Registration No : | | | | | | | | | | |

Total number of pages 02 **B.Tech.**
PCE5I102

5th Semester Regular/Back Examination 2018-19
PROCESS EQUIPMENT DESIGN
BRANCH : CHEM
Time : 3 Hours
Max Marks : 100
Q.CODE : E377

Answer Question No.1 (Part-I) which is compulsory, any eight from Part-II, and any two from Part-III.
The figures in the right-hand margin indicate marks.
Assume suitable notations and any missing data wherever necessary.
Answer all parts of a question at a place.

Part – I
Short Answer Type Questions (Answer All TEN)

Q1. Answer the following questions : **(10 x 2)**

a) When partial condenser is used in distillation operation?
b) If the purity of the products are 99% by weight for equal amount of distillate and residue, find out the feed composition in a continuous distillation operation.
c) Number of trays increases as reflux ratio decreases. (True/False)
d) Define HETP.How it is calculated ?
e) What is channeling in packed tower?
f) What are the factors considered for selecting the evaporator?
g) Why the down-take area is provided in calendria type evaporators?
h) Cold fluid heated from 30 to 75^0C with the help of hot fluidwhich is available at 120^0C. Calculate the LMTD for parallel flow condenser.
i) What is BWG number ? Mention its uses.
j) Baffles are necessary for shell and tube heat exchanger. Justify.

Part – II
Focused-Short Answer Type Questions(Answer Any Eight out of Twelve)

Q2. Answer the following questions : **(6 x 8)**

a) Show the number of ideal trays in McCabe Thiele diagram for total reflux condition for 90% purity product (mol%).
b) Draw a neat sketch of "top view of a sieve tray" with its specifications.
c) Draw a neat sketch of at least three "packing materials" used in a packed tower.
d) Show the number of stages in aX-Y plot for counter current absorption operation with reference to a packed tower with notations.
e) Differentiate between plate tower and packed tower.
f) Show the operating ranges of Desuperheater-Condenser and Condenser-Cooler on "Temperature-Length of exchanger" plot.
g) Draw a double pipe heat exchanger with specification.
h) Define the method to obtain the temperature correction factor (F_T) for a shell and tube heat exchanger.

i) A 1-2 shell and tube heat exchanger is to supply hot water receiving heat from flue gas at 440K and cooled to 400K. 1500 kg/sec of water at 300K enters the tubes at a velocity of 4 m/sec and leaves at 330K. Gas inlet pressure may be taken as 1 atm. Calculate the number of tubes, shell ID, and length of heat exchanger. Data: Tube ID =2.12cm, OD =2.54cm, P_T = 3.175cm(Δ), U_D = 1000 kcal/hr.m^2.K.

j) Write the energy balance equations for forward feed triple effect evaporator showing the notations in box diagram.

k) Draw a horizontal tube evaporator with specifications.

l) An evaporator is to be fed with 7500 kg/hr solution containing 5% solute by weight. The feed at 30^0C is to be concentrated to a solution of 40 % solute by weight. Steam is available at 120^0C. Overall heat transfer coefficient, U, is 2000 kcal/hr.m^2.^{0}C. Evaporator is operated at a pressure of 460 mmHg absolute (T = 87^0C, H_v = 635 kcal/kg). BPR can be neglected. Enthalpy of the feed and product stream can be taken as 90 and 80 kcal/kg respectively. For this purpose, 1.5 m length and 25mm OD tubes are used. Calculate the number of tubes, height, and diameter of the horizontal tube evaporator.

Part – III

Long Answer Type Questions (Answer Any Two out of Four)

Q3. A methanol (CH_3OH) – water(H_2O) solution containing 50 weight % methanol at 27^0C is to be continuously rectified at 2 std. atm. pressure at a rate of 5000 kg/hr to provide a distillate containing 95% methanol and a residue containing 8% methanol(by weight). The feed is to be preheated by heat exchanger with residue to its boiling point. The distillate is to be partially condensed to a liquid and the reflux returned at the bubble point. A reflux ratio of 2.0 times of minimum is to be used. Relative volatility of 2.8 can be taken for the system equilibrium data. Calculate the height and diameter of the distillation column assuming actual vapor velocity of 1.2 m/s. Boiling point of methanol is 65^0C. **(16)**

Q4. Draw a neat sketch of plate type continuous distillation column with all necessary accessories and specifications in detail. **(16)**

Q5. A forward feed double effect evaporator is employed to produce 6000 kg/hr of aqueous solution with 45% solids from a solution containing 10% solids at 25^0C. The dry and saturated steam at 240 kPa is used as a heating medium and the temperature in the second effect is 50^0C. The specific heat of the feed and product is 0.8 kcal/kg ^{0}C. BPR of 5^0C and 7^0C cannot be avoided in 1st and 2nd effects respectively. The overall heat transfer coefficients are 1500 and 950 kcal/hr.m^2.^{0}C in 1st and 2nd effects respectively.Calculate the height and diameter if the two evaporators are identical (heating surfaces are within 10% range). **(16)**

Q6. Draw a neat sketch of 2-4 shell and tube heat exchanger with all specifications in detail. **(16)**