

Solutions for Claus tail gas treating

Meet emission challenges with **reliable** Claus tail gas unit **performance**

Low pressure drops and operation at low reactor inlet temperature
with our specialized tail gas treatment catalysts



Optimal solutions for the refining industry

Meet emission directives while improving your sulfur management

In today's oil and gas industry, maximizing sulfur recovery from off-gases is extremely important. Regulations get tighter, forcing operators to constantly optimize the efficiency of their sulfur management units. Adding a tail gas treating plant to your Claus unit will enable you to meet the most stringent emission targets for final sulfur removal from the off-gases.

The effluent from a Claus plant is the feed for the Claus tail gas treating unit, which mainly consists of nitrogen and water; however, it also consists of S_x , SO_2 , COS, CS_2 , CO, H_2S , and H_2 which need further treatment. The sulfur containing compounds and CO are hydrotreated and hydrolyzed to H_2S and CO_2 in the Claus tail gas treating unit, and H_2S is recycled for conversion in the Claus unit.

We offer a range of tail gas treatment catalysts that allow you to reach overall sulfur recoveries of 99.9% and minimized pressure drops, which ultimately prolong the cycle length of your unit. With our solutions, you can balance optimal performance and process economics while ensuring low investment.

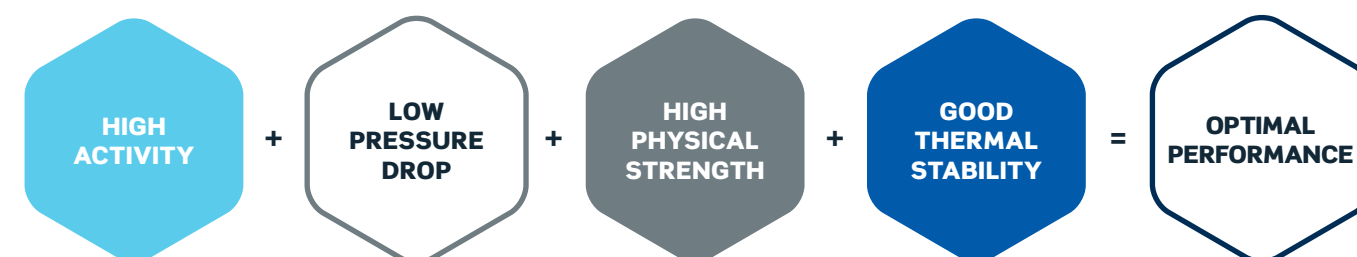
Key benefits:

- Low reactor inlet temperature
- Low catalyst pressure drops
- Low catalyst bulk densities



Struggling with **limited capacities** or high **pressure drops**?

Our catalysts are optimized to give you optimal performance



Your Claus tail gas treating unit is ensured a long lasting and stable performance with our catalysts. In fact, end-of-run for any of our tail gas catalysts is typically caused by an operational upset, such as burner operation issues causing soot formation or a temperature runaway, rather than the gradual loss of catalytic activity.

Our portfolio consists of three unique catalysts; TK-220 (extrudate), TK-222 (ring), and TK-224 (sphere). The catalysts have been optimized on four crucial areas: activity, pressure drop, physical strength, and thermal stability. Combined, they give you optimal performance.

*Topsoe has supplied more than **100 charges** of catalysts worldwide for treatment of Claus tail gas*

TK-222 (ring), TK-224 (sphere), and TK-220 (extrudate)

Optimized activity for low-temperature operation

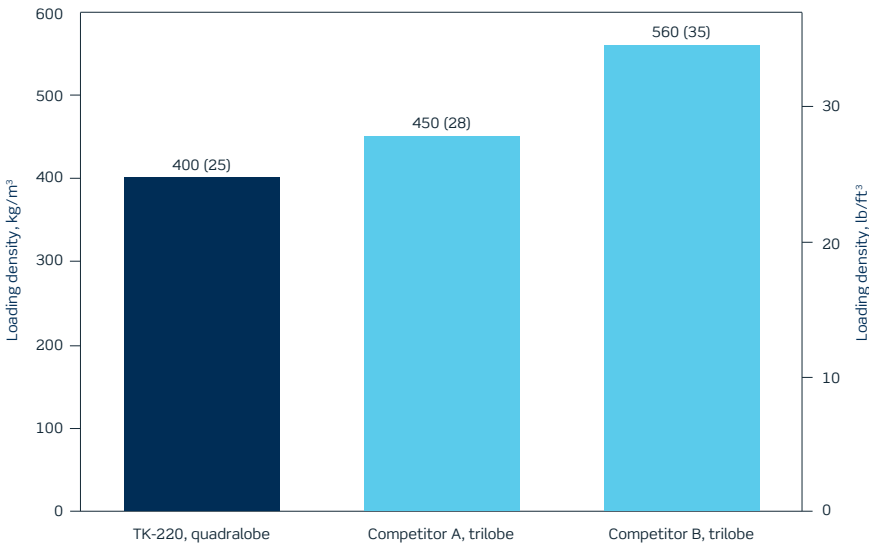
Our tail gas treating catalysts are designed with different porosities, pore sizes, and bulk densities to optimize the activity. Industrial experience confirms that the catalysts provide more than sufficient activity to convert all sulfur compounds at tail gas process conditions.

