MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Paper Code : ME-604 A

AIR CONDITIONING AND 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 : $10 \times 1 = 10$

i) The ozone-friendly refrigerant R-134a contain

a) One chlorine atom b) Two chlorine atom

c) Four chlorine atom d) No chlorine atom.

ii) If the wet bulb depression is zero, then the relative humidity is equal to

a) Zero b) 50%

c) 70% d) 100%.

iii) Where does the highest temperature of refrigerant occurs in vapour compression refrigeration system ?

a) In evaporator

b) Before expansion valve

c) Between compressor and condenser

d) Between compressor and evaporator.

iv) The refrigerant R-22 stands for

a) Ammonia b) Carbon Dioxide

c) Methyl chloride d) Methane.

v) While designing the refrigeration system of an aircraft prime consideration is that the

a) Weight of refrigerant circulated in the system is low

b) Weight of the refrigeration equipment is low

c) System has high COP

d) Work consumption per ton of refrigeration is low.

vi) In a vapour compression refrigeration plant in a vapour compression refrigeration plant the refrigerant leaves the evaporator with the enthalpy of 195 kJ/kg and condenser with 65 kJ/kg. for every kg of refrigerant the plant can supply per second, a cooling load of

a) 70 kW b) 100 kW

c) 130 kW d) 160 kW.

vii) A refrigerator works on reversed Carnot cycle producing a temperature of – 40°C. Work done per TR is 700 kJ per ten minutes. What is the value of its COP ?

a) 3 b) 4.5

c) 5.8 d) 7.

viii) The values of enthalpy at the beginning of compression, at the end of compression and at the end of condensation are 185 kJ/kg. 210 kJ/kg and 85 kJ/kg respectively. What is the value of the COP of the vapour compression refrigeration system ?

a) 0.25 b) 5.4

c) 4 d) 1.35.

ix) Cooling towers generally employs which of the following ?

a) Single speed fan drive

b) Two speed fan drives

c) Multi-speed fan drives in steps

d) None of these.

x) The condensation of moisture contained in air will take place at

a) Dew point temperature

b) Dry bulb temperature

c) Wet bulb temperature

d) Any of these.

GROUP – B

(Short Answer Type Questions)

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

2. Describe the effect of changes in evaporation pressure and condenser pressure on the performance of a simple vapour compression refrigeration system.

3. Show that the work of reciprocating compressor considering the effect of clearance vlolume is

$$W = \frac{n}{n-1} P_1 (V_1 - V_4) \left[\left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right]$$

where all terms of the expression have their usual meaning.

4. $1m^3$ of a ges is compressed adiabatically (γ = 1.4) from 1 bar to 5 bar in a reciprocating compressor with 8 per cent clearance, if the exponent of the reexpansion curve is 1.1 instead of 1.4, find the percentage increase in the work of compression.

5. The humidity ratio of atmospheric air at 27.5°C is 0.016 kg/kg of dry air. Assuming the standard barometric pressure of 760 mm of Hg, determine the following :

i) Partial pressure of water vapour

ii) Dew point temperature

iii) Relative humidity.

6. a) Explain with a neat sketch of Air-Conditioning cycle.

b) Define Sensible heating factor. 4 + 1

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) Derive an expression for COP of an ideal vapour absorption system in terms of T_G, T_E and T_C.

where, T_G = Temperature at which heat (Q_G) is supplied to generator.

T_E = Temperature at which heat (G_E) is absorbed in the evaporator, and

T_C = Temperature at which heat (Q_C) is discharge from condenser and absorber.

b) What is the function of shaft seal in a refrigerant compressor ? Explain why reciprocating compressor cannot be used as a vacuum pump for producing high vaccum.

c) Explain the actual vapour compression system on p-h chart clearly showing the typical variation from theoretical system. 6 + 4 + 5

8. a) Derive an expression for the equivalent dia of circular duct corresponding to a rectangular duct of sides *a* and *b* for the same pressure loss per unit length when the velocity of air flowing through both the ducts is the same.

b) Explain static regain method of duct design for air conditioning

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c) A 30 m long rectangular duct 20 mm × 160 mm in size carries standard air at the rate of 24 m^3/min. Assuming the friction factor f = 0.0048, determine

i) total pressure required at the inlet to the duct to maintain this flow; and

ii) air power required. 5 + 3 + 7

9. a) Derive an expression for clearance volumetric efficiency of a reciprocating compressor.

b) What is a condenser ? State the function of a condenser in a refrigeration system. What are the three main requirements which an evaporator must fulfil ? How is capacity of an evaporator defined ?

7 + 8

10. a) Obtain an expression for thermodynamic wet bulb temperature.

b) Moist air enters a chamber at 5°C DBT and 25°C WBT (wet bulb temperature) at a rate of 90 m^3/min. The pressure is 1 atmospheric. While passing through the chamber, the air absorbs sensible heat at the rate of 40.7 kW and picks up 40 kg/hr of saturated steam at 110°C. Determine the DBT and WBT of the leaving air. 7 + 8

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11. a) Compare the performance of reciprocating and centrifugal refrigeration compressors.

b) Explain briefly Static pressure and total pressure in a Duct system.

c) 400 m^3/min of recirculated air at 22°C DBT and 10°C DPT is to mixed with 150 m^3/min of fresh air at 30° DBT and 50% RH. Determine the enthalpy, specific volume, humidity ratio and dew point temperature of the mixture. 4 + 4 + 7