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Printed Pages—4 **EME604**

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

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

B. Tech.

(SEM. VI) THEORY EXAMINATION 2011-12

REFRIGERATION & AIR CONDITIONING

Time : 3 Hours *Total Marks : 100*

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

(2) All questions carry equal marks, distribution of marks are shown against the questions.

(3) Use of steam tables, refrigerant's property tables and charts, and psychrometric charts, and Enthalpy-concentration diagram is allowed.

(4) Assume missing data suitably, if any.

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

(a) Ambient air at a pressure of 0.8 bar is rammed to 1.05 bar, 17°C and made available for a 10 TR boot strap air craft refrigeration system. Air from main compressor at 4 bar, after passing through main heat exchanger, is further compressed to 5 bar in the secondary compressor. The isentropic efficiencies of both the compressors and turbine are 0.85. The effectiveness values of main and auxiliary heat exchangers (using rammed air as coolant) are 0.7 and 0.75 respectively. The cabin is to be maintained at 1.01 bar and 25°C. Take C_p = 1 kJ/kg K and γ = 1.4.

Find :

(i) Power required

(ii) COP of the system

(iii) Maximum cycle temperature.

(b) (i) Derive an expression for COP of Carnot refrigeration cycle. How the value of COP of a Carnot

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refrigeration cycle varies with higher and lower temperatures ? A scientist claims to have developed a Carnot refrigerator which maintains a freezer temperature of –15°C in a room whose temperature is 35°C and have a COP of 6.5. Justify, whether his claim is true or false.

(ii) With the help of neat sketch explain the working of "Reduced ambient air craft refrigeration system".

(c) (i) Derive an expression for the COP of Bell Coleman Cycle.

(ii) Define DART and discuss its variation with Mach number for common refrigeration systems.

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

(a) Answer the following :

(i) Discuss the effect of variation of condenser and evaporator pressures and sub-cooling of condensate on COP of a vapour compression refrigeration system.

(ii) Discuss the applications of flash chamber with the help of P-h chart and schematic diagrams.

(b) A vapour compression refrigeration system of 5 ton capacity operates at 40°C condenser and –16°C evaporator temperatures. The vapour is superheated by 5°C at the entry to the compressor. Determine COP and power requirement. Use the following properties of the refrigerant (do not use other property tables as refrigerant is not known to you) :

At t_{sat} = 40°C (P_{sat} = 1.0166 Mpa) :

h_f = 256.41 kJ/kg, h_g = 419.43 kJ/kg, s_g = 1.711 kJ/kg, and for superheated vapour c_p = 1.145 kJ/kg K

At t_{sat} = –16°C (P_{sat} = 0.15728 Mpa) :

h_g = 389.02 kJ/kg, s_g = 1.7379 kJ/kg K and for superheated vapour c_p = 0.831 kJ/kg K

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(c) Explain the working of Cascade Refrigeration System with the help of neat sketch. Is it different from multistage system ? Discuss.

3. Attempt any *two* parts of the following : **(10×2=20)**

(a) Define primary refrigerant and discuss desirable properties of primary refrigerants. Give the refrigerant number for the following : $CHClF_2$, C_2H_6, CO_2, $CH_2F\text{-}CF_3$.

(b) Explain the working of Practical Aqua Ammonia Vapour Absorption Refrigeration System. How do we ensure pure ammonia at the entry to the condenser ? Discuss the significance and working of aqua heat exchanger.

(c) Two aqua ammonia mixture streams at saturated liquid state and pressure of 20 bar each are mixed adiabatically. Stream A has a mass flow rate of 9 kg/s and a concentration of 0.8, whereas stream B has a mass flow rate of 9 kg/s and a concentration of 0.2. Determine the temperature, concentration and specific enthalpy of mixture stream after adiabatic mixing. Also find the concentration of ammonia in liquid and vapour phases after adiabatic mixing.

OR

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

(ii) How do we get temperature-concentration (T-c) diagram for a mixture (binary) ?

4. Attempt any *two* parts of the following : **(10×2=20)**

(a) Explain basic psychrometric processes with the help of neat sketches (after drawing psychrometric charts on answer book).

(b) The outdoor air (at 38°C DBT and 50% RH) is mixed with return (from room) air (at 27°C DBT and 40% RH) in the ratio of 1 : 2 before entering the cooling coil. The

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by-pass factor for the cooling coil is 0.25 and the ADP is 10°C. Air flow rate (total) the cooling coil is 10 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.

(c) Explain the following terms using temperature-entropy diagram :

(i) Dew point temperature of air

(ii) Saturation of air

(iii) Wet bulb temperature

If the total atmospheric pressure remains constant at a location, prove that the specific humidity is approximately a linear function of the partial pressure of the vapour in the atmosphere.

5. Attempt any ***four*** parts of the following : **(5×4=20)**

(a) What is Food Preservation ? Discuss some common methods used for food preservation.

(b) Describe working of Ice Plant. What would be the nature of ice if it is formed quickly ?

(c) What is the difference between the industrial and comfort air conditioning requirements ?

(d) List various types of compressors used in refrigeration units ? Discuss the advantages of hermetically sealed compressors.

(e) Explain the working of thermostatic expansion valve with the help of neat sketch.

(f) Explain frictional losses and dynamic losses in flow through duct. Give an expression for frictional pressure drop in ducts.