BENGAL ENGINEERING & SCIENCE UNIVERSITY, SHIBPUR

B.E./B.Arch. (Part IV) Odd Semester Examination, 2012

Refrigeration & Air-Conditioning (ME-702)

Semester: 7th Semester **Branch: ME**

Full Marks: 70 Time: - 3 Hrs.

First Half

Attempt any three from this half. All questions are of equal value. Unassigned marks reserved for neatness. Use of property tables/diagrams permitted.

1. (a) Explain how a cooling coil can act as a cooling and dehumidifying apparatus for moist air, stating the mass and energy equations for the related process. When a cooling coil would fail to dehumidify incoming air?

   In an AC system, air enters the cooling coil at 25°C and 50% RH and leaves the coil at 11°C and 90% RH. Air flow rate is 2 kg/s and the coil ADP 7°C. Find:
   i) The required cooling capacity of the coil,
   ii) Sensible Heat Factor for the process, and
   iii) 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)

   (b) Can adiabatic mixing of two air streams lead to condensation of vapor in the mixture? Justify by explaining the process on a psychrometric diagram.

   [7 + 4]

2. (a) Differentiate between RSHF and CSHF. When can both be same for an air conditioning system?

   (b) A summer AC system is designed for 100% outside air conditioning. It maintains an indoor air condition of 24°C DBT and 50% RH while the outdoor condition is 34°C DBT, 40% RH. The space has a sensible heat load of 400 kW and a latent heat load of 100 kW. The conditioned air is supplied at 14°C. Determine, assuming a coil bypass factor of 0.2:
   (i) supply air mass flow rate,
   (ii) sensible, latent and total heat loads of the coil and
   (iii) the coil ADP

   [4 + 7]

3. (a) Explain how the human body maintains its core temperature and thermal equilibrium with the environment and state the major factors that affect human comfort. "Teaching is an activity of 1.6 Met" – what useful information can be derived from this statement pertaining to cooling load calculation?

   (b) Define mean radiant temperature (MRT) and operative temperature (OT) for an AC system. Explain the Comfort Chart and show the representative summer/winter comfort regions on a neatly-drawn psychrometric diagram.

   [6 + 5]

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4. (a) Explain how air washers are employed in direct and indirect evaporative air conditioning systems. Use schematic as well as psychrometric diagrams for the same.

   (b) A large hall with a seating capacity of 1200 is to be supplied with conditioned outside air. The supply air condition is 20°C DBT, 60% RH while the outside air is at 40°C DBT, 20°C WBT. The ventilation requirement is 0.3 cmm per person. The supply condition is to be achieved by applying adiabatic humidification first followed by sensible cooling. Find the capacity of the humidifier and also that of the cooling coil.

   [5 + 6]

5. (a) What is 'balance point outside temperature'? How is it used to determine the need for heating or cooling for a given space?

   (b) A building is subjected to a design solar heat gain of 2.5 kW and it also has an internal heat generation rate of 1 kW (sensible) from the indoor appliances. The total exposed surface area is 400 m^2 and the overall U-value is 0.5 $W/m^2.K$. The required indoor temperature is 25°C. Determine whether a cooling system is required or a heating system, if the outdoor temperature is 5°C.

   [5 + 6]

ME-702 (Second Half)

Answer any three questions from this half

6. (a) How does a vapour absorption refrigeration system differ from vapour compression refrigeration system? State the merits and demerits of this system over vapour compression refrigeration system.

   (b) A dense air refrigerator is used in absorbing 2100 kJ/min. The expansion cylinder and the compression cylinder are double acting. The pressure limit for the compression as well as expansion cylinder is same and this is 4 bar and 16 bar. Compressor sucks air at 4°C and discharges air at 20°C to the expansion cylinder after the air cooler. Mechanical efficiency of the compressor and the expansion cylinder drive is 85 %. For 500 rpm and 25 cm stroke, determine: (a) power required to drive the unit; (b) bore of compressor and expansion cylinder and (c) ice tonnage from and at 0°C per day (24hrs). Assume isentropic compression and expansion with $\gamma = 1.4$, C_p=1.005 kJ/kgK

7. (a) Discuss the effects of sub-cooling and superheating on the performance of a standard vapour compression refrigeration system.

   (b) Determine the COP of a simple saturated vapor compression refrigeration cycle with the following data. Also determine the mass of the refrigerant per min per ton and the power per ton. Refrigerant- Freon-12 (R-12); Evaporator temperature- -20°C;

   Condenser temperature +40°C

   Solve the problem with refrigerant tables as well as charts.

   Given C_p for superheated Freon-12 0.65 kJ/kgK

8. (a) Describe the working of a shell and tube condenser with a neat functional diagram.

   (b) Determine the condensing area for F-12 condenser of a refrigeration plant of 20 ton capacity for air conditioning. The evaporator temperature is 10°C and the condensing temperature is 40°C. Water from the cooling tower at 30°C enters the condenser and leaves at 35°C. A two pass condenser with 24 tubes and the horizontal tube arrangement is to be assumed. Determine also the length of the tube to provide the area if copper tubes of 15 mm outside and 13 mm inside diameter and with fins on the outside so that $A_o/A_i = 1.8$ are used.

9. (a) Describe in brief with figures the functioning of thermostatic expansion valve and float valves.

   (b) Draw schematic and p-h diagrams and explain the working of a two-stage vapor compression refrigeration system with flash-intercooler.

10. (a) What do you mean by refrigerants? How are they designated? Give the chemical formulae and names of the following refrigerants: R-22, R-143, R-717 and R-744.

    (b) State the desirable properties of refrigerants. Why the positive condenser and evaporators are desired in a refrigeration system?