Claus Process

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Background :

Desulfurization of Hydrogen Sulfide for the production of Elemental Sulfur Claus Process is the most significant process petended by chemist Carl Friedrich Claus in 1883 which has industrial standard for production of sulphur.

The Claus multi-step method recovers sulfur from the gaseous hydrogen sulfide present in raw natural gas and from the by-product gases containing hydrogen sulfide produced from crude oil refining and other processes of industry. Gasses with an H2S content of more than 25% are ideal for sulfur recovery in Claus straight-through plants, whereas alternative systems such as split-flow set-up or feed and air preheating can be used to process leaner feeds.

Description:

The flowsheet use for recovery of Elemental consist of Burner ,Reaction Furnace Condenser, Reheater and Reactor. Thermal (in burner above 850^0C) and Catalytic are the two main step of this process.

The catalytic recovery of sulphur conist of three sub step:-

- The gases are reheated and introduced to catalyst bed.
- The remaining H2S is reacted with SO2 at lower temperature (About $200\text{-}350^0$C) over a catalyst to make more sulphur. For this reason more than one or two reactors are use.
- In the sulphur condenser the process gas coming from the burner and from catalytic reactors is cooled to between 150 to 130 ^{0}C, sulphur being removed from each step.

The reaction that are possible in reaction furnace are given below:

$2\ H_2S + 3\ O_2 \rightarrow 2\ So_2 + 2\ H_2O$ (ΔH = -518 KJ/Mol)

This is strongly exothermic reaction free-flame total oxidation of hydrogen sulphide genarting sulphur dioxide that subsequently react for the producting the sulphur. The most importance reaction in the claus process:

$2H_2S + SO_2 \rightarrow 3S + 2H_2O$ (ΔH = -1165.6 KJ/Mol)

The overall reaction is:

$2\ H_2S + O_2 \longrightarrow 2\ S + 2\ H_2O$

In this process Aluminium or Titanium Oxide are used to boost sulphur yield in reactor.

The temperature inside the furnce is often to maintained above 1050^0C which ensure BTEX destruction which otherwise would clog downstream claus catalyst. For sufficient combustion of hydrocarbons enough air supply should provided to burner and subsequently to reaction furnace. The air to acid gas ratio should maintained 1/3 for complete conversion of hydrogen sulphide to Sulfur dioxide.

Usually 60 to 80% of total amount of Elemental Sulfur produced in the process are obtained in thermal process step.

Side Reaction:

Following are the side reaction taking place in thermal step of claus process

- The formation os hydrogen gas

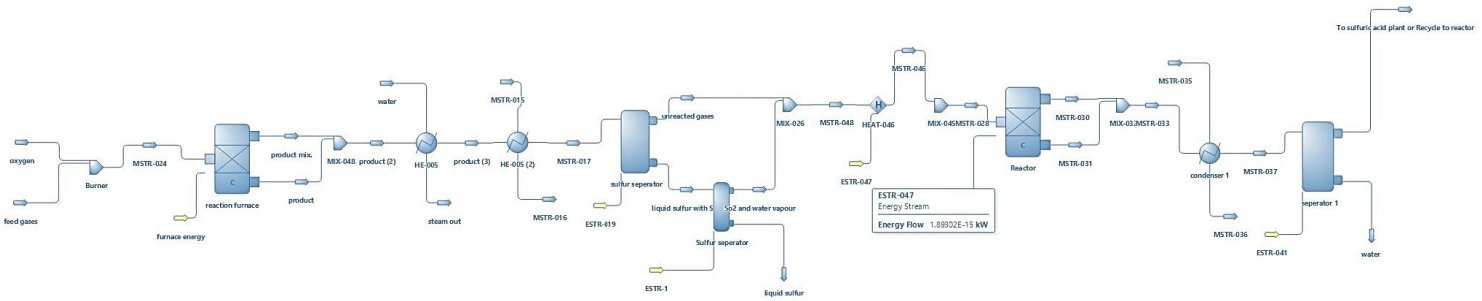
  $2\ H_2S \rightarrow S_2 + 2\ H_2$

  $CH4 + 2\ H20 \rightarrow CO_2 + 4\ H_2$
- The formation of carbonyl sulphide

  $H_2S + CO_2 \rightarrow S{=}C{=}O + H_2O$
- The formation of carbon disulphide

  $CH_4 + 2\ S_2 \rightarrow S{=}C{=}S + 2\ H_2S$

Flowsheet:



Claus Process for Recovery of Liquid Sulfur From Hydrogen Sulfide

Results:

Master Property Table							
Object	unreacted gases	oxygen	liquid sulfur with SO2	liquid sulfur	feed gases	To sulfuric acid plant or Recycle to reactor	
Temperature	90	25	90	90	25	25	C
Mass Flow	3.09911E-14	3.43475E-14	4.3949E-14	4.3949E-14	4.05925E-14	2.63077E-14	kg/h
Molar Flow	7.46173E-16	1.0734E-15	1.76979E-15	1.76979E-15	1.19106E-15	4.87031E-16	kmol/h
Volumetric Flow	2.20889E-14	2.62352E-14	1.2747E-15	1.2747E-15	2.89101E-14	1.18054E-14	m3/h
Mixture Density	1.40302	1.30922	34.4779	34.4779	1.4041	2.22844	kg/m3
Mixture Molar Weight	41.5334	31.9988	24.8329	24.8329	34.0809	54.0165	kg/kmol
Liquid Phase (1) Mass Flow	0	0	4.3949E-14	4.3949E-14	0	0	kg/h
Mass Flow (Mixture) / Oxygen	4.28172E-15	3.43475E-14	3.16541E-19	3.16541E-19	0	4.28171E-15	kg/h
Molar Flow (Mixture) / Sulfur	9.30509E-23	0	8.47018E-16	8.47018E-16	0	1.54034E-31	kmol/h
Mass Flow (Mixture) / Sulfur	2.98368E-21	0	2.71596E-14	2.71596E-14	0	4.93911E-30	kg/h
Molar Flow (Mixture) / Sulfur dioxide	3.40456E-16	0	3.5951E-18	3.5951E-18	0	3.40132E-16	kmol/h
Mass Flow (Mixture) / Sulfur dioxide	2.18109E-14	0	2.30316E-16	2.30316E-16	0	2.17902E-14	kg/h
Mass Flow (Liquid Phase 1) / Sulfur dioxide	0	0	2.30316E-16	2.30316E-16	0	0	kg/h
Mass Flow (Liquid Phase 2) / Sulfur dioxide	0	0	0	0	0	0	kg/h
Molar Flow (Mixture) / Water	2.71907E-16	0	9.19162E-16	9.19162E-16	0	1.30898E-17	kmol/h
Mass Flow (Mixture) / Water	4.89841E-15	0	1.65587E-14	1.65587E-14	0	2.35813E-16	kg/h
Molar Flow (Mixture) / Hydrogen sulfide	2.43041E-31	0	1.01437E-33	1.01437E-33	1.19106E-15	0	kmol/h
Mass Flow (Mixture) / Hydrogen sulfide	8.28303E-30	0	3.45707E-32	3.45707E-32	4.05925E-14	0	kg/h
Mass Flow (Liquid Phase 2) / Methanol	0	0	0	0	0	0	kg/h

Table 1: Stream wise Result for Recovery of Liquid Sulfur From Hydrogen Sulfide