Gas Desulfurization - The Claus Process

HOFFMAN LAMSON
by Gardner Denver

Gas Desulfurization

Sulfur is used for manufacturing sulfuric acid, medicine, cosmetics, fertilizers, pesticides and rubber products.

The Claus process, commonly referred to as a sulfur recovery unit (SRU), recovers sulfur from the gaseous hydrogen sulfide found in raw natural gas and in the by-product gases derived from oil refining and other industrial processes. First patented in 1883 by the scientist Carl Friedrich Claus, the process has become the industry standard.

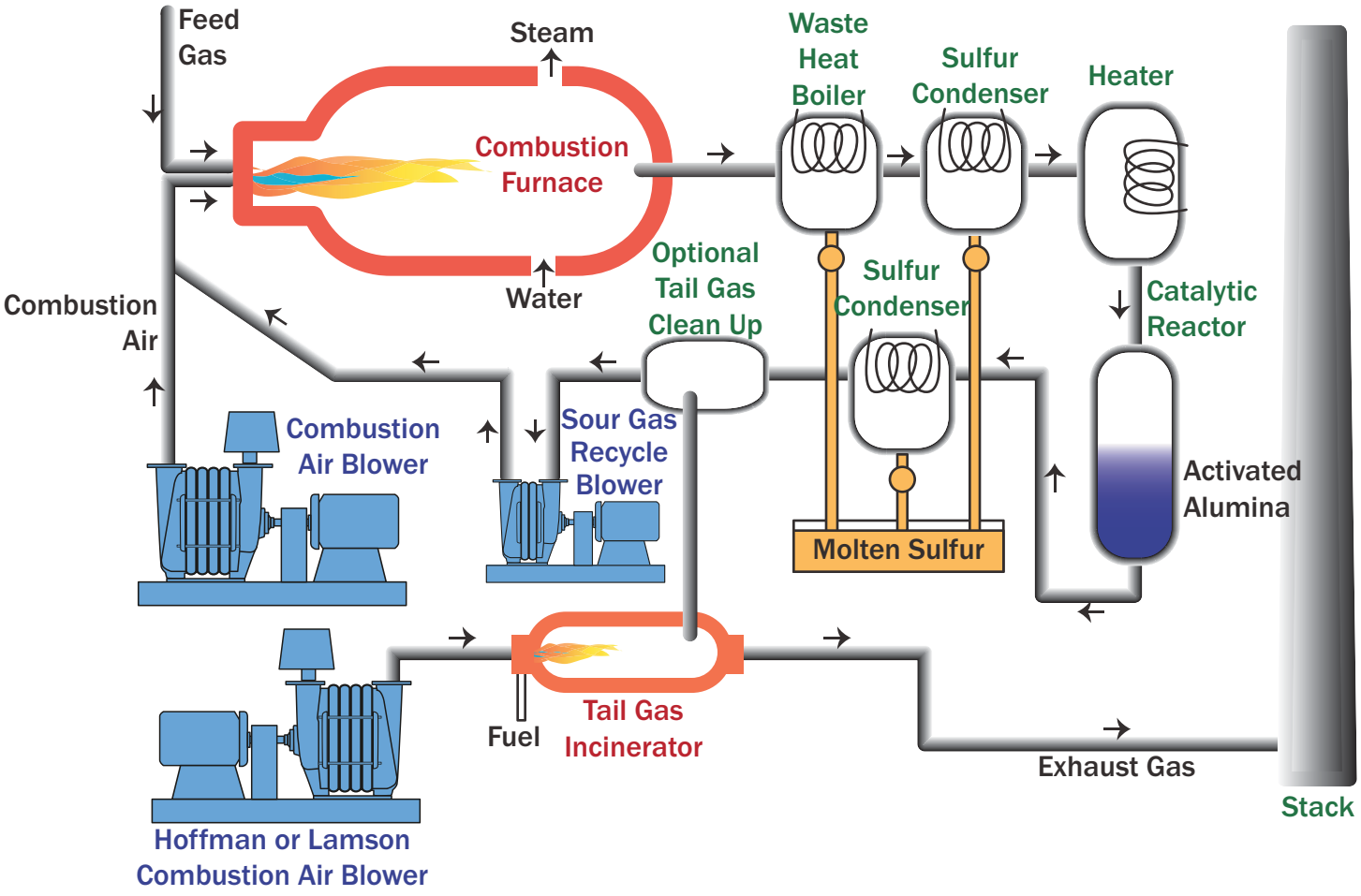
The by-product gases mainly come from gas treatment units such as amine scrubbers in refineries. These gases may also contain hydrogen cyanide, hydrocarbons, sulfur dioxide or ammonia.

