of Vapour Compression System

In any vapor compression refrigeration system, there are two different pressure conditions, one is called the high pressure side and other is known as low pressure side. The high pressure side includes a discharge line. [I.e. piping from delivery valve B to condenser] condenser, receiver and expansion valve. The low pressure side includes evaporator [I.e. piping from the evaporator to the suction valve A]. A simple vapor compression refrigeration system consists of following basic elements.

1. Compressor:

The low pressure and temperature vapor refrigerant from evaporator is drawn into the compressor through the inlet or suction valve A, Where it is compared to high pressure and temperature. This high pressure and temperature vapor refrigerant discharged into the condenser through delivery or discharge valve B.

2. Condenser:

The condenser or cooler consist of coils of pipes in which the high pressure and temperature vapor refrigerant is cooled and condensed. The refrigerant while passing through the condenser, gives up its latent heat to surrounding condensing medium which is normally air or water.

3. Receiver:

The condensed liquid refrigerant from condenser is stored in a vessel known as receiver, from where it is supplied to evaporator through the expansion valve or refrigerant control valve.

4. Expansion Valve:

It is also called as throttle valve or refrigerant control valve. The function of expansion valve is to allow liquid refrigerant under high pressure and temperature to pass at controlled rate after reducing its pressure and temperature. Some of the liquid refrigerant evaporates as it get passed through the expansion valve, but the greater portion is vaporized in the evaporator at the low pressure and temperature

5. Evaporator:

An evaporator consist of coils of pipes in which the liquid vapor refrigerant at low pressure and temperature is evaporated and changed into the vapor refrigerant at low pressure and temperature, In evaporator, the liquid vapor refrigerant absorbs its latent heat of vaporization from its medium [Air, Water Or Brine] which is to be cooled.

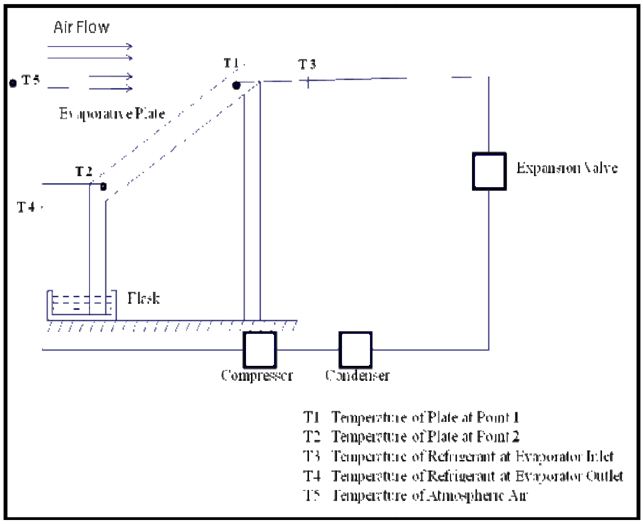


Figure 2.1 Set up diagram

2.3 Vapour Compression System

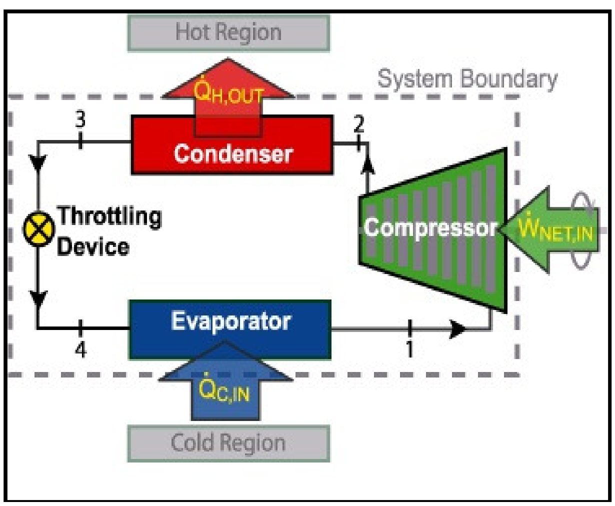


Figure 2.2: Vapour Compression System

A typical vapour compression system consist of four major components viz. compressor, condenser, expansion device and an evaporator are depicted schematically in Figure1 whereas, Figure 2 is a thermodynamic diagram of the process where the numbered points correspond to the numbered points in Figure1.

