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AUTONOMOUS
QUESTION BANK (DESCRIPTIVE)

Subject with Code : Refrigeration and Air Conditioning (16ME8806) **Course & Branch**: M.Tech - ME

Year & Sem: I-M.Tech & I-Sem

UNIT –I

VAPOUR COMPRESSION REFRIGERATION, COMPOUND COMPRESSION

1 (a) With necessary sketches explain working principle of vapor compression refrigeration system and find its COP. [5M]

(b) A F12 vapor compression refrigeration system has a condensing temperature of 50^0 C and evaporating temperature of 0^0 C. The refrigerating capacity is 7 tons. The liquid leaving the condenser is saturated liquid and compression is isentropic. Determine (i) power required to run the compressor. (ii) Heat rejected in the plant (iii) COP of the system. Given properties of F12 are as follows. Take enthalpy at the end of compression as 210 kJ/kg. [5M]

Temp (^{0} C)	Pressure(bar)	h_f (kJ/kg)	H_g (kJ/kg)	S_f (kJ/kg)	S_g(kJ/kg)
50	12.199	84.868	206.298	0.3034	0.6792
0	3.086	36.022	187.397	0.1418	0.6960

2 (a) Why compound vapor compression system is needed. Explain the system with a flash chamber. [5M]

(b) The following data refers to a two stage compression ammonia refrigerating system with water intercooler. Condenser pressure = 14 bar; Evaporator pressure = 2 bar; intercooler pressure = 5 bar; load on the evaporator = 2TR. [5M]
If the temperature of the de-superheated vapour and sub-cooled liquid refrigerant are limited to 30^0 C, find (a) the power required to drive the system, and (b) COP of the system.

3 A vapour compression refrigerator uses R-12 as refrigerant and the liquid evaporates in the evaporator at -15^0 C. the temperature of this refrigerant at the delivery from the compressor is 15^0 C when the vapour is condensed at 10^0C. find the coefficient of performance if (i) there is no understanding and (ii) the liquid is cooled by 5^0 C before expansion by throttling. [10M]
Take specific heat at constant pressure for the superheated vapour as 0.64KJ/ Kg K and that for liquid as 0.94 KJ/ Kg K. the other properties of refrigerant are as follows:

Temperature in ^{0}C	Entholpy in KJ/Kg		Specific entropy in KJ/ Kg K	
	Liquid	vapour	Liquid	Vapour
-15	22.3	180.88	0.0904	0.7051
+10	45.4	191.76	0.1750	0.6921

4 In a 12 tonnes refrigeration ammonia plant compression is carried out in two stages with water and flash inter-cooling and water sub-cooling. Condenser pressure, evaporator pressure and flash intercooler pressures are 12 bar, 3 bar and 6bar respectively. If the limiting temperature for inter-cooling and sub cooling is 20^0 C, determine the following: [10M]

(i) Draw the schematic arrangement with corresponding p-h diagram.

(ii) the COP of the plant

(iii) the power required for each compressor

5 (a) Describe the desirable characteristics of ideal refrigerant. Explain how refrigerants are designated. [5M]

(b) A two stage ammonia refrigeration system operates between overall pressure limits of 14 bar and 2 bar respectively. The liquid is sub cooled to 30^0C. The temperature of de-superheated vapor leaving the water intercooler is also 30^0C. The flash chamber separate the dry vapor at 5 bar pressure. The liquid refrigerant then expands to 2 bar. Estimate the COP of the machine and power required to drive the compressor if the mechanical efficiency of the drive is 80% and load on evaporator is 10TR. [5M]

6 (a) What is the effect of sub cooling on the performance of VCR system? [5M]

(b) Explain about physical and thermodynamic properties of a refrigerant? [5M]

7 (a) What is the effect of superheating on the performance of VCR system? [5M]

(b) A vapour compression refrigerator uses methyl chloride (R-40) and operates between temperature limits of -10^0C and 45^0C. At entry to the compressor, the refrigerant is dry saturated and after compression it acquires a temperature of 60^0C. find the COP of the refrigerator. the relevant properties of methyl chloride are as follows: [5M]

