(01) Q.P. Code is 20946

Set II

Q.1 (b)

Page-1

Pore volume = (vol of Hg displaced) − (vol of He displaced)
(V_g)

~~= 45.1 cm³~~ −

= 82.7 − 45.1

= 37.6 cm^3 per 101.5 gm of sample

(V_g) = Pore vol per gm of sample = $\frac{37.6\ cm^3}{101.5\ gm}$ = 0.371 $\frac{cm^3}{gm}$

The helium volume is also a measure of the density of the solid material in the catalyst

ρ_s = $\frac{\text{wt. of cat (sample)}}{\text{vol of helium displaced}}$ = $\frac{101.5\ gm}{45.1\ cm^3}$

ρ_s = 2.25 gm/cm^3

we know that porosity or void fraction, $\varepsilon_p = \frac{V_g \rho_s}{V_g \rho_s + 1}$

$\therefore \varepsilon_p = \frac{0.371 \times (2.25)}{0.371 \times (2.25) + 1}$ = 0.455

$\boxed{\varepsilon_p = 0.455}$ (45.5% of porosity)

Q2

Page-2- Q.2@

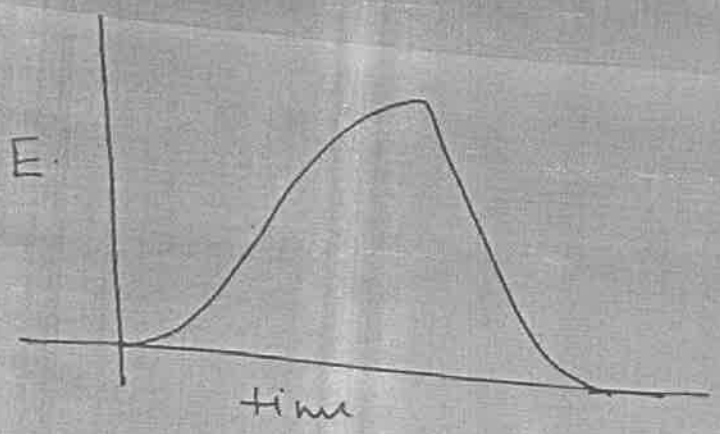
$$\int_0^{14} C\,dt = 47.4 \text{ (g min)/m}^3$$

$$E = \frac{C}{\int_0^{\infty} C.dt}$$

t_i	0	1	2	3	4	5	6	7	8	9	10	12	14
C	0	1	5	8	10	8	6	4	3	2.2	1.5	0.60	0
E	0	0.02	0.10	0.16	0.2	0.16	0.12	0.08	0.06	0.044	0.03	0.012	0

Q3

Page - 3



$$\int_{7.75}^{8.25} E\,dt = 0.03 \quad (3\%)$$

∴ 3% of the fluid leaving the vessel has been in the vessel between 7.75 & 8.25 min

---

$$\int_{3}^{6} E\,dt = 0.195 \quad (19.5\%)$$

i.e. 19.5% of the material leaving the vessel has spent 3 min & or less in the vessel.

 Q. 3 (a)

Solution:

The given gas-solid catalytic reaction syst
may be represented as follows:

$$A + X \rightleftharpoons A \cdot X$$
$$B + X \rightleftharpoons B \cdot X \quad \Big\} \text{ adsorption}$$

$$A \cdot X + B \cdot X \rightleftharpoons R \cdot X + X \quad \text{surface reaction}$$

$$R \cdot X \rightleftharpoons R + X \quad \text{desorption}$$

$$A + B \rightleftharpoons R \quad \text{overall reaction}$$

05

Page - 5 Q.3 (9)

If adsorption of B is the rate limiting step, then the adsorption of A, the surface reaction, and the desorption of R will occur at equilibrium.

