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MMTP - 203

M.E./MTech. II Semester

Examination, June 2013

Advance Refrigeration Systems

Time : Three Hours

Maximum Marks : 70

Note : 1. *Attempt any five questions.*
2. *Assume suitable data if missing.*
3. *Use of relevant Property tables and charts is permitted.*

1. a) How the actual vapour compression refrigeration cycle deviates from the theoretical cycle and why?
   b) Write a detailed note on screw compressor and compare it with reciprocating and centrifugal compressors for refrigerating systems.

2. a) Why is the throttling process preferred over isentropic expansion process in vapour compression refrigeration cycle? Justify your answer.
   b) Write a detailed note on refrigerant-absorbent pair for an vapour absorption refrigeration system.

3. A cascade refrigerator system is designed to supply 10 TR at an evaporator temperature of -60°C. The load at -60°C is absorbed by a unit using R22 as the refrigerant and rejected to a cascade condenser at -20°C. The cascade condenser is cooled by a unit using R-12 as a refrigerant and operating between - 30°C evaporator temperature and 25°C condenser temperature. The refrigerant leaving the R-12 condenser is

subcooled to 20°C, but there is no subcooling of R-22 refrigerant.

The gas leaving both evaporator is dry and saturated and compressions are isentropic. Neglecting losses, determine:

a) Compression ratio of each unit
b) Quantity of refrigerant circulated per minute for each unit
c) COP of each unit
d) COP of whole system
e) Theoretical power required to run the system

4. a) Explain in briefs which refrigerant/s would you choose for each of the following applications and why?
   i) A cold storage of 100 TR capacity using reciprocating compressor
   ii) An 800 TR air conditioning plant using centrifugal compressor.

   b) Calculate the latent heat of vaporization of R134a at -25°C and +50°C. the P^{sat} versus T^{sat} relationship of R134a is

$$\ln P^{sat} = 24.8 - \frac{3980}{T^{sat}} - 0.024\, T^{sat}$$

   where P^{sat} is in KPa and T^{sat} is in K. Use the specific volumes data from the table of properties of R 134a.

5. a) What is the purpose of an oil separator? Where is it provided in the vapour compression refrigeration system.
   b) Sketch a thermostatic expansion valve and explain its working.

6. a) Describe briefly the different types of evaporators used in the refrigeration industry.
   b) Describe the advantages of wire and tube condenser.

7. a) A spacer is used in reciprocating compressor to introduce clearance volume. A refrigerator manufacturer wishes to standardize the components of a reciprocating compressor

for refrigeration systems of capacities of 2 KW and 2.5KW by varying only the spacer. Both the systems use the same refrigerant which has an isentropic index of compression of 1.116 and operate over a pressure ratio of 5. The operating temperatures are also same for both the systems. If the required clearance factor for the 2.5KW system is 0.03, what should be the clearance factor for the 2KW system?

   b) Design a condenser for a refrigeration system using R-717. The condensing temperature is 313K and enthalpy of liquid R717 at 313K is 371 KJ/kg. The enthalpy at the end of compression is 1472 KJ/kg. There is no sub cooling of condensate and vapour at the end of compression is dry and saturated. The refrigerant flow rate is 0.1 Kg/s. The economic water velocity is 1.5 m/s and overall heat transfer coefficient (on outer diameter) is 2.04 KJ/m^2 -K-S.
   Pipe diameters are di = 15 mm and d_0 = 20 mm and pipe lengths not to exceed 3000 mm. The water temperature rise is 5K with an inlet temperature 303K. Obtain the number of tubes and number of Passes required for Shell and tube condenser.

8. a) The operating temperatures of a single stage vapour absorption refrigeration system are : generator : 90°C; condenser and absorber : 40°C; evaporator : 0°C. The system has a refrigeration capacity of 100 KW and the heat input to the system is 160 KW. The solution pump work is negligible. An inventor claims that by improving the design of all the components of the system he could reduce the heat input to the system to 80KW while keeping the refrigeration capacity and operating temperatures same as before. Examine the validity of the claim.
   b) Discuss the enthalpy - concentration behaviour of an ideal mixture and a real mixture with negative deviation from Raoult's Law.

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