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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]

- Heat transfer co-efficient for liquids increases with-----
a. Increasing temperature b. Decreasing temperature
c. Decreasing Reynolds number d. None of these
- Thermal diffusivity is given by
a. $C_p \mu/k$ b. $\rho C_p/k$ c. $k/\rho C_p$ d. $\mu/h C_p$
- The unit of heat transfer co-efficient is
a. W/m^2K b. $W/secK$ c. W/mK d. $W/secm$
- 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
- Nusselts number is
a. kD/h b. hD/k c. $C_p \mu /k$ d. $h C_p/\mu$
- 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
- 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
- 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]

- State Stefan Boltzman law and Newtons law.
- Distinguish between the various modes of heat transfer.
- Enlist the important requirements of insulating materials.
- Define the various dimensionless numbers used in forced convection calculations.
- Distinguish between triangular and square tube pitch.
- Why viscous fluid taken shell side in a shell & tube exchanger?
- Why are baffles placed in shell and tube heat exchangers? What is the Indian Standard for baffle spacing?
- Define heat of mixing with suitable example.
- 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 $1050^\circ C$ and $30^\circ C$. Thermal conductivity $K_1=1.52 W/m^\circ C$, $K_2 = 0.138 W/m^\circ C$, $K_3=45 W/m^\circ C$. Find the rate of heat transfer and interface temperatures. (06)
- b. 1000Kg/hr of butter at $20^\circ C$ is pumped through a tube of diameter 0.075m and 1.2m length which is maintained $60^\circ C$. Calculate heat transfer co-efficient. $\rho=1100Kg/m^3$, $\mu=86400Kg/hr.m$, $C_p=2.85KJ/Kg^\circ C$, $K=1.55 KJ/hrm^\circ C$ (06)

①

[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 $K=0.062 \text{ W/m}^\circ\text{C}$. The second layer is 0.010m thick with $K=0.800\text{W/m}^\circ\text{C}$. The third layer is 0.02m thick with $K=0.872\text{W/m}^\circ\text{C}$. The temperature at inner and outer surfaces is 600°C & 311°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 area for a counter current shell heat exchanger used to heat 4000kg/hr of oil from 10°C to 20°C using hot water entering at 70°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. $C_p \text{ oil} = 1.885 \text{ KJ/Kg.}^\circ\text{C}$, $C_p \text{ water} = 4.18 \text{ KJ/Kg.}^\circ\text{C}$, $U = 3000\text{KJ/hr m}^2.^\circ\text{C}$. (06)

OR

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

- 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)

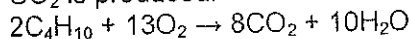
	Acetone	Chloroform
Extract	7.50	3.50
Raffinate	20.30	67.30

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. $\text{CO} + 2\text{H}_2 \rightarrow \text{CH}_3\text{OH}$ (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. $n=100$, $(a=29.5909$, $b= - 5.141 \times 10^{-3}T$, $c= 11.1829 \times 10^{-6}T^2$, $d= - 4.968 \times 10^{-9}T^3)$ in KJ/KmolK . (06)

OR

- b. Calculate the standard heat of reaction (ΔH_R) for following reaction if 50kmol CO_2 is produced. (06)



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