RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
Third Year– Semester I Examination – June/ July 2018

CHE 3206 – THEORETICAL FUNDAMENTALS OF CHEMICAL INDUSTRY/CHEMICAL AND PROCESS TECHNOLOGY

Answer 05 questions only Time: Two (2) hours

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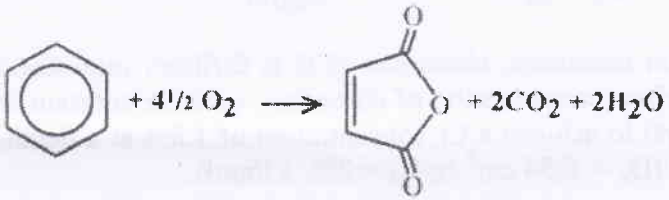
1. (a) Discuss the sustainability of modern chemical industry.
   (b) Comment on Contact Process of sulfuric acid production.
   (c) State five rules of green chemistry. Discuss their aplicability for modern industry.
   (d) Why concepts of Atom Economy is more appropriate than Yield.

   Calculate atom economy of the following reaction.

2. 

   (C=12; O =16; H=1)

   (a) Comment on the chemistry of different perfumes present today.
   (b) Discuss the principle of super critical extraction methods.
   (c) Why supercritical fluid extraction is superior to solvent extraction in perfume industry. Comment
   (d) Discuss the manufacturing steps of linoleic acid. How the selectivity of linoleic acid is increased over oleic acid?

3. (a) Define following terms with respect to industrial bio-reactor systems.

   (i) Anerobic and aerobic bioreactors (ii) Trickle bioreactor
   (iii) Air lift reaction (iv) Bubble column

   (b) Discuss the advantages and disadvantages of bioreactors in chemical industry.
   (c) Comment on the differences between bio reactor and fermentator.
   (d) Highlighting disadvantages, discuss the manufacturing process of papers. Explain a green chemical method of paper processing.

4.

(a) Comment on following processes of mass transfer

(i) Self disfussion (ii) Advection

(iii) Dispersion (iv) Difussion

(b) State Fick's first law of diffusion defining all terms therein.

(c) B is to be diffused into a Si crystal. At what temerature will the difussion coefficient be 5 x 10^{-11} cm^2/ s (E_A = 318 kJ/mol; D_0 = 1.70 cm^2/s)?

(d) Uisng B_2H_6, discuss the B diffusion process into Si.

5.

(a) Explain the principle of catalytic convertors used in automobiles.

(b) Why unleaded petroleum is introuduced in Sri Lankan market?

(c) State Fick's secound law of difussion. A solution to Fick's second law is shown below. Define all symbols used. State all boundary and initial conditions used to obtain this solution:

$$\frac{C\,(x,t) - C_0}{C_a - C_0} = 1 - erf\left[\frac{x}{2\sqrt{Dt}}\right]$$

(d) To increase its corrosion resistance, chromium (Cr) is diffused into steel at 980°C. If during diffusion the surface concentration of chromium remains constant at 100%, how long will it take (in days) to achieve a Cr concentration of 1.8% at a depth of 0.002 cm below the steel surface? (D_o = 0.54 cm^2 /s; E_A = 286 kJ/mol).

6.

(a) Explain the principles of following ideal reactors used in industry.

(i) Batch reactor (ii) Plug flow reactor

(iii) Continuous stirred tank reactor (iv) Packed reactor

(b) Prove that the general mass balance equation of a give process is as

$$F_{A0} - F_A + \int r_A\,dV = \frac{dN_A}{dt}$$

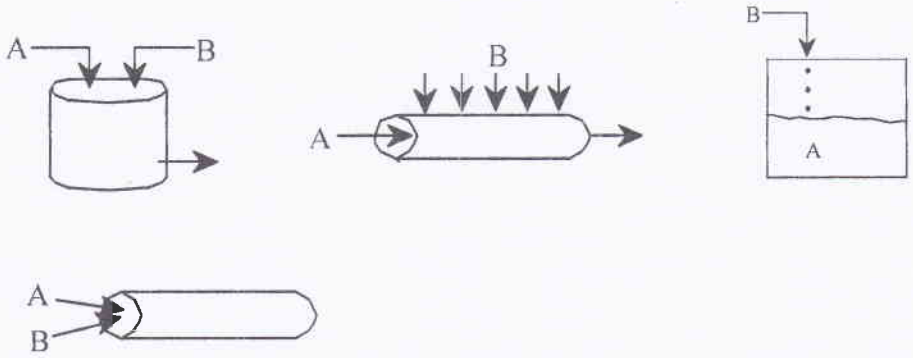
Derive mass balance equation of steady stqate mass balance equation of CSTR

(c) The following elementary liquid phase reactions are to be carried out

$$A + B \longrightarrow R$$

$$R + B \longrightarrow S$$

Species R is the desired product. Which of the following schemes should be used? Explain your selection.



(d) Given below is an elementary and irreversible gas phase reaction

$$A + B \rightarrow C$$

The entering flow rate of A is 10 mol/min and is equal molar in A and B. The entering concentration of A is 0.4 mol/dm^3. k = 2 dm^3/mol•min T_0 = 500 K

(i) What is the CSTR reactor volume necessary to achieve 90% conversion?
(ii) What PFR volume is necessary to achieve 90% conversion?

The Error Function

z	*erf(z)*	*z*	*erf(z)*
0	0	0.85	0.7707
0.025	0.0282	0.90.	0.7970
0.05	0.0564	0.95	0.8209
0.10	0.1125	1.0	0.8427
0.15	0.1680	1.1	0.8802
0.20	0.2227	1.2	0.9103
0.25	0.2763	1.3	0.9340
0.30	0.3286	1.4	0.9523
0.35	0.3794	1.5	0.9661
0.40	0.4234	1.6	0.9763
0.45	0.4755	1.7	0.9838
0.50	0.5205	1.8	0.9891
0.55	0.5633	1.9	0.9928
0.60	0.6039	2.0	0.9953
0.65	0.6420	2.2	0.9981
0.70	0.6778	2.4	0.9993
0.75	0.7112	2.6	0.9998
0.80	0.7421	2.8	0.9999