(ii) Grand total heat

(iii) Effective sensible heat factor

(iv) ADP

(v) Dehumidified air quantity

(vi) Condition of air entering and leaving apparatus.

Assume bypass factor of 0·15.

Total No. of Questions : 5] [Total No. of Printed Pages : 6

Roll No. .....

ME–802

B. E. (Eighth Semester) EXAMINATION, June, 2010

(Mechanical Engg. Branch)

REFRIGERATION AND AIR CONDITIONING

(ME – 802)

Time : Three Hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : Answer all questions as per internal choice given. Use of Psychrometric chart, Steam table and Refrigeration table and charts is permitted. Assume suitable data if, necessary.

1. (a) Explain bootstrap evaporative cooling air refrigeration system. Draw its schematic diagram and processes on T-S plane. Write down the equations for calculating mass flow rate, power and COP of the system. 8

(b) A cold storage plant is required to store 20 tons of fish : 12

The temperature of the fish when supplied = 27°C

Storage temperature of fish required = – 9°C

Specific heat of fish above freezing point = 3 kJ/kg/K

Specific heat of fish below freezing point = 1·254 kJ/kg/K

Freezing point of fish = − 3°C

Latent heat of fish = 232·2 kJ/kg

If the cooling is achieved within 10 hrs, find out (i) Capacity of the refrigerating plant. (ii) Carnot cycle COP between this temperature range. (iii) If the actual COP is 1/3 of the Carnot COP. Find out the HP required to run the plant.

Or

The cockpit of a job plane is cooled by a simple cooling cycle for an aeroplane having the following particulars : 20

Plane speed	= 1000 km/hr.
Ambient air pressure	= 0·9 bar
Ambient air temperature	= 35°C
Pressure ratio of main compressor	= 4
Temperature of air leaving the heat exchanger	= 58°C
Pressure drop in the heat exchanger	= 0·5 bar
Pressure in the cockpit	= 1 bar
Temperature of the air leaving the cockpit	= 30°C
Pressure loss between cooler turbine and cockpit	= 0·3 bar
Cooling load in cockpit	= 9 tons
Ram efficiency	= 95%
Isentropic efficiency of compressor	= 80%
Isentropic efficiency of cooling turbine	= 85%

Determine : 20

(i) Quantity of air passed through the cooling turbine.

(ii) Stagnation temperature and pressure of the air entering the compressor.

(iii) Net power delivered by the engine to the refrigeration unit.

(iv) COP of the system.

2. An ammonia refrigerator operates on the vapour compression refrigeration cycle. The pressure of liquid ammonia before throttling is 12·04 bar and its temperature is 27·2°C. The evaporator pressure is 2·47 bar. Ammonia gas leaves the evaporator at − 9·5°C. The power input to the compressor is 2·12 kW and the mass flow rate of ammonia is 27 kg/hr. Determine the dryness fraction of the gas after throttling, the heat absorbed per hour in the evaporator and the COP of the refrigerator. Sketch the cycle on the T-s and P-h diagrams.

Properties of ammonia are given below : 20

Temperature °C	Pressure bar	Enthalpy kJ/kg h_f	h_g
− 14	2·47	135·82	1445·2
31	12·04	346·614	1486·67

Specific heat of liquid at 12·04 bar may be taken to be 4·75 kJ/kg/K and the specific heat of superheated vapour at 2·47 bar may be taken to be 2·5 kJ/kg/K.

Or

(a) Explain with a suitable diagram the working of cascade refrigeration system. Why and where does this system find itself particularly useful ? 8

(b) Calculate the power needed to compress 20 kg/min. of R-12 from saturated vapour at 104 bar to a condensing pressure of 10 bar by two stage compression with intercooling by liquid refrigerant at 4 bar. Assume

saturated liquid to leave the condenser and dry saturated vapour to leave the evaporator. Draw schematic diagram and show the cycle on P-h chart. 12

3. Attempt any *two* of the following :

   (a) Discuss in detail the modifications necessary in the simple absorption machine in order to achieve efficient and better performance. 10

   (b) Explain the factors considered for the selection of refrigerant for a system. 10

   (c) Differentiate between two commonly used refrigerant R-12 and R-22. 10

4. (a) Show the following processes on psychrometric chart : 6

   (i) Cooling and humidification.

   (ii) Adiabatic mixing of two streams.

   (iii) Chemical humidification.

   Or

   Show that : 6

$$w = 0{\cdot}622 \frac{p_v}{p_t - p_v}$$

   where, w = Specific humidity

   p_v = Partial pressure of water vapour

   p_t = Atmospheric pressure

   (b) Air at 10°C dbt and 90% relative humidity is to be heated and humidified to 35°C dbt and 22·5°C wbt. The air is preheated sensibly before passing to the air washer in which water is recirculated. The relative humidity of the air coming out of the air washer is

90%. This air is again reheated sensibly to obtain the final desired condition. Find : 14

   (i) The temperature to which the air should be preheated.

   (ii) The total heating required.

   (iii) The make up water required in the air washer.

   (iv) Humidifying efficiency of air washer.

5. An air conditioned auditorium is to be maintained at 27°C dbt and 60% RH. The ambient condition is 40°C dbt and 30°C wbt. The total sensible heat load is 100000 kJ/hr. and the total latent load is 40000 kJ/hr. 60% of the return air is recirculated and mixed with 40% of make-up air after the cooling coil. The condition of air leaving the cooling coil is at 18°C. Determine : 20

   (i) RSHF

   (ii) Condition of air entering the auditorium

   (iii) Amount of make up air

   (iv) The apparatus dew point

   (v) Bypass factor of cooling coil

   Or

   A provision store located at 30°N latitude has the following loads : 20

   Room sensible heat = 58·15 kW

   Room latent heat = 14·54 kW

   The summer outside and inside design conditions are : outside 40°C dbt and 27°C wbt, inside 25°C dbt and 50% RH. 70 cum of ventilation air is used, determine the following :

   (i) Ventilation load