Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V • EXAMINATION – WINTER • 2014

Subject Code: 151403 Date: 28-11-2014

Subject Name: Food Refrigeration and Air Conditioning

Time: 10.30 am - 01.00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 (a) Answer the following questions: **07**

(i) Write "R" designations for CH_4 and CCl_2F_2.

(ii) Why are CFC's harmful to our environment?

(iii) What are centrifugal fans?

(iv) State the thermodynamic function of expansion valve in VCS?

(v) Why is Carnot COP greater than actual COP in VCS?

(vi) Define I TON of refrigeration and show that 1TR = 3.5167 kW.

(vii) What are azeotropes?

(b) An absorption type refrigeration system is operating with heating, cooling and refrigeration temperatures set at 107°C, 27°C and -13°C respectively. Calculate the theoretical COP of the system. If the heating temperature is increased to 217°C and the refrigeration temperature is decreased to -43°C, what would be the resulting percent change in the COP of the system? What is the underlying thermodynamic reason for this change? **03**

(c) Demonstrate mathematically that the ideal COP for an absorption refrigeration system is equal to the product of COP of Carnot cycle mechanical refrigeration system and the efficiency of Carnot cycle heat engine. Draw a line diagram for such a representation. **04**

Q.2 (a) Explain the construction and operation of a simple vapour compression system with the help of a flow diagram showing all components. Draw P-h, T-s and h-s diagrams of a simple vapour compression refrigeration cycle indicating various state points. **07**

With the help of P-h diagram explain the effect of

(i) Increase in condenser temperature.

(ii) Sub-cooling of liquid exiting condenser.

(b) A R134a based simple vapour compression refrigeration system is operating at the following set points: **07**

Refrigeration capacity = 30 TR
Evaporating temperature = - 14 ^oC
COP of the system = 4 ;
Condensing temperature = 28 ^oC
Compressor discharge temperature = 35 ^oC
C_{pv} of superheated compressor discharge vapours = 1.062 kJ/kgK

Calculate the following:

(i) Mass flow rate of the refrigerant in kg/s.
(ii) Compressor power requirement in kW.
(iii) Quality of refrigerant at evaporator entry in %.
(iv) Condenser heat rejection in kW
(v) Carnot COP of the system.
(vi) Refrigeration efficiency in %
(vii) If η_{vol}= 95%, calculate actual piston displacement in m^3/s.

Thermodynamic Properties of R134a				
Temperature ^oC	h_f (kJ/kg)	h_g (kJ/kg)	P (bar)	v_g m^3/kg
- 14 ^oC	181.56	390.33	1.7074	0.1161
28 ^oC	238.77	413.95	7.268	0.02829

OR

Q.2 **(b)** An R-12 based system operating on simple vapour compression cycle. It develops 20 TR refrigeration effect at evaporating and condensing temperatures of – 5 ^oC and 40 ^oC respectively. Calculate the following: **07**

(i) Refrigerant mass flow rate in kg/s.
(ii) Theoretical compressor piston displacement in m^3/s.
(iii) Compressor power in HP.
(iv) Condenser heat rejection in kW.
(v) Actual COP of the cycle.
(vi) Carnot COP of the cycle.
(vii) Refrigeration efficiency in %.

R-12 Properties								
t (^oC)	h_g kJ/kg	h_f kJ/kg	s_g kJ/Kkg	s_f kJ/Kkg	v_g m^3/kg	$v_{f\times 10^{-3}}$ m^3/kg	C_P kJ/Kkg	P bar
- 5 ^oC	349.32	195.4	1.5571	0.9831	0.06496	0.707	0.635	2.61
40^oC	367.15	238.5	1.5405	1.1298	0.01817	0.798	0.788	9.60

Q.3 **(a)** Write brief notes on the following: **04**

(i) Limit Switches
(ii) Air washers
(iii) Humidistat
(iv) Draft

(b) Mention different types of air filters used in air conditioning systems. State the purpose of installing air filters in air conditioning systems for food processing plants. With the help of neat diagram explain the operation of (i) Electronic air filters (ii) Centrifugal dust collectors. **04**