The rate can be formulated from the adsorption equation, that is

$$r_b = k_b\left(C_B \bar{C}_v - \frac{1}{K_B}\bar{C}_B\right) \qquad \text{(Equation 1)}$$

The absorbed concentration $\bar{C}_B$ in the expression is obtained from the equilibrium equations for the surface rate, adsorption of A and desorption of R which are as follows:

$$K_s = \left(\frac{\bar{C}_v \bar{C}_R}{\bar{C}_A \bar{C}_B}\right)_{eq} \qquad \text{(Equation 2)}$$

$$\left(\bar{C}_A\right)_{eq} = K_A C_A \bar{C}_v \qquad \text{(Equation 3)}$$

$$\left(\bar{C}_R\right)_{eq} = K_R C_R \bar{C}_v \qquad \text{(Equation 4)}$$

Thus,

$$\bar{C}_B = \frac{\bar{C}_v \bar{C}_R}{K_s \bar{C}_A} = \frac{\bar{C}_v\left(K_R C_R \bar{C}_v\right)}{K_s\left(K_A C_A \bar{C}_v\right)} = \frac{\bar{C}_v K_R C_R}{K_s K_A C_A}$$

06

Page - 5 Q.3 (9)

in the relationship of the several equilibrium constants,

$$K = \frac{K_1 K_B}{K_R} \cdot K_S \quad \text{or} \quad \frac{K_R}{K_S K_A} = \frac{K_B}{K} \qquad \text{(Equation 6)}$$

The expression for $\bar{C}_B$ may be simplified to

$$\bar{C}_B = \frac{K_B \bar{C}_v C_R}{K C_A} \qquad \text{(Equation 7)}$$

Substituting this value of $\bar{C}_B$ in the rate-controlling equation (Equation 1) gives:

$$\nu_b = \nu = k_b \left(C_B \bar{C}_v - \frac{1}{K_B} \cdot \frac{K_B \bar{C}_v C_R}{K C_A} \right) \qquad \text{(Equation 8)}$$

$$\therefore \nu_b = k_b \bar{C}_v \left(C_B - \frac{1}{K} \cdot \frac{C_R}{C_A} \right)$$

The expression for $\bar{C}_v$ can be formulated as follows:

The concentration of vacant sites can be expressed in terms of the total concentration of sites $\bar{C}_m$,

$$\bar{C}_m = \bar{C}_v + \bar{C}_A + \bar{C}_B + \bar{C}_R \qquad \text{(Equation 9)}$$

Substituting for $\bar{C}_A$, $\bar{C}_B$ and $\bar{C}_R$ from Equations 3, 7 and 4, respectively, in Equation 9 gives:

$$\bar{C}_m = \bar{C}_v + K_A C_A \bar{C}_v + \frac{K_B \bar{C}_v C_R}{K C_A} + K_R C_R \bar{C}_v$$

Q. 3a

$$\therefore \bar{C}_m = \bar{C}_v \left(1 + K_A C_A + \frac{K_B C_R}{K C_A} + K_R C_R\right)$$

$$\therefore \bar{C}_v = \frac{\bar{C}_m}{1 + K_A C_A + \frac{K_B C_R}{K C_A} + K_R C_R} \quad \text{(Equation 10)}$$

With this expression for $\bar{C}_v$ substituted in Equation 8, the final rate-equation for adsorption of B as the rate limiting step is:

$$r_b = r = \frac{k_b \bar{C}_m \left[C_B - (1/K)(C_R/C_A)\right]}{1 + K_A C_A + (K_B/K)(C_R/C_A) + K_R C_R} \quad \text{(Equation}$$

08

Page - 8 Q. 3 (b)

Solution:

For pure A, 1 volume of feed on complete conversion yields 4 volumes of product mi
Therefore, the fractional change in volume of the reaction system is

$$\varepsilon_A = \frac{4-1}{1} = 3$$

For a plug flow behaviour, the performance equation is

$$\frac{W}{F_{Ao}} = \int_0^{X_A} \frac{dX_A}{-r_A'}$$

$$-r_A' = 96.55\, C_A = k'C_A, \quad k' = 96.55\ l/(\text{h. kg cat})$$

For a variable density system, the concentration and conversion are related by

$$C_A = \left(\frac{1-X_A}{1+\varepsilon_A X_A}\right) C_{Ao}$$

For pure A at 3.2 atm and 117 °C,

$$C_{Ao} = \frac{p_{Ao}}{RT}$$

p_{Ao} = total pressure = 3.2 atm ..... for pure A feed

$R = 0.08206\ l.\text{atm}/(\text{mol. K})$

$T = 117\ ^\circ\text{C} = 390\ \text{K}$

$$C_{Ao} = \frac{3.2}{0.08206 \times 390} = 0.1\ \text{mol}/l$$

$$\frac{W}{F_{Ao}} = \int_0^{X_A} \frac{dX_A}{-r_A'} = \int_0^{X_A} \frac{dX_A}{k'C_A}$$

$$= \frac{1}{k'C_{Ao}} \int_0^{X_A} \left(\frac{1+\varepsilon_A X_A}{1-X_A}\right) dX_A$$

