Seat No. | | | | | | |

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Refrigeration & Air Conditioning

(New) (1210)

P. Pages : 3

Time : Three Hours

Max. Marks : 100

Instructions to Candidates :

1. Do not write anything on question paper except Seat No.
2. Answersheet should be written with blue ink only. Graph or diagram should be drawn with the same pen being used for writing paper or black HB pencil.
3. Students should note, no supplement will be provided.
4. All questions are compulsory. Solve **any two** bits from a, b and c.
5. Use of scientific calculator, steam table, refrigerent property tables and charts are allowed.
6. Draw neat sketches whenever necessary.
7. Assume suitable data, if necessary.

1. a) What is primary and secondary refrigerant ? Discuss the desirable properties of an ideal refrigerant. **10**

b) A dense air machine operates on reversed Brayton cycle and is required for a capacity of 10 TR. The cooler pressure is 4.2 bar and the refrigerator pressure is 1.4 bar. The air is cooled in the cooler at a temperature of 50°C and the temperature of air at inlet to compressor is –20°C. Determine for the ideal cycle -

i) C.O.P.
ii) Mass of air circulated per minute.
iii) Net power per tonne of refrigeration.

Show the cycle on P-V and T-S plane. **10**

c) 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 air increases from 0.85 bar to 1 bar due to ramming action of air. The pressure of 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 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 :

i) Power required to operate the system.
ii) C.O.P. of the system.

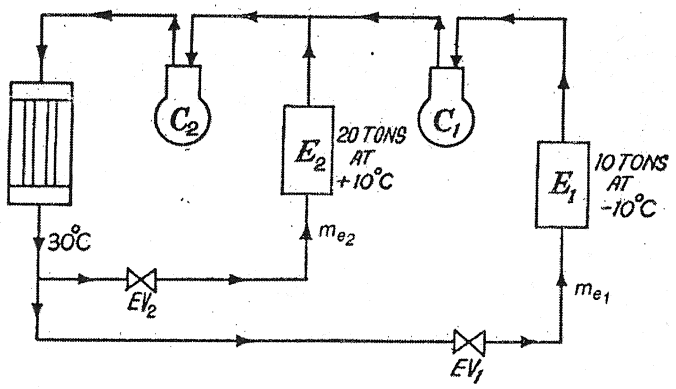
Draw temperature entropy diagram of the system.

Take r = 1.4 and C_p = 1 kJ/kg k. **10**

2. a) A vapour compression refrigerator uses R-12 as refrigerant and the liquid evaporates in the evaporator at –15°C. The temperature of this refrigerant at the delivery from the compressor is 15°C, when the vapour is condensed at 10°C. Find C.O.P. if
   i) there is no undercooling.
   ii) liquid is cooled by 5°C before expansion.
   Take specific heat at constant pressure for superheated vapour as 0.64 kJ/kg k and that for liquid as 0.94 kJ/kg k. **10**

Temperature T °C	Enthalpy liquid kJ/kg	Enthalpy Vapour kJ/kg	Sp. entropy liquid kJ/kg k	sp. entropy vapour kJ/kg k
–15	22.3	180.88	0.0904	0.7051
+10	45.4	191.76	0.1750	0.6921

b) A compound refrigeration system using R-12 as a refrigerant as shown in fig. is used for multi load purpose find :
   i) C.O.P. of the system.
   ii) Power required in kw to run the system. **10**



c) Write notes on :

   i) Cascade refrigeration system. **5**

   ii) Production of dry ice. **5**

3. a) Draw a neat line diagram of Electrolux refrigerator and explain its working. **10**

   b) Find the expression for the ideal C.O.P. for vapour absorption refrigeration system in terms of Tg, Tc and Te where -
   Te - Temperature at which refrigeration takes place in evaporator.
   Tg - Temperature at which heat is supplied to the generator
   Tc - Temperature at which the condensation in condenser and cooling in cooler takes place. **10**

c) In an aqua ammonia absorption system the highest and lower pressure are 16 bar and 3 bar respectively. The concentration of strong solution is 0.4 and degassing range is 0.1 with suitable assumptions find for 10 TR machine
i) Rate of heat transfer in different elements of system.
ii) H COP. **10**

4. a) Define the following : **10**

i) Specific humidity ii) Absolute humidity

iii) Relative humidity iv) Dew point temperature

v) Dry air

b) The atmospheric air at 760 mm of Hg, dry bulb temperature 15°C and wet bulb temperature 11°C enters a heating coil whose temperature is 41°C. Assuming by-pass factor of heating coil as 0.5, determine dry bulb temperature, wet bulb temperature and relative humidity of the air leaving the coil. Also determine the sensible heat added to the air per kg of dry air. **10**

c) 90 m^3 of air per minute at 5°C DBT and 2.5°C WBT is passed through a heating coil which gives 40.7 kw energy to the air saturated steam at 110°C and with a rate of 40 kg/hr is mixed with the air leaving the heater. Determine the DBT and WBT of the air after mixing the steam. Enthalpy of saturated steam at 110°C = 2691 kJ/kg. **10**

5. a) Explain with neat sketches direct and chilled water air conditioning. **10**

b) Define human comfort and explain the factors which affect human comfort. **10**

c) An air conditioning plant is to be designed for a small office for winter conditions - **10**
Outdoor conditions = 10°C DBT and 8°C WBT
Required indoor conditions = 20°C DBT and 60% RH
Amount of air circulation = 0.3 m^3/min/person
Seating capacity of the office = 50 persons
The required condition is achieved first by heating and then by adiabatic humidifying. Find :
i) heating capacity of the coil in kw and the surface temperature if by-pass factor of the coil is 0.32.
ii) Capacity of humidifier.

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