PAPER ID-310493

Roll No: | | | | | | | |

B TECH
(SEM-VII) THEORY EXAMINATION 2020-21
PROCESS DESIGN & ECONOMICS

Time: 3 Hours *Total Marks: 70*

Note: Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt *all* questions in brief. 2 x 7 = 14

a.	Write the relationship between individual and overall heat transfer coefficient.
b.	Draw the temperature-length curve for counter-current heat exchange.
c.	Write shot note on fouling factor.
d.	What do you understand by thermal boundary layer?
e.	Write the expression for Smoker equation.
f.	Differentiate fixed cost and variable cost.
g.	Define (i) Gross profit (ii) Net profit

SECTION B

2. Attempt any *three* of the following: 7 x 3 = 21

a.	A steel tube with ID of 200 mm, OD of 220 mm and a thermal conductivity (k_1= 40 kcal/m hr ^{0}C) is covered with two layers of two different insulating materials. The thickness of the first layer is 50 mm and that of the second layer is 80 mm while the thermal conductivities are k_2= 0.172 kcal/m hr ^{0}C and k_3 = 0.086 kcal/m hr ^{0}C. The temperature of the inner surface is 327 ^{0}C and that of the outer surface of insulation is 45 ^{0}C. Determine the heat loss through a length of 1 m of the pipe line and also the interface temperatures between the individual layers.
b.	Why LMTD is used in designing of double pipe heat exchange? Develop an expression for evaluation of LMTD in true co-current heat exchanger.
c.	Write a detail note on; (i) Condensers (ii) Reboilers
d.	Obtain an expression for the determination of the height of the absorption tower (HTU).
e.	A process plant has an initial investment of Rs. 50 lakhs. The estimated salvage value is Rs. 2 lakhs. It has a life of 8 years. Estimate the book value of the plant after 5 years by; i. Straight line depreciation method. ii. Declining balance method.

SECTION C

3. Attempt any *one* part of the following: 7 x 1 = 7

(a)	Explain the difference between a double pipe heat exchanger and a shell and tube heat exchanger. Also draw a neat sketch of a 2-4 shell and tube heat exchanger showing its operation.
(b)	Liquid Hg glows through a steel tube having an ID of 4 cm and heated from 350 ^{0}C to 450 ^{0}C. The tube wall is maintained at a constant temperature of 500 ^{0}C. Liquid Hg is flowing at the rate of 400 kg/minute. Calculate:

PAPER ID-310493

Roll No:

i. Heat transfer coefficient
ii. Length of required tube

Following properties for liquid Hg can be used ;

ρ = 825 kg/m^3
c = 1.36 kJ/kg K
k = 74 W/m K
μ = 2.165 X 10^{-4} Ns/m^2
Pr = 0.0039
Nu = 0.625 (RePr)$^{0.4}$

7 x 1 = 7

4. **Attempt any *one* part of the following:**

(a) Write detail note on;
(i) Jacketed vessels
(ii) Internal coils

(b) A hot fluid flows through a well-mixed stirred tank which is provided with a cooling jacket. The fluid in the cooling jacket can also be assumed to be well mixed. Calculate the heat transfer area of the jacket required given the following data:

Hot fluid: Flow rate W_h = 50 Kg/s
T_{ih} = 205 ^{0}C
C_{ph} = 2 KJ/ Kg ^{0}C

Cold fluid: Flow rate W_c = 100 Kg/s
T_{ic} = 25 ^{0}C
C_{pc} = 4 KJ/ Kg ^{0}C
U = 2.5 kW/m^2 ^{0}C

7 x 1 = 7

5. **Attempt any *one* part of the following:**

(a) Explain the procedure to determine the minimum number of theoretical plates by McCabe Thiele method.

(b) Write short note on;
i. Plate pressure drop
ii. Van Winkle's correlation

7 x 1 = 7

6. **Attempt any *one* part of the following:**

(a) It is desired to recover 98% ammonia from air-ammonia mixture containing 2% ammonia at 20 ^{0}C and at 1 atm by scrubbing with water in a tower packed with 2.54 cm reaching rings. If the gas flow rate is 19.5 kg/m^2 .min at the inlet and liquid flow rate is 1.8 times the minimum. Estimate the height of packed tower for countercurrent operation. Absorption is assumed to be isothermal. The equilibrium relation is given by y = 0.764 x, where y, x are gas and liquid phase composition of ammonia in mole fraction respectively. The overall mass transfer coefficient is 1.04 kg mole/m^3 atm min.

(b) Derive an operating line equation for gas absorber and stripper section of counter current tower.

7 x 1 = 7

7. **Attempt any *one* part of the following:**

(a) Discuss the type of cost indices available in the chemical engineering literature. Also discuss the importance of these cost indices for cost estimation of chemical engineering equipments.

(b) Discuss about the cash flow analysis in detail.