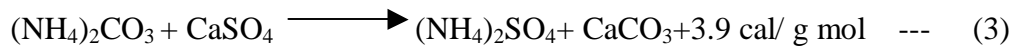

5. MATERIAL BALANCE

Chemical reactions:



Molecular weights:

NH ₃	-----	17
H ₂ O	-----	18
NH ₄ OH	-----	35
CO ₂	-----	44
(NH ₄) ₂ CO ₃	-----	96
CaSO ₄	-----	136
CaCO ₃	-----	100
(NH ₄) ₂ SO ₄	-----	132

The required production rate is 250 tonnes per day

$$\text{The production rate} = 10517 \text{ kg/ hour}$$

$$\text{Ammonium sulphate lost in filtration process} = 100 \text{ kg/hour}$$

$$\text{Required production rate} = 10417 \text{ kg/hour}$$

Raw materials required for the process:

For the process considered, assuming that conversion in reaction (1) & (2) is complete conversion and for reaction (3) conversion is 96%

BASIS: 1-HOUR OPERATION.

Amount of ammonium sulphate to be manufactured = 10517 kg

Amount of ammonium sulphate lost in filtration = 100 kg

Gypsum composition:

Gypsum	85%	1425 .0 kg
Calcium carbonate	10.4%	1733.0 kg
Insolubles	3.6%	600.0 kg
Free moisture	1%	167.5 kg

Gypsum required:

From reaction (3)

132 kg of ammonium sulphate requires 136 kg of gypsum

10517 kg of ammonium sulphate would require:

$$136/132 \times 10517 \times 1/0.85 \times 1/0.96 = \underline{13279\text{kg}}$$

Ammonium carbonate required:

Here 10 % excess requirement of ammonium carbonate is considered to overcome the inherent process losses.

136 kg of gypsum requires 96 kg of ammonium carbonate

13279kg of gypsum would require:

$$96 / 136 \times 13279 \times 1.05 = \underline{9842 \text{ kg}}$$

Aqueous ammonia required:

From reaction (2),

96 kg of ammonium carbonate requires 70 kg of ammonium hydroxide.

9842kg of ammonium carbonate would require:

$$70/96 \times 9842 = \underline{7176.5 \text{ kg}}$$

Ammonia required:

From reaction (1),

1 mole of Aq.ammonia is produced which is half the actual requirement :

$$\text{Amount of Aq Ammonia produced} = 6835 / 2 = 3588.25\text{kg}$$

Hence,

35 kg of Aq ammonia requires 17 kg of ammonia

3588.25 kg of Aq. Ammonia would require:

$$17/35 \times 3588.25 = \underline{1743 \text{ kg.}}$$

Carbon dioxide required:

From reaction (3),
 100 kg of ammonium carbonate requires 44 kg of carbon dioxide
 9842 kg of ammonium carbonate would require:

$$44/100 \times 9842 = \underline{4330 \text{ kg}}$$

Water required:

35 kg of Aq. Ammonia requires 18 kg of water
 3588.25 kg of Aq ammonia would require:

$$18/35 \times 3588.25 = 1845.38 \text{ kg}$$

Raw materials	Amount (kg per hour)
Gypsum	13279
Ammonium carbonate	9842
Aqueous ammonia	7176.5
Ammonia	1743
Carbon di oxide required	4330.7
Water required	1845.38

Material balance across all equipments:

All weights in kg/hour:

CRUSHER AND GRINDER

	Input	output
Gypsum lumps	13279	13279

SLURRY TANK

	Input	Output
Calcium sulphate	14250.0	14250.0
Calcium carbonate	1732.5	1732.5
Insolubles	600.0	600.0
Free water in Gypsum	167.5	167.5
Extra water added	490.0	490.0
	16640.0	16640.0

ABSORBER SECTION

	Input	Output
Aq. Ammonia	7176.5	-
Carbon dioxide	4330.7	-
Water	-	1665.2
Ammonium carbonate	-	9842.0
	11507.2	11507.2

REACTOR

	Input	Output
Calcium sulphate	14250	14250
Insolubles	600	600
Calcium carbonate	1732.5	9700
Water	657.5	657.5
Ammonium carbonate	9842	843.5
Ammonium sulphate	-	10517
	27082	27082

FILTERS

Ammonium sulphate	10517	10417
Ammonium sulphate lost	-	100
Ammonium carbonate	843.5	843.5
Calcium sulphate	570	570
Insolubles	600	600
Calcium carbonate	9700	-
Calcium carbonate lost in filtration	-	70
Calcium carbonate to settler	-	9630
Water	657.5	657.5
	22788	22788

DECOMPOSER

	Input	Output
Ammonium sulphate	10417	10417
Calcium carbonate	30	30
Water	657.5	557.5
Water evaporated	-	100
Ammonium carbonate	843.5	
Decomposition of Ammonium carbonate to atmosphere	-	843.5
	11948	11948

CRYSTALLIZER

	Input	Output
Ammonium sulphate	10417	10417
Water	557.5	212.5
Water evaporated	-	345
Calcium carbonate	30	30
	11004.5	11004.5

CENTRIFUGE

	Input	Output
Ammonium sulphate	10417	10417
Water	212.5	212.5
Calcium carbonate	30	
Calcium carbonate centrifuged		30
	10659.5	10659.5

ROTARY DRYER

	Input	Output
Ammonium sulphate	10417	10417
Water	212.5	105.25
Water dried		107.25
Air	16743.9	16743.9
	27373.2	27373.2

Product: 10417 kg/hr of ammonium sulphate crystals with 1% (dry basis) moisture