Fin Length and Air Flow Optimization of an AWG Device to be used in Manolo Fortich, Bukidnon

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ABSTRACT

Atmospheric water generator (AWG) is a device that collects water from the surrounding air. The length of the copper fins attached to the TEC and the intake fan were optimized by conducting a parametric analysis. The values of relative humidity and ambient air temperature used in the analysis was taken from the climatic data of Manolo Fortich, Bukidnon. Results showed that the 9cm is the maximum fin length that has a temperature distribution below the dew point along the fin. Moreover, high air velocity, at 4m/s, gave the maximum water generation for high RH levels and high air temperature.

METHODOLOGY

The main criterion considered in this study is to get the maximum water yield at different ambient environmental conditions. The length of cold side copper fins and airflow were optimized by conducting parametric analysis to existing formulas using different ambient air conditions. The length of the fin was discretely varied into 8cm, 9cm, 10cm and 11cm. The data set for ambient air temperature and relative humidity was taken from PAGASA. Equation 1 shows the temperature distribution along the rectangular fin using quasilinearization technique:

$$T(x) = R - (R - T_0)\frac{\cosh[m_y(L_f - x)]}{\cosh(m_y L_f)} \qquad (1)$$

This study computed for the temperature distribution at different conditions using Equation 1 by changing the magnitude of air velocity, air temperature and relative humidity. Once the temperature distribution is computed, the average temperature along the fin length was be calculated using Equation 2.

$$T_{ave} = \frac{1}{L}\int_0^L T(x)dx \qquad (2)$$

After getting the average temperature, the water generation rate was estimated with the use of mass transfer coefficient mw using Equation 3.

$$V = \frac{2NbL_f m_w}{\rho_l}$$

CONCLUSIONS

The maximum fin length that gave the optimal results was the 9cm copper fin length. The study also making the fin length excessively longer does not positively impact the water generation rate of the AWG. Longer fin lengths will develop dry regions along its length thus becoming inefficient.

The results in this study showed that there is an optimal air velocity at every climatic conditions in order. Low air velocities were assigned to low surrounding temperature with low relative humidity conditions while high air velocities were designated for high surrounding temperature and high relative humidity conditions.

INTRODUCTION

An atmospheric water generator (AWG) is a device that extracts water from the atmosphere. AWG extracts water from the atmosphere by changing water from its vapor phase to its liquid phase. There is a need to design the optimal extended cold side and air velocity in order to amplify and maximize the water generation rate. Moreover, the air velocity and cold side fin length should be designed appropriately based on the surrounding air temperature, relative humidity and climatic conditions it will operate in. In this study, the length of the extended cold side fins was maximized and the magnitude of the air velocity was varied in accordance to the climatic conditions. The temperature and relative humidity at the Municipality of Manolo Fortich, Bukidnon, was the basis for the AWG design.

RESULTS AND DISCUSSIONS

Optimum Length of Cold Side Extended Fins

The study computed for the temperature distribution at each fin length at different ambient environmental conditions. Figures 1-3 shows the temperature distribution at different ambient environmental conditions at each fin lengths.

