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Research Article

Development of Water Generation System from Air

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Abstract

The lack of clean drinking water is one of the key issues facing the world today. The water in many countries is of poor quality creating a big demand for bottled water where the economic means are available. For underdeveloped countries this has led to the death of millions while it in the industrialized world has meant a big increase in consumption of bottled water which has had a big negative effect on the environment. There have been some efforts in trying to develop an applicable technology as a solution to the water problem. One line of products in particular has been influential for this project. These products are known as atmospheric water generators and are trying to utilize the natural occurrence of water vapor in air in order to produce clean drinking water.

Keywords: *Relative Humidity, Specific Humidity, Dry Bulb Temperature, Dew Point Temperature*

1. Introduction

Because of pure water scarcity in many regions worldwide, finding alternative methods for pure water generation becomes beneficial enough to motivate many researchers to work on related topics. Atmospheric water generation is one of the promising methods for getting pure water. Atmospheric water generators (AWGs) apply vapour compression refrigeration to extract water vapour from the surrounding air. They produce drinking quality water and they require moist air and electricity.

2. Purpose

This thesis is a part of the development of an AWG, for this purpose the project group will initially investigate the suitability of the vapor compression cycle, where the extraction will be obtained on the evaporator. An AWG is a device that generates clean drinking water by utilizing the natural presence of water vapor in the air. This thesis will hopefully result in information that will be used as a basic data for decision-making. Since most of the evaporators on the market today are designed merely to cool the air passing through them, much effort will be made to design an evaporator that not only lower the temperature but also condensate some of the water vapor included in the air and to collect the condensed water if this technology is assessed to be liable. There can also be other technologies that can be more suitable for this application. The main purpose is to investigate which technology is the most suitable one in order to extract water. Other possible solutions for this problem will be presented, explained and discussed. The purpose is to find and develop a technology applicable for water extraction.

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3. Problem

The main objective of this project is to create a product that is able to produce safe and clean drinking water while only consuming air and energy. The problem of this thesis concerns the nature, technology and process of the actual extraction. This report will try to answer how the actual extraction will be performed, what technology will be used and why.

3.1 Experimentation and Methodology

Condensation of water vapour from air will be carried out by dehumidification using vapour compression refrigeration cycle

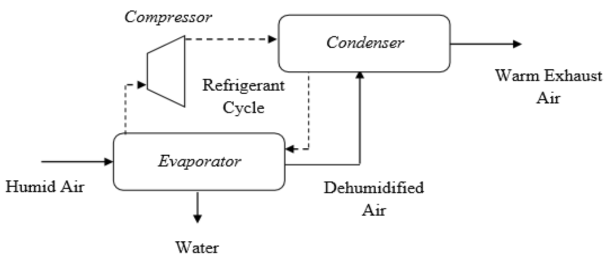
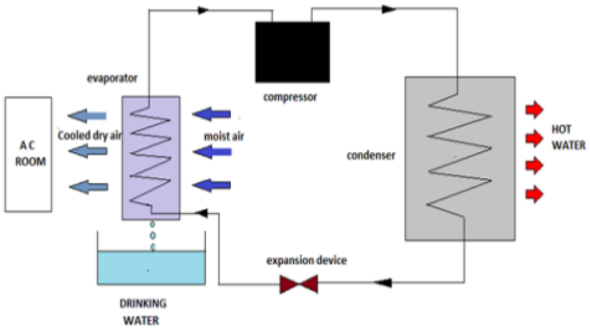


Fig.1 Dehumidification by Vapour Compression Refrigeration cycle

The above figure shows that water suspended in humid air is condensed by passing the humid air over the evaporator coils in Vapour Compression Refrigeration cycle.



Experimental setup consists of: Compressor, Condensor, Expansion Device, Evaporator, Water Collecting tank, Filtration System

Fig.2 Schematic diagram of Experimental setup

4. Calculation

At DBT=26 Degree C & RH=60%
we get dew point temperature = 17.64 Degree C

By taking references from Research papers,
Extraction efficiency=40%
Water extracted =20L
Specific humidity= 0.012 kg of water/kg of dry air.
It depicts that 1 kg of dry air contains 0.012 kg of water
& considering 40% extraction efficiency
from 1 kg of dry air 0.0048 kg of water is extracted

Table 1. Quantity of water present in Air

Water present in air	Water extracted	Dry air
0.0012 kg	0.0048 kg	1 kg
50 kg	20 kg	4166.67 kg

Cp(air)=1.005 kJ/kg K

Heat absorbed
by refrigerant = heat rejected by air + latent heat of water
=m(air)Cp.dT+ m(water)L
= 0.48466 + 0.52
= 1.0078 kW
Refrigeration effect = 1.0078 kW
Assumptions made
Temp of condenser = 55 degree C
Outlet to compressor = 60 degree C
Inlet to compressor = 15 degree C
Evaporator temperature = 2 degree C

From P-h chart,
h1 = 410 kJ/kg
h2 = 430 kJ/kg
h3 = h4 = 280 kJ/kg

i] Heat absorbed during
evaporation stage = m(r)[h1-h4]

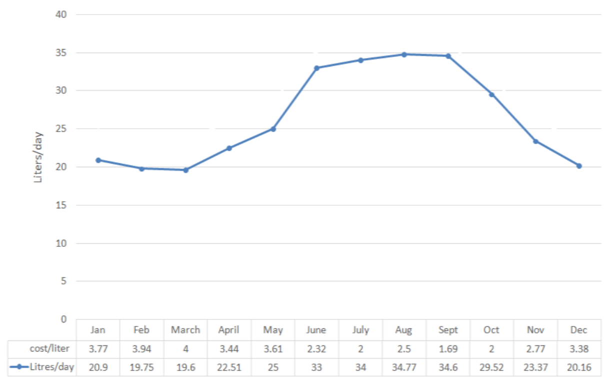
ii] mass flow of refrigerant
1.0078=m(r)[410-280]
m(r)=0.007752 kg/sec

Compressor work = m(r)[h2-h1]
= 0.155 kW/hr

Heat rejected in condenser = m(r)[h2-h3] = 1.162 kW
- Power required by compressor = 0.155 kW
- Total hours per month used = 30 x 24
- Total units consumed = 30 x 24 x 0.155 = 111.6 kWh
-

As per MSEDCL; cost per unit = 6.25 Rs
- To run compressor for a month = 111.6 x 6.25 = 697.5 Rs
- It will cost around Rs 23.33 per day
- Rs 23.33 for 20 L of water
    - For 1 L of water, it costs around Rs 1.16

5. Observation and Result



	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
cost/liter	3.77	3.94	4	3.44	3.61	2.32	2	2.5	1.69	2	2.77	3.38
Litres/day	20.9	19.75	19.6	22.51	25	33	34	34.77	34.6	29.52	23.37	20.16

Graph 1 Quantity of water vs cost

Conclusions

1) This application of this technology may result in solution for water supply problems in many situations without high infrastructure setup cost and time needed.
2) It could create additional potable water without depleting existing resources.
3) Thus it helps us to tackle the problem of availability of pure drinking water in remote locations, mining sites and instances where water scaling is an issue.

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