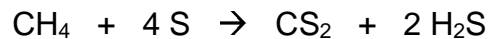


## Material Balance



Conversion : 90% based on methane supplied in the feed.

Output of the plant : 50 Ton per Day of CS<sub>2</sub>

Basis : 1 day of operation

Production of CS<sub>2</sub> : 50 tpd = 50,000/76.1 = 657.03 Kmols/day

Raw material required :

Methane : Theoretical amount of CH<sub>4</sub> required for 90% conversion

$$= 657.03/0.9 = 730.0 \text{ Kmols}$$

An excess of 10% to the stoichiometric requirement is used.

Excess methane = 73.0 Kmols

Hence, total methane requirement = 730.0 + 73.0 = 803.0 Kmols

Sulfur : Theoretical amount of Sulfur required in the reaction :

Sulfur required = 657.03 X 4 = 2628.12 Kmols

An excess of 10% to the stoichiometric requirement is used.

Excess sulfur = 262.18 Kmols

Hence, total sulfur requirement = 2628.12 + 262.8 = 2890.0 Kmols

H<sub>2</sub>S present in the output = 2 X 657.03 = 1314.06 Kmols

Thus the total requirements are :

Methane = 803.0 Kmols

Sulfur = 1314.06 Kmols

Catalyst = silica gel

1) Vaporizer :

Input :       $\text{CH}_4 = 803.0 \text{ Kmols}$   
                  $\text{S} = 2890.0 \text{ Kmols}$   
Output :       $\text{CH}_4 = 803.0 \text{ Kmols}$   
                  $\text{S} = 2890.0 \text{ Kmols}$

2) Reactor :

Input :       $\text{CH}_4 = 803.0 \text{ Kmols}$   
                  $\text{S} = 2890.0 \text{ Kmols}$   
Output :       $\text{CH}_4 \text{ (unconverted)} = 73.0 \text{ Kmols}$   
                  $\text{S} = 262.81 \text{ Kmols}$   
                  $\text{CS}_2 = 657.03 \text{ Kmols}$   
                  $\text{H}_2\text{S} = 1314.06 \text{ Kmols}$

3) Sulfur scrubber :

Input :       $\text{CH}_4 = 73.0 \text{ Kmols}$   
                  $\text{CS}_2 = 657.03 \text{ Kmols}$   
                  $\text{H}_2\text{S} = 1314.06 \text{ Kmols}$   
                  $\text{S} = 262.81 \text{ Kmols}$   
Output :       $\text{CH}_4 = 73.0 \text{ Kmols}$   
                  $\text{CS}_2 = 657.03 \text{ Kmols}$   
                  $\text{H}_2\text{S} = 1314.06 \text{ Kmols}$   
                  $\text{S} = 1.314 \text{ Kmols}$

(0.5% entrainment of sulfur in the exit gases)

99.5% of sulfur = 261.496 Kmols leaves to the accumulator.

4) CS<sub>2</sub> condenser :

Input : CS<sub>2</sub> = 657.03 Kmols

H<sub>2</sub>S = 1314.06 Kmols

CH<sub>4</sub> = 73.0 Kmols

S = 1.314 Kmols

30% of CS<sub>2</sub> gets condensed in the condenser.

Amount of CS<sub>2</sub> condensed = 0.3 X 657.03 = 197.1 Kmols

Remaining 70% goes to the absorber = 0.7 X 657.03 = 459.92 Kmols

Output : (gas stream): CS<sub>2</sub> = 459.92 Kmols

H<sub>2</sub>S = 1314.06 Kmols

CH<sub>4</sub> = 73.0 Kmols

Total gas = 1846.98 Kmols

Output : (condensed liquid) CS<sub>2</sub> = 197.1 Kmols

S = 1.314 Kmols

5) Absorber :

Total gas input to the absorber = 1846.98 Kmols

L/G ratio calculated in process design of absorber column = 1.44

Hence, amount of hydrocarbon oil required in the absorber = 1.44 X 1848.98

L = 1947.32 Kmols

Input : CS<sub>2</sub> = 459.92 Kmols

H<sub>2</sub>S = 1314.06 Kmols

CH<sub>4</sub> = 73.0 Kmols

Oil = 1947.32 Kmols

Output : (Bottom liquid, to stripper) CS<sub>2</sub> = 459.92 Kmols

H<sub>2</sub>S = 6.5703 Kmols

Oil = 1947.32 Kmols

(Exit gases, to H<sub>2</sub>S recovery unit) : CH<sub>4</sub> = 73.0 Kmols

H<sub>2</sub>S = 1307.49 Kmols

6) Stripper :

Input : CS<sub>2</sub> = 459.92 Kmols

H<sub>2</sub>S = 6.5703 Kmols

Oil = 1947.32 Kmols

Exit gases : CS<sub>2</sub> = 459.92 Kmols

H<sub>2</sub>S = 6.5703 Kmols

Oil = 19.473 Kmols

Assuming 1% oil losses, which is later added in make up.

Bottom liquid output : Oil = 19.473 Kmols

7) Distillation unit :

Input : Condensed liquid from crude CS<sub>2</sub> receiver :

CS<sub>2</sub> = 197.1 Kmols

S = 1.314 Kmols

From stripper column :

CS<sub>2</sub> = 459.92 Kmols

H<sub>2</sub>S = 6.5703 Kmols

Oil = 19.27 Kmols

Total feed CS<sub>2</sub> : Condensed liquid CS<sub>2</sub> from crude CS<sub>2</sub> receiver  
+ CS<sub>2</sub> from stripper unit = 197.1 + 459.92 Kmols  
= 657.03 Kmols

Output : (top) H<sub>2</sub>S = 6.4388 Kmols

(bottom)  $\text{CS}_2 = 657.03 \text{ Kmols}$

$\text{H}_2\text{S} = 0.1314 \text{ Kmols}$

$\text{S} = 1.314 \text{ Kmols}$

$\text{Oil} = 19.27 \text{ Kmols}$

7) Refining Column :

Input :  $\text{CS}_2 = 657.03 \text{ Kmols}$

$\text{H}_2\text{S} = 0.1314 \text{ Kmols}$

$\text{S} = 1.314 \text{ Kmols}$

$\text{Oil} = 19.27 \text{ Kmols}$

Output : (tops)  $\text{CS}_2 = 657.03 \text{ Kmols}$

$\text{H}_2\text{S} = 0.1314 \text{ Kmols}$

(bottoms)  $\text{Oil} = 19.27 \text{ Kmols}$

$\text{S} = 1.314 \text{ Kmols}$