The catalysts are stable at conventional operating temperatures; however, our catalysts also allow for conversion reactions to reach equilibrium even at operation with reactor inlet temperatures at 200–240°C (392–464°F) depending on the feed gas composition. Low-temperature capability creates significant fuel savings while increasing the overall efficiency of the Claus tail gas treating unit.

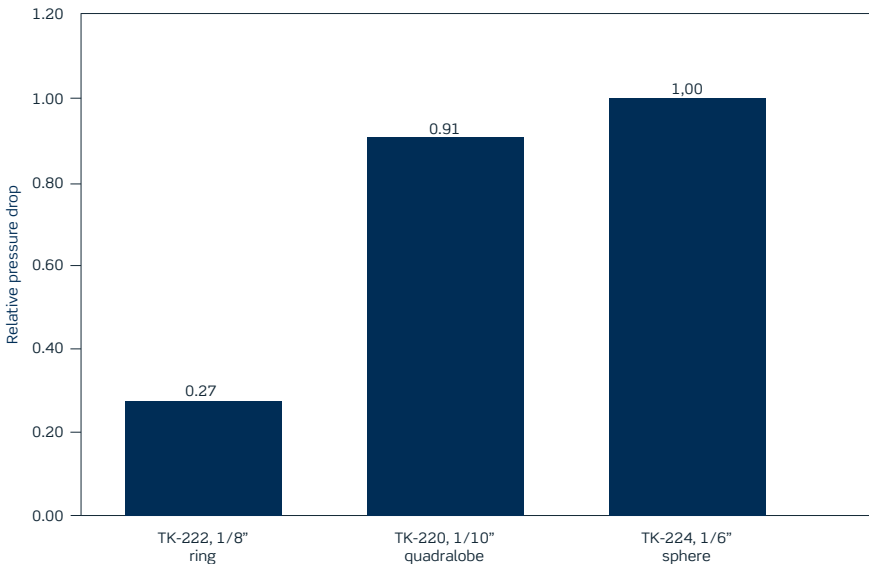
Overcoming pressure drop limitations

Pressure drop control is a key parameter for tail gas treating, as the unit operates at almost ambient pressure, and the blower is the only force pushing the feed through the reactor. A low start-of-run (SOR) pressure drop provides a higher fouling allowance caused by operational disruptions and unplanned shutdowns.

Our tail gas treating catalysts are shape-optimized in order to minimize pressure drop build-up, which can eventually lead to unwanted shutdowns. In fact, our ring-shaped catalyst, TK-222, provides the lowest pressure drops seen in the industry today. The low pressure drop also enables the refiner to increase throughput with the same blower capacity.



Loading density comparison of Topsoe's TK-220 against competitor catalysts



Relative pressure drops of Topsoe's Claus tail gas treatment catalysts

*More than
25 years of
experience
developing and
supplying Claus
tail gas treating
catalysts*

High physical strength for smooth operation

Careful transportation and installation of the catalyst are essential to avoid breakage and disintegration of the catalyst particles, which can have severe impact on your unit operation. The high physical strength of our tail gas treating catalysts makes them robust, reducing fines and dust formation during handling and loading that can ultimately lead to increased pressure drop.

Unmatched thermal stability for stable performance

Temperature excursions as a result of operating the burner with excess air can result in loss of catalyst activity/surface area. Our Claus tail gas treating catalysts exhibit a high thermal stability and unaffected activity even after exposure to temperatures up to 650°C (1202°F). Because the surface area of the catalyst does not change at elevated temperatures, sintering resulting in catalytic activity loss is avoided.

A better design for a longer life

Optimized activity, low pressure drop, superior physical strength, high surface area, and excellent thermal stability constitute our catalysts unique combination of properties, ensuring extended unit cycle lengths. The stable catalyst performance safeguards the unit during fatal upsets even when pushed beyond the design capacity.



