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CONDENSATION FROM ATMOSPHERE IN GULF REGION

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Abstract— This report discusses on the dew water collection by condenser in Gulf region based on weather condition and water condition of Gulf region. Best weather condition and optimal condenser size are firstly determined. The maximum water production rate 4.879kg/s can be reached under a certain weather condition with RH=90%, v=8. And the optimal condenser size that requires the least pumping power is determined to be D=1m, U=1.6, N=50 and S=1800. Yearly fresh water production can be satisfied in Gulf region.

Index Terms：condenser；Gulf region；optimal condenser size；

I. INTRODUCTION

Water is the basic substance of life on earth, and it is increasingly in short supply. As indicated by Leitner [1], water shortages affect 88 developing countries that are home to half of the world's population. In these places, 80-90% of all diseases and 30% of all deaths result from poor water quality. Furthermore, over the next 25 years, the number of people affected by severe water shortages is expected to increase fourfold [2]. Governments throughout the world are beginning to take notice of the looming crisis. There is recognition that future peace and prosperity is intimately tied to the availability of clean, fresh water. Dew water collection is the process that humid warm air passes through a cooling coil to be cooled down to dew point till condensation occurring. Dew water collection served as pollution free and energy efficient solution will be discussed in this research program. The ideal of dew water collection has been around for at least a century. It is pointed by James [3] that the ancient Greek used dew collection devices to produce water for the city of Feodosia. Nevertheless, the requirements that ensure the concentration of water in air are rigorous. First of all, it requires a large low temperature heat sink, for instance, deep ocean water. Secondly, high moisture content of air is also the dominating factor to be satisfied. Last but not least, relative high ambient temperature is required. Taking these factors into consideration, Gulf region has been selected as the research area. According to Privett [4], the evaporation rate of Gulf region is 1.4. Therefore, Gulf is an ideal area for dew water collection due to high ambient temperature and relative humidity.

During the research, the best weather condition for maximum fresh water production and optimal condenser size for minimum power requirement will be firstly determined using Engineering Equation Solver (EES). After that, United Arab Emirate (UAE) which is located in Gulf region will be taken as an example. A standard condensation rate, in other words, fresh water production rate will be set in relation to annual portable water requirement of UAE. Finally, based on the optimal condenser size, water production and power requirement are calculated for annual weather condition.

II. DESCRIPTION OF CONCEPT

A. Gulf weather condition

Weather data of Gulf region is record from Weatherbase [5]. Coastal city Damman in Saudi Arabia and Dubai in UAE are chosen for determination of range of weather condition. The summarized weather data are shown in table 2.1.1. Therefore, for Gulf region, the range of weather condition can be concluded in table 2.1.2. Because low the water temperature will increase the heat exchange rate and condensation rate, water temperature with 17℃ should be utilized by setting the pipe deep into the ocean.

Table 2.1.1. Weather data of chosen cities

City	Location	Relative humidity	Air temperature	Water temperature[16]	Wind speed
Damman	Saudi Arabia	40-70%	16-35℃	17-33℃	3-8
Dubai	UAE	50-80%	15-39℃	17-33℃	3-8

Table 2.1.2. Weather condition of Gulf region

Relative humidity	Air temperature	Water temperature	Wind speed
20-90%	10-40℃	17℃	3-8

B. Heat transfer coefficient of condenser

Heat transfer coefficient is a quantitative characteristic of convective heat transfer between a fluid medium and the surface flowed over by the fluid

[6]. The heat transfer coefficient has gained currency in calculations of convective heat transfer and in solving problems of external heat exchange between a heat conducting solid medium and its surroundings. Heat transfer coefficient depends on both the thermal properties of a medium, the hydrodynamic characteristics of its flow, and the hydrodynamic and thermal boundary conditions. For condenser the empirical values are listed in figure2.2.1. In this case, the typical heat transfer coefficient of condenser should be 0.3-1.2. However as stated, the lower values apply to comparatively adverse conditions. The higher values are valid for particularly favorable conditions, e.g., high flow velocities, thin fluid layers, optimum mass flow ratios, and clean surfaces. In special cases, values may fall below or exceed the given range. Therefore, the range of heat transfer coefficient for this project is set 0.2-2.

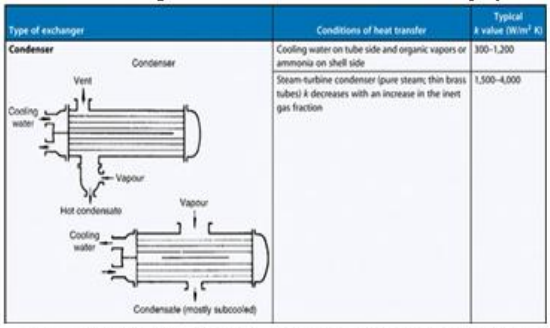

Figure 2.2.1. Condenser typical heat transfer coefficient value

III. The EES Model

A. Introduction to EES

EES is an acronym for Engineering Equation Solver. The basic function provided by EES is the solution of a set of algebraic equations. EES can also solve differential equations, equations with complex variables, do optimization, provide linear and non-linear regression, generate publication-quality plots, simplify uncertainty analyses and provide animations.

B. Sample calculation and reliability analysis of EES

In order to check the reliability of EES program produced in section, a sample calculation will be carried out by both theoretical calculation and EES program. It can be noted that, the results for both methods are the same. Hence, it can be concluded that EES program is valid and reliable.

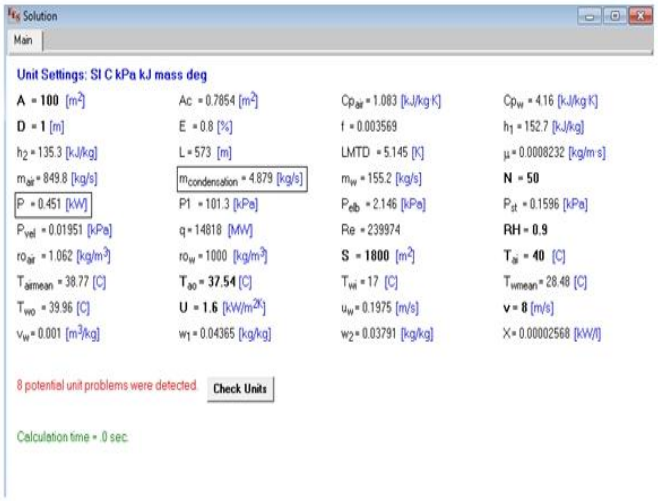

Figure 3.1. EES results of best weather condition and minimum power requirement

To conclude, at Gulf region dew water collection condenser can produce fresh water up to under specific best weather condition, i.e. RH=90%, v=8, A=100. Under the best weather condition, the optimum condenser size for minimum pumping power supply is solved to be D=1m, U=1.6, N=50 and S=1800. The EES results are displayed in figure 3.1.

IV. Conclusion

Dew water collection served as pollution free and energy efficient solution was discussed in this research program for portable water supply in Gulf region. During the research, by using Engineering Equation Solver(EES) the maximum water production 4.879kg/s was firstly solved under the weather condition RH=90%, v=8, A=100. Based on the best weather condition above, the optimum condenser size for minimum pumping power supply was solved to be D=1m, U=1.6, N=50 and S=1800 with minimum pumping power supply 0.451kW. Besides, as discussed before, the weather condition with relative humidity over 50%, wind velocity quicker than 5m/s and temperature higher than 25 will take the majority in UAE. it can be summarized that for most of the day in Gulf region the fresh water production of this dew water collection system can meet the requirements of it.

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