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Faculty of Engineering & Technology

Seventh Semester B.E. (Mech.)/Seventh Semester B.E.P.T. (Mech.) Examination

REFRIGERATION AND AIR-CONDITIONING

Elective—II

Sections—A & B

Time—Three Hours] [Maximum Marks—80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Answer **THREE** questions from Section A and **THREE** questions from Section B.

(3) Illustrate your answers wherever necessary with the help of neat sketches.

(4) Use of Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.

(5) Use of non-programmable calculator is permitted.

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SECTION—A

1. (a) Discuss in short desirable properties of an ideal refrigerant. 4

   (b) A simple ammonia vapour compression refrigeration system operates with a capacity of 150 TR. Condensation temperature in the condenser is 35 °C. The evaporation temperature in brine cooler is –25 °C. Ammonia leaves the evaporator and enters the compressor at –8 °C. Liquid ammonia enters the expansion valve at 30 °C. The pressure drops in suction and discharge valves are 0.1123 bar and 0.5275 bar respectively. The index of compression process is 1.22. If the volumetric efficiency is 75% then calculate :

   (i) Indicated power

   (ii) Heat transferred to cylinder jacket in kJ/min

   (iii) Piston displacement in m^3/min

   (iv) Heat transferred to condenser cooling water in kJ/min

   (v) C.O.P. 9

2. (a) Explain in short the working of a three fluid refrigerator. List its advantages and limitations too. 5

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(b) A two stage compression ammonia refrigeration system with water and flash intercooling and water sub-cooling, operates between overall pressure limits of 13.9 bar and 1.9 bar. The flesh intercooler pressure is 5.0 bar. The temperature of refrigerant leaving the water intercooler and water sub-cooler is limited to 30°C. If the load on the system is 25 TR, find :

(i) Coefficient of performance of the system

(ii) Power required to drive each compressor

(iii) Swept volume for each compressor if the volumetric efficiency for both the compressors is 75%. 9

3. A single compressor system using R-12 as refrigerant has three evaporators of capacities 10 TR, 20 TR and 10 TR. The temperatures in the three evaporators is to be maintained at 10°C, 0°C and –10°C respectively. The system is provided with individual expansion valves and back pressure valves. The condenser temperature is 40°C. The liquid refrigerant leaving the condenser is subcooled to 35°C. The vapours leaving the evaporators are dry and saturated. Assuming isentropic compression find :

(i) Mass of the refrigerant flowing through each evaporator

(ii) Power required to drive the compressor

(iii) C.O.P. of the system. 13

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4. (a) Discuss in short various applications of Cryogenics. 4

(b) Explain in brief with the help of a schematic diagram and T.S. diagram the working of a Claude air liquefaction system. 5

(c) Describe in short the working of a Bell-Coleman refrigerator. 4

5. Write short notes (any **THREE**) :—

(a) Mixture refrigerants

(b) Thermetically sealed compressors

(c) Thermostatic expansion valve

(d) Thermoelectric refrigerator. 13

SECTION—B

6. (a) Define the following Psychrometric properties of moist air :—

(i) Dew point temperature

(ii) Relative humidity

(iii) Humidity ratio

(iv) Degree of saturation. 4

(b) Air at 10°C drybulb temperature and 8°C wet bulb temperature is supplied at the rate of 15 m^3/mins. It is brought to 20°C dry bulb temperature and 60%

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relative humidity by heating and then by adiabatic humidification. Find :

(i) Capacity of the heating coil in kW

(ii) Surface temperature of the coil if the bypass factor is 0.32 and

(iii) Capacity of the humidifier. 9

7. The following data is given for the space to be air conditioned :

(i) Outdoor design condition = 43°C DBT & 27°C WBT

(ii) Indoor design condition = 25°C DBT & 50% RH

(iii) Room Sensible heat load = 40 kW

(iv) Room Latent heat load = 10 kW

(v) Bypass factor of the cooling coil = 0.2.

The return air from the space is mixed with the outdoor air before entry to the cooling coil in the ratio of 3 : 1 by mass.

Determine :

(a) Supply air flow rate,

(b) Outdoor air sensible heat,

(c) Outdoor air latent heat,

(d) Grand total heat, and

(e) Effective room sensible heat factor. 13

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8. The following design data is available for an air conditioning system of a restaurant :

(i) Outdoor conditions = 34°C DBT & 28°C WBT

(ii) Indoor conditions = 24°C DBT & 50% RH

(iii) Solar heat gain through walls, roof and floor = 4.7 kW

(iv) Solar heat gain through glass areas = 4.4 kW

(v) Occupants = 25

(vi) Sensible heat gain/person = 85 W

(vii) Latent heat gain/person = 105 W

(viii) Internal lighting load = 15 lamps of 100 watts capacity each plus 10 fluorescent fixtures of 80 watts each

(ix) Sensible heat gain from other sources = 11.6 kW

(x) Infiltration air = 14 m^3/min

(xi) Coil bypass factor = 0.15

If the return and outdoor air are adiabatically mixed in the ratio of 3 : 2 (by mass) and then passed through the conditioner, determine :

(a) Condition of supply air,

(b) apparatus dew point, and

(c) Capacity of the air conditioning plant. 14

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9. (a) Briefly describe the static regain method of duct sizing. 4

(b) What is the selection criterion for choosing air outlets ? What are the different types of air outlets ? 5

(c) Write in short about the following :—

(i) Humidistat

(ii) Thermostat. 4

10. Write short notes on (any **THREE**) :—

(a) Comfort chart

(b) Desert cooler

(c) Year round air conditioner

(d) Thermodynamic wet bulb temperature. 13

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