M.E. Second Semester (Mechanical Engineering (Thermal Engg.)) (New-CGS)

13516 : Advanced Refrigeration Engineering

2 MTE 2

P. Pages : 2
Time : Three Hours

0358

AW - 3537
Max. Marks : 80

Notes : 1. Answer **any three** question from Section A and **any three** question from Section B.
2. Assume suitable data wherever necessary.
3. Illustrate your answer necessary with the help of neat sketches.
4. Use of slide rule logarithmic tables, Steam tables, Mollier's Chart, Drawing instrument, Thermodynamic table for moist air, Psychrometric Charts and Refrigeration charts is permitted.

SECTION - A

1. a) Describe the mechanism of a simple vapour compression refrigeration system. **6**

b) A vapour compression refrigerator works between the pressures 4.93 bar & 1.86 bar. The vapour is superheated at the end of compression its temperature being 25°C. The liquid is cooled to 9°C before throttling. The vapour is 95% dry before compression. Calculate : **8**
i) Coefficient of performance &
ii) Refrigerating effect per kg of the working substance circulated.
The specific heat at constant pressure for the superheated vapour is 0.645 kJ/kg k and for the liquid is 0.963 kJ/kg k.

2. A single compressor using R-12 as refrigerant has three evaporators of capacity 30 TR, 20 TR and 10 TR. The temperature in the three evaporators is to be maintained at -10°C, 5°C and 10°C respectively. The system is provided with multiple expansion valves and back pressure valves. The condenser temperature is 40°C. The liquid refrigerant leaving the condenser is subcooled to 30°C. The vapours leaving the evaporators are dry and saturated. Assuming isentropic compression, find : **13**
a) The mass of refrigerant flowing through each evaporators.
b) The power required to drive the compressor.
c) The C.O.P. of the system.

3. a) Draw a neat diagram of three fluid system of refrigeration (Electrolux refrigeration system) and explain it's working. **7**

b) In a vapour absorption refrigeration system, heating, cooling and the refrigeration take place at the temperatures of 100°C, 20°C and -5°C respectively. Find the maximum C.O.P. of the system. **6**

4. a) Draw a neat diagram of lithium bromide water absorption system and explain its working. **7**

b) List out the merits and demerits of thermo-electric refrigeration system over other refrigeration system. What are the fields of its applications. **6**

5. a) Derive the expression for COP of refrigerating system consisting of two evaporators at different temperatures with individual compressors and individual expansion valves. **5**

b) The following data refer to a LiBr + H_2O absorption system : 8
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 generator is 0.65 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 :
i) Pressure in generator, condenser, evaporator and absorber in mm of mercury head.
ii) Tonnage or cooling capacity.
iii) Heat rejection to condenser & absorber. iv) Coefficient of performance.

SECTION - B

6. a) Classify refrigerants. Discuss important properties of following refrigerants : 7
i) NH_3 ii) R-134 a

b) Explain the designation systems for refrigerants. 6

7. a) Describe with the neat sketch Boot-Strap cycle of air refrigeration system and draw its T-S diagram. 6

b) Sketch and explain the working of thermostatic expansion valve. How is it suitable for variable loading. 7

8. a) Classify the condensers. Compare the Air cooled condenser and water cooled condenser. 6

b) Explain the working principle of scroll compressor with help of a neat sketch. Also state its advantages. 7

9. a) Why CFC refrigerants are to be phased out ? What are the recent trends to replace these CFC refrigerants ? Discuss in brief. 6

b) An air refrigeration used for food storage provides 25 TR. The temperature of air entering the compressor is 7°C and the temperature at exit of cooler is 27°C. Find : 7
i) COP of the cycle.
ii) Power per tonne of refrigeration required by the compressor.
The quantity of air circulated in the system is 3000 kg/hr. The compression and expansion both follow the law $PV^{1.3} = C$ and take the r = 1.4 and C_P = 1 kJ/kg k for air.

10. In an aeroplane, a simple air refrigeration is used. The main compressor delivers the air at 5 bar and 200°C. The bled air taken from compressor is passed through a heat exchanger, cooled with the help of ram air so that the temperature of air leaving the heat exchanger is 45°C and the pressure is 4.5 bar. The cooling turbine drives the exhaust fan which is used to force the ram air through the heat exchanger. The air leaving the heat exchanger passes through the cooling turbine and then supplied to cabin at 1 bar. The pressure loss between the cooling turbine and cabin is 0.2 bar. If the rate of flow of air through the cooling turbine is 20 kg/min, determine the following : 14
a) The temperature of the air leaving the expander.
b) The power delivered to ram air which is passed through the heat exchanger &
c) The refrigeration load in tonnes when the temperature of the air leaving the cabin is limited to 25°C.
Assume that the isentropic efficiency of the cooling turbine is 75% and no loss or heat from air between the cooling turbine and cabin. Take γ = 1.4 and C_P = 1 kJ/kg k.

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