

B.Tech. MECHANICAL ENGINEERING

Term-End Examination

December, 2012

00091

**BIME-015 : REFRIGERATION AND AIR
CONDITIONING**

Time : 3 hours

Maximum Marks : 70

Note : Attempt any five questions. Use of non - programmable scientific calculator is permitted. Uses of psychrometric chart, steam tables, Mollier diagrams, refrigeration and air conditioning tables and charts is permitted.

1. (a) What is the difference between a refrigerator and heat pump ? Derive an expression for the performance factor for both if they are running on reversed carnot cycle. 7+7=14
- (b) 100kg of ice at -5°C is placed in a bunker to cool some vegetables. 24 hours later, the ice has melted into water at 10°C . What is the average rate of cooling in kJ/h and TR provided by the ice ?

Given :

Specific heat of ice = 1.94kJ/kgK Specific heat of water = 4.1868kJ/kgK Latent heat of fusion of ice at 0°C
= 335kJ/kg

2. (a) Explain the effect of refrigerating and condensing temperatures on the C.O.P. of the system. **4+10=14**
- (b) The ambient air temperature during summer and winter in a particular locality are 40°C and 15°C respectively.
- (i) Find the values of carnot COP for an air conditioner for cooling and heating corresponding to refrigeration temperatures of 5°C for summer and 55°C for winter respectively. Take a temperature difference of 5°C in the exchanger that exchanges heat with the surroundings.
- (ii) If water from the cooling tower at 30°C is used as a cooling medium with 3°C temperature differential for air conditioning in summer, what will be the carnot COP for cooling.
- (iii) Also, find the power consumption per ton of refrigeration in each case. Assume no increase in the temperature of the surrounding air or water.
3. A refrigerant 12 vapour compression system **14**
operating at a condenser temperature of 40°C and
an evaporator temperature of -5°C develops 15
tons of refrigeration.

Using $p-h$ diagram for R-12 determine :

- (a) the mass flow rate of the refrigerant circulated,
- (b) the theoretical piston displacement of the compressor and piston displacement per ton of refrigeration,
- (c) the theoretical horse power of the compressor and horse power per ton of refrigeration.
- (d) the heat rejected in the condenser, and
- (e) the carnot COP and actual COP of the cycle.

4. In an ammonia - absorption system with an analyser but without a dephlegmator, the following data are given : 14

Condenser pressure = 20.3 bar

Evaporator pressure = 21.0 bar

Generator temperature = 156°C

Absorber temperature = 40°C

Determine, per unit mass of the vapour distilled :

- (a) Specific solution circulation rates
- (b) Temperature t_{o1} at inlet to evaporator if the liquid from the condenser is cooled by 13°C in the liquid - vapour heat exchanger.
- (c) The refrigerator effect if the maximum refrigeration temperature is 5°C .
- (d) The heat transfer in the liquid - liquid heat exchanger.
- (e) The heat added in the generator

5. The sling psychrometer in a laboratory test recorded the following readings : 14

Dry bulb temperature = 35°C

Wet bulb temperature = 25°C

Determine the following :

- (a) Specific humidity
- (b) Relative humidity
- (c) Vapour density in air
- (d) Dew point temperature
- (e) Enthalpy of mixture per kg of dry air. Take atmospheric pressure = 1.0132 bar.

6. It is required to design an air conditioning plant for a small office room for following winter conditions : 8+6=14

Out door conditions ___ 14°C DBT and 10°C WBT

Required conditions ___ 20°C DBT and 60% RH

Amount of air circulation ___ $0.30\text{m}^3/\text{min}/\text{person}$

Seating capacity of office ___ 60

The required condition is achieved first by heating and then by adiabatic humidifying.

Determine the following :

- (a) Heating capacity of the coil in kW and the surface temperature required if the by pass factor of coil is 0.4.
- (b) The capacity of the humidifier. Solve the problem by using psychrometric chart.

7. A retail shop located in a city at 30°N latitude has the following loads. 14

Room sensible heat : 58.15 kW

Room latent heat : 14.54 kW

The summer outside and inside design conditions are :

Outside : 40°C DB, 27°C WB

Inside : 25°C DB, 50% RH

70 cmm of ventilation of air is used. Determine the following :

- (a) Ventilation load
 - (b) Grand total heat
 - (c) Effective sensible heat factor
 - (d) Apparatus dew point
 - (e) Dehumidified air quantity
 - (f) Condition of air entering and leaving apparatus
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