Serving the **world's largest** sulfur recovery **unit**

Approximately 1000 m³ (35,000 cubic ft) of our Claus tail gas catalysts are installed in the world's largest sulfur recovery unit located in the Middle East. The unit processes 1.2 million m³/h (1 billion SCFD) of sour gas containing 23% hydrogen sulfide and produces

approximately 9,200 tons (20.3 million lbs) elemental sulfur per day. It is a benchmark for world gas processing and treating as well as sulfur production.

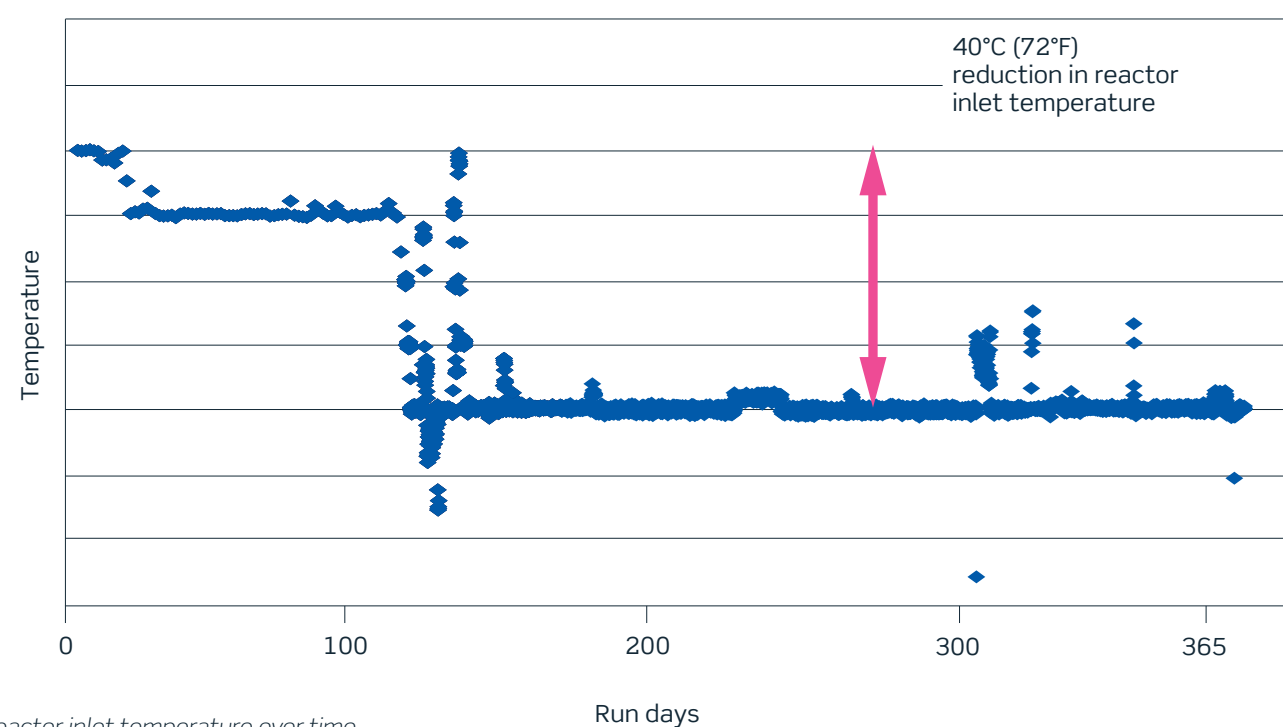
Helping a refinery **cut costs** by operating at **low temperature**

A European refinery installed TK-220 in their Claus tail gas treating unit. The refinery was able to reduce the reactor inlet temperature by 40°C (72°F) and still obtain the required performance compared to the previous cycle at the same conditions. This resulted in significant savings in fuel gas, with 30% less consumption in the burner used for heating up the inlet gas

for the unit. Consequently, the fuel consumption in the incinerator down-stream the Claus tail gas treating unit was additionally reduced by 20% due to less off-gas from the absorber.

The refinery saved EUR 11,000 per year for every cubic meter of TK-220 catalyst installed (USD 360 per cubic ft). The savings alone could pay back

the catalyst charge in less than one year. Operating at the lower reactor inlet temperature more than doubled the expected cycle length of the TK-220 catalyst, which resulted in savings for an extra catalyst charge, as well as shutdown and turnaround activities.



