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

PAPER ID : 2538 Roll No. | | | | | | | | | |

B.Tech.

(SEMESTER-VI) THEORY EXAMINATION 2012-13

REFRIGERATION & AIR CONDITIONING

Time : 3 Hours] ***[Total Marks : 100***

Section – A

1. Attempt **all** question parts : **10 × 2 = 20**

(a) Why should the evaporator be at a lower temperature than the refrigerator cabinet ?

(b) What are the systems by which mechanical refrigeration can be accomplished ?

(c) What are the effects of pressure drop in (a) suction line (b) hot gas line (c) liquid line ?

(d) Define the terms 'refrigeration capacity' and 'coefficient of performance' in relation to a refrigeration system. Why is the term 'efficiency' not used to indicate the performance in the case of refrigerators and heat pumps ?

(e) In the absorption system, which components replace the compressor of the compression system ?

(f) Describe a Lithium bromide absorption system.

(g) Describe the three major ways of classifying Air conditioning systems.

(h) Briefly explain the different modes of heat rejection from human body.

(i) Explain the surging phenomenon in centrifugal compressor.

(j) Briefly explain the basic difference between comfort and industrial air conditioning.

Section – B

2. Attempt any **three** question parts : **3 × 10 = 30**

(a) Discuss the below :

(i) The limitations of the Reversed Carnot cycle with gas as refrigerant.

(ii) The Bell-Coleman cycle for gas refrigeration with the help of schematic, T-s and P-v diagrams.

(b) Why is Reversed Carnot cycle not a practical cycle ? Briefly explain the modifications done to Reversed Carnot cycle in the Reversed Brayton cycle.

(c) Explain the merits and demerits of the absorption system compared to the mechanical vapour compression refrigeration system.

(d) Briefly explain about the psychrometric Air conditioning process.

(e) Enumerate the advantages and disadvantages of the Capillary tube.

Section – C

Attempt **all** questions. **5 × 10 = 50**

3. Attempt any **two** parts : **2 × 5 = 10**

(a) In a gas cycle refrigeration system working on Joule cycle, the outlet temperature from the cold space is 270 K and the temperature at inlet to turbine is 318 K. The pressure ratio is 4.0. Determine the mass flow rate, heat rejection, compressor work, turbine work, COP and the volume flow rates at inlet to compressor and at outlet of turbine for a system of 1 TR cooling capacity. The working substance is air.

(b) Show that for subcooling from condenser temperature of 40 °C to 30 °C, the enthalpy of subcooled liquid may be approximated by the enthalpy of saturated liquid at 30 °C for R 22 and NH_3.

(c) Moist air enters an insulated duct at the rate of 10 kg/min at 20 °C, 15% relative humidity and standard atmospheric pressure. If it is heated by a heater of 1 kW capacity, find the outlet state.

4. Attempt any **one** part : **1 × 10 = 10**

(a) In a simple absorption system the conditions at various points are as given in the table below. Show all the state points on the h-x diagram. Determine the mass flow rate through the evaporator and those of weak and strong solutions for 1 TR cooling capacity. Then determine the heat transfer rates through absorber, generator and the condenser. Check the energy balance and find the COP.

State	Pressure (bar)	Temperature (°C)
1	1.75	25
2	13.5	100
3	13.5	100
4	13.5	40
5	1.75	0

(b) A boot-strap cooling system of 10 TR capacity is used in an aeroplane. The ambient air temperature and pressure are 20 °C and 0.85 bar respectively. The pressure of the air increases from 0.85 bar to 1 bar due to ramming action of air. The pressure of the air discharged from the main compressor is 3 bar. The discharge pressure of air from the auxiliary compressor is 4 bar. The isentropic efficiency of each of the compressor is 80%, while that of turbine is 85%. 50% of the enthalpy of air discharged from the main compressor is removed in the first heat exchanger and 30% of the enthalpy of air discharged from the auxiliary compressor is removed in the second heat exchanger using rammed air. Assuming ramming action to be isentropic, the required cabin pressure of 0.9 bar and temperature of the air leaving the cabin not more than 20 °C. Find (1) the power required to operate the system and (2) COP of the system. Draw the schematic and temperature-entropy diagram of the system. Take $\gamma = 1.4$ and Cp = 1 kJ/kg K.

