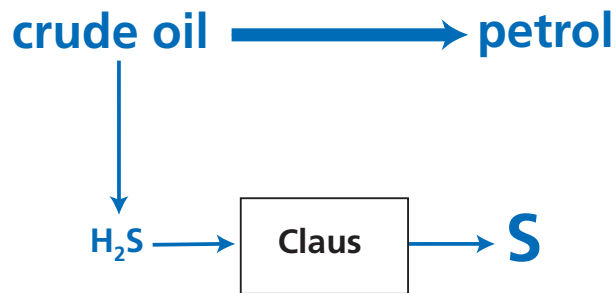


Lurgi Sulfur Management



Introduction

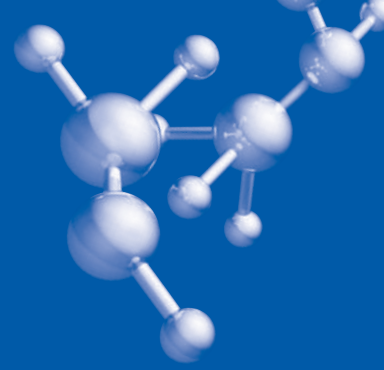
On the way from gaseous, liquid or solid feedstocks to petrol, heating oil or petrochemical products, the feedstocks need to be purified of sulfuric compounds.

For environmental reasons, these compounds must not be burned off and thus released to the atmosphere. Consequently, these sulfuric compounds need to be converted to sulfur in a Claus plant.

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Claus Plant with a Capacity of 132 t/d



Claus Technologies

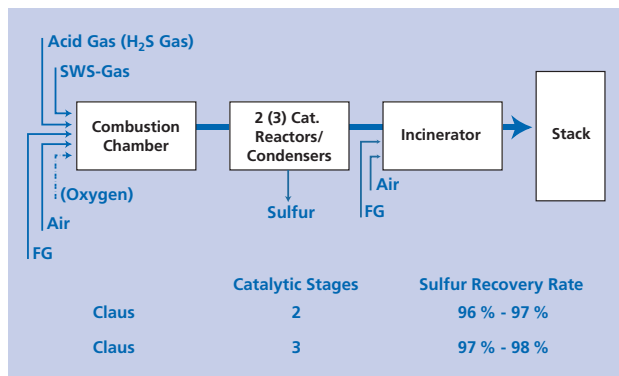
Claus Process

The Claus process continues to be the most widely used process worldwide for the conversion of H_2S to sulfur. The requirements to be met by Claus plants are dictated by the operating conditions of modern, flexible refineries and natural gas plants and increasingly stringent emission control regulations. The highly efficient recovery of elemental sulfur from hydrogen sulfide, carbonyl sulfide, carbon bisulfide, sulfur dioxide or other gaseous sulfur compounds involves four main process steps:

- partial substoichiometric combustion,
- catalytic conversion in two or more stages,
- tail gas cleanup to boost sulfur yield,
- thermal or catalytic incineration of tail gases.

Advantages of the Lurgi Claus Process

- Unique burner system including ammonia/RSH destruction

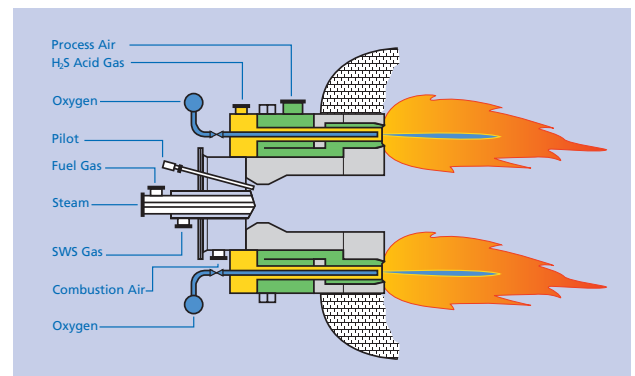


Lurgi Claus Process

OxyClaus® Process

Advantages of the OxyClaus® Process

- Capacity boosting of existing Claus and tail gas units.
- Significant reduction in capital investment when building new Claus and tail gas units.
- Processing of feed gases with both high and low hydrogen sulfide contents (20–100 vol %).
- Flexible processing when handling temporarily high or low amounts of hydrogen sulfide by automatic change over from air to oxygen operation and vice versa.
- Processing of Claus gases with elevated hydrocarbon contents.
- Complete combustion of ammonia contained in ammonia-laden sour water stripper offgases.



