Printed Pages : 7

TME – 606

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

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

B. Tech.

(SEM. VI) EXAMINATION, 2007-08

REFRIGERATION & AIR CONDITIONING

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

Notes : *(1) Attempt **all** questions.*

*(2) **All** questions carry **equal** marks.*

(3) All symbols have usual meaning.

*(4) Assume missing **data suitably**, if any.*

*(5) Use of refrigerant **tables** and **charts**, psychrometric **chart**, and enthalpy-concentration **chart** for mixtures is permitted.*

(6) Be precise and to the point in your answer.

1 Attempt any **two** parts of the following : **10×2=20**

(a) In a Bootstrap air refrigeration system of an aircraft, the ram air temperature and pressure are 17°C and 1.05 bar, respectively. Air leaving the main compressor at 4 bar is cooled to 27°C using rammed air. This air is then compressed in the auxiliary compressor (driven by the cooling turbine) and again cooled to 27°C in auxiliary heat exchanger using rammed air. Finally, expansion takes place to cabin pressure of 1.01

bar, and air leaves the cabin at 25°C. Determine the maximum pressure and COP of the system.

Take : $\gamma = 1.4$ and $c_p = 1.004\ kJ/kg\ K$.

(b) Attempt the following :

(1) Derive a relation between the COP of refrigerator and heat pump.

(2) Define Ton of Refrigeration.

(3) Compare open and closed air refrigeration cycles.

(c) A Bell Coleman refrigerator operates between pressure limits of 1.1 bar and 5 bar. The temperatures at the suction to the compressor, and inlet to the expander are 27°C and 37°C, respectively. Isentropic efficiencies of the compressor and expander are 0.80 and 0.82, respectively. Determine the power input to the compressor, if the refrigerator produces cooling at the rate of 50 TR.

Take : $\gamma = 1.4$ and $c_p = 1.004\ kJ/kg\ K$.

2 Attempt any **two** parts of the following : **10×2=20**

(a) In a vapour compression refrigeration system working between 0°C and 30°C, the refrigerant (R-12) enters the compressor at the saturated vapour state. The refrigerant is saturated liquid at

the beginning of the throttling process. Determine the COP of this cycle and compare it with the COP of Carnot cycle working bewteen the same temperature limits. Solve without using P-h chart, use property values given (after part c).

(b) (i) Plot Carnot vapour compression refrigeration cycle on T-s and P-v curves.

(ii) Explain the purpose of "Capillary Tube", "Filter", "Drier", and "Receiver" in a vapour compression refrigeration system.

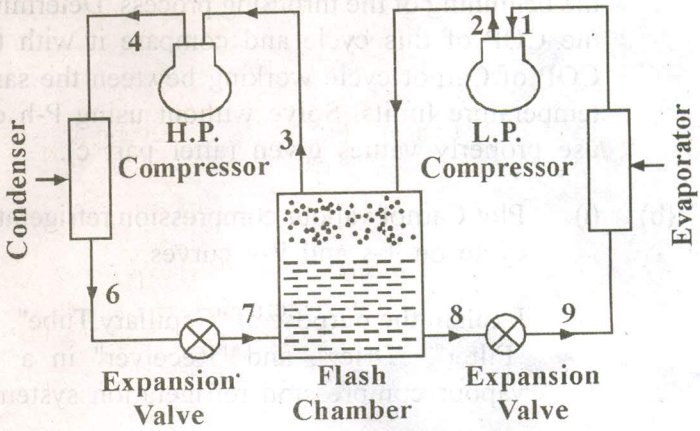
(c) A 100TR system using R-12 is to operate on a two stage vapour compression refrigeration system with a flash chamber. The refrigerant is evaporating at $-40°C$ (0.641 bar), flash chamber works on an intermediate temperature of 0°C (3.08 bar), and condensation takes place at 30°C (7.45 bar). Low pressure compressor and expansion valve operate between 0.641 bar and 3.08 bar, and the high pressure compressor and expansion valve operate between 3.08 bar and 7.45 bar. Saturated vapour enters both the compressors and saturated liquid enters each expansion valves. Determine :

(1) the flow rate of regrigerant handled by each compressor

(2) the power requirement of compressors

(3) COP of the system.

May use the properties given below and figure at the end of question paper.



Superheated properties for R-12 :

Pressure (bar)	T_s (°C)	Properties	20°C superheat	40°C superheat
3.08	0	s (kJ/kg K)	0.7423	0.7853
		h (kJ/kg)	200.5	213.5
7.45	30	s (kJ/kg K)	0.7321	0.7751
		h (kJ/kg)	214.3	228.6

Saturation properties for R-12 :

Pressure (bar)	Sat. Temp. (°C)	h_f (kJ/kg)	h_g (kJ/kg)	S_f (kJ/kg K)	S_g (kJ/kg K)
0.641	-40	0	169.6	0	0.7274
2.19	-10	26.9	183.2	0.1080	0.7020
3.08	0	36.1	187.5	0.1420	0.6966
7.45	30	64.6	199.6	0.2399	9.6854
9.6	40	74.6	203.2	0.2718	0.6825

3 Answer any **two** of the following : **10×2=20**

(a) Answer the following :

(i) Explain the method of obtaining an isotherm (in two phase region) on enthalpy-concentration (h-c) diagram for a mixture.

(ii) Compare aqua ammonia vapour absorption refrigeration system with Li-Br water absorption refrigeration system.

(b) Give classification and nomenclature of refrigerants in detail. Discuss the effects of CFC refrigerants on Ozone layer briefly.

(c) Two aqua ammonia mixtures at saturated liquid state and pressure of 20 bar each are adiabatically mixed. Mixture A has a mass 6kg and a concentration of 0.7, while mixture B has a mass of 3kg and concentration of 0.1. Find the temperature, concentration, and specific enthalpy of mixture after adiabatic mixing. Also determine the concentration of liquid and vapour phases, and the masses of liquid and vapour phases.

4 Attempt any **two** of the following : **10×2=20**

(a) What do you understand by the followings ? Explain by plotting psychrometric chart(s) on your answer book :

(i) Enthalpy deviation lines

(ii) Grand sensible heat factor and room sensible heat factor

(iii) Adiabatic saturation of air.

(b) Give thermal analysis of human body. Discuss comfort chart and explain effective temperature.

(c) The out door air (at 39°C DBT and 45% RH) is mixed with return (from room) air (at 27°C DBT and 50% RH) in the ratio of 1:1 before entering the cooling coil. The by-pass factor for the cooling coil is 0.2 and the ADP is 12°C. Air flow rate (total) through the cooling coil is 8 kg/s.

Determine :

(i) Condition of air at inlet and exit of the cooling coil

(ii) RSHF (room sensible heat factor)

(iii) Tonnage of the plant and

(iv) Rate of condensation.

5 Attempt any **two** of the following : **10×2=20**

(a) What are the different types of condensers used in the refrigeration systems ?

(b) Describe various types of Cooling Towers with the help of neat sketch.

(c) With the help of example, explain any one of the following methods of duct design :

(1) Equal Friction method

(2) Static Regain method.
