Code: 9D17103

M.Tech I Semester Supplementary Examinations February/March 2018

REFRIGERATION

(Refrigeration & Air Conditioning)

(For students admitted in 2012, 2013, 2014, 2015 & 2016 only)

Time: 3 hours Max. Marks: 60

Answer any FIVE questions

All questions carry equal marks

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1 (a) Discuss the effect of the following on the performance of a vapour compression system: (i) Effect of suction pressure. (ii) Effect of delivery pressure. (iii) Effect of super heating. (iv) Effect of sub-cooling of liquid.

(b) The following data refer to a single stage vapour compression system.

Refrigerant used (Ozone friendly) - R-134a
Condensing temperature = 35℃
Evaporator temperature = -10℃
For compressor rpm = 2800
Clearance volume / Swept volume = 0.03
Swept volume = 269.4 cm^3
Expansion index = 1.12
Compression efficiency = 0.8
Condensate sub-cooling = 5℃

Determine: (i) Tonnage. (ii) Power. (iii) C.O.P. (iv) Heat rejection to condenser. (v) PI.

T,℃	P, bar	$V_g\ m^3/kg$	$H_f, KJ/kg$	$H_g, KJ/kg$	$S_f, KJ/kg\ K$	$S_g, KJ/kg\ K$
-10	2.014	0.0994	186.7	392.4	0.9512	1.733
35	8.870	-	249.1	417.6	1.1680	1.715

Assume: Specific heat of vapour at 8.87 bar.

2 (a) An ammonia saturated vapour compression cycle works between the pressure limits of 1.4 bar evaporator pressure and 10 bar condenser pressure. The mass flow rate of NH_3 to L.P. compressor is 16 kg/min. Calculate the power needed to run the plant and cop of the system when:

(i) System uses two stage compressions with liquid inter-cooling. The intermediate pressure is 4 bar and the vapour after inter cooling is dry saturated.

(ii) Single stage compression without intercooling. Assume no sub-cooling in the condenser.

(b) When will you recommend for multi stage VCR systems? What is the difference between a flash chamber and a flash intercooler?

3 In an aqua ammonia absorption refrigeration system of 9 tonnes refrigeration capacity, the vapour leaving the generator is 100% pure NH_3 saturated at 40℃. The evaporator, absorber, condenser and generator temperatures are -20℃, 30℃, 40℃, 170℃ respectively. At absorber exit (strong solution), the concentration of ammonia in solution is x = 0.35 and enthalpy h = 22 kJ/kg. At generator exit (weak solution) x = 0.1 and $h = 695\ kJ/kg$.

(i) Determine the mass flow rate of ammonia in the evaporator.

(ii) Carry out overall mass conservation and mass conservation of ammonia in absorber to determine mass flow rates of weak and strong solution.

(iii) Determine the heat rejection in absorber and condenser, heat added in generator and C.O.P.

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4 (a) Draw a neat diagram of "Electrolux refrigerator" and explain its working principle. What is the important role of hydrogen in this refrigeration system?
(b) Find the maximum COP of a vapour absorption refrigeration system in which heating, cooling and refrigeration takes place at the temperature of 100℃, 20℃ and -5℃ respectively.

5 A boot strap refrigeration system is used in airplane. The following observations are made. The ambient air temperature is 15℃ and pressure of 0.85 bar. Due to ramming action, pressure increases to 1 bar. This ram air is used for heat exchangers. This air is then compressed in primary compressor to 3.25 bar. The discharge pressure of air from secondary compressor is 4.25 bar. Assume compression efficiency of 0.9 and turbine efficiency of 0.85. Effectiveness for both heat exchangers is 0.7. The cabin pressure is 0.9 bar and temperature of air leaving the cabin is 22℃. Assuming remaining action isentropic, calculate COP and power required per ton of refrigeration.

6 (a) Describe the working of a steam jet refrigeration system with the help of a neat sketch.
(b) Derive an expression for finding out the mass of motive steam required per kg of water vapour produced.

7 Give the chemical formulae for the following refrigerants:
(a) (i) R-12. (ii) R-22. (iii) R-113. (iv) R-717.
(b) Why are R-12 and R-22 are used in hermetic compressors?
(c) Why is R-12 system susceptible to expansion valve freeze up?
(d) Among R-12, R-22, R-21 systems, which one requires an oil separator and why.
(e) Among R-11, R-12, R-21 and R-22 which are best suited for centrifugal compressors and why.
(f) Why is evaporator pressure kept above atmospheric in most refrigeration system?

8 Explain briefly:
(a) Montreal protocol and Kyoto protocol.
(b) Greenhouse effect and global warming.

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