B.E. Mechanical Engineering (Model Curriculum) Semester - VIII

PCC-ME-404 - Refrigeration and Air Conditioning

P. Pages : 3 **GUG/S/23/14369**

Time : Three Hours * 3 0 5 7 * Max. Marks : 80

Notes : 1. Due credit will be given to neatness and adequate dimensions.
2. Assume suitable data wherever necessary.
3. Illustrate your answers wherever necessary with the help of neat sketches.
4. Use of slide rule, Logarithmic tables, Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.

1. a) Comment in brief about the following for VCRS: **4**
i) Wet compression is not desirable,
ii) Throttling device is used in place of expander.

b) The following data refers to single stage VCRS: **12**
Refrigerant used: R – 134a, condensing temperature = 35 ºC, evaporator temperature = -10ºC, Compressor R.P. M. = 2800, clearance volume / swept volume = 0.03, Swept volume = $269.4\times10^{-6}\,m^3$, Expansion Index = 1.12, Condensate sub- cooling by 5 ºC.
Find:
i) Capacity of the system in TR
ii) Power required
iii) C. O. P.
iv) Heat rejection to condenser
v) Refrigeration efficiency
Assume isentropic compression, dry saturated suction vapour $C_{pv}=1.1kJ/kg.K$,
$C_{pl}=1.458kJ/kg.K.$ (Use refrigeration table for the properties of R - 134a)

OR

2. a) What are the advantages of compound compression with intercooling over single stage compression process? **4**

b) A simple ammonia compression system operates with a capacity of 150 tonnes. The condensation temperature in the condenser is 35ºC. The evaporation temperature in the brine cooler is -25ºC. Ammonia leaves the evaporator and enters the compressor at -8ºC. Ammonia enters the expansion valve at 30ºC. **12**
Write drawing through the compressor valves:
Suction = 0.118 bar, discharge = 0.23 bar; compression index = 1.2; volumetric efficiency = 0.8
Calculate:
i) Power
ii) Heat transferred to cylinder water jacket
iii) Piston displacement
iv) Heat transfer in condenser
v) Coefficient of performance.

3. a) Discuss in brief about various thermodynamic properties of refrigerants? **6**

b) Designate the refrigerant: **4**
i) CH_3Cl ii) $C_2Cl_2F_4$

c) Write a note on. **6**
i) Substitutes for CFC refrigerants ii) Secondary refrigerants.

OR

4. a) What is the function of expansion device in VCRS? With neat sketch discuss the operation of capillary tube in refrigeration system. **6**

b) What is the function of condenser in VCRS? With neat sketch describe the working of evaporative condensers? **6**

c) Describe with neat sketch, a centrifugal compressor. **4**

5. a) What is the function of following components in an absorption system: **6**
i) Rectifier ii) Analyser
iii) Heat Exchanger

b) With neat sketch describe the working of Electrolux refrigerator? **6**

c) What are the advantages of vapor absorption refrigeration system over vapor compression refrigeration system. **4**

OR

6. a) What is Joule - Thomson co - efficient? Explain its significance. **4**

b) Describe with neat sketch and T-s diagram Linde - Hampson air liquefaction method? **6**

c) Explain vortex tube refrigeration system with neat schematic? Also discuss the applications and advantages. **6**

7. a) Define the following psychrometric terms: **6**
i) Specific humidity ii) Relative Humidity
iii) Degree of saturation.

b) Explain and show the following processes on psychrometric chart: **4**
i) Cooling and humidification by water injection .
ii) Heating and humidification by steam injection?

c) A mixture of dry air and water vapour is at a temperature of 21ºC under a total pressure of 736 mm Hg. The dew point temperature is 15ºC. **6**
Find:
i) Partial pressure of water vapour
ii) Relative humidity
iii) Specific humidity
iv) Specific enthalpy of air per kg of dry air and
v) Volume of air per kg of dry air {Use steam table}

OR

8. a) Enlist the factors affecting human comfort? **4**

b) Distinguish clearly between heat stroke, heat exhaustion and heat cramp? **6**

c) The atmospheric air at 25ºC dry bulb temperature and 12ºC wet bulb temperature is flowing at the rate of $100\,m^3/min$ through the duct. The dry saturated steam at 100ºC is injected into the air stream at the rate of 72 kg per hour. Calculate the specific humidity and enthalpy of the leaving air. Also determine the dry bulb temperature, wet bulb temperature and relative humidity of leaving air? **6**

9. a) Show on a psychrometric chart GSHF, RSHF and ERSHF lines when a mixture of outdoor and indoor air passes over a cooling coil? **4**

b) The following data refers to summer air conditioning of a building: **12**
Inside design conditions = 25ºC DBT, 50% RH
Outdoor air conditions = 43ºC DBT, 27ºC WBT
Room sensible heat gain = 84000 KJ/hr
Room latent heat gain = 21000 KJ/hr
By pass factor of cooling coil = 0.2
The return air from the space is mixed with the outside air before entering the cooling coil in the ratio of 4:1 by mass
Determine:
i) Apparatus dew point.
ii) condition of air entering and leaving the cooling coil.
iii) Fresh air mass flow and volume flow rate.
iv) Refrigeration load on the cooling coil.

OR

10. An air conditioning system is to be designed for a restaurant with following data: **16**
Outside design conditions = 40ºC DBT, 28ºC WBT
Inside design conditions = 25ºC DBT, 50% RH
Solar heat gain through walls, roof and floor = 5.87 KW
Solar heat gain through glass = 5.52 kW
Occupants = 25
Sensible heat gain per person = 58 watt
Latent heat gain per person = 58 watt
Internal lighting load = 15 lamps of 100 watt, 10 tubes of 80 watt
Sensible heat gain from other sources = 11.63 kW
Infiltrated air = $15\,m^3/min$
If 25% fresh air and 75% recirculated air mixed and passed through the conditioner coil.
Find:
i) The moment of total air required in m^3/h
ii) Dew point temperature of the coil.
iii) The condition of supply air to the room.
iv) The capacity of conditioning plant.
Assume the by – pass factor equal to 0.2
Draw the schematic diagram of the system and show the system on skeleton. Psychrometric chart and insert the temperatures and enthalpy values at salient point.

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