Cooling Tower Lab

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1. Plots

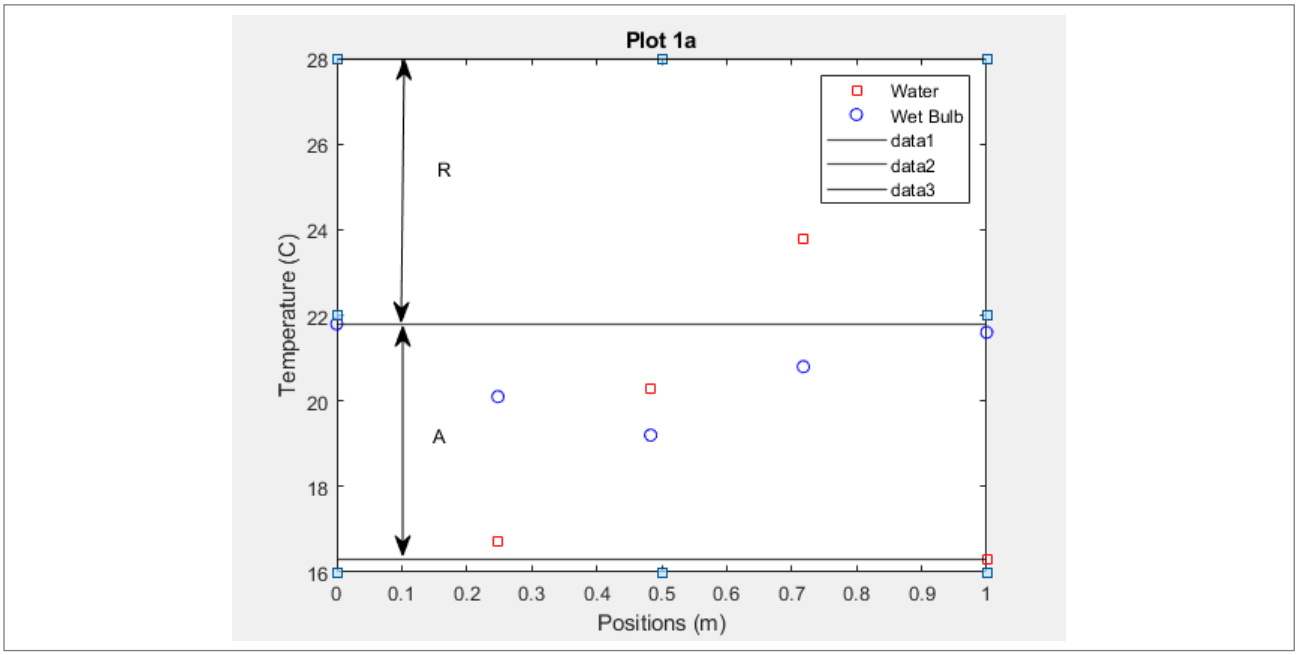

Figure 1a. Water temperature and wet bulb temperature of the air as a function of height along the cooling tower for the case of an inlet water flow rate of 32 gm/s. The Range and Approach are denoted by the vertical lines labeled "R" and "A", respectively.