Saturation Temperature in ^{0}C	Enthalpy in KJ/Kg		Entropy in KJ/ Kg K	
	Liquid	vapour	Liquid	vapour
-10	45.4	460.7	0.183	1.637
45	133.0	483.6	0.485	1.587

8 (a) What are the desirable properties of a refrigerant? [5M]

(b) A CO2 refrigerator works between 56.25 bar and 21.2 bar. The temperature of vapor leaving the compressor is 32^0C. Find (i) Dryness fraction of vapor entering and leaving the evaporator. (ii) COP

Consider the enthalpy of refrigerant as 245.78 kJ/kg at the end of compression. The properties of CO2 measured are [5M]

Saturation Pressure (bar)	Saturation Temp (^{o}C)	hf (kJ/kg)	hg (kJ/kg)	Sf (kJ/kg.K)	Sg (kJ/kg.K)
56.25	18.5	52.67	214.02	0.1672	0.7231
21.2	-18.0	-37.6	234.5	-0.1505	0.9154

9 The following data refers to two stage vapor compression system.
Condensing temperature as 40^0C; Refrigerant used Ammonia;
Flash intercooler temperature as 15^0C; Evaporating temperature as -15^0C
Refrigerant flow through compressor side as 0.4 kg/s;
Condensate is subcooled in condenser by 5^0C; Compressor efficiency as 80%;
Find the following

(i) Flow through the evaporator
(ii) Tons of refrigeration
(iii) Total power input
(iv) COP
(v) Heat transfer to condenser [10M]

10. Write about mathematical analysis of vapor compression refrigeration? [10M]

UNIT-II

VAPOUR ABSORPTION REFRIGERATION SYSTEM

1. Explain simple vapour absorption system with neat sketch? [10M]

2. (a) State the functions of the following components in an absorption system: [5M]
i)Absorber ii) Rectifier iii) Analyser iv) Heat exchanger

(b) Mention the function of each fluid in a three fluid vapour absorption system? [5M]

3. Explain about enthalpy-concentration diagram for a mixture? [10M]

4. Draw a neat diagram of Three fluid system of refrigeration and explain its working? [10M]

5. Draw a neat diagram of Lithium bromide water absorption refrigeration system

and explain its working? [10M]

6. What are the advantages and disadvantages of three fluid absorption refrigeration over conventional refrigeration ? [10M]

7. Derive the equation of maximum C.O.P of an ideal vapour absorption refrigeration system? [10M]

8. Explain aqua ammonia refrigeration system using concentration enthalpy chart? [10M]

9. In an aqua ammonia absorption system, the highest and lowest pressures 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 10TR machine the following
   (i) Rate of heat transfer in different elements of the system
   (ii) HCOP
   (iii) Energetic efficiency [10M]

10. In an ammonia absorption system, the pressures are 12 bar and 3 bar. The concentration of strong solution, weak solution, vapour after generator and vapour before condenser may be taken as 0.4, 0.3,0.96,0.99 respectively. The reflux temperature is 60^0C. A heat exchanger is used between the absorber and generator find
    (i) Heat received or rejected in the absorber, generator, condenser and evaporator per kg of NH_3
    (ii) HCOP
    (iii) Energetic efficiency [10M]

UNIT-III

AIR REFRIGERATION, STEAM JET REFRIGERATION SYSTEM, UNCONVENTIONAL REFRIGERATION SYSTEMS

1. (a) Explain about boot strap air cooling system with the T-S diagram? [5M]
   (b) Write the factors considered in selecting the refrigeration system for an aeroplane. [5M]

2. The reduced ambient air refrigeration system used for an aircraft consists of two cooling turbines, one heat exchanger and one air cooling fan. The speed of aircraft is 1500 km/hr. The ambient air condition is 0.8 bar and 10^0C. The ram efficiency may be taken as 90%. The rammed air used for cooling is expanded in the first cooling turbine and leaves it at a pressure of 0.8 bar. The air bled from the main compressor at 6 bar is cooled in the heat exchanger and leaves it at 100^0C. The cabin is to be maintained at 20^0C and 1 bar. The pressure loss between the second cooling turbine and cabin is 0.1 bar. If the isentropic efficiency for the main compressor and both of the cooling turbines are 85% and 80% respectively. Find
   1. Mass flow rate of air supply to cabin to take a cabin load of 10 tons of refrigeration.
   2. Quantity of air passing through the heat exchanger if the temperature rise of ram air is limited to 80K.
   3. Power used to drive to cooling fan
   4. COP of the system. [10M]

