INDIAN INSTITUTE OF TECHNOLOGY

Mechanical Engineering Department

MEL-711 Refrigeration and Air-conditioning Technologies Dated: 26.11.2008

Time: 2 hour Major Test Max Marks: 35

Note: 1. Do **four questions in all**, question no. 1 is compulsory.

2. Use of Refrigerant charts and tables is allowed

Q.1 (a) Explain in brief which of the refrigerant(s) HFC-123, HFC-134a, R-410A, R-404A and R600a would you choose for each of the following applications and why?

(i) Domestic Refrigeration

(ii) Small capacity air-conditioning (Window/Split units)

(b) Why is it necessary to use double rectifying column in industrial vapour-absorption using ammonia- water as refrigerant-absorbent combination. Explain the Principal Operating line for a double rectifying column.

(c) A hybrid liquid desiccant cycle is proposed to be used for a supermarket application. In this system the return air at 25^0C/ 10g/kg is mixed with saturated outdoor air at 30^0C in the ratio 2:1 and the mixture enters the dehumidifier which is simultaneously cooled by chilled water at 15^0C. The regenerator uses heated outdoor air for driving out the moisture from the solution. Make a schematic of the suggested system and show the processes on a psychrometric chart. Using steam tables, calculate the humidity ratio of the mixture and its dew point temperature.

(3 + 3 + 5)

Q.2 A R-404 A compound compression system is to be designed to provide 10 TR at (-) 20^0 C and 20 TR at 5^0 C. The system uses two stage compressions with multiple expansion valves and flash inter-cooling. The condensing temperature is 40^0C. Draw the schematic diagram and pressure-enthalpy diagram and calculate the following:

(a) Mass flow rate of refrigerant through each evaporators

(b) Power consumed by each compressor

(c) COP of the system **(8)**

Q.3 A 100 TR ammonia-water vapour-absorption system with liquid-liquid heat-exchanger and analyzer is to operate with the following data:

Evaporator temperature	=	-10° C
Condenser/absorber temperature	=	40° C
Condenser pressure	=	16 bar
Evaporator pressure	=	2 bar
Generator temperature	=	140° C

Show the cycle on enthalpy composition diagram and calculate the following:

(i) Specific strong and weak solution circulations.

(ii) Amount of heat to be supplied in the generator

(iii) COP of the system

(8)

Q. 4 A steam ejector refrigeration system using water as refrigerant is supplied with dry saturated motive steam at 8bar. The water evaporates in the flash chamber at 6^0C, while the make up water enters at 20^0C. The condenser pressure is 4kPa. The quality of mixture at the inlet of diffuser is 0.9.

Calculate the COP of the system and the mass flow rate of motive steam required per unit mass flow rate of water. For the sake of simplicity, assume nozzle, diffuser and entrainment efficiencies to be 1, 0.8,0.6 respectively.

(8)

Q.5 a) Explain the Claude process of gas liquefaction and distinguish it from the Linde-Hampson process. Derive a formula for liquid yield for the Claude process and compare it with the Linde process for the same pressures across the compressor. How does the work of compression compare for the two processes?

b) In the experiment on vortex tube conducted in the laboratory, is it possible to vary the cold air mass fraction at a given inlet pressure? Plot a curve of temperature drop with the cold air fraction. How does this curve change at a higher pressure?

(6+2)