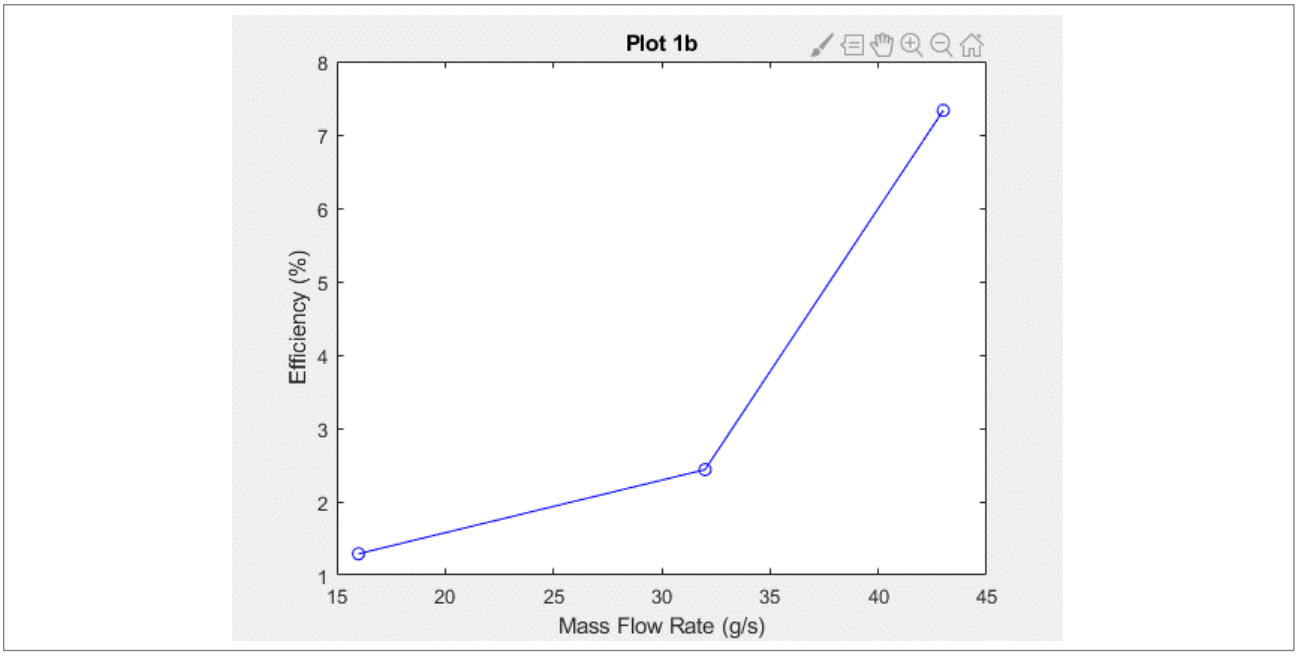

Figure 1b. Cooling tower efficiency as a function of water inlet flow rate.

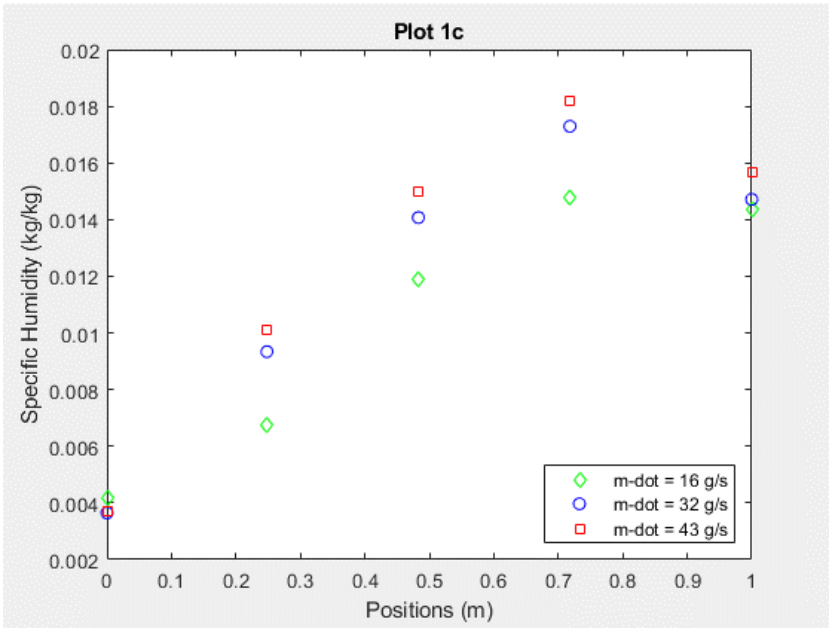

Figure 1c. Specific humidity as a function of height along the cooling tower. The results for three different water inlet flow rates are shown.