OxyClaus® Process



1000 t/d Claus-Sulfreen Plant

Tailgas Technologies

MAXISULF® and SULFREEN®

A very efficient and low-budget SULFREEN tail gas treatment process is MAXISULF. It is basically a one-stage (one adsorber, one regenerator) SULFREEN unit with an open regeneration loop.

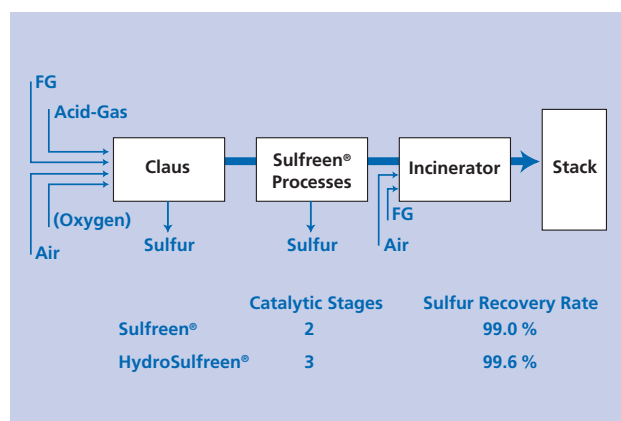
The regeneration gas is fed to the adsorber together with the Claus tail gas, whereas in the SULFREEN process the regeneration gas is recycled. With MAXISULF, yields of up to 98.5 % can be achieved. The SULFREEN process is a catalytic tail gas process which has been successfully employed in more than 45 Claus plants. This SULFREEN process permits sulfur yields to be boosted to over 99.0 %. For even higher yields, a second absorber stage can be added.

HYDROSULFREEN®

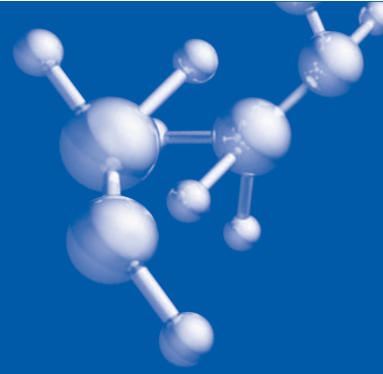
If even higher sulfur yields have to be obtained, an additional process stage comprising hydrogenation and hydrolysis with adjustment of the H_2S/SO_2 ratio to 2 can be installed upstream of the SULFREEN process. This concept permits sulfur yields of up to 99.6 %.

Advantages of the SULFREEN® Processes

- Continuation of catalytical Claus process
- No chemicals/solvents needed
- Increase of sulfur recovery rate step by step by using existing SULFREEN equipment and just adding more catalytical stages.

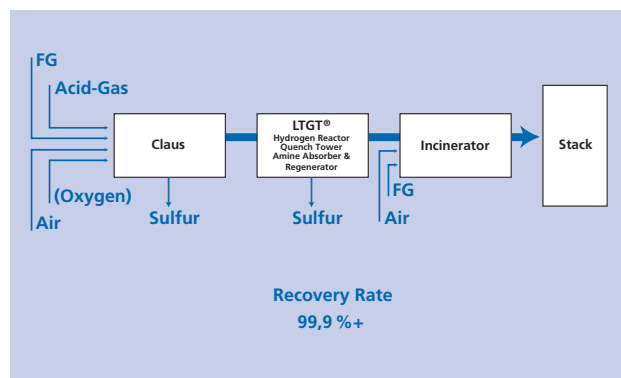


Lurgi Sub-dewpoint Processes



Lurgi Tail Gas Treating LTGT®

Catalytic tail gas processes reach their practical limits when sulfur yields of over 99.9 % are required. In such a case, hydrogenation and water condensation have to be followed by a (usually) selective chemical absorption process to remove the remaining H₂S and return it to the Claus feed gas. Lurgi has built a number of such absorption systems and can offer the necessary references. This process combination brings off-gas H₂S levels down to 200 ppm prior to thermal incineration.



