INDIAN INSTITUTE OF TECHNOLOGY

Mechanical Engineering Department

MEL-711	*Refrigeration and Air-conditioning Technology*	Dated: 01.12.2006
Time: 2 hour	Major Test	Max Marks: 40

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

   2.   Use of Refrigerant charts and tables is allowed

1. a) What are the desirable characteristics of a refrigerant? Explain in brief giving precise reasons, how would you select a non Ozone Depleting refrigerant for a small freezer (500W cooling capacity) operating at an evaporator temperature of − 25°C out of following refrigerants CFC-12, HCFC-22, HC blend, HC-600a and R-404A?

   b) Explain Ewing's construction for determining the state of beginning of compression process for optimum COP of a vapour compression system. State its limitations.

   c) Explain in brief water to air vapour compression heat pump. Why is HFC-227 preferred as an alternative to CFC-114 in heat pumps?

   d) The pressure − temperature relationship of a pure substance is given by the following expression:

   $$\ln p = A - B/T$$

   Explain how the slope of the line is affected by the latent heat of vapourization?

   (3 + 2 + 2 + 3)

2. HFC-134a vapour compression refrigeration system of 80TR refrigeration capacity is being used for air-conditioning of a building with following operating conditions:

   Condensing temperature = 45°C   ;   Evaporator temperature = 5°C

   The condensate is sub cooled to 35°C by suction vapour in a regenerative heat exchanger. The system uses a reciprocating compressor having 5% clearance and process index. 1.12. Neglect pressure drop at suction & discharge valves.

   If this system is to be used for low temperature application like cold storage where the evaporator is to operate at -10°C, show the cycles on P-h diagram and calculate:

   a) The percentage change in refrigeration capacity of the compressor.

   b) The change in work of compression per ton refrigeration.

   c) COP of the system operating as cold storage.   **(10)**

3.   An aqua-ammonia vapour absorption refrigeration system having dephlegmator, analyzer and liquid-heat exchanger working with geometrical energy is to be designed for an apple cold storage under following conditions:

Generator temperature	=	90°C
Condenser temperature	=	15°C
Mean cvaporator temperature	=	-10°C
Condensing pressure	=	6.5 bar
Evaporator pressure	=	2.5bar

Establish the thermodynamic states on $h - \xi$ diagram, write the assumptions made and calculate the following for 7.5 tons of refrigeration.

   a) Specific strong solution eirculation.
   b) Heat supplied at the generator.
   c) Heat rejected at condenser and absorber.
   d) COP of the system.   (10)

4. a) Explain in brief the working principle of steam jet compression system. Derive an expression for the ratio of motive steam to vapour flashed in a steam ejector using a simplified approach.

   b) What is principal operating line of a generator having a dephlegmator and analyzer? Derive an expression for the principal operating line.

   c) Explain with the help of suitable thermodynamic diagram, the working prineiple of CO_2 transcritical cycle for heat pumps. Why is CO_2 considered as one of the potential refrigerant for heat pump applications?   (3+4+3)

5. a) What are the main characteristics of solid desiccant based systems? Explain the working principle of Ventilation cyele with the help of schematie and psyehrometrie process diagrams.

   b) Explain in brief with the help of line diagram the working principle of single stage and two stage thermoelectric cooling. Derive expressions for correeted eooling capaeity and COP of a simple thermoelectrie cooler.

   e) Why is reversed sterling cycle used for liquefaction of gases? Explain its working principle with the help of suitable thermodynamic cycle. Show that its COP is equivalent to Carnot COP.   (4+3+3)