# MATERIAL BALANCE

OVERALL MASS BALANCE

( Tryglyceride ) + 3 ( water ) ⟶ 3 ( Fatty Acids ) + Glycerine

98% yield

One mole of fat gives three moles of Stearic acid.Therefore to produce (5000/284.47 =)
17.58 Kmoles of Stearic acid, we require (17.58/3=)
5.86 Kmoles of fat.

But yield =98%

Fat required = 5.86/0.98
= 5.98 Kmoles

From literature,
5000 kg of Stearic acid is associated with
6100 kg of Oleic acid
793.8 kg of Glycerine.
The fat associated with this is 12.3 Kmoles.

WATER BALANCE

One mole of fat requires three moles of fat of water.
12.3 Kmoles of fat require = 12.3 * 3
= 36.9 Kmoles of water.

25% of glycerine is removed.

Water associated with 25% of Glycerine = [793.8/0.25 – 793.8]/18

= 132.3 Kmoles of water.

Total water required = 36.9 + 132.3

= 169.2 kmoles.

Taking 10% extra = 186.12 kmoles.

**EQUIPMENT MATERIAL BALANCE**

FAT SPLITTER

Stearic acid is produced in batches of 4 hours each.Therefore to produce 5000 kg of stearic acid / day (24/4 =) 6 batches of (5000/6 =) 833.33 kg each is produced.Doing calculations for one single batch, we have

From literature
833.33 kg of Stearic acid is associated with
1016.66 kg of Oleic acid
132.3 kg of Glycerol.

(833.33/284.47 = ) 2.93 kmoles of Stearic acid require 2 kmoles of fat.

But yield is 98%

Therefore fat required = 2/0.98

= 2.05 kmoles

Conversion of fat = 99%

Fat reacting = 2.05/0.99

= 2.03 kmoles

Stearic acid formed = 2.958 kmoles

= 841.47 kg

Water reacting = (2.03 * 3 * 18 + {132.3/0.25}-132.3)

= 508.662 kg

Taking 10% excess water = 559.52 kg

FAT SPLITTER

| INLET | OUTLET |
|---|---|
| 1826.06 KG OF FAT | 841.47 KG OF STEARIC ACID |
| 559.52 KG OF WATER | 1025.3 KG OF OLEIC ACID |
| | 45.51 KG OF WATER |
| | 18.26 KG OF UNREACTED FAT |

**Table 2.1 Inlets And Outlets For Fat Splitter**

Sweet water required = 25 % Glycerine

= 400.76 kg of water + 133.6 kg of Glycerol.

**STILL**

| INLET | OUTLET |
|---|---|
| 18.26 KG OF UNREACTED FAT | 841.47 KG OF STEARIC ACID |
| 841.47 KG OF STEARIC ACID | 1025.3 KG OF OLEIC ACID |
| 1025.3 KG OF OLEIC ACID | |
| 45.51 KG OF EXCESS WATER | |

**Table 2.2 Inlets And Outlets Of Still**

PITCH contains

18.26 KG OF UNREACTED FAT

45.5 KG OF EXCESS WATER.

**CHILLER**

CALCULATING AMOUNT OF METHANOL REQUIRED

Solubility of Fatty acids at -10$^{o}$ C

Stearic acid = 0.48g/100g of Methanol

Oleic acid = 31.6g/100g of Methanol

Solubility of Stearic acid at 30$^{o}$C = 1820g/100g of Methanol.

To ensure complete crystallization of Stearic acid at and complete solubility of Oleic acid at -10$^{o}$ C,

Methanol required = 1025.3 * (100/31.6) + 841.47 * (100/1820)

= 3290.86 kg of Methanol.

Taking 10% excess = 3619.94 kg of Methanol.

| INLET | OUTLET |
|---|---|
| 3619.94 KG OF METHANOL | MOTHER LIQUOR + 841.25 KG OF STEARIC ACID CRYSTALS. |
| 841.47 KG OF STEARIC ACID | |
| 1025.3 KG OF OLEIC ACID | |

**Table 2.3 Inlets And Outlets Of Chiller**

MOTHER LIQUOR has

3619.94 KG OF METHANOL

1025.3 KG OF OLEIC ACID

0.22 KG OF STEARIC ACID

**FILTER**

| INLET | OUTLET |
|---|---|
| MOTHER LIQUOR + 841.25 KG OF STEARIC ACID CRYSTALS | 837.27 KG OF STEARIC ACID CRYSTALS +FILTRATE. |

**Table 2.4 Inlets And Outlets Of Filter**

Loss of Stearic acid crystals during separation = 5%

**STRIPPING STILL 1**

FOR THE FILTER CAKE

Loss of Stearic acid = 5%

Outlet = 833.33 kg of Stearic acid crystals.

**STRIPPING STILL 2**

FOR THE FILTRATE

| INLET | OUTLET |
|---|---|
| 1025.3 KG OF OLEIC ACID | FROM TOP →<br>3619.94 KG OF METHANOL<br>0.22 KG OF STEARIC ACID<br>10.25 KG OF OLEIC ACID |
| 3619.94 KG OF METHANOL | FROM BOTTOM →<br>1016.7 KG OF OLEIC ACID |
| 0.22KG OF STEARIC ACID | |

**Table 2.5 Inlets And Outlets Of Stripping Still 2**

LOSS OF OLEIC ACID =1%