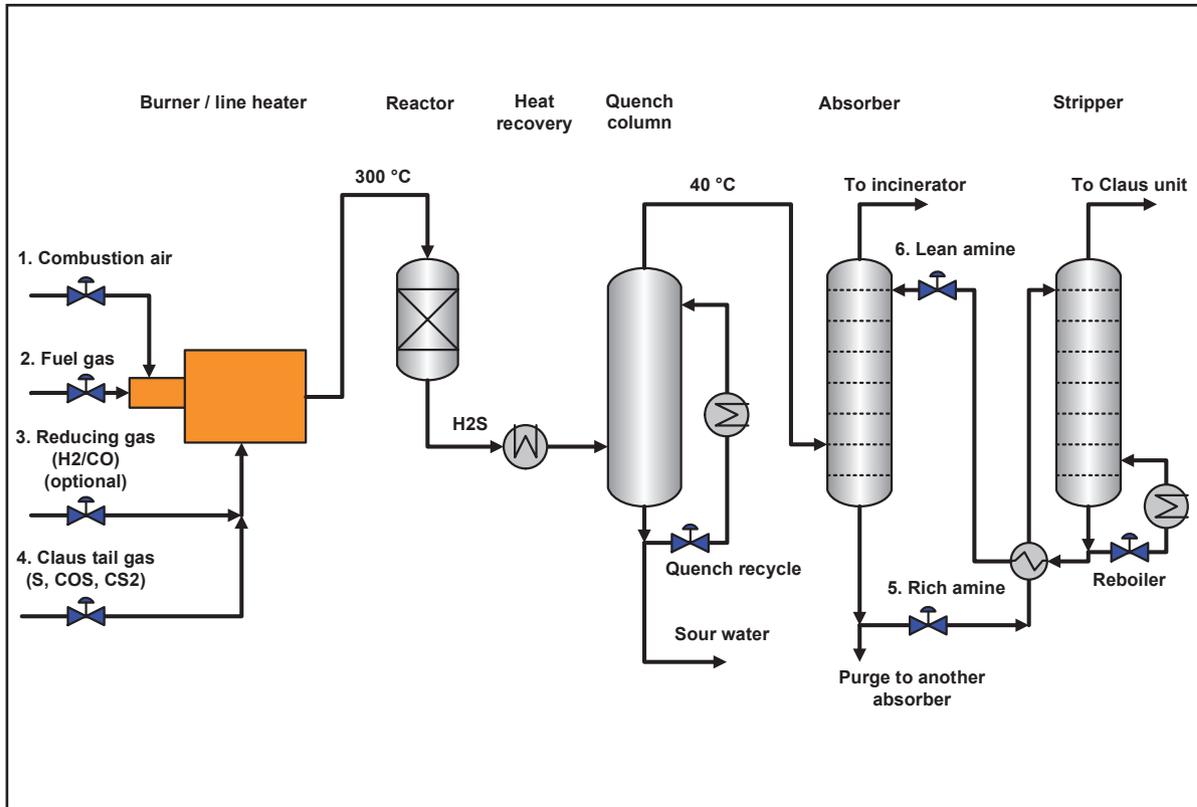


Tail gas treatment



Process overview

Gases from various refinery processing operations contain hydrogen sulphide and occasionally carbon dioxide. Some H₂S in refinery gases is formed as a result of conversion of sulphur compounds in processes such as hydrotreating, cracking and coking. Environmental and pipeline regulations require that most of the H₂S must be removed from plant tail gas and converted to elemental sulphur.

Tail gas treatment processes are used extensively to clean up Claus sulphur recovery tail gas streams to meet environmental requirements where overall sulphur recovery must exceed 95 – 97 percent. The residual sulphur recovered from the tail gas stream is recycled as H₂S back to the Claus sulphur recovery, resulting in total sulphur recovery efficiency of over 99.9 percent.

The Claus tail gas feed is heated to about 300 °C using an inline burner with optionally added H₂ or a mixture of H₂/CO. The heated gas then flows through a catalyst bed where sulphur components SO₂, S, COS and CS₂ are converted to H₂S. The gas is cooled to 40 °C in an optional heat recovery system and water-quench tower. The H₂S is sent to an amine unit where H₂S is selectively removed in a low pressure amine absorber, typically 10 to 400 ppm. The acid gas from the solvent regenerator is recycled to the sulphur plant for sulphur recovery. The absorber offgas is thermally or catalytically incinerated. The most common TGPU processes are the Shell Claus Offgas Treating / Beavon Sulphur Reduction-MDEA units capable of achieving overall recoveries of 99.9 percent.

Tail gas treatment challenges

Proper catalyst performance is required in order to keep the allowed SO₂ levels released to the atmosphere. If the catalyst loses activity, there is a danger of SO₂ breakthrough. This can cause corrosion in the circulating quench water circuit, and the SO₂ poisons the amine. Catalyst activity and pH levels of the circulating water are usually carefully monitored. Amine solution maintenance is required and typically there is an amine filter upstream of the regenerator. Correct valve selection for control and isolation is therefore a critical factor in overall TGTU performance.

Health, Safety, Environment – Valve leaking poses both an environmental and safety issue due to risk of fire and toxicity of volatile gases. ESD and on/off valves must be able to perform their action in a process or equipment failure.

Top-class products at maximum yield – The market calls for clean products and high quality. It is important that the process is stable, flexible and under control. Poor control valve performance reduces the accuracy of throughput control and adversely affects to the plant performance and also the downstream processes.

