solution to Dec 2019 — subject code paper code 50705 — QP code 78122

SE III CBCGS Process calculation

Q1 (a) (5)

Mavg = $\Sigma M_i x_i$

$= 28 \times 0.79 + 32 \times 0.21$

$= 28.84$

Composition by mass

$N_2 = \frac{0.79 \times 28}{28.84} = 77$

$O_2 = \frac{0.21 \times 32}{28.84} = 23$

Q1 (d) 294 g/L (3)

$= \frac{294}{49} = 6$ gm eq

N = 6 N

M = 3 M

ans

Q2 (a) (5)

→ Basis – 1500 kg soln

$K_2Cr_2O_7$ in $sol^n = 0.15 \times 1500$
$= 225$ kg

Water in 15% $sol^n = 1500 - 225 = 1275$ kg

M.B for water

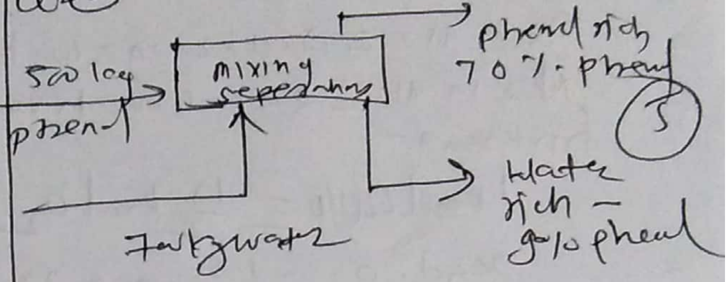
Water in final $sol^n = 1275 - 700 = 575$ kg

Solubility of $K_2Cr_2O_7$ at 293 K $= 115/100$ kg

Amt. $K_2Cr_2O_7$ in soln at 293 $= \frac{115}{100} \times 575$
$= 66.125$ kg

$K_2Cr_2O_7$ crystals produced $= 225 - 66.125$
$= 158.875$ kg

Q2 (b) Basis – 700 kg water + 500 kg phenol



(5)

$x + y = 700 + 500$

$x + y = 1200$ (1)

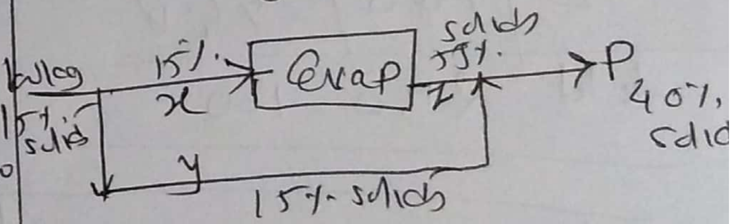
$0.7x + 0.09y = 500$ (2)

Solve (1) & (2)

phenol rich $x = 642.4$ kg

water rich $y = 557.6$ kg

(c) Basis: 100 kg fresh juice to the process (10)



M.B for solids over evap

$0.15x = 0.55z$ (1)

Also

$z + y = P$ (2)

$x + y = 100$ (3)

$0.55z + 0.15y = 0.4P$ (4)

$0.55(P - y) + 0.15y = 0.4P$

$(100 - y) = x$

Solving we get

$z = 23.44$

$P = 37.5$

$y = 14.06$

% bypass $= \frac{14.06}{100} \times 100 = 14.06\%$

Scanned by CamScanner

Q3 (9) Basis 50 kmol/h of butane — (10)

