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APR-MAY

B. E. (Eighth Semester) Examination, 2020

(Old Scheme)

(Mech. Engg. Branch)

REFRIGERATION and AIR CONDITIONING

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Part (a) is compulsory and solve any two from (b), (c) and (d) for each unit. Use of refrigeration table and psychrometric chart is permitted.*

Unit-I

1. (a) Define tonne is refrigeration. 2

(b) A refrigeration machine is required to produce ice at 0°C from water at 20°C. The machine has a condenser temperature of 298 K while the evaporator temperature is 268 K. The relative efficiency of the machine is 50% and 6 kg of Freon-12 refrigerant is circulated through the system per minute. The refrigerant enters the compressor with a dryness fraction of 0·6. Specific heat of water is 4·187 kJ/kgK and the latent heat of ice is 335 kJ/kg. Calculate the amount of ice produced in 24 hours. The table properties of Freon-12 is given below : 7

Temperature (K)	Liquid Heat (kJ/kg)	Latent Heat (kJ/kg)	Entropy of liquid(kJ/kgK)
298	59·7	138·0	0·2232
268	31·4	154·0	0·1251

(c) In a 12 tonnes refrigeration ammonia plant compression is carried out in two stages with water and flash intercooling and water sub-cooling. Condenser pressure, evaporator pressure and flash intercooler pressure are 12 bar, 3 bar and 6 bar respectively. If the limiting temperature for intercolling and sub-cooling is 20°C, determine the following :

(i) The coefficient of performance of the plant.

(ii) The power required for each compressor.

(iii) The swept volume for each if the volumetric efficiency of each of the compressor is 82%. 7

(d) Explain Cascade refrigeration system along with its advantages. 7

Unit-II

2. (a) Draw T-S and P-V plot for reversed Carnot cycle. 2

(b) Explain working of air-refrigeration system based on reversed carnot cycle, through following points :

(i) Components of systems

(ii) Schematic diagram of system

(iii) P-V and T-S plot

(iv) COP of the system in terms of temperature 7

(c) A aircraft refrigeration plant has to handle a cabin load of 25 tonnes. The atmospheric temperature is 16°C. The atmospheric air is compressed to a pressure of 0·96 bar and temperature of 29°C due to ram action. This air is then further compressed in a compressor to 4·8 bar, cooled in a heat exchanger

to 66°C, expanded in turbine to 1 bar pressure and supplied to the cabin. The air leaves the cabin at a temperature of 26°C. The isentropic efficiency of both compressor and turbine are 0·9. Calculate :

(i) The mass of air circulated per minute.

(ii) C.O.P.

Take for air C_p = 1·005 kJ/kgK and $\gamma = 1 \cdot 4$ 7

(d) A regenerative air refrigeration system is designed to take 18 tonnes of refrigeration load of air craft cabin. The ambient air at pressure 0·82 bar and temperature 12°C is rammed isontropically till the presure rises to 1·22 bar. The air bleed off the main compressor at 4·4 bar is cooled by the ram air in the heat exchanger whose effectiveness is 0·62. The air from heat exchanger is further cooled to 64°C in the regenerative heat exchanger with a portion of the air bled after expansion in the cooling turbine. The cabin is to be maintained at a temperature of 22°C and a pressure of 1 bar. If the isotropic efficiency of the compressor and turbine are 88 percent and 82 percent respectively. Determine :

(i) Mass of the air bled from cooling turbine to be used for regenerative cooling.

(ii) Power required for maintaining the cabin at required condition.

(iii) C.O.P. of the system. 7

Unit-III

3. (a) Point out thermodynamic properties of good refrigerant. 2

(b) Give detailed comparison between VARS and VCRS on following points. 7

(c) Explain the working of domestic Electrolux refrigerator with following key points :

(i) Schematic diagram

(ii) Principle

(iii) Working

(iv) Role of hydrogen

(v) Advantages and disadvantages 7

(d) Explain the working of Hermetically sealed type compressor used in VCRS system. The explanation must be provided with neat sketch, merits and demerits of this compressor. 7

Unit-IV

4. (a) What is the term means DBT and WBT used in refrigeration? 2

(b) Air at 32°C DBT and 20°C WBT is passed through a cooling coil maintained at 5°C, the heat extracted by the cooling coil from air is 14 kW and air flow rate is 42·5 m^3/min.

Determine :

(i) DBT and WBT of the air leaving the coil

(ii) Coil by pass factor 7

(c) Atmospheric air at 15°C DBT and 30% RH passes through furnace and through a humidifier, in such a way that the final DBT is 32°C and 40% RH. Determine :

(i) Heat and moisture added to air

(ii) Sensible heat factor of the process 7

(d) Explain various factors governing the optimum effective temperature of human comfort. 7

Unit-V

5. (a) Define the term room sensible heat factor (RSHF) used in refrigeration. 2

(b) An office for seating 30 occupants is to be maintained at 22°C DBT and 55% RH. The outdoor conditions are 36°C DBT and 27°C WBT. The various loads in the office are :

Solar heat gain ..... 8500 W

Sensible heat gain per occupant ..... 83 W

Latent heat gain per occupant ..... 100 W

Lighting load ..... 2500 W

Sensible heat load from other sources ..... 12000 W

Infiltration load ..... 15 m^3/min

Assuming 40% fresh air and 60% of recirculated air passing through the evaporator coil and the by-pass factor of 0·12, determine :

(i) Dew point temperature of the coil; and

(ii) Capacity of the plant 7

(c) In an air-conditioning plant, an air handling unit supplies a total of 4000 m^3/min of dry air which comprises by mass 20% of fresh air at 39°C DBT and 26°C WBT and 80% recirculated air at 24°C DBT and 50% RH. The air leaves the cooling coil at 12°C saturated. Calculated :

(i) Total cooling load

(ii) Room heat gain 7

(d) Explain central system of air conditioning, also mention the advantages and disadvantages of this system. 7