Integrating the above equation, we get

$$\frac{W}{F_{Ao}} = \frac{1}{k'C_{Ao}} \left[(1+\varepsilon_A)\, ln\left(\frac{1}{1-X_A}\right) - \varepsilon_A X_A\right]$$

$$W = \frac{F_{Ao}}{k'C_{Ao}} \left[(1+\varepsilon_A)\, ln\left(\frac{1}{1-X_A}\right) - \varepsilon_A X_A\right]$$

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Page-9 Q.3 (b)

where : k' = 96.55 *l*/(h. kg cat)

$C_{Ao} = 0.10$ mol/*l*, $X_A = \frac{35}{100} = 0.35$

$\varepsilon_A = 3$, $F_{Ao} = 2000$ mol/h

$$W = \frac{2000}{96.55 \times 0.10}\left[(1+3)\,ln\left(\frac{1}{1-0.35}\right) - 3 \times 0.35\right]$$

$$= 207.146\,[1.723 - 1.05]$$

$$= 139.41 \text{ kg}$$

Amount of catalyst needed in the packed bed reactor = 139.41 kg

Example 6.15 : If

Page-10 Q. 4 (a)

$$NO + \tfrac{1}{2}O_2 \longrightarrow NO_2$$

$$A + \tfrac{1}{2}B \longrightarrow R.$$

P = total pr = 3 atm.

Sp. gr. of catalyst = 0.48.

∴ Bulk density of cat. = 0.48 × 1000
= 480 kg/m³.

flow rate of NO = 50 metric tonnes per day.

$= 50 \times 10^3$ kg/day

$= \frac{50 \times 10^3}{24}$ kg/hr

$= 2083.3$ kg/hr.

(Mol. wt. of NO = 14 + 16 = 30)

Molar flow rate of NO to the reactor

$= \frac{2083.3}{30} = 69.44 \frac{\text{kmol}}{\text{hr.}}$

Marks awarded

(KK)

Starting of Answer to Question No.

Air - NO mixture to the reactor contain 15 mole% of NO.

Molar flow rate of NO to the reactor = 69.44 kmol/hr

(15% NO).

$$\frac{\text{Molar flow rate of Air}}{85} = \frac{\text{Molar flow rate of NO}}{15} = \frac{69.44}{15}$$

$$\therefore \text{Molar flow rate of air } (N_2 + O_2) = \frac{69.44 \times 85}{15}$$

$$= 393.49 \text{ kmol/hr}$$

O_2 in air $= 0.21 \times 393.49 = 82.63$ kmol/hr

N_2 in air $= 0.79 \times 393.49 = 310.86$ kmol/hr

$\therefore$ Total Molar flow rate $= 69.44 + 393.49$

$= 462.93$ kmol/hr

Moles at time t, at conv. 90%.

$$\left(\because N_A = N_{A0} - N_{A0} X_A\right)$$

$$\frac{\text{mol}}{\text{hr}} = \left(F_{A0} - F_{A0} X_A\right)$$

Moles of NO $= F_{NO} - F_{NO} \cdot X_A$

$= 69.44 - (0.90 \times 69.44)$

Moles of NO $= 6.944$ kmol/hr

Moles of $O_2 = F_{O_2} - \frac{1}{2} F_{NO} \cdot X_A$

= Initial moles of O_2 − Reacted moles

$= 82.63 - \frac{1}{2}(0.9 \times 69.44)$

$= 51.38$ kmol/hr

Marks Awarded

Moles of $NO_2 = \frac{1}{1}(0.9 \times 69.44) = 62.946$ kmol/hr

N_2 in air $= 0.79 \times 393.49$

$= 310.86$ kmol/hr

Total Moles = (moles of NO) + (moles of O_2) + (Moles of NO_2) + (moles of N_2)

$= 6.944 + 51.38 + 310.86 + 62.946$

Total moles $= 432.13$ kmole/hr

P.P of NO, $P_{NO} = \left(\frac{6.944}{432.13}\right) \times 3$

$P_{NO} = 0.048$ atm

P.P of O_2, $P_{O_2} = \left(\frac{51.38}{432.13}\right) \times 3$, $P_{O_2} = 0.357$ atm