LTGT®-Lurgi Tail Gas Treatment Technology

Advantages of Selective Chemical Adsorption (LTGT®)

- Extremely high sulfur recovery rates of more than 99.9 %
- Possibility of using existing solvent regeneration units
- No license fee for LTGT

Sulfur Degassing

Sulfur Degassing Process AQUISULF®

For sulfur degassing, Lurgi uses the AQUISULF process from ELF.

Liquid sulfur obtained from H₂S in Claus units necessarily contains dissolved H₂S desorbed during transportation and accumulated in the gaseous phase of tanks. At a certain concentration, it may become explosive and, in any case, is hazardous for operators.

Moreover, H₂S in liquid sulfur has an adverse effect on the solidity of sulfur and particularly on sulfur slate strength. In order to solve these problems, ELF conducted their own experiments to develop a liquid sulfur degassing process bringing residual H₂S down to less than 10 ppm by weight.

Advantages of the degassing catalyst

- Guaranteed H₂S level in liquid sulfur of less than 10 ppm by weight
- Best solubility in sulfur (only small quantities are required)
- No solid deposits in sulfur



Sulfur

Special Sulfur Concepts

Emission-free SRU

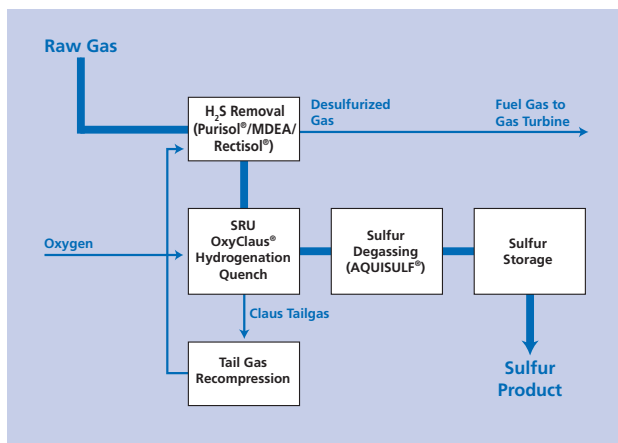
For residual H_2S levels below 10 vol. ppm, Lurgi offers a process combination in which the process gases leaving the Claus plant are cooled to temperatures of around $125\text{ }^\circ\text{C}$ to precipitate the elemental sulfur. Subsequently, the sulfur compounds are hydrolyzed to hydrogen sulfide, water is condensed and the gas is directed to an absorber stage in the upstream gas purification unit, where its H_2S content is reduced to below 10 ppm. All sorbents employed in the different absorption stages including the ones for Claus feed supply are jointly regenerated. The resulting hydrogen sulfide is returned to the combustion chamber. After having been freed of its H_2S load, the gas is routed to the gas turbine, via intermediate compressors, if required, or used as stripping gas, resulting in an overall flue gas-free process. This makes it an ideal choice for combined cycle power plant applications.

Advantages of Emission-free SRU

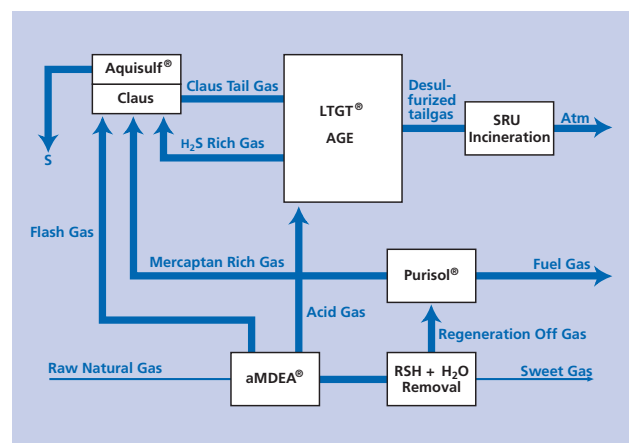
- Lower investment cost due to the use of oxygen (OxyClaus®)
- No sulfur emissions from SRU
- Recycle of process gas results in reduction of sulfur emissions to atmosphere in overall complex
- Higher efficiency in energy production section in IGCC due to higher gas volume