Making the right catalyst selection

Creating value by balancing cost-effectiveness and performance

Our CoMo catalysts TK-220, TK-222, and TK-224 are specifically designed for tail gas treating applications and cover a wide range of operating conditions, including low-temperature operation.

We will assist you in making the right catalyst selection for your specific feed and unit design.

	TK-220	TK-222	TK-224
Shape	Quadralobe	Ring	Sphere
Normal size, mm (in)	2.5 (1/10)	3.2 (1/8)	4.0 (1/6)
CoMo oxide, % wt	~14	~18	~12
Attrition index	>98	>97	>98
Sock loading density, kg/m ³ (lb/ft ³)	400 (25)	500 (31)	700 (44)
Sock loaded void fraction, %	48	53	35
Relative pressure drop	0.91	0.27	1.00



TK-220, 2.5 mm (1/10")



TK-222, 3.2 mm (1/8")



TK-224, 4.0 mm (1/6")

TK-220
TK-220 is our cost-efficient catalyst for tail gas treating with a very low bulk density, resulting in low filling cost of your reactor without compromising activity. The catalyst has the capability of converting CO to H₂O to H₂ and CO₂ via the water-gas shift reaction while ensuring the required sulfur conversion. These reactions are enhanced by the high surface area and optimized porosity of TK-220.

TK-222
For operation requiring a very low catalyst bed pressure drop, our TK-222 catalyst is superior. TK-222 has only 30% of the pressure drop of any catalyst shapes utilized today, namely extrudates and large size spheres. In fact, TK-222 has the lowest pressure drop of any commercially available catalyst applicable for tail gas service. As such, it provides a cost-efficient debottlenecking opportunity of any unit by allowing a substantial increase in throughput with the same blower capacity.

TK-224
TK-224 is a spherically-shaped catalyst with very high physical strength. It is the optimal catalyst choice for conventional operation and radial reactors thanks to its shape that prevents it from migrating through the reactor mesh holding up the catalyst.

Synergy of optimized grading and catalytic performance

Because solutions that are designed to work together, simply work better

Claus tail gas treating units can experience excessive pressure drop build-ups that can lead to unwanted shutdowns. They are typically caused by reactor bed fouling which reduces the void volume in the reactor. When this happens, it can lead to pressure drop build-up, channeling, and hot spots that negatively impact catalyst performance, and, as a result, the cycle length of the unit is reduced.

We have developed inert grading materials: TK-10, TK-15, and TK-26 TopTrap™ for topping layers. They

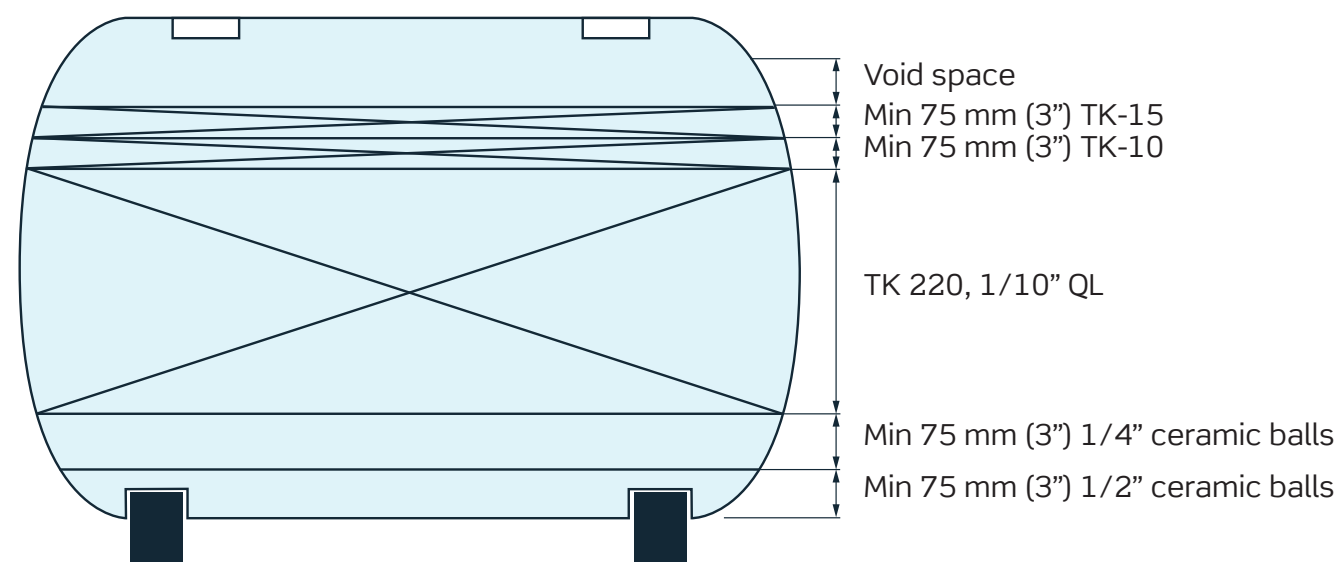
play an important role in the catalyst hold-down function to avoid catalyst milling.

