

Refrigeration & Air Conditioning (ME-304, Dec-07)

Note: Section A is compulsory. Attempt any four questions from Section B and any two from Section C.

Section-A

1. a) Define the term "refrigeration effect". Derive the value of 'unit of refrigeration' effect in S.I units.
b) Differentiate between air refrigeration system and vapour compression refrigeration system.
c) Derive the relationship between COP of a refrigerator and COP of a heat pump.
d) Explain the effect of superheating on the performance of vapour compression refrigeration system.
e) Briefly explain the working principle of steam jet refrigeration system.
f) What do you understand by the term cascading in refrigeration systems?
g) What are various types of drying agents and antifreeze solutions commonly employed in refrigeration and air conditioning systems?
h) Enumerate the alternative refrigerants proposed for the R-12 and R-22 refrigerants.
i) What do you understand by adiabatic saturation temperature?
j) Differentiate between working of package and central air conditioning systems.

Section-B

2. Give the brief description of any two of the following refrigeration and air conditioning equipment: (a) Rotary compressors, (b) Flooded expansion valve, (c) Natural draft cooling towers.
3. In a bell Coleman refrigeration cycle, air is drawn from cold chamber at 1 bar and compressed to 6 bar in the compressor. The compression and expansion indices are 1.25 and 1.30 respectively. Obtain COP and Tonnage of the unit for an air flow rate of 0.5 kg/sec. Neglect the clearance volume and take temperatures at the beginning of compression and expansion to be 7°C and 37°C respectively. If the compression and expansion are isentropic, how the results will be modified?
4. A simple R-12 heat pump for space heating operates between temperature limits of 15°C and 50°C. The heat required to be pumped in the conditioned space is 100 MJ/hr. Determine: dryness fraction of R-12 entering the evaporator, mass flow rate of the refrigerant, theoretical piston displacement of the compressor, theoretical horsepower of the compressor and COP. Assume $C_{pV} = 0.8$ kJ/kg.K. Assume specific volume of R-12 saturated vapor at 15°C is 0.0345 m³/kg.
5. The three stage ammonia vapor compression machine working between the pressure range of 1.4 bar to 10 bar with an intermediate pressure of 3 bar and 6 bar operating with three expansion and flash inter-cooling. Find the power required to run the unit, if the load on the plant is 10TR.
6. Write a short note on human requirements of comfort. Define the term effective temperature and discuss the construction of comfort chart showing the comfort zone human comfort.

Section-C

7. The following data refer to summer air conditioning of insulation:
Outside design conditions: 43°C DBT and 27°C WBT, Inside design conditions: 25°C DBT and 50% R.H, Room sensible heat gain: 84000 kJ/hr, Room latent heat gain: 21000 kJ/hr, By pass factor of cooling coil used: 0.2. The return air from the room is mixed with the outside air before entry to cooling coil in the ratio of 4:1. Determine apparatus dew point of the cooling coil, entry and exit conditions of air cooling coil, fresh air mass flow rate, and refrigeration load on the cooling coil.
8. (a) Air enters on evaporative cooler at a pressure of 1 atm, a DBT of 38°C and WBT of 21°C. the air leaves the cooler at 1 atm and DBT of 24°C. Assume the process to be adiabatic. Determine relative humidity of cool air and quantity of water that must be supplied to cooler for each kg of dry air.
(b) Describe the effect of traditional chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) on the environment. What can be done to prevent the ill effects of these refrigerants on environment?
9. (a) A dehumidifying spray washer is chosen to operate under the following conditions
Inlet air condition: 28°C DBT, 21°C WBT, Outlet air condition: 10°C DBT, 6°C WBT
Volume of air handled= 2000 cubic meter/ minute (cmm), The chilled water inlet and outlet temperatures are 7°C and 12°C respectively. Evaluate cooling load on the coil, water flow rate through the coil.
(b) Explain the construction and working of an Electrolux vapor absorption refrigeration system with the help of a neat sketch.