Gases with an H_2S content of over 25% are suitable for the recovery of sulfur in Claus plants while alternate configurations are used to process leaner feeds.

The Claus Process

As shown in the diagram below, the feed gas is burned in a furnace using sufficient combustion air to burn one-third of the H_2S. A flow ratio controller is used to provide the required ratio of combustion air to feed gas.

The reaction furnace pressure and temperature is maintained at about 1.5 bar gauge and 980-1540°C (1800-2800°F). At those conditions, the Claus reaction occurs thermally in the reaction furnace with no catalyst needed. About 70% of the H_2S in the feed gas is thermally converted into elemental sulfur in the reaction furnace.



The hot reaction product gas, containing gaseous sulfur, is used to produce steam in a boiler (called a waste heat boiler) which serves to cool the gas. It is further cooled and condensed in heat exchangers while producing additional steam. The condensed liquid sulfur is separated from the remaining unreacted gas in the condenser and sent to product storage.

The separated gas is then reheated and sent to the first catalytic reactor, where about 20% of the H_2S in the feed gas is converted into elemental sulfur. The catalytic reactors operate at lower temperatures, ranging from 200-315°C (400-600°F). The gas from the first reactor is cooled in another condenser while also producing steam. Again, the condensed liquid sulfur is separated and sent to storage.

The separated gas from the second condenser is sent to another reheater and the sequence of gas reheat, catalytic reaction, condensation and separation of liquid sulfur from unreacted gas is repeated for the second and third reactors at successively lower reactor temperatures.

The remaining gas, separated from the last condenser, is referred to as "tail gas" and it is either burned in an incinerator or further desulfurized in a tail gas treatment unit (TGTU).

Older Claus sulfur recovery units were designed using only two catalytic reactors. Because of stringent environmental regulatory requirements, many of those units have been upgraded to include three reactors. The tail gas from those that have not been upgraded is usually desulfurized further in a tail gas treatment unit.

Catalysts

The catalytic reactors each contain a bed of catalyst with a depth of 90-120 cm (35-47 in). The most widely used Claus reaction catalyst is porous aluminum oxide, commonly referred to as alumina. The catalyst not only increases the rate of reaction, but it also hydrolyzes the carbonyl sulfide (COS) and carbon disulfide (CS2) that are formed in the reaction furnace. The resulting H_2S is then converted into elemental sulfur through the Claus reaction. Most of the hydrolysis occurs in the first Claus reactor.

Hoffman & Lamson Blowers

Multistage centrifugal blowers are used to supply combustion air to the furnace. An additional multistage blower is often utilized to recycle gas back through the process to increase the sulfur yield and/or to decrease the hydrogen sulfide content.

An additional combustion air blower is occasionally used for the tail gas incinerator. The blowers are also useful for propelling exhaust gas to the stack.

Hoffman & Lamson multistage centrifugal blowers are designed to fit the needs of each desulfurization process. They are usually manufactured without copper, so there is no reaction with the hydrogen sulfide. Sour Gas recycling blowers are made with steel internals and seals using carbon rings or purged labyrinth construction. Other common elements are bearing shields and section drain pipe assembly to deal with condensate.

Hoffman & Lamson has extensive experience with blowers having 20"-24" inlets, as well as with the smaller blowers for gas recycling. Ask about our sulfur recover installations found worldwide.

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