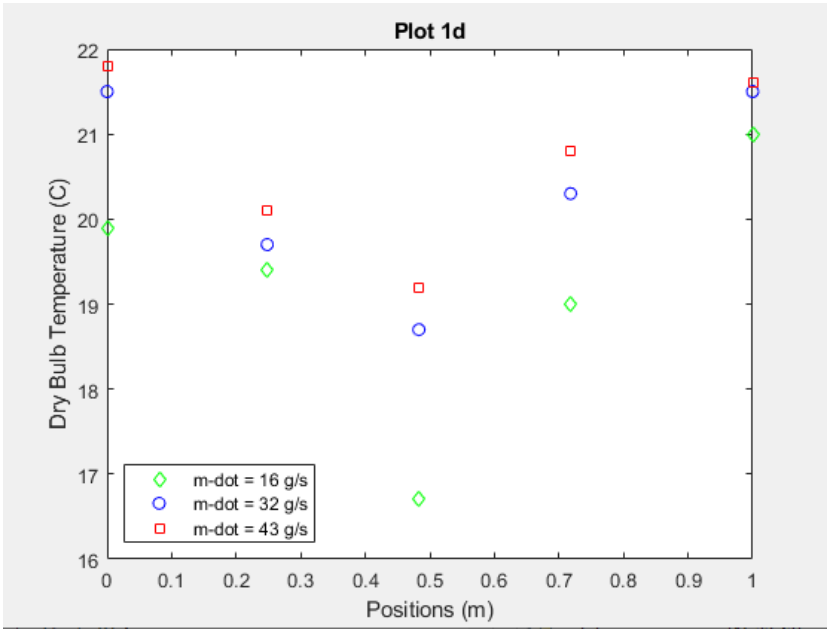

Figure 1d. Dry bulb temperature as a function of height along the cooling tower. The results for three different water inlet flow rates are shown.

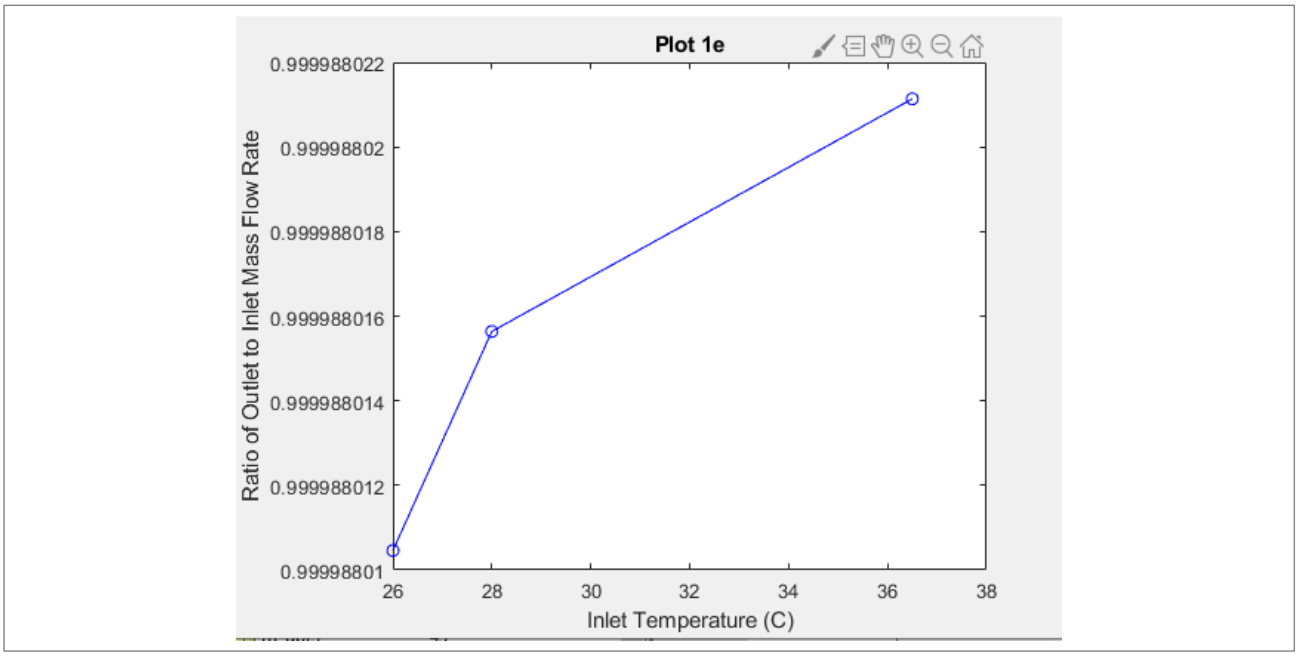

Figure 1e. Ratio of water outlet mass flow rate over water inlet mass flow rate as a function of water inlet temperature.

