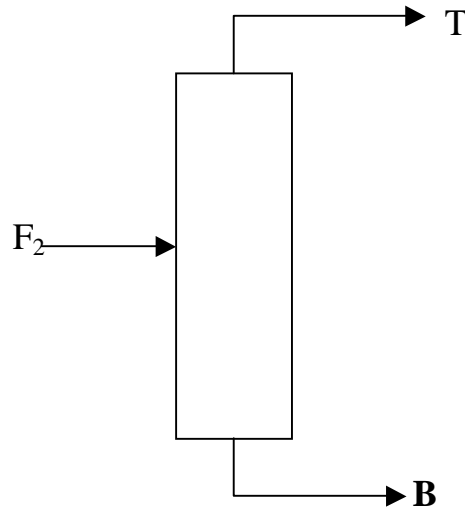


# MATERIAL BALANCE

## (1) BALANCE ACROSS FRACTIONATOR - 2



### *Assumptions involved*

- (1) Assume the feed  $F_2$  contains 70% o-xylene and 30% of 1-3-5 Trimethyl benzene (C-9)
- (2) Assume the top product purity of o-xylene to be 99%.
- (3) Assume the bottoms B to contain 5% o-xylene.

Notations : OX  $\rightarrow$  o-xylene

TMB  $\rightarrow$  1-3-5 Trimethyl Benzene

### **OX Balance**

It is required to produce 35000 TPA of orthoxylene.

$$\begin{aligned}\text{And therefore orthoxylene required} &= ( 35000 \times 1000 / 330 \times 24 ) \\ &= 4419.19 \text{ kg/hr}\end{aligned}$$

The above figure was obtained using the assumptions that there are 330 working days in a year.

$$0.7F_2 = 4419.19 + 0.05B \dots \dots \dots (1)$$

Top product obtains 99% orthoxylene

$$0.99T = 4419.19$$

$$T = 4463.83 \text{ kg/hr}$$

Therefore TMB in T = 44.64 Kg/hr

TMB Balance :

$$0.3F_2 = 44.64 + 0.95B \dots \dots \dots (2)$$

Solving (1) and (2) simultaneously

$$F_2 = 6455.38 \text{ Kg/hr}$$

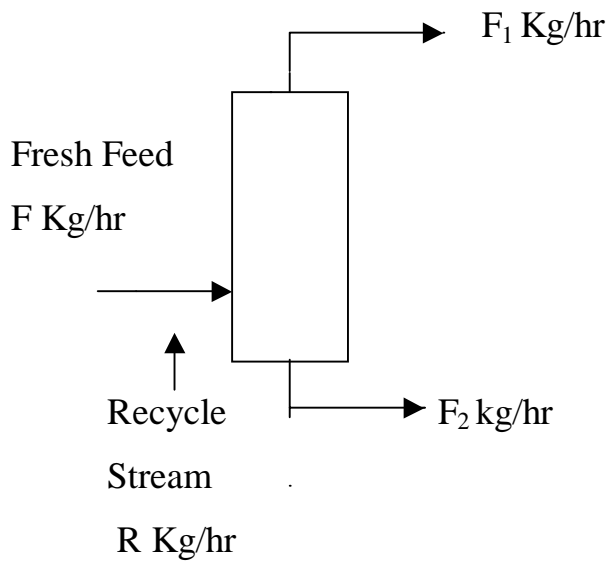
$$B = 1991.55 \text{ Kg/hr}$$

## II BALANCE ACROSS FRACTIONATOR –1

### *Assumptions involved :*

(1)The bottoms contain 70% o-xylene and the top product contains 10% o-xylene.

(2)All the 1-3-5 TMB goes in the bottoms of fractionator 1



### Feed compositions

Notations	OX : o-xylene
	Eb : ethyl benzene
	PX : p-xylene
	MX : m-xylene
	TMB : 1-3-5 trimethyl benzene

From literature,

Feed composition (in weight %)

Eb : 11.03%

PX : 19.03%

MX : 40.38%

OX : 18.42%

TMB : 11.14%

The recycle stream arrives from an isomerization reactor where the xylene mixtures reach an equilibrium composition.

Recycle Composition (in weight %)

EB : 8.5%

PX : 22.5%

MX : 47.5%

OX : 21.5%

TMB balance :

$$0.1114F = 0.3 F_2 = 0.3 * 6455.38$$

$$\therefore F = 17384.33 \text{ Kg/hr}$$

OX BALANCE :

$$F * 0.1842 + 0.251 R = 0.7 F_2 + 0.1 F_1$$

$$\Rightarrow 0.215 R = 0.1 F_1 + 564.25 \dots \dots \dots (1)$$

Overall balance :

$$F + R = F_1 + F_2 \dots \dots \dots (2)$$

Solving (1) and (2) simultaneously,

$$F_1 = 31880.85 \text{ Kg/hr}$$

$$R = 20951.9 \text{ Kg/hr}$$

$$\begin{aligned} \text{EB in } F_1 &= 0.1103 * 17384.33 + 0.085 * 20951.9 \\ &= 3698.4 \text{ Kg/hr} \end{aligned}$$

$$\begin{aligned} \text{PX in } F_1 &= 0.1903 * 17384.33 + 0.225 * 20951.9 \\ &= 8022.41 \text{ Kg/hr} \end{aligned}$$

$$\begin{aligned} \text{MX in } F_1 &= 0.4038 * 17384.33 + 0.475 * 20951.9 \\ &= 16971.94 \text{ Kg/hr} \end{aligned}$$

$$\begin{aligned} \text{OX in } F_1 &= 0.1842 * 17384.33 + 0.215 * 20951.9 \\ &= 7706.85 \text{ Kg/hr} \end{aligned}$$