2200 kg/h of air to reactor

$C_4H_{10} + 13/2 O_2 \rightarrow 4CO_2 + 5H_2O$

O_2 in air $= 0.21 \times 2000 = 420$ kmol/h

N_2 in air $= 2000 - 420 = 1580$ kmol/h

from reaction —

1 kmol $C_4H_{10} \equiv \frac{13}{2}$ kmol O_2

req. $O_2 = \frac{13}{2} \times 50 = 325$ kmol/h

% Excess air = % Excess $O_2 = \frac{420 - 325}{325} \times 100$

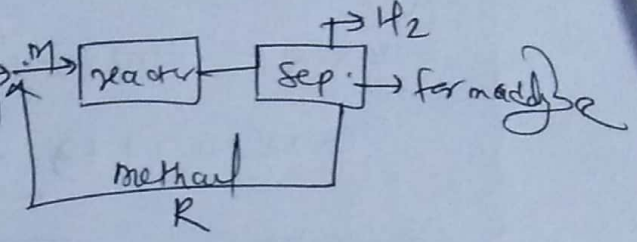
$= 29.23\%$

from stoichiometry

Compound	kmol	%
CO_2	200	9.39
H_2O	250	11.73
O_2	100	4.70
N_2	1580	74.18
total	2130	100

Q4 (9) Basis — 100 kg/h formaldehyde — (10)

$CH_3OH \rightarrow HCHO + H_2$



$F + R = M$

Rate of formaldehyde $= \frac{100}{30} = 33.33$ kmol/h

CH_3OH reacted $= 33.33$

Conversion $= 67\%$

methanol reacted $= 0.67 \cdot M$

$0.67\,M = 33.33$

$M = 49.74$ kmol/h

Unreacted methanol $= 49.74 - 33.33$

$= 16.41$ kmol/h

Unreacted methanol recycled

$R = 16.41$ kmol/h

Methanol as fresh feed = methanol reacted to give product $= 33.33$

Combined feed ratio $= \frac{M}{F} = \frac{49.74}{33.33}$

$= 1.492$

flow of methanol req. $= 33.33$ kmol/h $= 1068.5$ kg/h

Q2 (b) (10)

Basis — 15 hr operation

Gas burning rate $= 100$ l/h

CaH_2 generated = CaH_2 burned $= 1500$ l.

$n = \frac{PV}{RT} = \frac{98.68 \times 1500}{8.3145 \times 298}$

$= 59.74$ mol

$CaH_2 + 2H_2O \rightarrow 2H_2 + Ca(OH)_2$

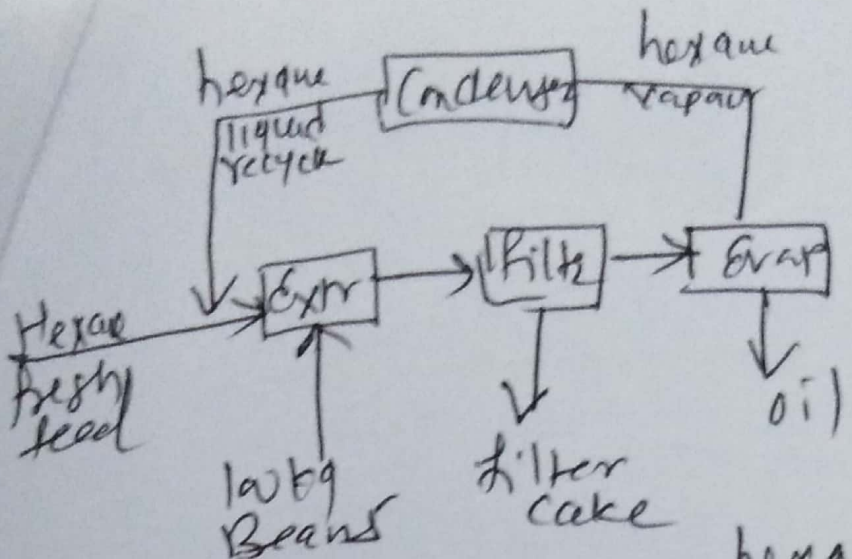
1 : 1

CaH_2 req. $= 59.74$ mol

Quantity req. $= 59.74 \times 64 = 3823$ g

10

→



Given feed ratio :- 3 kg $\frac{\text{hexane}}{\text{kg beans}}$

Hexane in the feed to extractor = 3 × 100 = 300 kg

oil is in bean = 0.1 × 100 = 10 kg

solids in bean = 90 kg

Assuming leaving extractor contains 10 kg oil, 300 kg hexane & 90 kg solids

Composition of Stream

Comp	Quantity	Weight %
hexane	300	75
oil	10	2.5
solids	90	22.5
Total	400	100