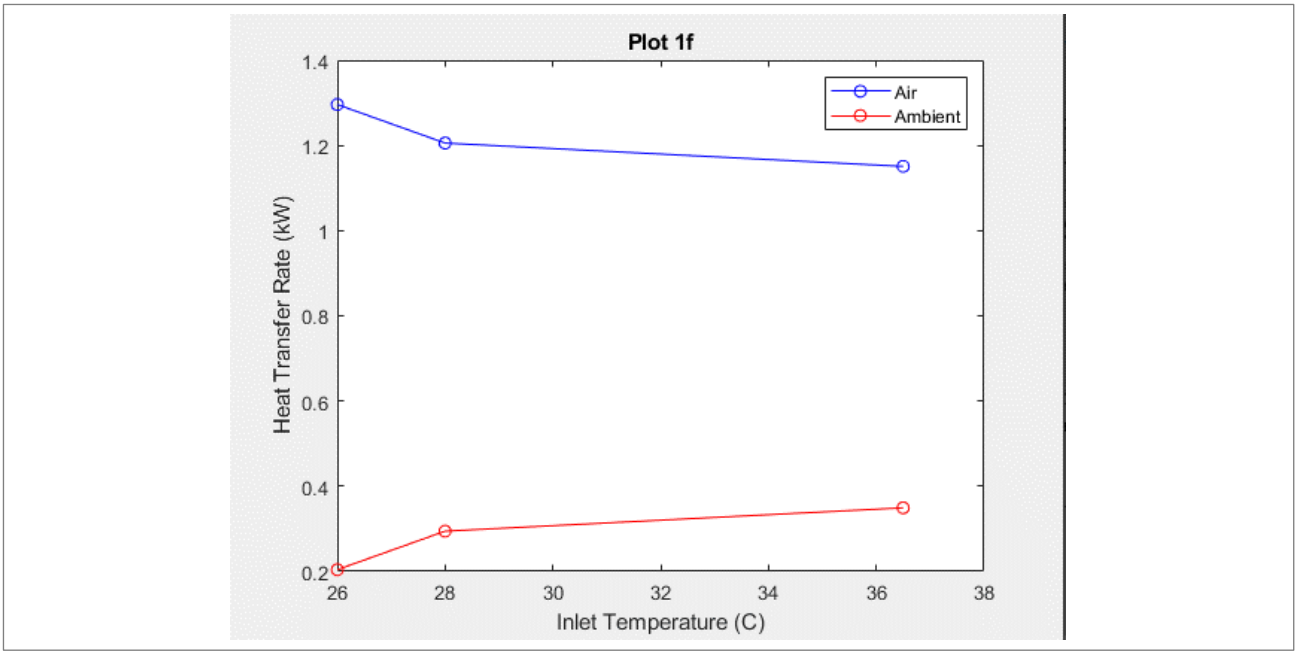

Figure 1f. Heat transfer rate to the dry air and the surroundings as a function of water inlet temperature.

2. Short Answer Questions

a) *Briefly describe what happens to the dry bulb temperature and the specific humidity of the air-water vapor mixture passing through the tower from point A (air inlet, water outlet) to point B (air outlet, water inlet). Explain the reason for these observations. Your response should consider the effect of evaporation. [4–6 sentences]*

From point A to point B, the dry bulb temperature and the specific humidity increases. Heat transfer from the warm water to the dry air causes the increase in dry bulb temperature, which measures the air temperature. The reason for the increase in specific humidity is evaporation from the heat transfer. Additionally, as long as the vapor pressure of water is lower than the saturation pressure of water, evaporation will occur thus increasing specific humidity.

b) *What percentage of the inlet water is evaporated? State how this percentage changes as the inlet water temperature increases. Provide a physical explanation for the observed trend. [2–4 sentences]*

Based on the height change of the makeup water, for…

Trial 1: 10.7% of inlet water evaporated
Trial 2: 15.6% of inlet water evaporated
Trial 3: 7.14% of inlet water evaporated.

Based on these calculations, there is no trend observed with the increase of inlet water temperature. The cause for this could be the unsteady state of the cooling system at the time of trials. If there were a trend, I would assume that as the inlet temperature increases, the percentage of inlet water evaporated increases as well. This is due to the increase of energy that comes with temperature which allows more water to turn into vapor.

c) Based on your analysis of the data, what is the makeup water flow rate required (in g/s) for this facility? Your answer should be an average over the three experiments. State how close this average value is (in terms of a percentage) to what you observed during the experiments [2 sentences]

Based on the average mass flow rate of water out of the cooling system, the makeup water flow rate is 42.99 g/s.

d) *State the maximum efficiency achieved (in %) over the measurement range investigated in the lab. Describe how efficiency varies with inlet water flow rate. [2 sentences]*

The maximum efficiency achieved is 7.333%. It is observed that with the increase of inlet flow rate, the efficiency of the cooling system increases as well.