

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 4054

Roll No.

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B.Tech.

SIXTH SEMESTER EXAMINATION, 2004-2005

REFRIGERATION AND AIR CONDITIONING

Time : 3 Hours

Total Marks : 100

- Note :**
- (i) Attempt **ALL** the five questions.
 - (ii) All questions carry equal marks.
 - (iii) Use of **STEAM TABLES**, Refrigerant's properties tables and charts, specially P-H chart for R-12, is permitted.
 - (iv) In case of numerical problems assume data wherever not provided.

1. Answer **any four** of the following : (5x4=20)

- (a) What is meant by C.O.P. of a refrigerating machine? Also define the terms, 'Refrigerating effect' and Unit of refrigeration.
- (b) 30 tons of 'Fish' are required to be stored in a cold storage plant at a temperature of -10°C . The temperature of the fish when supplied is 30°C . The specific heat of the fish above freezing point is $2.94 \text{ kJ/kg} \cdot ^{\circ}\text{C}$ and below freezing point is $1.25 \text{ kJ/kg} \cdot ^{\circ}\text{C}$. The freezing point of the fish is -3°C and its latent heat is 233 kJ/kg . If the cooling is achieved in 10 hours, calculate the capacity of the refrigerating plant and the carnot cycle C.O.P. between this temperature range.

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- (c) What are the limitations of Carnot refrigeration cycle and how these limitations are overcome in Bell-Coleman air refrigeration cycle. Describe in brief, with the help of T-S diagram.
- (d) In a closed cycle air refrigeration system, air is drawn from cold chamber at -5°C and 1 bar and compressed to 6 bar. The air is cooled to 20°C and then expanded to 1 bar. To produce 10TR, find the mass flow rate of air, COP and power required to run the compressor.
- (e) Why air refrigeration system is most common in the aircrafts inspite of low C.O.P. of the cycle? Also discuss the necessity of air conditioning of air crafts at high altitudes where ambient temperatures are very low.
- (f) What is the basic function of refrigerants in a refrigeration cycle and how they are classified? Write some desirable properties of refrigerants enumerating the names of some common refrigerants.
2. Answer *any two* of the following : (10x2=20)
- (a) Draw a single stage simple vapour compression refrigeration cycle on Temperature-Entropy and Pressure-Enthalpy diagrams and show how its C.O.P. can be calculated by making thermodynamic analysis of the cycle. Also draw the actual vapour compression refrigeration cycle on P-H diagram showing important deviations from the theoretical cycle.

- (b) What is the effect of change of evaporator pressure and condenser pressure on the performance of simple vapour compression refrigeration system? A Freon 12 (R-12) simple vapour compression refrigeration system operating between condenser temperature of 40°C and evaporator temperature of -5°C , develops 20 tons of refrigeration. The refrigerant vapour is super heated to 0°C before entering the compressor and the liquid refrigerant after the condenser (i.e. condensate) is subcooled to 30°C . Assuming isentropic compression, draw the cycle on P-H chart of R-12 and determine :
- the mass flow rate of the refrigerant
 - the power required by the compressor
 - the theoretical piston displacement of the compressor
 - the heat rejected in the condenser
 - C.O.P. of the vapour compression refrigeration cycle
- (c) A two stage vapour compression refrigeration system working on R12 refrigerant is operating between pressure limits of 0.1 and 1.0 mPa. The refrigerant leaves the condenser as saturated liquid and is first throttled to a flash chamber operating at 0.32 mPa. Vapour from the flash chamber is mixed to the refrigerant leaving the L.P. compressor. The mixture is then compressed to condenser pressure by HP compressor. The liquid in the flash chamber is throttled to the evaporator pressure and vaporises in evaporator. Assuming refrigerant leaves the evaporator as a saturated vapour and both compression being isentropic, calculate :

- (i) mass fraction of vapour leaving the flash chamber
- (ii) Refrigeration effect per kg of refrigerant
- (iii) COP of the system.

3. Answer *any two* of the following : (10x2=20)

- (a) Explain in brief, the working principle of a continuous vapour absorption refrigeration cycle. Determine the C.O.P. of a vapour absorption system working with the following operating temperatures :

Generator temperature = 90°C

Absorber temperature = 35°C

Evaporator temperature = -12°C

If the evaporator temperature falls to -20°C , what should be the new generator temperature to operate the system with the same C.O.P.

- (b) (i) Enumerate the basic difference between vapour absorption and vapour compression refrigeration system, enlisting the merits and demerits of vapour absorption system over vapour compression system.
- (ii) A stream of 15kg/s of aqua-ammonia [$C_1 = 0.8$] at 0°C and 5 bar mixes adiabatically with another saturated liquid stream with the flow rate 10kg/s and 100°C at the same pressure. Establish the state points on h-C diagram and obtain :
- (a) mixture concentration
 - (b) mixture enthalpy and
 - (c) amount of liquid and vapour after mixing

- (c) Explain the concept of theory of mixtures as related to vapour absorption system. Also give the significance of Temperature-Concentration diagram explaining its importance in the analysis of vapour absorption refrigeration system.
4. Answer *any two* of the following : (10x2=20)
- (a) (i) What is the basic difference between refrigeration and air conditioning ? What is psychrometrics ? How do you define the terms; Dew Point Temperature, Specific humidity, Relative humidity and Degree of saturation, as related to psychrometrics.
- (ii) Air at 20°C, 40% RH is mixed adiabatically with air at 40°C and 40% RH in the ratio of 1kg of former to 2kg of latter (dry basis). Find the final condition of air.
- (b) What do you understand by Adiabatic saturation and Thermodynamic Wet Bulb temperature ? In an adiabatic saturator, moist air enters at a temperature of 32°C and leaves at 22°C which is also the adiabatic saturation temperature. If the pressure remains constant at 1 bar, determine the Specific humidity and Relative humidity of the inlet mixture. Take C_p for air as 1.005 kJ/kg - °C
- (c) (i) What is the basic difference between the requirements for comfort and industrial air conditioning processes.
- (ii) What is a cooling tower ? Describe in brief, with the help of a neat sketch.