# Question Set 05

### Gas Mixtures Review

1. A vessel of volume 0.4m3 contains 0.45kg of carbon monoxide and 1kg of air, at 15oC. Calculate the partial pressure of each constituent and the total pressure in the vessel. The gravimetric analysis of air is taken as 23.3% oxygen and 76.7% nitrogen. Take the molar mass of carbon monoxide, oxygen and nitrogen as 28, 32, and 28 kg/kmol.
2. An insulated rigid tank is divided into two compartments by a partition, as shown in Fig. 13–14. One compartment contains 7 kg of oxygen gas at 40°C and 100 kPa, and the other compartment contains 4 kg of nitrogen gas at 20°C and 150 kPa. Now the partition is removed, and the two gases are allowed to mix. Determine the mixture pressure after equilibrium has been established.

### Psychrometric Properties, Processes, Chart

1. Calculate the moisture content (e.g. specific humidity) of air at 20oC, 50%RH. The gas constant for dry air is 287 J/kg.K.
2. Which of the following statements are TRUE?

a) During sensible cooling of air, both dry bulb and wet bulb temperatures decrease

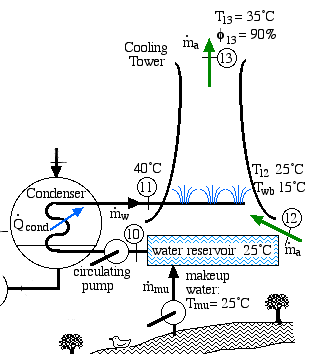
b) During sensible cooling of air, dry bulb temperature decreases but wet bulb temperature remains constant

c) During sensible cooling of air, dry and wet bulb temperatures decrease but dew point temperature remains constant

d) During sensible cooling of air, dry bulb, wet bulb and dew point temperatures decrease

1. Calculate the humidity ratio of air at 60%RH when the temperature is 30oC using equations, then compare this with a psychometric chart. The barometric pressure is the standard value 101.325kPa.
2. A 5-m x 5-m x 3-m room contains air at 25°C and 100kPa at a relative humidity of 75%. Determine (a) the partial pressure of dry air, (b) the specific humidity, (c) the enthalpy per unit mass of the dry air.
3. Determine the relative humidity, humidity ratio (specific humidity), enthalpy of the atmospheric air per mass of dry air, and the specific volume of the mixture per mass of dry air at a state where the dry-bulb temperature is 24oC, the wet-bulb temperature is 16oC, and atmospheric pressure is 100 kPa.
4. Which of the following statements are TRUE?   
   a) During sensible cooling of air, both dry bulb and wet bulb temperatures decrease   
   b) During sensible cooling of air, dry bulb temperature decreases but wet bulb temperature remains constant   
   c) During sensible cooling of air, dry and wet bulb temperatures decrease but dew point temperature remains constant   
   d) During sensible cooling of air, dry bulb, wet bulb and dew point temperatures decrease
5. Moist air with a dry bulb temperature of 25oC and a wet bulb temperature of 18oC exists at a pressure of 101.33kPa. This air is cooled until it is at 13.5oC dry bulb, 11.5oC wet bulb. Using the psychrometric chart, determine
6. The dew point of the entering air.
7. The apparatus dew point
8. The initial and final relative humidity
9. The initial and final moisture content
10. The mass of condensate removed during the cooling process (per kilogram of dry air)
11. The initial and final specific enthalpy.
12. The amount of heat removed during the cooling process (per kilogram of dry air)
13. The amount of latent heat removed and the amount of sensible heat removed (per kilogram of dry air)
14. The ratio of sensible heat removed to total heat removed.
15. Assume that the outside air temperature is 8°C. If the air in a room is at 25°C with a relative humidity φ = 40%, use the psychrometric chart to determine if the windows of that room which are in contact with the outside will become foggy.

### Cooling Tower and Evaporative Cooling Analysis

1. A cooling tower is used for cooling the condenser water of a refrigeration system having a heat rejection rate of 100 kW. In the cooling tower air enters at 35oC (DBT) and 24oC (WBT) and leaves the cooling tower at a DBT of 26oC relative humidity of 95%. What is the required flow rate of air at the inlet to the cooling tower in m3/s. What is the amount of make-up water to be supplied? The temperature of make-up water is at 30oC, at which its enthalpy (hw) may be taken as 125.4 kJ/kg. Assume the barometric pressure to be 1 atm.
2. Clearly mark and label the relevant values on the Psychrometric Chart, including the values of enthalpy (h), relative humdity (φ) and specific humidity (ω) of stations

Starting with the energy equation and using values obtained from the Psychrometric Chart, determine the volumetric flow rate of the dry air required at station (12) in order to cool the water from 40°C to 25°C

1. A cooling tower is a device that cools a spray of water by passing it through a stream of air. If 15 m3 /s of air at 35°e dry-bulb and 24°C wet-bulb temperature and an atmospheric pressure of 101 kPa enters the tower and the air leaves saturated at 31° e, *(a)* to what temperature can this airstream cool a spray of water entering at 38°C with a flow rate of 20 kg/s and *(b)* how many kilograms per second of makeup water must be added to compensate for the water that is evaporated?
2. Which of the following statements are TRUE?

a) In a direct evaporative cooling system, the lowest possible temperature is the wet bulb temperature corresponding to the outdoor air

b) In a direct evaporative cooling system, the lowest possible temperature is the dew point temperature corresponding to the outdoor air

c) In a direct evaporative cooling system, cooled and humidified air is supplied to the conditioned space

d) In a direct evaporative cooling system, cooled and dehumidified air is supplied to the conditioned space

1. A large warehouse located at an altitude of 1500 m has to be maintained at a DBT of 27oC and a relative humidity of 50% using a direct evaporative cooling system. The outdoor conditions are 33oC (DBT) and 15oC (WBT). The cooling load on the warehouse is 352 kW. A supply fan located in the downstream of the evaporative cooler adds 15 kW of heat. Find the required mass flow rate of air. Assume the process in evaporative cooler to follow a constant WBT.

