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SULPHUR RECOVERY BY TAIL GAS TREATING TECHNOLOGY (MCRC PROCESS) MAXIMUM CLAUS

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Abstract: During the past two decades, the principal concern on the control of sulfur oxides emission has been focused on flue gases from fuel combustion. Fuel combustion accounts for three-fourth of the estimated sulfur dioxide emissions in the world. On one hand, the emission limits are tightening, sulfur in fuel has also shown an increasing trend. During the past decade a lot of energy has been directed to remove elemental sulfur from the sour gas containing varying compositions of hydrogen sulfide. Of all the industries electric power generation and industries using boilers account for the major emissions of sulfur oxides. The light hydrocarbon produced in the refineries, both straight run and cracked, contain varying proportions of hydrocarbon sulfides. This must be removed for two reasons:
(i) To reduce the sulfur dioxide emissions if the gas is burned.
(ii) To meet the product specifications if the light hydrocarbon product is sold.
The conventional processes with 94% efficiency is finding hard to keep up with the tightening controls. Thus modification of conventional units is the need of ours that increase the sulfur recovery to about 99%. To choose a suitable process, various parameters should be kept in mind, namely – cost, product specifications, safety, and location.
Keywords: Sulfur, Sulfreen, MCRC process, Claus process, sulfuric acid.

Introduction

Sulfur is a widely used chemical agent for its chemical and non-chemical properties. Sulfuric acid is known as the king of the chemicals, can also be obtained by sulfur. Some important properties of sulfur are:

Color	Atomic number	Melting point	Boiling point	Standard atomic weight	Heat of Fusion
Bright yellow	16	113 K	445 K	32.06 g/mol	1.727 KJ/mol

Sulfur is also extracted directly from nature as it is found in meteorites, volcanoes, and hot springs. Some important uses of sulfur are as follows:

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It is used for the production of sulfuric acid, which then used in many other manufacturing processes.

Sulfuric acid is used primarily for the manufacture of fertilizers, organic and inorganic chemicals, pigments, steel, rayon, petroleum products, and explosives.

The principal industries using elemental sulfur as such include wood pulp, carbon disulphide, insecticide and fungicides, rubber, sugar, starch, and malt dyestuffs.

Rubber uses ground sulfur and specially prepared amorphous sulfur for compounding and vulcanizing.

Sulfur is also used in the manufacture of polysulfide elastomers in making sulfur cements in the production of free aching steels.

It is also used as a polymerization inhibitor in the manufacturing of matches.

Sulfur is also used in building constructions.

Sulfur is required for the preparation of sulfide cooking liquors in the production of sulfite pulp.

Methods for recovery of sulfur:

1) Super Claus Process.

(2) IFP - 1500 Process

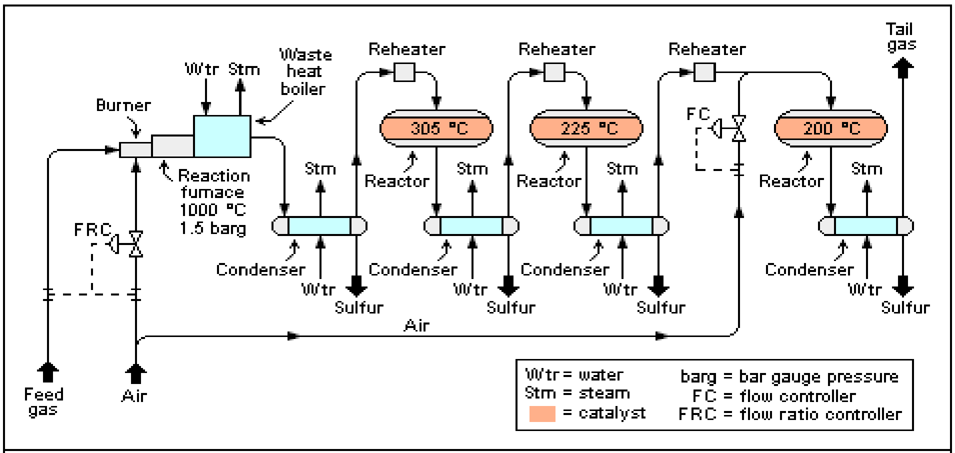
(3) Shell Claus off gas Treating

(4) Sulfreen Process.

(5) Selectox Process

PROCESS AND EQUIPMENT DESCRIPTION

In this hydrogen sulfide rich acid gas stream from the Amine Regeneration Unit stripper is delivered to the sulfur recovery plant at a very low positive pressure (about 9 psig) situated with water vapor at 94 ^{o}F. The gas without any treatment passes to the free flame combustion furnace. The stoichiometric amount of air for the combustion is supplied by a positive displacement rotary blower. It has been shown stoichiometrically that oxygen required will be that needed to convert one third of hydrogen sulfide in feed to sulfur dioxide. The ratio of air to acid gas is manually controlled by means of a by pass on the air line in order to provide the correct amount of air for complete combustion of hydrocarbons, and oxidation of the hydrogen sulfide to sulfur.



