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

PAPER ID : 4097 Roll No. | | | | | | | | | | |

B.Tech.

(SEM VI) EVEN SEMESTER THEORY EXAMINATION, 2009-2010

REFRIGERATION & 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, Psychrometric chart for Air and Refrigerant's properties tables and charts, Temperature-concentration diagram is **permitted**.*

(iv) In case of numerical problems, assume suitable data wherever not provided

1. Answer **any four** of the following : (4x5=20)

(a) Enumerate different methods of producing refrigeration and define the terms, ' Refrigerating effect', 'unit of refrigeration' and 'C.O.P', as related to refrigeration systems.

(b) A refrigeration system is working on reversed Carnot cycle between higher and lower temperatures of 40°C and −30°C respectively. Determine its C.O.P. It is desired to increase the C.O.P. of the cycle to 4.75 by changing the temperatures of the cycle. If the increase (or decrease) in higher temperature is equal to the decrease (or increase) in lower temperature, calculate the new temperatures of the cycle.

(c) What is the main characteristic feature of an air refrigeration system and what is the main difference between open and closed refrigeration cycles ? Derive an expression for C.O.P of an air refrigeration system working on Bell-Coleman cycle, with the help of (P-V) and (T-S) diagrams.

(d) The capacity of a dense air refrigeration system operating on reversed Brayton cycle is 15 T. The cooler and refrigerator pressures are 3.9 bar and 1.3 bar respectively. The temperature of air entering the compressor is −20°C and air is cooled in the cooler at a temperature of 50°C. Assuming isentropic expansion and compression, determine the C.O.P of the cycle, mass of air circulated/min and net power of the machine take γ for air as 1.4.

(e) Although, the C.O.P of an air refrigeration cycle is very low, even then it is commonly used in aircraft refrigeration. Explain the reason. Also discuss the necessity of air conditioning of aircraft at high altitudes where ambient temperatures are very low.

(f) Enumerate the classification of Aircraft refrigeration systems and differentiate between a simple aircraft refrigeration system and a Boot strap refrigeration system. What do you understand by Dry Air Rated Temperature (DART) ?

2. Answer **any two** of the following : (2x10=20)

(a) With the help of P-H diagram, show the effect of (i) subcooling of condensate (ii) superheating of refrigerant vapours (iii) change in suction and discharge pressure, on the performance of a simple vapour compression refrigeration system. Which of the above parameters are used to improve the C.O.P of the cycle. What do you understand by 'Superheat Horn' ? Show it on T-S diagram.

(b) The condenser and evaporator temperatures of a 20 T capacity, simple saturated vapour compression refrigeration system, are 40°C and – 20°C respectively. The refrigerant used in the system is R–22. Draw the cycle on P–H diagram (assuming isentropic compression) and calculate (i) the mass of refrigerant to be circulated (ii) Power required in the compressor and (iii) the C.O.P of the cycle. "If the system employes 5°C subcooling of refrigerant liquid and a superheating of 10°C of refrigerant vapour, what will be the new C.O.P of the cycle ? Whether it will increase or decrease ?

(c) What is the significance of multistage vapour compression system and what are its advantages over simple vapour compression system ? Also explain the purpose of flash gas removal and flash intercooler in multistage compression system.

3. Answer **any two** of the following : (2x10=20)

(a) With the help of a neat sketch, explain in brief, the working principle of a continuous Vapour Absorption Refrigeration system, obtaining an expression for maximum C.O.P of the cycle. Also determine the C.O.P of a Vapour Absorption system having a Generator temperature of 100°C, evaporator temperature of – 15°C and absorber/condenser temperature of 40°C .

(b) A stream of 15 kg/s of aqua ammonia having concentration of 0.8 and a pressure of 5 bar mixes with another saturated liquid stream with flow rate of 10 kg/s at 100°C at the same pressure. During mixing it receives heat at the rate of 4000 kJ/s. Obtain mixture concentration, enthalpy, and amount of liquid and vapour after mixing.

(c) (i) With the help of a neat labelled sketch, describe the working principle of a Practical Ammonia–water vapour absorption system of refrigeration.

(ii) What is the basic function of refrigerants in a refrigeration cycle and how they are classified ? Write some desirable properties of refrigerants. What is the basic difference between primary and secondary refrigerants ?

4. Answer **any two** of the following : (2x10=20)

(a) What do you understand by Psychrometrics and Psychrometric properties ? Define 'Dew Point temperature', 'specific humidity', 'relative humidity' and 'degree of saturation', as related to psychrometrics. Calculate the (i) relative humidity, (ii) specific humidity (iii) dew point temperature and (iv) degree of saturation; for atmospheric air having dry bulb temperature of 40°C, wet bulb temperature of 25°C and atmospheric pressure of 1.013 bar, using steam tables only. The partial pressure of water vapour (Pv) can be calculated by Carrier's equation,

given as : $$P_v = \left[P_{wb} - \frac{(P - P_{wb})(t_{db} - t_{wb})}{1547 - 1.44\, t_{wb}} \right]$$

Where, P_{wb} = saturation pressure corresponding to wet bulb temperature.

P = barometric pressure

t_{db} and t_{wb} = dry bulb and wet bulb temperatures of air (in °C) and, Gas constant for air, R_a = 0.287 kJ/kg – K

(b) What is the importance of Psychrometric chart and how different Psychrometric processes are represented on it ? Draw the following process on a Psychrometric chart describing them in brief :

(i) Sensible heating and cooling

(ii) Latent heating and cooling i.e humidification and dehumidification.

(iii) Cooling and dehumidification

(iv) heating and humidification

Room Air having a Dry bulb temperature of 40°C and wet bulb temperature of 25°C is cooled through sensible cooling process upto a temperature of 25°C show it on a Psychrometric chart and determine the amount of heat removed (in kJ/kg of d.a)

(c) As related to air conditioning, write short notes on the following :

(i) Thermal analysis of human body

(ii) Effective temperature and comfort chart

(iii) Sensible Heat Factor (S.H.F), By Pass Factor and Apparatus Dew Point temperature (ADP).

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5. Answer **any four** of the following : (4x5=20)

(a) Which are the important equipments being used in refrigeration and airconditioning systems ? Describe the basic function and significance of each equipment, in brief.

(b) What is the function of Cold storages and what is their importance in today's life ? 2000 Tons of potato are available at a temperature of 30°C. It has to be preserved in a cold storage at a temperature of 2°C. How much refrigeration is necessary ? If this refrigeration is to be obtained in 3 days, what should be the capacity (tonnage) of the plant ?

(c) What is the basic difference between a 'coil equipment', and a 'spray equipment,' as used in air conditioning systems ? Explain the working of an 'Air Washer' with the help of a neat labelled sketch, explaining how can you calculate its humidifying efficiency ?

(d) Describe in brief, the transmission and distribution of air through Ducts and Fans, explaining the different factors which lead to pressure drop in ducts.

(e) What is the basic difference between the requirements for Confort and Industrial air conditioning ? Explain in brief, the factors affecting Comfort air conditioning.

(f) A water cooler is required to be installed in an industrial organisation to supply drinking water at 10°C to 600 workers for 8 hours duty time. Water is available at 30°C. The heat transfer through insulation is 5% of the total heat load. The drinking water requirement for this heavy duty cooler is 1.1 litres per hour. Determine the capacity (tonnage) of water cooler and the total water consumption per day. Take C_p for water as 4.1868 kJ/kg – K

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