P.P of NO_2, $P_{NO_2} = \frac{62.946}{432.13} \times 3 = 0.437$ atm

$P_{NO_2} = 0.437$ atm

$69.44 + 0.85 A_0 = 1 A_0$

$100 A_0 = (85 A_0 + 69.44)$ (kmol)

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Page - 12 Q. 4 (a)

$$(-r_A') = \frac{\cdot NO \cdot V_L}{a + b P_{NO}^2 + C P_{NO_2}}$$

$$(-r_A') = 0.06947 \frac{mol}{g.cat-hr} = 0.06947 \frac{kmol\ NO\ converted}{kg.cat.hr.}$$

$$wt.\ of\ catalyst = \frac{molar\ feed\ rate\ of\ NO}{Reaction\ rate}$$

$$= \frac{69.44}{0.06947}\ kg\ of\ cat. \left(\frac{kmol\ NO\ converted/(kg.cat.hr)}{kmol\ NO.\ converted/kg.cat.hr} \right)$$

$$wt.\ of\ cat. = 999.6\ kg$$

$$volume\ of\ reactor = \frac{wt.\ of\ cat.}{Bulk\ den\ of\ cat}$$

$$= \frac{999.6}{480}$$

$$Vol.\ of\ Reactor. = 2.08\ m^3.$$

Vol. of reactor = vol. of cat. = 2.08 m^3.

$$\frac{W}{F_{A0}} = \frac{dx_A}{(-r_A')} \qquad \frac{W}{F_{A0}} = \int_0^{x_A} \frac{dx_A}{(-r_A')}$$

$$\frac{W}{F_{A0}} = \int_0^{0.90} \frac{dx_A}{(-r_A')} \qquad \left[\frac{x_{A_2}}{(-r_A')} \right]_0^{0.90}$$

$$W = \frac{x_A}{(-r_A')}$$

Solution : Time required for complete conversion $= \tau = 20$ min

Mean residence time of solids in the bed $= \bar{t} = 48$ min

(i) **Chemical reaction step is rate controlling.**

For particles of single unchanging size in a fluidised bed with chemical controlling, we have :

$$1 - \bar{X}_B = \frac{1}{4}\left(\frac{\bar{t}}{\tau}\right) - \frac{1}{20}\left(\frac{\tau}{\bar{t}}\right)^2 + \frac{1}{120}\left(\frac{\tau}{\bar{t}}\right)^3 - \ldots\ldots$$

9.5 (a)

$\tau = 20$ min, $\bar{t} = 48$ min, $\therefore \frac{\tau}{\bar{t}} = \frac{20}{48} = 0.4167$

$$1 - \bar{X}_B = \frac{1}{4}(0.4167) - \frac{1}{20}(0.4167)^2 + \frac{1}{120}(0.4167)^3$$

$$= 0.096$$

The fraction of the original ore remaining unconverted ($1 - \bar{X}_B$) is 0.096 or 9.6%

(ii) **Ash diffusion step is rate controlling :**

For this mechanism the mean value for the fraction of solids unconverted is given

$$1 - \bar{X}_B = \frac{1}{5}\left(\frac{\tau}{\bar{t}}\right) - \frac{19}{420}\left(\frac{\tau}{\bar{t}}\right)^2 + \frac{41}{4620}\left(\frac{\tau}{\bar{t}}\right)^3 - \ldots\ldots$$

where $\frac{\tau}{\bar{t}} = 0.4167$

$$1 - \bar{X}_B = \frac{1}{5}(0.4167) - \frac{19}{420}(0.4167)^2 + \frac{41}{4620}(0.4167)^3$$

$$= 0.076$$

The fraction of the original ore remaining unconverted ($1 - \bar{X}_B$) is 0.076 or 7.6%

Page - 15, Q. 4 (b)

Solution : Here the reacting particle shrinks during reaction and finally disappears.

$C(s) + O_2(g) \rightarrow CO_2(g)$

From the reaction, b = 1

Given : R = 12 mm = 1.2 cm

$\rho_B = 2.4$ g/cm^3

Molar density of graphite (C) $= \rho_B = \frac{2.4}{12} = 0.2$ mol/cm^3

Given : T = 900 °C = 1173 K, P = 1 atm.