Schematic flow diagram of a Claus process plant

COMBUSTION FURNACE

A cylindrical horizontal furnace equipped with an electric arc filament in the pre-heat chamber is used. Acid gas and air are pre-heated at the entry and the combustion starts and reaction from passes along the length of furnace. The furnace is very loosely packed with refractory material and is lined over the walls with silica bricks. The need for such packing has been demonstrated in pilot plant studies, where it was found that in the absence of packing the reaction front moved out through the exist end of furnace and combustion was eventually extinguished in the line. With the operating conditions of 1350 Deg. C flame temperature and one atmosphere pressure, a 75% conversion of H_2S to SO_2 is affected.

WASTE HEAT BOILER

A waste heat boiler is used to cool furnace exit gases prior to admitting them to the converters. The boiler, along with a feed water economizer recovers sufficient heat to generate high pressure saturated steam. After leaving the boiler, the gases are then condensed in a first sulfur condenser where the sulfur vapor is condensed and liquid sulfur is separated from gas and flows down in sulfur pit.

FIRST STAGE REHEATER

Process gas from the condenser then goes to the reheater so that the gases obtain the optimum temperature for the catalytic conversion in catalytic converter.

CATALYTIC CONVERTER

In order to make possible a recovery of over 80% it was found necessary to include catalytic converter for further treatment of the furnace exit gases. In this plant for example, three converters are used in series. Gas enters each converter in the center in the center of the dome, is deflected radically by means of a single flat deflector, and then descend through the catalyst Bauxite (type) catalysts or Alumina based catalysts.

All elemental sulfur formed in the kiln is allowed to remain in the gas stream to the 1st reactor it does not affect the reactions occurring there. In order to obtain the highest possible conversion in the 2nd stage. The sulfur produced in the kiln and the 1st converter is removed prior to admission of the gas to the second converter stage. This lowers the sulfur dew point of the second converter exit gas.

CONDENSORS

The gases from the first converter is then condensed in a second sulfur condenser where the sulfur vapor is condensed and liquid sulfur is separated from gas and flows down in sulfur pit.

SECOND STAGE

The second stage is similar to first stage.

THIRD STAGE

The gases leaving the third condenser is reheated in a reheater. The reheated gas is passed through the 3^{rd} converter containing high activity iron catalyst on a carrier. The sulfur product flows the condenser to a rundown pit. Then these exit gases goes to the vapor liquid separator where the last traces of molten sulfur is separated from gases and flows into a rundown pit. Remaining gases are then routed directly to the thermal incinerator.

Tail Gas Treating Unit

Tail gas treating unit is used to enhance the efficiency of the process up to 99.99 %. Basically the conversion of sulfur compounds having sulfur content less than takes place in TGTU which were not converted in Sulfur recovery process. The remains of SRU is heated and transferred to the catalytic converters where catalysts help to recover the remaining sulfur. The treated gas is sent back to the absorbers to remove the H_2S and remaining CO_2. The rich amine (gas containing sulfur or H_2S) is reheated and sent to regenerator column. The steam which is generated in the re-boiler removes H_2S and CO_2 from the amine. The lean amine is removed and returned to the absorber. The remaining H_2S and CO_2 and removed again fed to the condenser after cooling.

Conclusion

With the introduction of tail gas treating unit the efficiency can reach upto the level of 99.99 % [R3]. Also the product obtained is more yellow in color as compared to other processes for sulfur recovery. Purity level is also high and around, saleable sulfur. Less pressure drop, less heat loss, no refractory damages, less vibrations are some other prominent advantages of MCRC process.

The cost plays a vital role in selection of any project and the cost is much less as compared to that of Sulfreen process for sulfur recovery.

In MCRC process an additional stage is added to the Claus unit containing iron-based high activity material on a carrier. This catalyst is insensitive to high water content in the process gas. This method has a distinct advantage over other processes as it is very easily adapted to the Claus Unit. It requires very little space as compared to sulfreen or Liquid Redox Method. Though sulfreen Process has fixed costs less than 60% of that super Claus unit it uses two reactors and produces sulfur which is less yellow than that obtained in Claus unit.

The Selectox process has its limitation as the recovery is around 97% where as the recovery in super Claus unit is around 99%. The IFP – 1500 could not really take off because of high operating costs though it provided high conversion rates.

So, in nutshell it can be clearly observed that MCRC process is widely acceptable to recover sulfur.

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