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SEAT No._____

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SARDAR PATEL UNIVERSITY
EXTERNAL EXAMINATION
M.SC. INDUSTRIAL CHEMISTRY
(SECOND SEMESTER)
PS02CICH24: HEAT TRANSFER OPERATIONS AND STOICHIOMETRY
THURSDAY, 12TH APRIL, 2018

Time: 10:00 am to 1:00 pm **Total Marks: 70**

Q-1. Answer the following multiple choice question. **[08]**

1. Heat transfer co-efficient for liquids increases with-------
   a. Increasing temperature b. Decreasing temperature
   c. Decreasing Reynolds number d. None of these
2. Thermal diffusivity is given by
   a. Cp μ/k b. ρCp/k c. k/ρCp d. μ/hCp
3. The unit of heat transfer co-efficient is
   a. W/m^2K b. W/secK c. W/mK d. W/secm
4. Multipass exchangers are used
   a. Because of its simplicity in construction
   b. For low heat load
   c. To obtain high heat transfer co-efficient
   d. To reduce pressure drop
5. Nusselts number is
   a. kD/h b. hD/k c. $C_p\mu$ /k d. hC_p/μ
6. The ratio of moles of any component to the total moles of the system is called....
   a. Mole percent b. Mole ratio
   c. Molality d. Molarity
7. Heat flux is the amount of heat transferred per
   a. Unit area b. Unit time
   c. Unit area x unit time d. Unit area x unit density
8. Heat sensitive materials can be concentrated in an evaporator by employing
   a. Vacuum b. High pressure
   c. High residence time d. High temperature

Q-2 Answer any seven of following. **[14]**

1. State SteafanBoltzman law and Newtons law.
2. Distinguish between the various modes of heat transfer.
3. Enlist the important requirements of insulating materials.
4. Define the various dimensionless numbers used in forced convection calculations.
5. Distinguish between triangular and square tube pitch.
6. Why viscous fluid taken shell side in a shell & tube exchanger?
7. Why are baffles placed in shell and tube heat exchangers? What is the Indian Standard for baffle spacing?
8. Define heat of mixing with suitable example.
9. Define the capacity of evaporator & economy of evaporator.

Q-3 a. The four walls are made of different types of material. The distance between wall is 0.2 m, 0.2 m, 0.006 m respectively. Temperature are 1050^0C and 30^0C. Thermal conductivity K_1=1.52 W/m^0C, K_2 = 0.138 W/m^0C, K_3=45 W/m^0C. Find the rate of heat transfer and interface temperatures. **(06)**

b. 1000Kg/hr of butter at 20^0C is pumped through a tube of diameter 0.075m and 1.2m length which is maintained 60^0C. Calculate heat transfer co-efficient.ρ=1100Kg/m^3, μ=86400Kg/hr.m, Cp=2.85KJ/Kg^0C, K=1.55 KJ/hrm^0C **(06)**

[P.T.O.]

OR

b. A 0.115m diameter pipe is covered with 3 layer of insulation. The first layer is 0.052m thick with a thermal conductivity K=0.062 W/m^{0}C. The second layer is 0.010m thick with K=0.800W/m^{0}C. The third layer is 0.02m thick with K=0.872W/m^{0}C. The temperature at inner and outer surfaces is 600^{0}C & 311^{0}C. Find the heat loss per meter length and the interface temperature. (06)

Q-4 a. Discuss the construction and working of double pipe heat exchanger with neat diagram with its merits and demerits over S&T HE. (06)

b. Calculate the surface are for a counter current shell heat exchanger used to heat 4000kg/hr of oil from 10^{0}C to 20^{0}C using hot water entering at 70^{0}C and flowing at 690kg/hr. the internal diameter of shell 0.5m, 10 tubes are fitted having outer diameter 0.021m and internal diameter 0.018m. (06)
Cp oil = 1.885 KJ/Kg.^{0}C, Cp water = 4.18 KJ/Kg.^{0}C, U = 3000KJ/hr m^2.^{0}C

OR

b. A parallel S&T HE of 1.5m length and 10 tubes has to cool 1000Kg/hr of oil from 60^{0}C to 35^{0}C. The cooling water enters at 15^{0}C, which leaves at 25^{0}C. Calculate the efficiency of heat exchanger. (06)
Cp oil = 2.1 KJ/Kg.^{0}C, Cp water = 4.18 KJ/Kg.^{0}C

Q-5 a. 5000Kg/hr of feed contains 50% of methanol & 50% of water. The distillate contains 95% methanol & a residue contains 8% methanol. Calculate the % loss of methanol. (06)

b. 100Kg mixture of acetone(28%) and chloroform(72%) by weight is to be separated by extraction using a solvent. Calculate the weight ratio of solvent to feed. The composition of extract and raffinate is as follows: (06)

	Acetone	Chloroform
Extract	7.50	3.50
Raffinate	20.30	67.30

OR

b. 2000Kg of wet solid contains 70% solid is fed in to a rotary drier where it is dried using hot air. The product from drier contains 1% moisture and 99% solids. Calculate the Kg of water removed. (06)

Q-6 a. $CO + 2H_2 \rightarrow CH_3OH$ (06)
By using above reaction calculate the following:
1. Stoichiometric coefficient of H_2 to CO
2. Kmol methanol produced
3. Kg of CO required to produce 1000Kg methanol

b. A stream of N_2 flowing at rate of 100Kmol/hr is heated from 303K to 373K. Calculate heat that must be transferred per hour. n=100, (a=29.5909, b= - 5.141x10^{-3}T, c= 11.1829 x10^{-6}T^2, d= - 4.968 x10^{-9}T^3) in KJ/KmolK. (06)

OR

b. Calculate the standard heat of reaction (ΔH_R) for following reaction if 50kmol CO_2 is produced. (06)
$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

	ΔH_F (KJ/kmol)
C_4H_{10}	125.79
CO_2	393.51
H_2O	285.83