O_2 in the gas stream = 12% by volume

Specific : $C(s) + O_2(g) \rightarrow CO_2(g)$

General : $b\,B(s) + A(g) \rightarrow$ fluid product

Comparing the above two equations, we get b = 1 and A = O_2

C_{Ag} - concentration of O_2 in the bulk gas phase

For an ideal gas : mole % = volume %

∴ Mole % O_2 in the gas stream = 12

We know :

$$p_{Ag} = x_A.P = \frac{12}{100} \times 1 = 0.12 \text{ atm.}$$

The concentration of O_2 is calculated using the relation :

$$C_{Ag} = \frac{p_{Ag}}{RT}, \quad R = 82.06 \text{ (cm}^3\text{-atm)/mol.K}$$

$$= \frac{0.12}{82.06 \times 1173}$$

$$= 1.25 \times 10^{-6} \text{ mol/cm}^3$$

Given : $k'' = 25$ cm/s

Given : Negligible gas film resistance.

Therefore, for the shrinking spherical particle, in our case, chemical reaction controls the rate.

For the situation where chemical reaction controls, we have for shrinking sphere :

$$\tau = \frac{\rho_B R}{b\,k''\,C_{Ag}} = \frac{0.2 \times 12}{1 \times 25 \times 1.25 \times 10^{-6}}$$

$$= 7680 \text{ s}$$

Time required for the complete conversion of graphite particles of size R = 12 mm = 7680 s ... Ans.

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Page - 16, Q. 6

$F_g = 90000$ mol/h, $F_l = 900000$ mol/h.

$b = 1$, $p_{A1} = 100$ Pa, $C_{B1} = 55.56$ mol/m^3

$C_T \simeq C_U = 55556$ mol/m^3, $\pi = 10^5$ Pa

$$p_A - 100 = \frac{900000 \times 10^5}{90000 \times 1 \times 55556}(55.56 - C_B)$$

$$p_A = 1100 - 18\, C_B$$

or $$C_B = 61.11 - 0.0555\, p_A$$

Now we will find C_{B2} in the exit stream.

$$p_A = p_{A2} = 1000 \text{ Pa}$$

and $$C_{B2} = 61.11 - 0.0555\, p_{A2}$$

$$\therefore \quad C_{B2} = 61.11 - 0.0555\,(1000) = 5.61 \text{ mol/m}^3$$

Let us now find the form of rate equation to be used :

$$k_{Ag}\, a = 0.36 \text{ mol/(h.m}^3\text{.Pa)}$$

$$k_{Al}\, a = 72 \text{ h}^{-1}, \quad a = 100 \text{ m}^2/\text{m}^3$$

$$\therefore \quad k_{Al} = \frac{k_{Al}\, a}{a} = \frac{72}{100} = 0.72 \text{ m/h}$$

$$\mathscr{D} = \mathscr{D}_{Bl} = \mathscr{D}_{Al} = 3.6 \times 10^{-6} \text{ m}^2/\text{h}$$

$$k = 2.6 \times 10^7 \text{ m}^3/\text{(mol.h)}$$

$$H_A = 10^5 \text{ (Pa.m}^3\text{)/mol}$$

At the top of the tower :

$$p_A = p_{A1} = 100 \text{ Pa and } C_B = C_{B1} = 55.56 \text{ mol/m}^3$$

$$M_H = \frac{(\mathscr{D}_{Al}\, C_B\, k)^{1/2}}{k_{Al}}$$

$$= \frac{(3.6 \times 10^{-6} \times 55.56 \times 2.6 \times 10^7)^{1/2}}{0.72} = 100$$

$$E_i = 1 + \frac{\mathscr{D}_{Bl}\, C_B\, H_A}{\mathscr{D}_{Al}\, p_{Ai}} = 1 + \frac{C_B\, H_A}{p_{Ai}}$$

For $p_{Ai} = 100$ Pa – liquid-film controls

For no gas-phase resistance : $p_{Ai} = p_A = 100$ Pa and in this case

$$E_i = 1 + \frac{55.56 \times 10^5}{100} = 55560$$

Here E_i > 5 M_H for any other small value of p_{Ai} ; $E_i > 5\, M_H$

(17) Page - 17 Q.6

At the bottom of the tower :

$$p_A = p_{A2} = 1000 \text{ Pa}, \quad C_B = C_{B2} = 5.61 \text{ mol/m}^3$$

$$M_H = \frac{(3.6 \times 10^{-6} \times 5.61 \times 2.6 \times 10^7)^{1/2}}{0.72} = 31.83$$

Assume $p_{Ai} = p_A = 1000$ Pa

$$E_i = 1 + \frac{C_B H_A}{p_{Ai}} = 1 + \frac{5.61 \times 10^5}{1000} = 561$$

Here also $E_i > 5\ M_H$ and for any other small value of p_{Ai} : $E_i > 5\ M_H$.