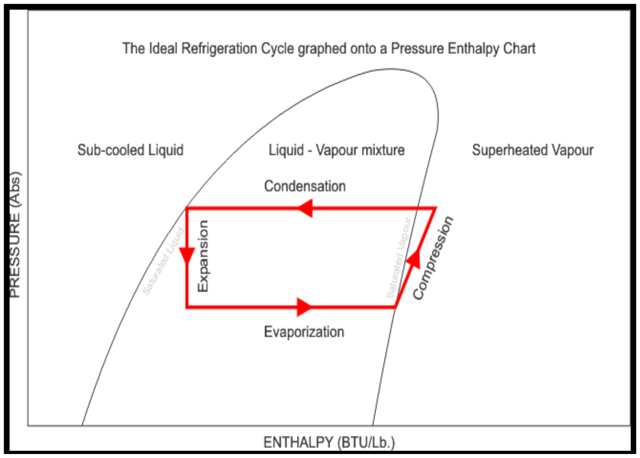


Figure 2.3: P-H Diagram

The operation cycle consist of compressing low pressure vapour refrigerant to a high temperature vapour(process 1-2); condensing high pressure vapour to high pressure liquid(process 2-3); expanding high pressure liquid to low pressured super cooled liquid (process 3-4); and evaporating low pressure liquid to low pressure vapour (process 4-1). The heat absorbed from evaporator in process 4-1 is rejected to outside ambient during condensation process 2-3 and is generally a waste heat. The condensation process can be divided in 3 stages viz. desuperheating2-2a, condensation and sub cooling. To understand the refrigeration cycle better, one must be familiars with the idea of phase change. An evaporating liquid stays at constant temperature until it makes the phase change into a gas.

Fig 2.3 :Actual Set up

3.EXPERIMENTAL PROCEDURE

3.1 PROCEDURE

1) Put the set up in proper position, where its level is horizontal and it is well ventilated.
2) The set up must have at least 1.5 meters empty space from all sides.
3) Give 230V, 50Hz and single phase power supply to unit.
4) Start the compressor by putting the main switch ON.
5) Record all readings as per observation table. Allow at least half hour running time for the system to get stabilized.
6) Calculate the results and plot the graph.

3.2 Working

The experimental set up consists of various refrigeration components connected to each other by copper pipes. In this, the dew formation is carried out by four processes; which include compression, condensation, expansion and evaporation. These are explained below:

At first, the low pressure and temperature vapor refrigerant is supplied from the evaporator to compressor. In compressor the refrigerant is compressed to high pressure and temperature. This high pressure and temperature vapor refrigerant is discharged to condenser. The condenser consists of three rows of coils, in which the high pressure and temperature vapor refrigerant is cooled and condensed by forcing atmospheric air using fan. This condensed refrigerant is passed through filter to remove dust, dirt particles before it is supplied to capillary tube. High pressure liquid refrigerant from condenser is stored in accumulator, which is further supplied to evaporator through expansion device. We are using capillary tube as an expansion device. The function of capillary tube is to allow the liquid refrigerant under high pressure and temperature to pass at controlled rate after reducing its pressure and temperature. Then it is supplied to evaporator. In this set up evaporator is consists of evaporative coil which is soldered to copper plate. The liquid refrigerant at low pressure and temperature is evaporated and changed into vapor refrigerant at low pressure and temperature. In evaporating the liquid refrigerant absorbs its latent heat of vaporization from the medium which is to be cooled (copper plate). Again this low pressure and temperature refrigerant is supplied to compressor and cycle is completed.

Observation Table 1

Table No. 8.1 Readings taken from 20th February to 3rd March.

SR NO	Date OF NOV/DEC2014	Temperatures (ºC)						Water Collected (ml)
		T1	T2	T3	T4	T5	T6	
1	20	33.8	28.3	2.1	6.4	26	3.3	1650
2	21	32.6	28.9	3.5	4.8	25.5	4.8	1200
3	22	31.5	27.7	-0.3	-0.1	25.4	0.5	1550
4	23	38	31.6	3.9	6.9	28.5	6.6	1590
5	24	33.7	28.5	1.1	2.2	26.2	3.5	1300
6	25	30.6	26.8	-0.1	-0.5	24.5	1.3	1350
7	26	33.8	28.5	1.7	3.7	26.4	4.2	1350
8	27	40.4	35.2	5.3	6.2	31.8	7.8	1200
9	28	35.1	29.1	2.3	5.2	26.1	4.7	1200
10	01	25.7	21.4	-2	-2.5	19.6	-2.1	1450
11	02	31.1	27.9	-0.6	-0.3	25.2	0.1	1050
12	03	33.7	29.6	1.6	3.6	27.2	3.5	650

Mass Flow Rate (LPH)	Pressure (psi)		Time Required For 10 Impulse (Sec)	COP
	Suction	Discharge		
5	35	115	48	1.09
5.5	35	115	46	1.03
5	30	110	47	0.95
5.5	38	125	46	1.13
5.5	32	112	48	1.03
5	30	110	47	1.14
5.5	35	115	48	1.06
6	30	140	46	1.08
6	40	120	47	1.24
5	30	95	48	1.25
5	30	110	47	1.05
5	35	115	47	1.07