3. Explain in detail about Regenerative air cooling system with a neat sketch and T-s diagram? [10M]

4. A boot strap cooling system of 10 TR capacity is used in an aeroplane. The ambient air temperature and pressure are 20^0C and 0.85 bar respectively. The pressure of air increases from 0.86 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 the 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 20^0C, Find:
   1. Power required to operate the system .
   2. C.O.P of the system

   Draw the schematic and temperature - entropy diagram of the system. Take $\gamma = 1.4$ and C_p= 1KJ/Kg K [10M]

5. (a) What is the working principle of steam jet refrigeration. Explain with the help of a neat sketch, the working of a steam jet refrigeration system. [5M]
   (b) Draw the temperature – entropy and enthalpy – entropy diagram of a steam jet refrigeration system. [5M]

6. (a) List out the merits and demerits of vortex tube over other refrigeration system. [5M]
   (b)What are the various fields of application of vortex tube? [5M]

7. (a) What are the advantages of steam jet refrigeration system over other types of refrigeration system? [5M]
   (b) Define the following efficiencies [5M]
   i) Nozzle efficiency ii) Entrainment efficiency and iii) Compression efficiency.

8. (a) Define the following: i) Seebeck effect ii) Peltier effect and iii)Thomson effect. [5M]
   (b) List out the merits and demerits of thermo-electric refrigeration system over other refrigeration system. [5M]

9. (a) Explain about Thermo electric refrigeration with a neat sketch? [5M]
   (b) What are the applications of thermo electric refrigeration? [5M]

10. (a)What is the situation under which the steam jet refrigeration system is recommended? What are its limitations? Can it be used for obtaining subzero temperatures. [5M]
    (b)What are the various components of steam jet refrigeration system and briefly discuss the function of each component ? [5M]

UNIT-IV

AIR-CONDITIONING

1. Write about various psychometric process? Explain any four processes with neat sketches? [10M]

2 . Explain the construction of psychometric chart? [10M]

3. (a) What is meant by bypass factor? Write the expression for bypass factor of cooling or heating coil. [5M]

(b) The atmospheric air at 30^0C dry bulb temperature and 75% relative humidity enters a cooling coil at the rate of 200 m^3/min. The coil dew point temperature is 14^0C and the by-pass factor of the coil is 0.1. Determine

i) the temperature of air leaving the cooling coil.

ii)capacity of coil in tonnes of refrigeration and in kilowatt. [5M]

4. (a) Write about the factors affecting optimum effective temperature? [5M]

(b) Sketch comfort chart and show on it the comfort zone? [5M]

5. Discuss briefly the different types of heat loads which have to be taken into account while designing air conditioning system? [10M]

6. (a) Define [6M]

i) Wet-bulb temperature and Dew – point temperature.

ii) Degree of saturation and Relative humidity

iii) Dew point depression

(b) Explain Summer air conditioning system with a neat sketch? [4M]

7 (a) Explain winter air conditioning system with a neat sketch? [4M]

(b) What is the need for ventilation? Brief about Crack length method for estimating the infiltrated air? [6M]

8. An air conditioned hall is to be maintained at 27^0C dry bulb temperature and 21^0C wet bulb temperature. It has a sensible heat load of 46.5 KW and latent heat load of 17.5 KW. The air supplied from outside atmosphere at 38^0C dry bulb temperature and 27^0C wet bulb temperature is 25m^3/min, directly into the room through ventilation and infiltration. Outside air to be conditioned is passed through the cooling coil whose apparatus dew point is 15^0C. The quantity of re-circulated air from the hall is 60%. This quantity is mixed with the conditioned air after the cooling coil. Determine

i) Condition of air after the coil and before the re-circulated air mixes with it;

ii)Condition of air entering the hall, i.e. after mixing with the re-circulated air,

iii)Mass of fresh air entering the cooler

iv) By-pass factor of the cooling coil and

v) Refrigerating load on the cooling coil [10M]

