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Extraction of Water from Thin Air

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Abstract: Two-thirds of the worldwide populace (four billion people) stay under situations of excessive water shortage. In many regions, means for water are being run down quicker than they may be renewed. But even today at any given time, the surroundings carries 3400 trillion tons of water vapor, which could be sufficient to cowl the whole Earth in one inch of water. In order to take advantage of this, an Atmospheric Water Generator (AWG) that is a tool that could convert atmospheric moisture directly into usable or even drinkable water has been advanced. This project focuses on enhancing the efficacy of a present AWG through 20%. The layout will allow extraction of 1.2 liters of water per hour with low energy consumption. The parameters and dimensions for the project have been acquired through the existing setup and the layout of improved setup was obtained through rigorous studies and iterative theoretical calculations. The evaluation of AWG focuses on the flow and thermal conditions that it is subjected to and was executed on ANSYS Fluent.
Keywords: Atmospheric water generator, ANSYS, evaporator, condenser.

NOMENCLATURE

AWG	Atmospheric Water Generator
$\dot{m}$	mass flow rate of refrigerant
h	enthalpy
COP	Coefficient of performance

I. INTRODUCTION

Water shortage is one of the most difficult problems that threaten the lives of mankind. Due to the uncertainties related to global climate change and probable populace growth, totally different components of the developing and industrialized countries (especially urban regions) are experiencing water shortages or flooding and security of fit-for-purpose provides is popping into an important issue. According to studies and research conducted by various organizations such as the United Nations it is predicted that due to the combined effects of factors such as climate change and population growth, the demand for extensive water will exceed forty percent of the supply by 2035. The Atmospheric Water Generator (AWG) or air to water, untapped potential element in the water solution portfolio. Atmospheric water harvesting is rising as a promising method used to obtain drinking water in arid areas, inland areas and remote areas. Air to water technology can be defined as a method of converting water vapour present in the atmosphere (that is, the existing moisture) to water. The atmospheric water generators reflect this natural method of condensation by simulating the dew point. This means that water can be produced even when the air humidity is low. The condenser transforms the vapour in the air from gaseous phase to a liquid phase (ie. water) through always reaching the dew point with cool air. This form of AWG is reasonably-priced and affordable, works flawlessly with a vast variety of humidity and thus is mainly suitable for clean water production in remote regions. Our project targets at increasing the efficiency of the existing Atmospheric Water Generator by enhancing the setup and verifying the results by carrying out various simulations.

II. MATERIALS AND METHODS

Technical research on various methods of water extraction, performance improvement, water productivity and water crisis was researched, this helped in lighting the path for the progress of the project. Various data and parameters were collected from studying the existing setup. Without changing the refrigerant mass flow rate, iterative theoretical calculations are performed to determine the appropriate component size. The design of the two-phase ejector and other components were completed based on theoretical considerations. The flow simulation of the evaporator, condenser and ejector were carried out with the aim to evaluate the system and to get the output parameters. Software's used are: Autodesk Fusion 360, Solidworks, Ansys Fluent, Microsoft Office and Coral Draw. Simulation was conducted in Ansys Fluent. The parameters taken into consideration were Pressure, Temperature and Velocity of the refrigerant R-22 through the evaporator and condenser.

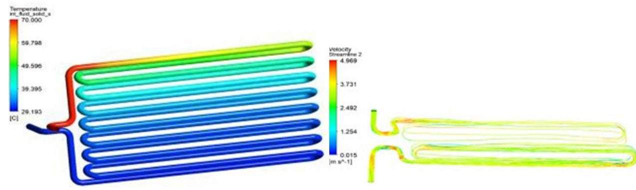

Figure 01: CFD Simulation of Condenser

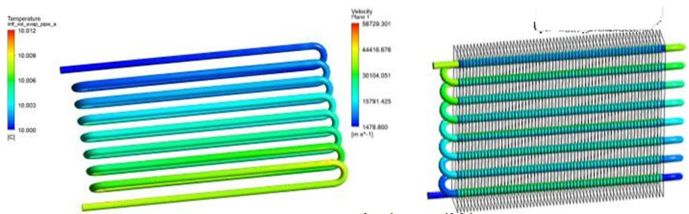

Figure 02: CFD Simulation of Evaporator

III. EXPERIMENTATION

A. *Experiment 1*

Existing configurations uses a fan to cool the condenser, drawing air from the atmosphere and forcing it to flow through the condenser, and in response, hot air is released into the atmosphere. The maximum lowest temperature that can be attained is the temperature of the atmosphere. If the atmosphericair is around 30°C then the maximum temperature that we can get out from the condenser will also be 30°C as it cannot go lower than the temperature of air flowing over it. But the air that is coming through the evaporator after theevaporation process is of lower temperature i.e., around 18°C which is released back into the atmosphere. This cooler air can be directed to the condenser which will to help condense more quantity of refrigerant.

