MADE EASY PUBLICATIONS

POSTAL BOOK PACKAGE 2025

MECHANICAL ENGINEERING

CONVENTIONAL Practice Sets

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REFRIGERATION AND AIR CONDITIONING

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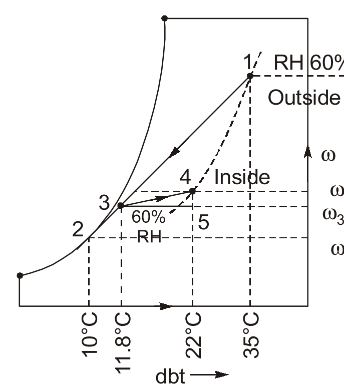
6 CHAPTER

Air Conditioning System

Practice Questions : Level-I

Q.1 Outside air at 35°C, 60% RH is passed over a cooling coil having an apparatus dew point of 10°C and 0.06 by pass factor. The cooled air is then supplied to a room which is to be maintained at 22°C DBT and 60% RH. The supply of air rate 45000 kg/hr. Estimate the sensible and latent heat loads of room and the heat removed in the cooling coil in kW.

Solution:



$\because$ Mass flow rate of dry air = $\left(\dfrac{4500}{1+\omega_1}\right)$ kg/hr

From Psychrometric chart = 4403.13 kg dry air

h_1 = 92 kJ/kg d.a.

h_2 = 29.5 kJ/kg d.a.

h_4 = 47 kJ/kg d.a.

h_5 = 44.5 kJ/kg d.a.

$\because$ By pass factor of air cooling coil = 0.06

$$\therefore \quad 0.06 = \left(\frac{h_3 - h_2}{h_1 - h_2}\right) = \left(\frac{h_3 - 29.5}{92 - 29.5}\right)$$

$$h_3 = 29.5 + 0.06 \times (92 - 29.5) = 29.5 + 3.75 = 33.25 \text{ kJ/kg d.a.}$$

Temperature at 3

$$0.06 = \left(\frac{T_3 - T_2}{T_1 - T_2}\right) = \left(\frac{T_3 - 10}{40 - 10}\right)$$

$$T_3 = 10 + 0.06 \times 30 = 11.8°\text{C}$$

(i) Sensible heat load $= m_a (h_5 - h_3) = \dfrac{4500}{3600(1.022)} (44.5 - 33.25) = 13.76$ kW

(ii) Latent heat load $= m_a (\omega_4 - \omega_5) \times 2500$

$$= \frac{1.25}{1.022} (0.01 - 0.00884) \times 2500 = 3.547 \text{ kW}$$

(iii) Capacity of cooling coil $= m_a (h_1 - h_3) = \dfrac{1.25}{1.022} (92 - 33.25) = 72.144$ kW

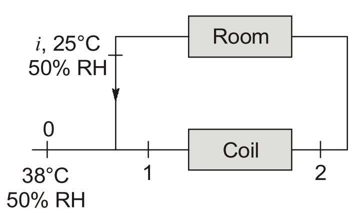
Practice Questions : Level-II

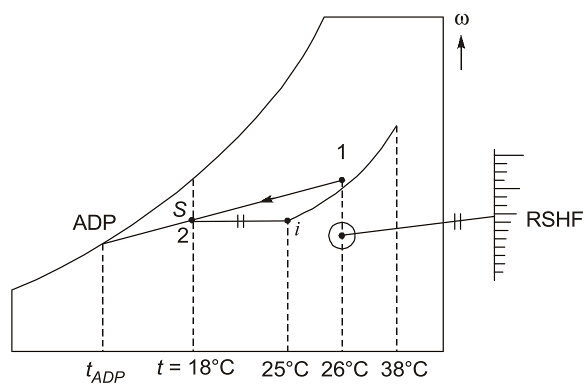
Q.5 A building has the following calculated cooling loads :
RSH gain = 310 kW, RLH gain = 100 kW.
The building's inside space is maintained at the following conditions of Room DBT = 25°C and Room RH = 50%. The outdoor air is at 38°C DBT and 50% RH. And 10% by mass of air supplied to the building is outdoor air. If the air supplied to the space is not to be at a temperature lower than 18°C, find
(i) minimum amount of air supplied to the space in m^3/s.
(ii) volume flow rate of air entering the coil,
(iii) capacity of the cooling coil in TR, and
(iv) ADP and bypass factor of the cooling coil.
Also, draw the layout sketch.

