

## Exercises on Air Conditioning Processes

1. Determine the quantity of heat required to raise  $14 \text{ m}^3/\text{min}$  of air at  $20^\circ\text{C}$  and 80 per cent relative humidity to  $35^\circ\text{C}$ . What is the final relative humidity?

[Ans.:  $4.27 \text{ kJ/s}$ ,  $\text{RH} = 34\%$ ]

2. Determine the quantity of heat removed from  $14 \text{ m}^3/\text{min}$  of air when cooled from  $37^\circ\text{C}$  dry bulb and  $21^\circ\text{C}$  wet bulb temperatures to  $15^\circ\text{C}$ . What are the initial and final relative humidities?

[Ans.:  $6.04 \text{ kJ/s}$ , initial  $\text{RH} = 23\%$ , final  $\text{RH} = 85\%$ ]

3. How much heat and moisture must be added to  $28 \text{ m}^3/\text{min}$  of air at  $24^\circ\text{C}$  and 40% relative humidity to raise it to  $38^\circ\text{C}$  dry bulb and  $27^\circ\text{C}$  wet bulb temperature?

[Ans.:  $22.73 \text{ kJ/s}$ ,  $0.00581 \text{ kg/s}$ ]

4. How much heat and moisture must be removed to cool  $28 \text{ m}^3/\text{min}$  of air from  $35^\circ\text{C}$  dry bulb and  $26^\circ\text{C}$  wet bulb temperature to  $21^\circ\text{C}$  and 40% relative humidity?

[Ans.:  $20.57 \text{ kJ/s}$ ,  $0.0051 \text{ kg/s}$ ]

5. Air at  $33^\circ\text{C}$  dry bulb and  $19^\circ\text{C}$  wet bulb temperatures is cooled and humidified by passing it through an air washer in which the water is continuously recirculated. The air leaves the air washer at  $23^\circ\text{C}$  dry bulb temperature. Determine the moisture added per kg of dry air. What is the efficiency of the air washer?

[Ans.:  $0.0041 \text{ kg/s}$ , air washer efficiency =  $71.43\%$ ]

6. Air at  $24^\circ\text{C}$  dry bulb and  $15^\circ\text{C}$  wet bulb temperatures enters dehumidifier and leaves at  $41^\circ\text{C}$  dry bulb and  $19^\circ\text{C}$  wet bulb temperatures. How much moisture has been removed per kilogram of dry air?

[Ans.:  $0.0023 \text{ kg/kg}$ ]

7. One half cubic meter per second of air at  $15^\circ\text{C}$  dry bulb and  $13^\circ\text{C}$  wet bulb temperatures are mixed with  $0.20 \text{ m}^3$  per second of air at  $25^\circ\text{C}$  dry bulb and  $18^\circ\text{C}$  wet bulb temperatures. Determine (a) the dry bulb, wet bulb, and dew point temperatures of the mixture, and (b) the enthalpy of the mixture.

[Ans.: (a)  $\text{DBT} = 17.8^\circ\text{C}$ ,  $\text{WBT} = 14.6^\circ\text{C}$ ,  $\text{DPT} = 12.5^\circ\text{C}$ ; (b)  $41 \text{ kJ/kg}$ ]

8. Outdoor air at 35°C dry bulb and 24°C wet bulb temperatures is to be mixed with room air at 26°C dry bulb and 50 per cent relative humidity. The final mixture is to consist of one-third outdoor air and two-thirds return air from the room. Find the resulting dry bulb and wet bulb temperatures of the mixture.

[Ans.: DBT = 29°C, WBT = 20.7°C]

9. A lecture theatre is to be maintained at a temperature of 25°C dry bulb and 19°C wet bulb temperatures. The sensible heat load is 88 kW and 58 kg per hour of moisture must be removed. Air is supplied to the lecture theatre at 18°C. Determine (a) the mass flow rate of supply air, (b) the relative humidity, dew point, and wet bulb temperatures of the supply air, (c) the latent heat load, and (d) the sensible heat ratio.

[Ans.: (a) 12.49 kg/s; (b) RH = 77%, DPT = 14.2°C, WBT = 15.6°C; (c) 40.59 kW; (d) 0.684]

10. In a space, the sensible heat load is 13.5 kW and the latent heat load is 3.4 kW. Outside air is at 32°C and 50 per cent relative humidity. The space is to be maintained at 25°C dry bulb and 18°C wet bulb temperatures. All outside air is supplied with reheater to satisfy the space conditions. The conditioned air leaves the supply fan at 17°C. Determine (a) the refrigeration load, (b) the capacity of the supply fan, and (c) the heat supplied in the reheater.

[Ans.: (a) 57.12 kW; (b) 1.40 m<sup>3</sup>/s; (c) 5.88 kW]

11. A space to be air conditioned has a sensible heat load of 36 kW and a latent heat load of 10.2 kW. The space is to be maintained at 26°C and 50 per cent relative humidity. Outside air is at 32°C dry bulb and 24°C wet bulb temperatures. The conditioned air will enter the space at 19°C. If 45 per cent of the supply air is fresh air and the rest is recirculated air, find (a) the volume flow rate of fresh air at supply conditions, (b) the apparatus dew point, and (c) the refrigeration load.

[Ans.: (a) 1.93 m<sup>3</sup>/s; (b) 14°C; (c) 116 kW]

12. An auditorium is to be maintained at a temperature of 26°C dry bulb and 50% relative humidity. Air is to be supplied at a temperature not lower than 15°C dry bulb. The sensible heat gain is 1102 kW and the latent heat gain is 37.5 kW. Take ventilating air as 25% by weight of the air from the room and is at 35°C dry bulb and 60% relative humidity. Determine the refrigeration capacity in tons of refrigeration (TR).

[Ans.: 68.5 TR]