MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Paper Code : ME-604A

AIR CONDITIONING & REFRIGERATION

Time Allotted : 3 *Hours* *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : 10 × 1 = 10

i) The refrigerant R-717 stands for

a) Ammonia b) Carbon dioxide

c) Sulphur dioxide d) Methyl chloride.

ii) A good refrigerant should have

a) low specific heat ratio

b) high latent heat

c) high thermal conductivity

d) all of these.

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iii) In a simple saturated vapour compression cycle, heat removed in condenser = 10,500 kJ/min; work input to the compressor = 2100 kJ/min. C.O.P. of the cycle is

a) 5

b) 4

c) 1·33

d) not possible to calculate.

iv) Which of the property of the refrigerant remains constant after condensation and before entering into the evaporation in a vapour compression refrigeration system ?

a) Temperature b) Energy

c) Enthalpy d) Entropy.

v) Compound compression is adopted for refrigeration system is

a) to improve volumetric efficiency

b) to reduce mechanical work input per unit mass

c) to take care of very large pressure ratios

d) to achieve all of these.

vi) The relative humidity, during heating and humidification

a) increases b) decreases

c) may increase d) remains constant.

vii) If by-pass factor of each depth coil is 0·8, the combined by-bass factor of a 4 depth coil is approximately

a) 0·41 b) 0·62

c) 0·95 d) 0·8.

viii) For rectangular ducts, the aspect ratio is equal to

a) sum of longer and shorter sides

b) difference of longer and shorter sides

c) product of longer and shorter sides

d) ratio of longer and shorter sides.

ix) Specific humidity (W) of moist air with P_v as partial pressure of water vapour is related as

a) $W = 0{\cdot}622\, P / (P - P_v)$

b) $W = 0{\cdot}622\, P_v / (P - P_v)$

c) $W = 0{\cdot}622\, P / (P - P_a)$

d) $W = 0{\cdot}622\, P_a / (P - P_v)$.

x) For the same fricitional loss in the air conditioning duct of round cross-section, the equivalent round duct dia is

(a = width of the duct, b = breadth of the duct)

a) $D_e = \frac{2ab}{a+b}$ b) $D_e = \frac{ab}{a+b}$

c) $D_e = \frac{a+b}{2ab}$ d) $D_e = \frac{a+b}{ab}$.

GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Draw the schematic diagram of Lithium-Bromide absorption refrigeration system.

3. Draw schematic diagram of absorption system of refrigeration and determine the idea COP of an absorption refrigeration system in which the heating cooling and refrigeration take place at 197°C, 17°C and – 3°C respectively.

4. 250 m^3/min of air at atmospheric conditions 12°C DBT and 50% RH is supplied to an air-conditioned hall. The required conditions are 18°C DBT and 60% RH. Determine :

a) Sensible heat and latent heat removed from the air per minute and

b) Sensible heat factor for the system.

5. a) State relative humidity.

b) Prove that relative humidity : (φ) is given by

$$\varphi = \mu/1 = (1 - \mu) (P_{vs} - P_t)$$

Where, μ = degree of saturation

P_{vs} = Saturation pressure of vapour in moist air

P_t = Total pressure of moist air. 1 + 4

6. a) What do you mean by pressure control defrosting method in evaporation ?

b) Write short note on constant pressure expansion valve. 3 + 2

7. Show that the volumetric efficiency of a reciprocating compressor used in a domestic refrigerator is given by $\eta_{vol} = 1 + C - C\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}}$, where all the terms of the expression have their usual meaning.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

8. a) What is bypass factor ? Explain Room sensible heat factor (RSHF) and Grand sensible heat factor (GSHF).

   b) A vapour compression refrigerator uses R-12 as refrigerant and the liquid evaporates at – 15°C. The temperature of the refrigerant at the delivery from the compressor is 15°C when the vapour is condensed at 10°C. Find the co-efficient of performance and the capacity of the refrigerator per ton if the liquid is cooled by 5°C before throttling.

   Take C_p for superheated vapour as 0·64 kJ/kg K and that for liquid as 0·94 kJ/kg K.

Temperature	Enthalpy in kJ/kg		Specific entropy in kJ/kg K	
(°C)	Liquid	Vapour	Liquid	Vapour
– 15	22·3	180·88	0·0904	0·7051
10	45·4	191·76	0·1750	0·6921

(2 + 3) + 10

9. a) What are the desirable properties of an ideal refrigerant ?

   b) The following data is available for designing an air conditioning system for a hall :

Indoor condition	: 23°C DBT, 65% RH
Outdoor condition	: 37°C DBT, 28% WBT
Sensible heat load in the room	: 45·5 kW
Latent heat load in the room	: 11·5 kW
Total infiltration air	: 1150 m^3/min
Apparatus dew point	: 90°C
Air circulated from the hall	: 60%

   If the quantity of recirculated air is mixed with the conditioned air after the cooling coil, determine :

   i) Mass of the air entering the cooler

   ii) Mass of the total air passing through the hall

   iii) By-pass factor of the cooling coil

   iv) Refrigeration load of the cooling coil. 3 + 12

10. a) Briefly explain different types of condensers used in refrigeration.

    b) What are the advantaged of vapour absorption refrigeration system over vapour compression refrigeration system ?

c) A dense air refrigeration cycle operates between 5 bar and 20 bar. The air temperature after heat rejection to surroundings is 37°C and air temperature at exit of refrigerator is 7°C. The isentropic efficiencies of compressor and turbine are 0·84 and 0·82 respectively. Determine :

i) Compressor and turbine work per ton of refrigeration

ii) Co-efficient of performance of the system.

Take $\gamma = 1{\cdot}4$ and $C_p = 1{\cdot}005$ kJ/kg K.

4 + 4 + 7

11. a) Describe the different psychrometric processes used in air conditioning and their application. Also show the processes on psychrometric chart.

1 kg of air at 35°C DBT and 60% RH is mixed with 2 kg air at 20°C DBT and 13°C t_{dp}.

Calculate specific humidity and specific enthalpy of mixture. Take $C_{ps} = 1{\cdot}88$ kJ/kg.

b) Name three common methods of duct design. Why aspect ratio is considered as an important factor in duct design ?

c) What is the function of a filter ? How are filters classified ? Explain briefly an automatic or self-cleaning filter.

7 + 4 + 4

12. Write short notes on any *three* of the following : 3 × 5

a) Dehumidification

b) Specific humidity

c) Adiabatic saturation process

d) Capillary tube

e) Wet bulb and dry bulb temperature.