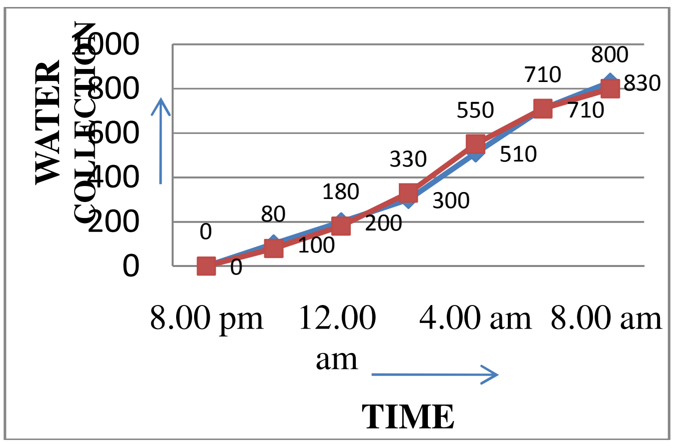
Observation Table 2

Table No. 8.2 Readings taken on 12/3/2014 for 2 hours interval

SR NO.	Date 2014	Time	Temperatures (ºC)					
			T1	T2	T3	T4	T5	T6
1	12/3	08.00 pm	35.6	34.6	5.6	12.5	32.9	4.8
2		10.00 pm	37.2	33.1	2.5	8.1	31.2	3.3

3		12.00 am	36.3	31.8	2.1	5.9	29.6	3
4		02.00 am	36.8	32	2.3	7.1	29.5	3.2
5		04.00 am	32.9	1.9	0	2.1	26.6	0.7
6		06.00 am	32.7	28.9	0.5	1.9	26.7	1.7
7		08.00 am	33.1	29.6	0.2	1.8	27.4	0.7

Water Collected (ml)	Mass Flow Rate (LPH)	Pressure (psi)		Time Required For 10 Impulse (Sec)
		Suction	Discharge	
50	6	40	130	44
100	6	40	140	45
200	6	35	130	45
300	6	35	130	46
510	6	30	120	46
710	5.5	30	120	46
830	5.5	35	120	46



Graph- Time Vs Water Collection.

4.Cost of 1 Litre Water

Total Water Collected in 32 Days = 34.720 litre
Avg. Water Collection per day = 01.085 litre
So, assuming 5 Years life of the set-up,
Total Water Collection in 5 years =1980.125 litre
Total Power Consumption in 32 Days =96 Units
Avg. Power Consumption per Day =3 Units
Total Power Consumption in 5 Years =5475 Units
Cost of Electricity For 5 Years =5475 x 3
=RS. 16,425
Set-up Cost =RS. 17,860
Therefore, Cost of 1 litre Water
=34,285/1980.125
=RS. 17.31

5.ADVANTAGES AND LIMITATIONS

5.1 Advantages

1) Important Resource for water

Dew is not considered to be an important source of water for humans because of the small quantities produced and its infrequent occurrence. This is true in general but there are areas where dew occurs frequently and in appreciable quantities which could be of significance to humans. So by using this method dew can be used as alternate resource of water.

2) Useful in Coast line area

The potable water shortage in the area is widespread and chronic. More than 150 villages near the coast have no water source and the villagers survive on water hauled daily from long distance by trucks. In such a context dew water could provide a small but critical water source for humans if efficiently harvested.

3) No adverse effect.

This method of water collection is ecofriendly. The refrigerant used in this system is environment friendly so it has no adverse effect on environment and human.

5.2 Limitations

1) Cost

As this setup contains refrigeration system components such as compressor, condenser, rotameter, refrigerant, motor & fan, etc, so the capital cost of this system is high.

2) Continuous observation

As we have used refrigeration system, so it is required to calculate COP of the system and also different parameters which are considered in calculation part. Thus to note down the readings continuous observation is necessary.

3) Time consuming

The process of atmospheric air condensation is little bit slowly so this system is time consuming. Compression refrigeration system requires some time to attain steady state condition. And the process of condensation of air is also depends upon atmospheric conditions, so refrigeration system has to operate according to change in atmospheric conditions.

Thus the process of atmospheric air condensation is time consuming.

6.CONCLUSION

1) Atmospheric water vapour recovery for human needs, not yet exploited on a large scale, could become a reality in the future. Although at present only small amounts of water are recovered. This can be easily achieved by our setup. This method is interesting because water could be obtained even in arid regions, including deserts.

2) We have considered the humidity effect on water collection during night. High relative humidity will cause condensation on a relatively cold surface; because the thin layer of surrounding the surface cools below the dew point and can no longer hold the water vapour. Thus if relative humidity is more condensation will be more.

3) We have also considered effect of different time durations at night. It is observed that water collection during 08.00 am to 12.00 am was uniform. And it increased during the period of 02.00 am to 06.00 am. For further durations up to 08.00 am it remained uniform.

4) Thus, we can conclude that, “by using this setup on large scale, there can be considerable increase in water collection.”

5) By laboratory testing the water is potable.

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