B. *Experiment 2*

The capillary tube, thermostatic expansion valve and the automatic expansion valve all are employed in Vapor Compression cycle as an expansion device. Typically, in VCRS the expansion process is isenthalpic in nature. However, due to the energy loss in the expansion process, the isenthalpic process causes the cooling capacity of the evaporator to decrease. An efficiency improving option was suggested to prevent this energy Loss by changing this expansion process from isenthalpic to isentropic with the use of ejector. The use of an ejector as an expansion device increases the efficiency of the system. Power input to the compression also reduces with the use of ejector as pre-compression device and evaporative cooling capacity also gets improved by changing expansion process from isenthalpic to isentropic. For this reason, we are using Ejector as an expansion device in our proposed solution.

IV. RESULTS AND DISCUSSION

After construction of the system and performing various tests and experiment we came with the following results and analysis related to economics, efficiency and various other factors that effects the system work and competence.

Quantity	Unit	Values	
		Cycle 1 ($\dot{m}$ = 0.0205 kg/s)	Cycle 2 ($\dot{m}$ = 0.0179 kg/s)
Heating Capacity	kW	3.5015	2.86937
Cooling Capacity	kW	3.8853	3.5775
Compressor Capacity	kW	0.4393	0.7081
Fraction of compression in Ejector		0.0777	-
Coefficient of Performance (COP)		7.97	4.05
COP1/ COP2 ratio		1.967	

Table 01: Specific energy characteristics of the cycle with a vapor-liquid ejector (Cycle 1) in comparison to the traditional cycle (Cycle2)

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Compressor Work = $\dot{m} \times (h_2 - h_1)$ (1)
Cooling load in evaporator = $\dot{m} \times (h_1 - h_4)$ (2)
Heat rejected by condenser = $\dot{m} \times (h_2 - h_3)$ (3)

$$COP = \frac{\text{Cooling load}}{\text{Work done by compressor}}$$

V. CONCLUSION

After many tests, it can be determined that the ejector is usedas an expansion device in the atmospheric water generator increases the efficiency of the entire system in all aspects. We can conclude that using the above two solutions the efficiency ofthe Atmospheric Water Generator has shown an increase of 38.51%. With the help of ejector which is used as an expansion device, the work done by the compressor has reduced by 20.80%, cooling capacity and heating capacity have also shown a significant increase.

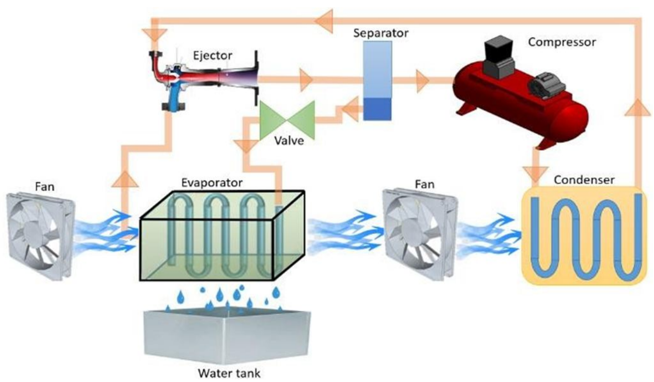

Figure 03: Modified layout of the AWG

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REFERENCES

[1] Guillermo Valencia, Jaison Beltrán, Osvaldo Romero, José Cabrera and Marisol Osorio, 2017, “Comparative Evaluation ofDifferent Refrigerants on a Vapor Compression Refrigeration System via Exergetic Performance Coefficient Criterion”, Contemporary Engineering Sciences, Vol. 10, 2017, no. 14, 691- 702.
[2] Van Hung Tran, Thanh Nhan Phan, Nikola Kaloyanov, Momchil Vassilev, 2020, “Efficiency evaluation of water production from the atmospheric air in Vietnam”, E3S Web of Conferences 207, 010 (2020).
[3] T. Anbarasu, S. Pavithra, 2011, “Vapour Compression Refrigeration System Generating Fresh Water from Humidity in the Air”, Chennai and Dr.MGR University Second InternationalConference on Sustainable Energy and Intelligent System.
[4] Vaibhav Jain, Surendra Singh Kachhwaha, GulshanSachdeva, 2014, “Exergy analysis of a vapour compressionabsorption cascaded refrigeration system using modified Gouy–Stodola equation”, Int. J. Exergy, Vol. 15, No. 1.
[5] Renyuan, Yusuf, Mossab, Mengchun, 2018, “Hybrid