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# M. TECH. DEGREE EXAMINATIONS: DECEMBER 2009

First Semester

## BIOTECHNOLOGY

BTY505: Chemical Process Engineering

**Time: Three Hours** **Maximum Marks: 100**

**Answer ALL Questions:-**

**PART A (10 x 2 = 20 Marks)**

1. Prove that Reynolds number and Prandel Number are dimensionless.
2. In the production of sulphur trioxide 100kmol of $SO_2$ and 200kmol of $O_2$ are fed to a reactor. The product stream is found to contain 80kmol $SO_3$. Find the percentage conversion of $SO_2$.
3. What are the methods adopted to prevent cavitations in a pump?
4. Write the relation between friction factor and pressure drop.
5. What are the common arrangements made in tubes for a shell and tube heat exchanger?
6. Write the relation between h and U with units.
7. Define $\upsilon$ and $R_M$ with units for membrane filter.
8. Name the equipment where equimolar counter current diffusion taking for separating two liquids.
9. How will you measure the humidity of gases released from an anerobic reactor during biogas production?
10. How will you control the flow of air in an air lift fluidized bed bioreactor?

**PART B (5 x 16 = 80 Marks)**

11. (a) The ultimate analysis of a coal sample is given below

Carbon = 61.5%, Hydrogen = 3.5%, Sulphur = 0.4%, Ash = 14.2%, Nitrogen = 1.8% and the rest oxygen.

Calculate

(i) Theoretical oxygen requirement per unit weight of coal.

(ii) Theoretical oxygen requirement per unit weight of fuel.

(iii) The orsat analysis of flue gases when the coal is burned with 90% excess dry air.

**(OR)**

(b) (i) Obtain an empirical equation for calculating the heat of reaction at any temperature T(in K ) for the following reaction (10)

$$CH_4 + C_2H_4 \rightarrow C_3H_8$$

Data: $\Delta H_R$ at 298k =-82.66kj/mol

$C_P = a + .bT + .cT^2 + .dT^3$, KJ/ (Kmol. K)

| Component | a | bx $10^3$ | c x $10^6$ | dx$10^9$ |
|---|---|---|---|---|
| $CH_4$ | 19.2494 | 52.1135 | 11.973 | -11.3173 |
| $C_2H_4$ | 4.1261 | 155.0213 | -81.5455 | 16.9755 |
| $C_3H_8$ | -4.2227 | 306.264 | -158.6316 | 32.1455 |

(ii) With a block diagram write the general overall and component material balance for Distillation and Evaporator. (6)

12. (a) (i) Discuss in detail about head losses due to friction for various station when fluid flows through a pipe line. (8)

(ii) With a neat explain the construction and working principle of velocity pump. (8)

**(OR)**

(b) (i) Derive and discuss in detail the mechanical energy equation with its corrected form for fluid friction. (10)

(ii) Explain the application of the above equation in industrial equipments. (6)

13. (a) For a nuclear reactor a 2-4 counter flow shell and heat exchanger is used with a process stream (Cp = 4.2KJ/kg.k ) is cooled from 550 -450 k using water (Cp = 4.2KJ/kg.k) at 300k.

Data:

Mass flow rate of process stream =2kg/sec

Mass flow rate of process stream =6kg/sec

Heat transfer coefficient of shell side = 1000w/$m^2$k

Heat transfer coefficient of shell side = 1500w/$m^2$k

(i) Determine the required heat transfer area

(ii) By what factor will the required area change if the flow is co- current?

**(OR)**

(b) (i) A double pipe heat exchanger is cooled with water flowing in the outer pipe with ethyl alcohol flowing in the inner pipe. The inside and outside diameter of the inner pipe are 2.6cm and 3.5cm .The thermal conductivity of the steel is 26cal/cm.hr°C. The individual film coefficient and fouling factors are (10)

Data:

Alcohol coefficient = 180 kcal/hr.$m^2$°C.

Water coefficient = 300

Inside fouling factor = 1000

Outside fouling factor = 500

Calculate the overall coefficient based on the outside area of the inner pipe.

(ii) Explain the role of baffles and Tie rods in heat exchanger. (6)

14. (a) A tube 1cm in inside diameter that is 20cm long is filled with $CO_2$-$H_2$ system under these conditions is 0.275 $cm^2$ / sec. If the partial pressure of $CO_2$ is 1.5atm at the one end of the tube and 0.5atmat the other end .Find the rate of diffusion

(i) Steady state equimolar counter diffusion ($N_A = -N_B$)

(ii) Steady state counter diffusion where $N_B = -0.75\ N_A$

(iii) Steady state diffusion of $CO_2$ through stagnant $H_2$ ($N_B = 0$)

**(OR)**

(b) (i) Derive filter cake and filter medium resistance for filtration process. (10)

(ii) Explain the application of cross flow and membrane filtration. (6)

15. (a) Explain the measuring principle of viscosity and how does it related with characteristics of microbial broath.

**(OR)**

(b) (i) Explain the calibration of ph and area flow meter. (8)

(ii) Explain the working principle of inclined and inverted U-tube manometer. (8)

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