Therefore Composition of  $F_1$  (weight in %)

$$\text{EB : 11.6\%}$$

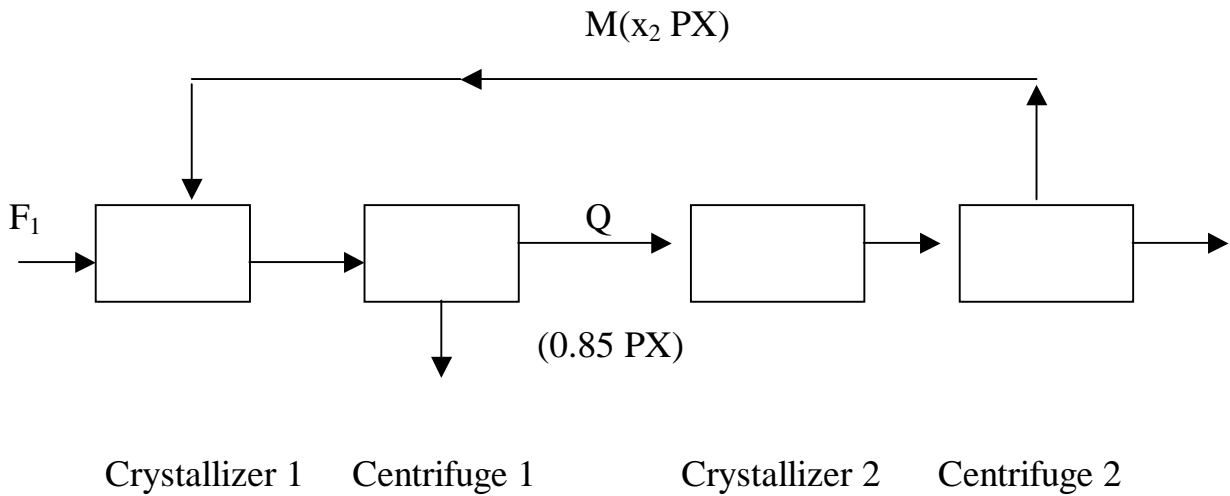
$$\text{PX : 25.2\%}$$

$$\text{MX : 53.2\%}$$

$$\text{OX : 10\%}$$

### III BALANCE ACROSS CRYSTALLIZER

Consider a two stage crystallizer, the first stage cools the entering mixture to  $-60^{\circ}\text{C}$ , just above the p-xylene and m-xylene eutectic temperature. The solubility of p-xylene at  $-60^{\circ}\text{C}$  is 9%. The crystallized slurry leaving the stage contains 85% p-xylene and 15% m-xylene. The second stage melts the crystals and cools the mixture to  $-20^{\circ}\text{C}$  to give a slurry containing 99% pure p-xylene and a recycle containing  $x_2$  weight % of p-xylene.



Assume there are no losses in the centrifuge.

Overall balances :

$$F_1 + M = N + Q \dots\dots(1)$$

$$Q = P + M \dots\dots\dots(2)$$

$$N = F_1 - P \dots\dots\dots(3)$$

P-XYLENE BALANCES :

$$X_2M + 0.252 F_1 = 0.09 (F_1) + 0.85 Q \dots\dots\dots(4)$$

$$0.85Q = 0.99 P + X_2M \dots\dots\dots(5)$$

From (4) and (5)

$$P = 5216.86 \text{ Kg/hr}$$

$$\text{From (1)} \quad N = 26663.99 \text{ Kg/hr}$$

Composition of N (weight %)

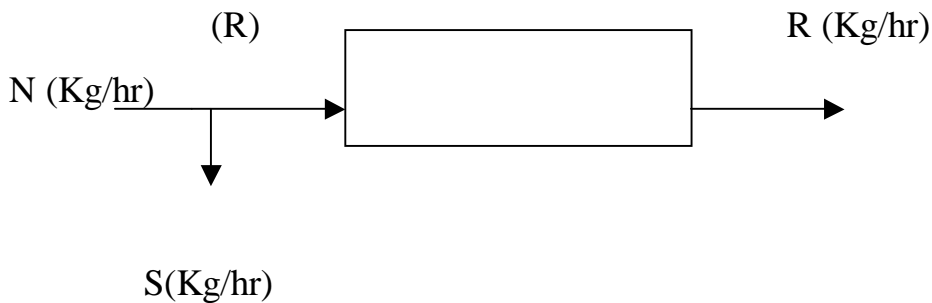
$$\text{EB in N} = (3698.4 \times 100) / 26663.99 = 13.84\%$$

$$\text{PX} = (0.09 \times 31880.85 \times 100) / (26663.99) = 10.76 \%$$

$$\text{OX} = (7706.85 \times 100) / (26663.99) = 28.90\%$$

$$\therefore \text{MX} = 46.47\%$$

### IV BALANCE ACROSS REACTOR



Isomerization reaction, therefore constant flow rate into and out of reactor in steady state conditions.

$$S \text{ (purge stream)} = N - R$$

$$\therefore S = 2475.7 \text{ kg/hr}$$

Fresh feed entering the plant,  $F = 17384.33 \text{ kg/hr}$

Assuming 10% spillage and handling losses

(inclusive for all streams)

$$F_{\text{reqd}} = 1.1 F = 19122.76 \text{ kg/hr}$$