(c) What are Axial and Centrifugal flow fans? State fan laws with the help of a 'Pressure-Flow' plot indicating variation of parameters like FTP, FVP, FSP, W and η. A fan running at 750 rpm delivers 12 m^3/minute of air developing a static pressure of 15 mm WC and consumes 75 Watts. If the fan speed is increased to 1500 rpm, calculate **06**

(i) Air flow rate in cmm

(ii) Static pressure in mm WC

(iii) Horsepower consumed

OR

Q.3 **(a)** Enumerate sensing elements employed for measurement of temperature, pressure and humidity in air-conditioning systems. With the help of a schematic layout diagram explain operation of an automatic temperature control device indicating feedback, amplifier, sensor, set point comparator, actuator indicator, controller etc. What do you mean by PID controller? **04**

(b) Answer the following: **04**

(i) What are Time Switches
(ii) What are AHU's?
(iii) What are good room air distribution requirements?
(iv) State the criteria for choosing the right fan.

(c) Classify different types of blowers and fans used for air-conditioning systems on the basis of their duty requirements. Graphically explain fan characteristics and state fan laws. A constant speed fan delivers air @10 m^3/s against a static head of 100 mm of WC when air density is 0.96 kg/m^3. Calculate the air flow delivery in m^3/s, power required in kW and static head in mm of WC when the air density becomes 1.20 kg/m^3. Take fan motor efficiency as 80%, g = 10 m/s^2. **06**

Q.4 **(a)** Write differentiating notes on the following: **06**

(i) Controlled atmospheric storage and modified atmospheric storage.
(ii) Vapour compression and vapour absorption refrigeration system.
(iii) Air cooled and water cooled condensers.

b) With the help of a neat sketch, explain the construction and working of an Electrolux refrigeration system. **04**

(c) What is the purpose of steam in vapour absorption refrigeration (VAR) system. Identify and enlist different components of a vapour absorption refrigeration (VAR) system that replace the compressor of a vapour compressor refrigeration system and state their functions? What is the function of hydrogen gas in Electrolux refrigeration system? **04**

OR

Q.4 **(a)** Classify different types of compressors. With the help of a neat sketch explain the construction and working of screw compressor and hermetically sealed compressor. **06**

(b) A cold room has four side walls measuring 2.5 m × 3.2 m × 2.6 m from inside. Each of these walls is made of 25 cm brick, 18 cm best board and 1.5 cm cement. The inside wall temperature is maintained at -25°C while the outside wall temperature is 27°C. Calculate the required refrigeration load in TR due to heat loss from the walls of the cold room. Take a safety factor of 2.5 for losses through door joints, crevices etc. Thermal conductivities of brick, board and cement plaster are 0.62 W/m°C, 0.042 W/m°C and 0.81 W/mK. **04**

(c) State the factors required to be considered while estimating total refrigeration load in cold storages. Suggest sustainable means to minimize heat loss from cold stores. **04**

Q.5 (a) Classify different types of evaporators on the basis of their construction and operation. Explain with neat diagram the principle, construction and working of shell-and-tube flooded type evaporator. Why are they considered more effective? **07**

(b) Explain the following: **07**

(i) CA storage (ii) Instant Freezing (iii) Pre-cooling of fruits
(iv) Modified atmospheric storage (v) HP/LP cut outs
(vi) Solenoid valves (vii) IQF

Q.5 (a) What do you mean by cold chains? Briefly explain different components of a cold storage and list out different types of safety devices and write their functions and location in the cold storage. **07**

(b) Explain the following: **07**

(i) MA storage (ii) Cascade refrigeration (iii) Flow regulating valves
(iv) Liquid accumulators (v) Latent heat (vi) Centrifugal compressor
(vii) Commonly used expansion valves

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