Maintenance costs - Sulphur crystallization poses as risk of valve clog up. Poorly performing valves in the process must be serviced because they will have a direct impact on the efficiency of the process. The cost of unscheduled maintenance will be quite high, up to 70% of the cost of a new valve in some applications. Add this to the cost of removing the valve from the line and disruption of the process and the total cost will be much higher.

Plant run-time – Refineries are looking for longer plant run-times since downtime means production losses and is a remarkable cost including maintenance costs. This requires reliable equipment and process control.



Metso solutions

We have several control, on-off and ESD installations worldwide in sulphur recovery plants and over 20 years of experience in the valve requirements for these plants. Sulphur compounds being very hostile to metals, particularly at high pressures and temperatures encountered in refining, the quality of control valves takes on prime importance.

Health, Safety & Environment - Rotary stem operation reduces fugitive emissions and protects from leaking. Packing construction meets the latest emission standards. Our products are fire tested and apply to the latest standards. Neles ValvGuard™ partial stroking will ensure that plant emergency shutdown valves will always perform properly when needed.

Efficiency - Throughput losses due to sticking and poor control performance will be avoided with high performance rotary valves. Flow through the process unit may be changed as the need arises with rangeability of 150:1 and further with full bore ball valves. Our advanced ND9000® digital valve controller ensures higher positioning accuracy and faster response to reduce process variability. Correct valve selection and sizing with our Nelprof-program we can assure the best valve performance and process control.

Availability - Simple rotary designs, same face-to-face dimensions, and global service network and inventory management will help you to optimize your maintenance activities. Rotary valves have been in service for several years without requiring maintenance and show no sign of leakage. To protect the valves from sulphur build-up they can be equipped with steam jacketed bodies and high temperature bearing seals.

Reliability - Trend data collected by our smart valve controllers and analysed by FieldCare configuration and condition monitoring software based on open FDT/DTM technology makes it possible to predict and respond to maintenance requirements and reduce unscheduled downtime. This gives full transparency to the valve performance in process control.



Burner/reactor applications

1. Combustion air
2. Fuel gas
3. Reducing gas (H₂/CO) (optional)
4. Claus tail gas (S, COS, CS₂)

Challenge – The main control parameters to control in the catalytic process are typically inlet temperature, hydrogen content and air/fuel ratio in the in-line burner. The inlet temperature is usually maintained at the lowest temperature that will achieve the desired conversions, typically as low as 275 °C. The reaction temperature may be required to increase as the activity of the catalyst declines. Burner control is essential in order to avoid premature catalyst failure. If A/F ratio is too high, oxygen can bypass the burner and degrade the catalyst. At too low A/F ratio, soot will form that will plug the catalyst pores, reducing its activity and with greater amount will eventually plug the catalyst bed, shutting down the entire unit due to pressure drop increase. Fugitive emission control is important for acid gas service and in many cases NACE is applied.

Metso solution – Finetrol eccentric plug valve for accurate and high rangeability applications. Neldisc butterfly valve is another option particularly for large size applications.

Benefits – Long lasting metal seat tightness with fire safe construction assures process availability. Optimum flow characteristics with dynamic performance and control loop stability provide accurate control even at low opening angles. This is extremely important in supplying stable flow to the burners. The savings are realized in reliable burner control. Process reliability can be improved further by ND9000 on-line diagnostics that provides full transparency to valve performance during process run. Rotary design low emission with reliable stem packing provides simple and cost effective way to reduce overall fugitive emission.



Neldisc

Amine applications

5. Rich amine
6. Lean amine

The cooled effluent is contacted in the absorber with selective performance solvent to absorb most of the H₂S. Incineration of the treated off-gas from the absorber ensures that all sulphur species are converted to SO₂ prior to venting. The H₂S-rich amine from the absorber is preheated in a reboiler before stripping the absorbed acid gases from the solution. The lean solvent is recycled to the absorber after cooling. MDEA, a tertiary amine, has become the most common selective solvent due to its resistance to degradation and low tendency to corrosion.

Challenge – Key operational parameters of a TGTU include control of SO₂ breakthrough from the reactor and the lean amine temperature. Due to increasing amine costs, loss reduction is desirable. A breakthrough of SO₂ will cause corrosion in downstream equipment and severely contaminate the amine solution. It may be necessary to reclaim or discard the amine following a large breakthrough of SO₂. This can be controlled by excess hydrogen in the catalytic reactor. The design and control of the upstream quench tower is very important because it determines the gas temperature entering the absorber. Depending on the type of solvent used the lean amine temperature should typically not exceed 38 °C in order to meet the off gas H₂S specifications.

Metso solution – Finetrol eccentric plug valve for accurate and high rangeability applications. Neldisc butterfly valve is another option particularly for large size applications.

Benefits – Long lasting metal seat tightness with fire safe construction assures process availability. Optimum flow characteristics with dynamic performance and control loop stability provide accurate control even at low opening angles. This is extremely important in providing stable rich/lean amine loadings. The savings are realized in reduced amine costs due to reduced variability. Process reliability can be improved further by ND9000 on-line diagnostics that provides full transparency to valve performance during process run.



Finetrol

APPLICATION REPORT

Optimize your amine plant performance, reduce energy and maintenance costs and produce top-class products with our intelligent rotary control, on-off and ESD-valves.



Neles intelligent valve controllers



Visibility to switching applications



Reliable ESD -solutions

The information provided in this bulletin is advisory in nature, and is intended as a guideline only. For specific circumstances and more detailed information, please consult with your local automation expert at Metso.

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