Solution:

Given data: RSH = 310 kW, RLH = 100 KW ⇒ RTH = 310 + 100 = 410 kW

Room sensible heat factors, RSHF $= \dfrac{RSH}{RSH + RLH} = \dfrac{310}{310+100} = \dfrac{310}{410} = 0.756$





Draw RSHF line, its intersection with t = 18° C vertical given supply air state point s-which is the same as coil leaving air state point-2.

From Psychrometric chart

Room condition, h_i = 50.5 kJ/kg dry air
Outdoor condition, h_0 = 92.0 kJ/kg dry air

	Enthalpy (kJ/kg)	Specific Volume (m^3/kg of dry air)	Specific humidity
Room condition	h_i = 50.5		
Outdoor condition	h_0 = 92		
Supply state	h_s = 41.2	0.836	

(i) Supply air condition and volume flow rate (minimum) to the space:

$$\dot{m}_{as} = \frac{RTH}{h_i - h_s} = \frac{410}{50.5 - 41.2} = 44.09 \text{ kg/s}$$

$$\dot{Q}_{vs} = \dot{m}_{as} v_s = (44.09)(0.836) = 36.86 \text{ m}^3/\text{s}$$

(ii) Quantity and volume flow rate of air entering the coil

$$t_1 = 0.9\, t_i + 0.1\, t_0 = 0.9\,(25) + 0.1\,(38) = 26.3°\text{C}$$

From the Psychrometric chart, v_1 = 0.865 m^3/kg of dry air

h_1 = 54.6 kJ/kg

Volume flow rate of air entering the cooling coil, Specific humidity of air in the room, $\omega_2 = \dfrac{0.622 \times 0.0158465}{(1.01325 - 0.0158465)} = 0.00988$ kg/kg d.a.

(ii) OASH and OALH

$$\text{OASH} = 0.0204\ \text{cmm}_o\,(t_1 - t_2) = 0.0204 \times 30 \times (43 - 25) = 11.016\ \text{kW}$$
$$\text{OALH} = 50\ \text{cmm}\,(\omega_1 - \omega_2)$$
$$= 50 \times 30\,(0.01635 - 0.00988) = 9.705\ \text{kW}$$

(iii) ERSH and ERLH

$$\text{ERSH} = \text{RSH} + \text{OASH} \times \text{BPF} = 100 + 11.016 \times 0.15 = 101.6524\ \text{kW}$$
$$\text{ERLH} = \text{RLH} + \text{OALH} \times \text{BPF} = 15 + 9.705 \times 0.15 = 16.456\ \text{kW}$$

(iv) Supply air temperature at *S*.

Total air supply

$$\text{cmm} = \frac{\text{ERSH}}{0.0204 \times (25 - 11.8)} = \frac{101.6524}{0.0204 \times 13.2} = 377.5$$

$$\text{Recirculated air} = 377.5 - 30 = 347.5\ \text{cmm}$$

Temperature at the inlet of cooling coil.

$$t_X = \frac{30 \times 43 + 347.5 \times 25}{377.5} = 26.43°\text{C}$$

$$\text{By-pass factor} = 0.15 = \frac{(t_S - t_A)}{(t_X - t_A)} = \frac{(t_S - 11.8)}{(26.43 - 11.8)}$$

$$t_S = 13.99°\text{C} \approx 14°\text{C}$$

(v) Supply air volume rate = 377.5 cmm

(vi) Temperature at in let to cooling coil.

$$t_X = 26.43°\text{C}$$

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