∴ At both ends of the tower, we have : $E_i > 5\ M_H$.

As we have $E_i > 5\ M_H$ at both ends of the tower, we have a pseudo first-order reaction by gas-liquid interface and for this $E = M_H$.

It is a case of fast reaction with high C_B, the reaction zone is (near) by the interface in the liquid film.

For this case, the form of rate equation to be used is

$$\left(-r_A''\right) a = -r_A''' = \frac{1}{\frac{1}{k_{Ag} a} + \frac{H_A}{a\sqrt{\mathscr{D}_{Al} k C_B}}} p_A$$

or

$$-r_A''' = \frac{1}{\frac{1}{k_{Ag} a} + \frac{H_A}{k_{Al} aE}} \text{ with } E = M_H = \frac{\sqrt{\mathscr{D}_{Al} k C_B}}{k_{Al}}$$

As M_H is different at the top and the bottom, the rate also varies and so we have to adopt a graphical procedure determine the tower height.

For graphical procedure, in addition to p_{A1} and p_{A2} take two additional p_A values and evaluate C_B at these values and then the rate and tabulate.

We have

$$C_B = 61.11 - 0.0555\ p_A$$

Use the above equation to evaluate C_B

For $p_A = 300$ Pa , $C_B = 44.46$ mol/m^3

For $p_A = 500$ Pa , $C_B = 33.61$ mol/m^3

For $p_A = 750$ Pa , $C_B = 19.48$ mol/m^3

Now we will estimate the rate :

For $p_A = 100$ Pa, $C_B = 55.56$ mol/m^3

$\mathscr{D}_{Al} = 3.6 \times 10^{-6}$ m^2/h, $k = 2.6 \times 10^7$ m^3/(mol. h)

$H_A = 10^5$ (Pa.m^3)/mol, $a = 100$ m^2/m^3

$k_{Ag} a = 0.36$ mol/(h.m^3.Pa)

1 8

Page - 18 Q·6

$$-\bar{r}_A = \left(-\bar{r}_A\right) a = \frac{100}{\frac{1}{0.36} + \frac{10^5}{100\sqrt{3.6\times10^{-6}\times2.6\times10^{7}\times55.56}}}$$

$$= 6 \text{ mol/(h.m}^3\text{)}$$

Calculate the rate for other p_A values and tabulate :

p_A	C_B	$1/k_{Ag}a$	$H_A/a\,(\mathscr{D}_{Al}\,k\,C_B)^{1/2}$	$-r_A'''$	$\frac{1}{(-r_A''')}$
100	55.56	2.78	13.87	6	0.167
300	44.46	2.78	15.50	16.41	0.061
500	33.61	2.78	17.83	24.26	0.041
750	19.48	2.78	23.41	28.64	0.035
1000	5.61	2.78	43.64	21.54	0.046
200	50.61	2.78	14.62	11.5	0.087

The volume of tower (for dilute systems) is given by

$$V_r = \frac{F_g}{\pi}\int_{p_{A1}}^{p_{A2}} \frac{dp_A}{\left(-\bar{r}_A\right)a} = \frac{F_g}{\pi}\int_{p_{A1}}^{p_{A2}} \frac{dp_A}{-\bar{r}_A'''}$$

$$V_r = \frac{F_g}{\pi}\int_{100}^{1000} \frac{dp_A}{-\bar{r}_A'''}$$

To evaluate the integral on the RHS of the above equation, plot $\frac{1}{(-\bar{r}_A''')}$ i.e., $\frac{1}{(-\bar{r}_A)a}$ v/s p_A and measure the area under the curve between $p_A = p_{A1} = 100$ Pa and $p_A = p_{A2} = 1000$ Pa.

From the plot [Fig. Ex 3.8 (b)] :

Area under the curve = 1880 mm^2 = 18.80 cm^2.

$$\therefore \quad V_r = \frac{F_g}{\pi} \times \text{Area under the curve} \times \text{scale of x-axis} \times \text{scale of y-axis}$$

$$= \frac{90000}{10^5} \times 18.80 \times \frac{100}{1} \times \frac{0.05}{2}$$

$$= 42.3 \text{ m}^3$$

Volume of the tower required for the countercurrent operation = 42.3 m^3 ... Ans.