5. Attempt any **one** part : **1 × 10 = 10**

(a) The following data refers to a single stage vapour compression system : Refrigerant used (Ozone friendly) R – 134a ; Condensing temperature = 350 °C ; Evaporator temperature = – 100 °C ; Compressor RPM = 2800 ; Clearance volume/Swept volume = 0.03 ; Swept volume = 269.4×10^{-6} m^3 ; Expansion index = 1.12 ; Compression efficiency = 0.8 ; Condensate subcooling = 50 °C. Find :

(1) Capacity of the system in TR ; (2) Power required ; (3) COP ; (4) Heat rejection to condenser and (5) Refrigeration efficiency. The properties of R-134 a are given below :

Sat. temp. °C	**Pressure bar**	**Specific volume of vapour, m^3/kg**	**Specific enthalpy kJ/kg**		**Specific entropy kJ/kg K**	
			Liquid	**Vapour**	**Liquid**	**Vapour**
–10	2.014	0.0994	186.7	392.4	0.9512	1.733
35	8.870	0.0231	249.1	417.6	1.1680	1.715

Assume isentropic compression and suction vapour as dry saturated. The specific heat of vapour refrigerant may be taken as 1.1 kJ/kg K and for liquid refrigerant as 1.458 kJ/kg K.

(b) A two stage compression ammonia refrigeration system operates between overall pressure limits of 14 bar and 2 bar. The temperature of the superheated vapour and subcooled liquid refrigerant are limited to 30 °C. The flash tank separates dry vapour at 5 bar pressure and the liquid refrigerant then expands to 2 bar. Estimate the COP of the machine and power required to drive the compressor, if the mechanical efficiency of the drive is 80% and load on the evaporator is 10 TR.

6. Attempt any **one** part : **1 × 10 = 10**

(a) An air handling unit in an Air conditioning plant supplies a total of 4500 m^3/min of dry air which comprises by mass 20% of fresh air at 40 °C DBT and 27 °C WBT and 80% recirculated air at 25 °C DBT and 50% RH. The air leaves the cooling coil at 13 °C saturated. Calculate the total cooling load and room heat gain. The following data can be used :

Condition	DBT °C	WBT °C	RH %	Sp. Humidity kg of water vapour/kg of dry air	Enthalpy kJ/kg of dry air
Outside	40	27	–	17.2	85
Inside	25	–	50	10.0	51
ADP	13		100	9.4	36.8

The specific volume of air entering the cooling coil is 0.869 m^3/kg of dry air.

(b) The following data refer to air conditioning of a public hall :

Outdoor conditions = 40 °C DBT, 20 °C WBT

Required comfort conditions = 20 °C DBT, 50% RH

Seating capacity of hall = 1000

Amount of outdoor air supplies = 0.3 m^3/min/person

If the required condition is achieved first by adiabatic humidifying and then cooling, find :

(1) The capacity of the cooling coil and surface temperature of the coil if the by-pass factor is 0.25 and

(2) The capacity of the humidifier and its efficiency.

7. Attempt any **two** parts : **2 × 5 = 10**

(a) Explain about the applications of Air conditioning systems in industry.

(b) The following data refer to a LiBr + H_2O absorption system :

Generator temperature = 80 °C ; Condenser temperature = Absorber temperature = 30 °C ; Evaporator temperature = 10 °C ; Condensate temperature = 25 °C. Steam enters the generator heating coil at 120 °C (dry-saturated state steam) and leaves it at 100 °C as condensate. The concentration of liquid leaving the absorber is 0.51 and its enthalpy is –170 kJ/kg. The enthalpy of vapour leaving the generator is 2620 kJ/kg. The flow rate through the evaporator is 0.4 kg/s.

Find :

(1) Pressure in generator, Condenser, evaporator and absorber in mm of Mercury head

(2) Tonnage

(3) Heat rejection to condenser and absorber

(4) COP

(5) Relative COP

(c) Explain the desirable properties of an Ideal Refrigerant.