9. The atmospheric air at 25^0C DBT and 12^0C wet bulb temperature is flowing at the rate of 100m^3/min through the duct. The dry saturated steam at 100^0C is injected into the air

stream at the rate of 72kg per hour. Calculate the specific humidity and enthalpy of leaving air. Also determine the dry bulb temperature, wet bulb temperature and relative humidity of leaving air ? [10M]

10 (a) What is effective temperature? What factors affect effective temperature? [5M]

(b) For a sample of air having 22^0C DBT, relative humidity 30% at barometric pressure of 760mm Hg calculate 1. Vapour pressure, 2. Humidity ratio, 3. Vapour density, and 4. Enthalpy using theoretical formulas. [5M]

UNIT-V

AIR-CONDITIONING SYSTEMS

1. (a) Draw the psychrometric chart representing the condition for all fresh air used and recirculated air? [6M]

   (b) Define the terms [4M]
   i) ADP ii) RSHF iii) ESHF iv) GSHF

2. (a) Write about recirculated air with reheat coil? [4M]

   (b) An air-conditioned space is maintained at 26^0C DBT 50% RH when the outdoor conditions are 35^0C DBT and 28^0C WBT. The space has a sensible heat gain of 17.6kW and the air to the space is supplied at a condition of 8^0C saturated. Determine [6M]

   i) the mass and volume flow rate of the air supplied.
   ii) Latent head in the room
   iii) The cooling load of the refrigerator plant is 15% of total mass of air supplied to the space is fresh air and the remaining air is recirculated?

3. (a) What is dehumidification and the necessity of it? What are the common methods of dehumidification? [5M]

   (b) Describe briefly absorption and adsorption? [5M]

4. What are the parameters that affect the bypass factor? What are the effects of varying bypass factor on the conditioning coil? [10M]

5. A conference room for seating 100 persons is to be maintained at 22^0C DBT and 60% relative humidity. The outdoor conditions are 40^0C DBT and 27^0C WBT. The various loads in the auditorium are as follows:

Sensible and latent heat loads per person, 80W and 50W respectively: lights and fans, 15000W: sensible heat gain through glass, walls, ceiling, etc., 15000W. The air infiltration is 20m^3/min and fresh air supply is 100m^3/min. Two-Third of re circulated room air and one-third of fresh air are mixed before entering the cooling coil. The by-pass factor of the coil is 0.1. Determine apparatus dew point , the grand total heat load and effective room sensible heat factor. [10M]

6. (a) What are the advantages of steam humidifiers? [5M]
   (b) Explain the process of humidification by Air- washing method? [5M]

7. (a) What is meant by a grill? How to design a grill? [5M]
   (b) What is meant by a register? what are the factors affecting grill performance? [5M]

8. (a) Explain about the FC, BI and VA fans? [5M]
   (b) Describe the types of blowers based on air flow patterns with sketches? [5M]

9. The room sensible and latent heat loads for an air conditioned space are 25kW and 5 kW respectively. The room condition is 25^{0}C DBT and 50% RH. The outdoor condition is 40^{0}C DBT and 50% RH. The ventilation requirement is such that on mass flow rate basis 20% of fresh air is introduced and 80% of supply air is recirculated. The by-pass factor of cooling coil is 0.15.
   Determine i) Supply air flow rate ii) Outside air sensible heat iii) Outside air latent heat iv) Grand total heat v) Effective room sensible heat factor. [10M]

10. The following data relates to the office air conditioning plant having maximum seating capacity of 25 occupants.

    Outside design conditions = 34^{0}C DBT, 28^{0}C WBT ,

    Inside design conditions = 24^{0}C DBT, 50 % RH Solar heat gain= 9120 W,

    Latent heat gain per occupant = 105 W, Sensible heat gain per occupant = 90 W,

    Lightening load = 2300 W, Sensible heat load from other sources = 11630 W,

    Infiltration load = 14 m^3/min.

    Assuming 40 % fresh air and 60% of recirculated air passing through the evaporator coil and the by-pass factor of 0.15. Find the dew point temperature of the coil and capacity of the plant. [10M]