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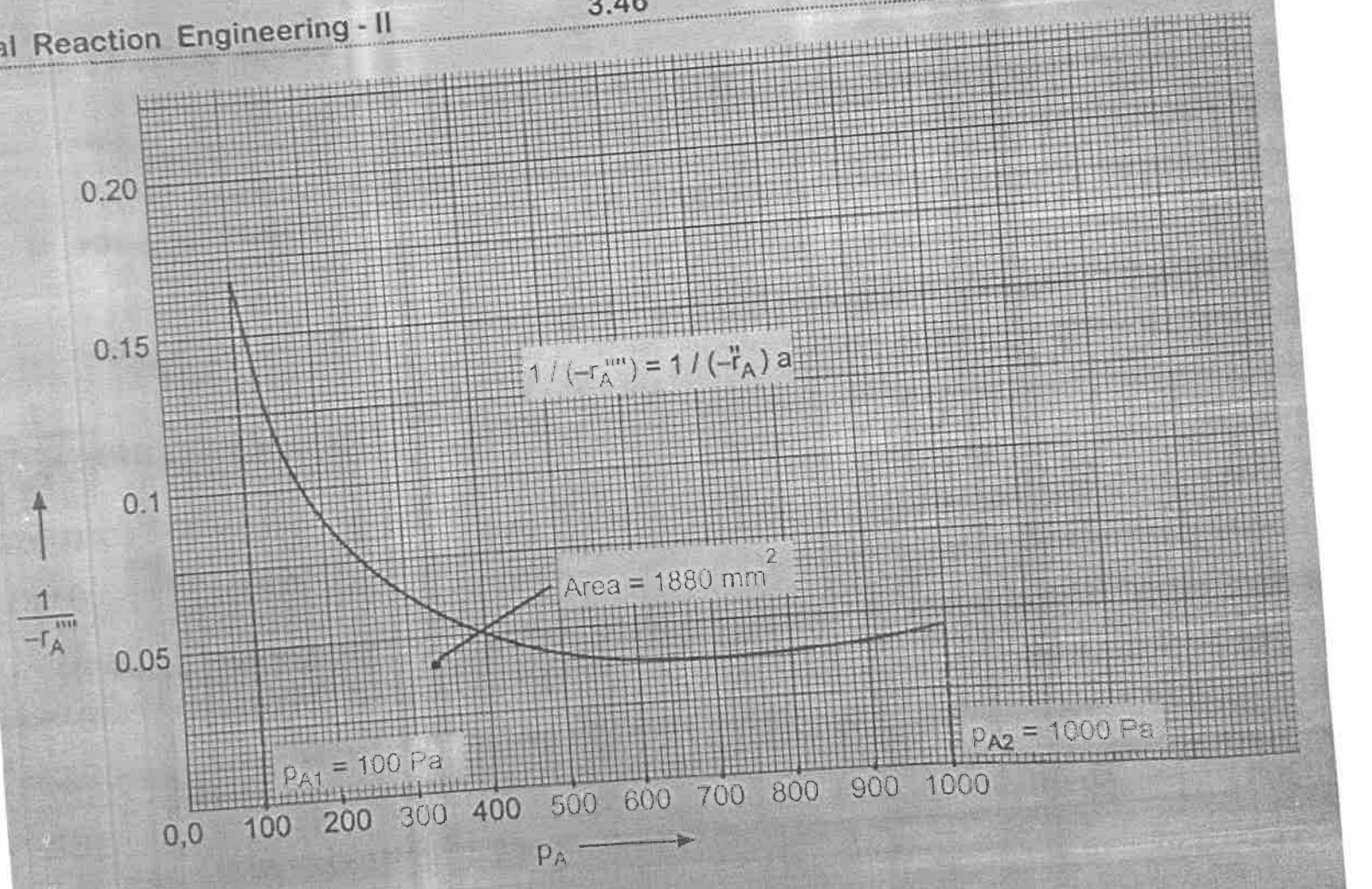
Page - 19, Q.6


0.20
0.15
0.1
0.05
$1/(-r_A''') = 1/(-r''_A)\,a$
Area = 1880 mm^2
$\frac{1}{-r_A'''}$
p_{A1} = 100 Pa
p_{A2} = 1000 Pa
0,0 100 200 300 400 500 600 700 800 900 1000
p_A