Enrolment No._

GUJARAT TECHNOLOGICAL UNIVERSITY BE - SEMESTER-V • EXAMINATION – SUMMER • 2015

Subject Code: 151403 Subject Name: Food Refrigeration and Air Conditioning Time: 02.30pm-05.00pm Instructions:

- 1. Attempt all questions.
- 2. Make suitable assumptions wherever necessary.
- 3. Figures to the right indicate full marks.
- Q.1 (a) A simple vapour compression refrigeration system is operating on given set of 07 conditions as follows:

Refrigerant operating fluid : R134a, Evaporating temperature = -10 °C COP of the system = 4.25 Avg. Sp. heat of superheated vapours = $1.11 \text{ kJ/kg}^{\circ}$ C Refrigeration capacity = 25 TR Condensing temperature = 34 °C Compressor discharge temperature = 40 °C η_{vol} = 95%,

Determine the following:

- (i) Carnot COP of the system
- (ii) Refrigeration efficiency in %
- (iii) Compressor power requirement in HP
- (iv) Actual piston displacement in m³/s
- (v) Mass flow rate of the refrigerant in kg/s.
- (vi)Refrigerant dryness fraction as it enters the evaporator.
- (vii) Heat rejected by the Condenser in kW

Thermodynamic Properties of R-134a											
t (⁰ C)	P bar	h _f kJ/kg	s _g kJ/kgK	s _f kJ/kgK	v _g m³/kg	$ ho_{f}$ kg/ m ³	C _{Pv} kJ/Kkg	h _g kJ/kg			
- 10	2.0	186.8	1.734	0.951	0.1	1326	0.842	393.8			
34	8.62	247.5	1.714	1.162	0.024	1171	1.073	417			
40	10.17	256.4	1.711	1.19	0.02	1147	1.12	419.6			

(b) Explain the operation of vapour absorption type refrigeration system with the help a 07 neat and labeled flow diagram. A vapour absorption type refrigeration system is operating such that refrigeration temperature is set at -13°C while heating and cooling temperatures are set at 109°C and 29°C respectively. Calculate the theoretical COP of such a system. If heating temperature is elevated to 220°C & the refrigeration temperature is lowered to −33°C, compute the resulting percent change in the COP of the system.

Date: 05/05/2015

Total Marks: 70

- Q.2 (a) Answer the following questions:
 - (i) Write chemical formula of R134a and R11?
 - (ii) Define COP of refrigeration systems.
 - (iii) What are radial flow fans?
 - (iv) What is the function of compressor in VCS?
 - (v) Why is Carnot COP greater than actual COP in VCS?
 - (vi) Define popular unit of refrigeration and show that its value is 3.5167kW.
 - (vii) State the safety criteria adopted while selecting refrigerants.
 - (b) What are desirable thermodynamic properties of refrigerants? Work out the 07 international designation 'R' for the following refrigerants:

 $C_2Cl_2F_4$, $C_2Cl_3F_3,\,C2H_4,\,and\,CO_2.$

A heat pump and a heat engine are operating together as depicted in the block diagram below:



- (i) Calculate & compare Input power in both the cases.
- (ii) Calculate & compare Carnot COP in both the cases.

OR

- (b) Explain the construction and operation of a simple vapour compression system with 07 the help of a neat flow diagram. With the help of P-h plot explain the effect of the following on the performance of a simple vapour compression refrigeration system:
 - (i) Decrease in evaporator pressure
 - (ii) Increase in condenser pressure
 - (iii) Sub-cooling of liquid exiting condenser
 - (iv) Suction vapour superheat
- Q.3 (a) Explain the need of instrumentation and control in refrigeration and air conditioning 06 equipments employed for food processing. Explain basic sensing elements used for measurement of temperature, pressure and relative 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, comparator, actuator indicator, controller etc.
 - (b) List different types of air filters used in air conditioning systems. With the help of 04 neat diagrams explain the construction and working of
 - (i) Electronic air filters
 - (ii) Wet scrubbers

A fan generates an air flow 720 m^3 /hour when running at 960 RPM. While 04 (c) operating, the fan consumes 0.12 HP power and develops a static pressure of 18 mm WC. If the fan speed is increased by 50%, calculate the following:

> (i) Air flow rate in m^3/h . (ii) Static pressure in mm WC. (iii) Power consumption in HP.

OR

- **Q.3** Write brief notes on the following: (a)
 - (i) Centrifugal flow fans (ii) Economic criteria for refrigerants (iii) Slot diffusers (iv) Draft (v) Cryogenic fluids
 - (vi) Azetropes
 - A spice processing industry has installed an air-filtration system which receives fine 04 **(b)** dust laden air having a specific dust loading of 3 kg/100 m³ of air. The exhaust air coming out of the filter has a dust loading of 100 g /100 m³ of air. Calculate the mass of dust separated by the filtration system per day (20 hours operation) if the air-filtration system handles 360 m³/min of input polluted air. Calculate the filtration efficiency of the filtration system?
 - Explain fan laws with the help of 'Pressure Versus Flow' diagram. For a fixed fan, (c) 04 calculate the percentage increase in air volume flow rate and power consumption if the fan speed is increased by 30%.

Q.4	(a)	Explain			
		(i) Limit switches			
		(ii) Green House Effect			
		(ii) Reason for 'Ozone layer' depletion in the stratosphere			
	(b)	Explain the following with diagrams wherever applicable:	08		
		(i) Cascade refrigeration system			
		(ii) Shell and tube evaporator			
		(iii) Sensible heat and latent heat			
		(iv) Screw type compressor			
		OR			
Q.4	(a)	a) Explain			
		(i) Time switches			
		(ii) Air Washer.			
		(iii) Induction or entrainment ratio			
	(b)	Explain the following with diagrams wherever applicable:	08		
		(i) Centrifugal compressor			
		(ii) Cold chain for fruits and vegetables			
		(iii) Commonly used expansion valves			
		(iv) Limitations of vapour compression refrigeration system			
Q.5	(a)	Explain the different components of a cold storage and state their functions. List different types of safety devices employed in cold storage units and mention their functions and location in the system.	07		

What is the function of compressor in a vapour absorption refrigeration system? **(b)** 07 Classify different types of compressor. Briefly explain the principle, construction and working of a water cooled condenser.

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- Q.5 (a) Explain the construction and working of a Domestic Electrolux Refrigerator with 07 neat well-labeled sketch.
 - (b) Differentiate between Controlled atmosphere storage and Modified atmosphere 07 storage. What are the applications of Modified atmosphere storage in food processing? Write a short note on Individual quick freezing (IQF) and mention its applications.