Advantages of OmniSulf® Integrated Natural Gas Treating Concept

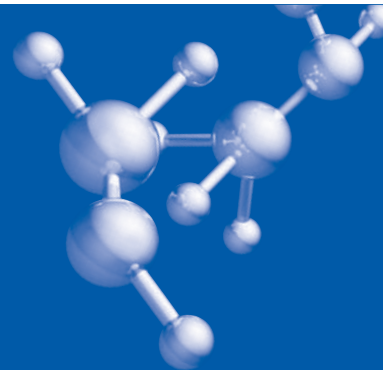
- Single source responsibility
- One licensor
- No interfaces
- Overall guarantees
- One-stop shop



Lurgi Emission-free SRU Option



OmniSulf®



For natural gas treating, i.e. for gas sweetening and mercaptan removal, Lurgi has developed an innovative concept, the BASF-Lurgi OmniSulf® process.

The first step is an activated MDEA (aMDEA® of BASF) acid gas removal unit removing H₂S, COS and CO₂ to LNG gas quality, producing an acid gas as well as a very small amount of flash gas. The sweetened natural gas still containing mercaptans, but only little H₂S and COS, is routed to a molecular sieve unit.

This special molecular sieve unit finally produces the dry, sweet gas according to LNG specification. The batch regeneration of the molecular sieves yields a gas stream containing almost all the mercaptans and a significant amount of hydrocarbons. From this stream, hydrocarbons are recovered in the PURISOL® (Lurgi's proprietary physical absorption) process as fuel gas. In the PURISOL® solvent regeneration unit, a stream rich in mercaptans is produced and completely combusted in the Claus unit together with the aMDEA® flash gas, containing mainly hydrocarbons but also some mercaptans as well as some H₂S.

The acid gas from the aMDEA® is routed to an acid gas enrichment (AGE) absorber. The AGE is part of the Lurgi Tail Gas Treatment (LTGT®) unit and produces a semi-lean gas. This semi-lean gas leaving the absorption column is routed to the LTGT® unit. The solvent used in the LTGT® absorber as well as in the AGE absorber is generic MDEA. This allows for a common regenerator to be used. This regenerator produces the acid gas with an enriched amount of H₂S for the Claus unit, which makes the Claus plant (and the whole SRU) smaller and easier to operate than without the AGE unit. The gas from the LTGT® is combusted in the incinerator.

Recovery Rates and Cost Factors

Lurgi Sulfur Technology	Recovery in %	Cost Factor in %
Claus, 2 catalytic stages	96.0 – 97.0	100
Claus, 3 catalytic stages	97.0 – 98.0	110
Claus (2) + SULFREEN®	99.0 – 99.2	135
Claus (3) + SULFREEN®	99.2 – 99.5	145
Claus (2) + HYDROSULFREEN®	99.5 – 99.7	155
Claus (2) + LTGT® using existing regeneration unit	99.8 – 99.9+	165
Claus (2) + LTGT® incl. regeneration	99.8 – 99.9+	185
Emission-free Claus	100	165

Approximate SRU cost depending on recovery (minimum 50 % vol. H₂S in feed gas to Claus)

References

Status: end of 2008

We have contracted:

- more than 170 Claus plants, having sulfur capacities per train from 4 t/d up to 1000 t/d
- more than 40 OxyClaus® processes (sulfur capacities per train: 4 t/d up to 270 t/d)
- more than 60 tail gas treating processes (sulfur capacities per train from 4 t/d up to 1000 t/d)
- contracts have been signed for more than 50 Aquisulf® sulfur degassing units having total degassing capacities from 20 t/d up to 3600 t/d

Lurgi is a leading technology company operating worldwide in the fields of process engineering and plant contracting. The strength of Lurgi lies in innovative technologies of the future focusing on customized solutions for growth markets. The technological leadership is based on proprietary technologies and exclusively licensed technologies in the areas gas-to-chemical product via synthetic gas or methanol and synthetic fuels, petrochemicals, refinery technology and polymer industry as well as renewable resources/food.

Lurgi is a member of the Air Liquide Group. 

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