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B. Tech

PCME 4402

Seventh Semester Examination – 2011

REFRIGERATION AND AIR-CONDITIONING

Full Marks – 70

Time : 3 - Hours

*Answer Question No. 1 which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions :   2×10

    (a) Define Energyperformance ratio (EPR) and express its relationship with COP.

    (b) What is boot strap with reference to aircraft refrigeration systems ?

    (c) Why capillary tube is preferred to other throttling devices in household refrigerators ?

    (d) What are the advantages of using a flash chamber in parallel with evaporator ?

    (e) What is the necessity of analyser in an absorption refrigeration system ?

    (f) What is secondary refrigerant ? Where is it used ?

    (g) Write the chemical formula of R_{10} and R_{113}.

    (h) Write down the factors affecting human comfort.

    (i) On a particular day the weather forecast states that the dry bulb temperature is 37°C, while the relative humidity is 50% and the barometric pressure is 101.325 kPa. Find the humidity ratio of moist air on this day.

    (j) What is the required wattage of an electrical heater that heats 0.1 m/s of air from 15°C and 80% RH to 55°C ? The barometric pressure is 101.325 kPa.

2. A boot strap cooling system of 10 tons is used in an aeroplane. The temperature and pressure conditions of atmosphere are 20°C and 0.9 atm. The pressure of air is increased from 0.9 atm to 1.1 atm due to ramming. The pressures of air leaving the main and auxiliary compressor are 3 atm and 4 atm respectively.

P.T.O.

Isentropic efficiency of compressors and turbine are 0.85 and 0.8 respectively. 50% of the total heat of air leaving the main compressor is removed in the first heat exchanger and 30% of their total heat of air leaving the auxiliary compressor is removed in the second heat exchanger using removed air. Find :

(a)   Power required to take cabin load

(b)   COP of the system

The cabin pressure is 1.02 atm and temperature of air leaving the cabin should be greater than 25°C. Assume ramming action to be isoentropic.   10

3.   A R 12 plant of 12 tons capacity has its evaporation temperature of –10°C and condenser temperature of 33°C.The refrigerant is sub cooled by 5°C before entering the expansion valve and the vapour is super heated by 6°C after leaving the evaporator. Find the COP of the plant and the theoretical power required to run the compressor.   10

4.   (a)   Draw a neat sketch of an improved vapour absorption refrigeration cycle.Indicate there on the phase of various fluids and the name of the equipments. Also indicate the direction of the external energy flow to or from the equipment .   6

(b)   The operating temperatures of a single stage vapour absorption refrigeration system are : generator : 90°C; condenser and absorber : 40°C; evaporator : 0°C.The system has a refrigeration capacity of 100 kW and the heat input to the system is 160 kW. The solution pump work is negligible. An inventor claims that by improving the design of all the components of the system he could reduce the heat input to the system to 80 kW while keeping the refrigeration capacity and operating temperatures same as before. Examine the validity of the claim.   4

5.   A vapour compression system with NH_3 as refrigerant works between the pressure limits of 2 bar and 14 bar. It is fitted with expansion valves. and flash chamberssuch that the vapoursare extractedat 6 bar and 10 bar and sent to the appropriate compressor suction. For a refrigerating load of 18 tonnes, calculate the power required to drive the three compressors.   10

6.   A cooling tower is used for cooling the condenser water of a refrigeration system having a heat rejection rate of 100 kW. In the cooling tower air enters at 35°C (DBT) and 24°C (WBT) and leaves the cooling tower at a DBT of 26°C relative humidity of 95%. What is the required flow rate of air at the inlet to the cooling tower in m^3/s. What is the amount of make-up water to be supplied ? The temperature of make-up water is at 30°C, at which its enthalpy (h_w) may be taken as 125.4 kJ/kg. Assume the barometric pressure to be 1 atm.   10

7. In an air conditioning system air at a flow rate of 2 kg/s enters the cooling coil at 25°C and 50% RH and leaves the cooling coil at 11°C and 90% RH. The apparatus dew point of the cooling coil is 7°C. Find
   (a) The required cooling capacity of the coil
   (b) Sensible Heat Factor for the process
   (c) By-pass factor of the cooling coil
   Assume the barometric pressure to be 1 atm. Assume the condensate water to leave the coil at ADP (h_w = 29.26 kJ/kg).   10

8. Write down the equation for the heat loss from human body. Explain in brief how the human body reacts to changes in temperature of environment. Also explain the effect of activities on the heat load calculation for comfort application.   10