The grading materials are shape-optimized with pressure drops less than that of a sphere, which reduces the start-of-run (SOR) pressure drop of the catalyst fill. Their inherent large void fractions enable high uptake of soot and contaminants from upstream operation during the cycle.

Optimal catalyst loading sets the stage for future operations,

determines SOR pressure drop, activity, and, ultimately, the cycle length of the unit.

By combining our tail gas catalysts with our unique grading solutions, you can avoid costly and time-consuming skimming of the top of your catalyst bed.

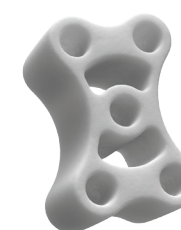


Typical reactor loading with Topsoe's grading and Claus tail gas treating catalysts.

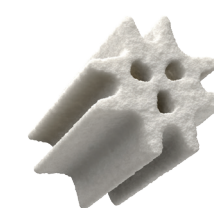
Talk to our experts about the grading solutions **best suited for you**



TK-10 is an inert hold-down catalyst applicable as topping layer in catalytic reactors instead of spherical material. It is shape-optimized and provides a high void fraction for accumulation of feed stock contaminants.



TK-15 is a shape-optimized inert catalyst providing high void fraction with a high bulk density to prevent milling caused by high gas velocities. TK-15 is used as the top layer instead of ceramic spheres and is the optimal choice for units experiencing carry-over of coke spalling off the tubes in the heater.



TK-26 TopTrap™ is an inert macroporous material designed to pick up iron scale and other inorganic contaminants. As opposed to other particulate traps in the market, TK-26 TopTrap™ contains a large internal pore volume which picks up contaminants without adding to the bed pressure drop.

More than **4,000** grading catalyst charges supplied to date

Why **partner** with Topsoe?

The Topsoe advantage lies not just in individual solutions, but in how our solutions work together

Additional solutions

Discover the full range of our catalysts and technologies for optimizing performance

H_2SO_4

Energy-efficient alternative to the Claus process - Wet gas Sulfuric Acid (WSA)

Our WSA process is a wet gas catalytic process for purification of streams containing sulfur compounds and is an energy efficient alternative to a Claus unit for sulfur management. Concentrated commercial grade sulfuric acid (98.5%) is produced directly by condensation from a wet process gas, and over 99.9% of the sulfur can be recovered. Furthermore, much more high quality steam can be exported compared to a Claus unit.

SMC™

Catalytic incineration with SMC™ technology

The conventional way to process lean H_2S gases with low fuel value is through thermal oxidation, which consumes a considerable amount of fuel. Our SMC™ (sulfur monolith catalyst) technology offers a smarter way to incinerate Claus tail gas, treating off-gas with valuable fuel savings. Up to 99.99% H_2S is converted to SO_2 with only a minimum of oxidation to SO_3 .



FUEL GAS HDT

Reduce sulfur emissions with fuel gas hydrotreating

Light off-gases from cokers, FCC's, and hydroprocessing units are often used as fuels in the many heaters and boilers in the refinery. Our patented fuel gas hydrotreating process reduces the sulfur emissions from the fuel gas by 99.9%. In fact, the treated fuel gas is so clean, it can be used as feed to a hydrogen plant, thus eliminating the consumption of expensive natural gas.

Please visit our website www.topsoe.com for more information about our Claus tail gas catalysts and related solutions.



When you partner with Topsoe, you partner not only with the world's leading technology licensor and supplier of hydroprocessing catalysts. You partner with a company that takes a uniquely holistic approach to your plant and your business.

When we look at your plant, we look at the big picture – and then apply the full breadth of our expertise to deliver a thoroughly tailored solution, where individual components work together to maximize your plant's performance and your business success.

Haldor Topsoe is a world-leader in catalysis and surface science, committed to helping our customers achieve optimal performance. We enable our customers to get the most out of their processes and products, using the least possible energy and resources, in the most responsible way. We are headquartered in Denmark and have production plants, sales & service as well as R&D and engineering activities across the globe.



Get in touch today
www.topsoe.com/processes/gas-processing

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