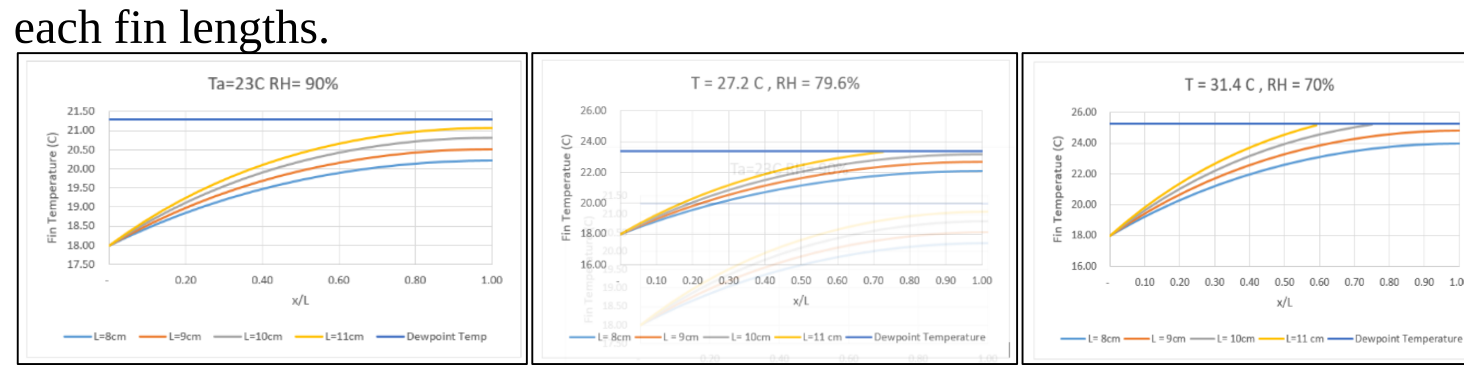

Figure 1. Fin Temperature Distribution for Different Ambient Conditions and RH Levels.

The results shown in Figure 1 indicate that the 9cm fin length of copper gave the maximum length and the optimal result in terms of temperature distribution at every climatic conditions.

Variable Intake Velocity at Different Environmental Conditions

The theoretical water generation rate was calculated at different climatic conditions and varying air velocity. The air velocity was varied by starting at 0.1m/s to 4m/s at 0.1m/s increments.

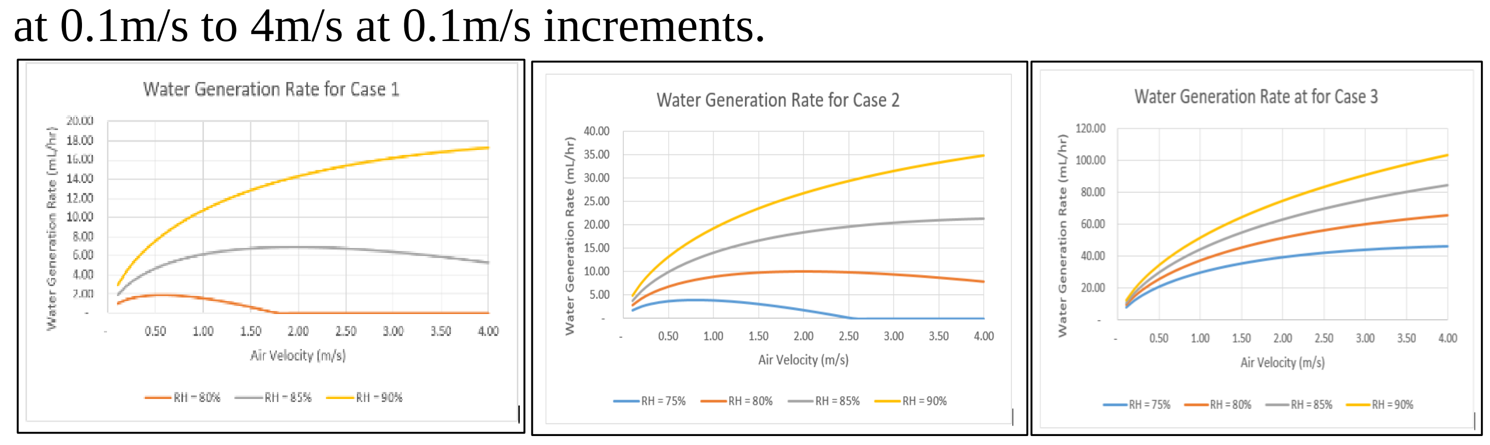

Figure 2. Theoretical Water Generation at Different Ambient Temperatures.

. Higher relative humidity means that the partial pressure of the water vapor in the ambient air is also high. Having a high value of partial pressure of water vapor in the ambient air meant higher values of mass transfer coefficient resulting to higher water generation rate. Table 1 below summarizes the optimal magnitude of air velocity at different climatic conditions for the location Manolo Fortich.

Relative Humidity Levels	TEMPERATURE RANGE (^{0}C)			
	23 < T ≤ 24	24 < T ≤ 26	26 < T≤ 28	28 < T
	Intake Air Velocity (m/s)			
75% < 80%	0.00	0.20	2.00	4.00
80% < 85%	0.60	2.00	4.00	4.00
85% < 90%	2.00	4.00	4.00	4.00
90% < 100%	4.00	4.00	4.00	4.00

Table 2. Optimal Air Velocity (m/s) at Different Climatic Conditions.