



In-Class Exercises n°01

Exercise 1.1 – Psychrometric properties

The air in a room is at **26.7 °C** and a pressure of **101.325 kPa** and contains water vapor with a partial pressure $P_A = 2.76 \text{ kPa}$. Calculate the following:

- Humidity, H
- Saturation humidity, H_S , and percentage humidity, H_P
- Percentage relative humidity, H_R

Exercise 1.2 – Psychrometric properties from chart

An air – water vapor mixture has a dry-bulb temperature of **50 °C** and a wet-bulb temperature of **35 °C**. Estimate its psychrometric properties at a total pressure of **1 atm**.

Given data:

Total pressure: **1 atm = $1.0133 \times 10^5 \text{ N/m}^2$**

Average molecular weight of dry air: $M_{\text{dry air}} = 28.84 \text{ kg/kmol}$

Exercise 1.3 – Heating and Humidifying

Two and a half cubic meters of lumber is being dried at **60°C** dry-bulb temperature and **52°C** wet-bulb temperature. The drying rate of the lumber is **12.5 kg of water/hour**.

If outside air is at **27°C** dry-bulb temperature and **80%** relative humidity, how much outside air is needed per minute to carry away the evaporated moisture?

Exercise 1.4 – Cooling and Dehumidifying

Moist air at **50°C** dry bulb temperature and **32%** relative humidity enters the cooling coil of a dehumidification kiln heat pump system and is cooled to a temperature of **18°C**.

If the drying rate of **6 m³** of red oak lumber is **4 kg/hour**, determine the **kW** of refrigeration required.

Exercise 1.5 – Adiabatic humidification

Humid air has the following characteristics: Wet-bulb temperature: **20 °C** and relative humidity **40%**. From the humidity diagram, determine its: temperature, humidity percentage, absolute humidity, dew point, humid volume, humid heat, specific enthalpy.

This air is introduced into an adiabatic humidification chamber where it is brought into contact with liquid water. The air leaves at a temperature of **21 °C**. If the dry air flow rate is **5.6 kg/s**:



1. Determine from the psychrometric diagram the absolute humidity of the outlet air.
2. Calculate the flow rate of water evaporated in the humidifier.

Exercise 1.6 – Thermal and Mass Balance Analysis of a Counter flow Cooling Tower

Water, at $30\text{ }^{\circ}\text{C}$, flows into a cooling tower at the rate of **1.15 kg per kg air**. Air enters the tower at the dry-bulb temperature of $20\text{ }^{\circ}\text{C}$ and a relative humidity of **60 %** and leaves it at a dry-bulb temperature of $28\text{ }^{\circ}\text{C}$ and **90 %** relative humidity. Makeup water is supplied at $20\text{ }^{\circ}\text{C}$. **Determine:**

- a) the temperature of water leaving the tower,
- b) the fraction of water evaporated, and
- c) the approach and range of the cooling tower.

Exercise 1.7 – Steady-State Energy and Mass Balance of a Mechanical-Draft Cooling Tower Including Fan Power

Warm water at $45\text{ }^{\circ}\text{C}$ enters a cooling tower at the rate of **6 kg/s**. An ID fan draws **10 m³/s** of air through the tower and absorbs **4.90 kW**. The air entering the tower is at $20\text{ }^{\circ}\text{C}$ dry-bulb temperature and **60%** relative humidity. The air leaving the tower is assumed to be saturated and its temperature is $26\text{ }^{\circ}\text{C}$. Calculate the final temperature of the water and the amount of makeup water required per second. Assume that the pressure remains constant throughout the tower at **1.013 bar**.