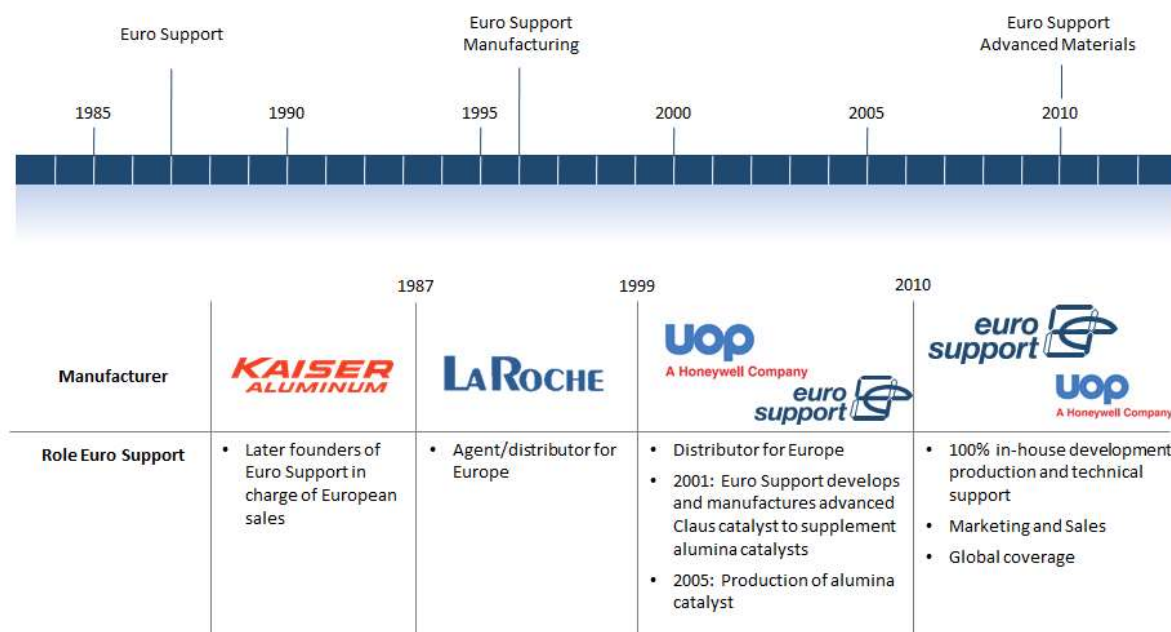


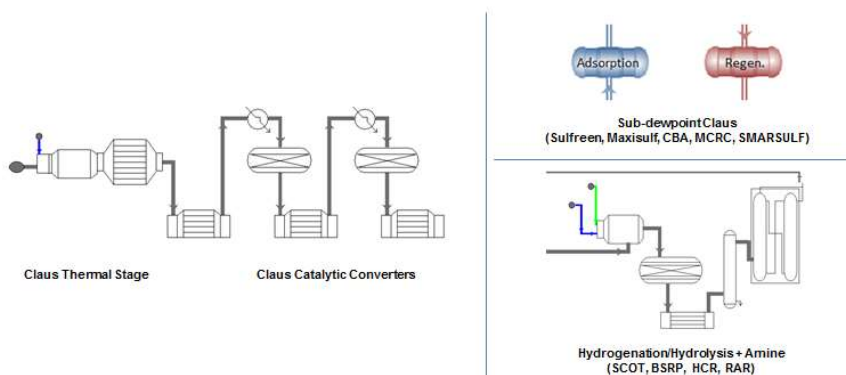
## Euro Support - Sulphur Recovery Catalysts

### Euro Support – 30 years of experience with Claus

Euro Support has represented the Claus sulphur recovery catalysts of Kaiser, and their successors LaRoche and UOP, in Europe for almost 30 years. In 2010 Euro Support took over the Claus business from UOP entirely from which we grew into a company dedicated to the continuous improvement of sulphur recovery catalysts. Today Euro Support offers a full package of Claus and tail gas treating catalysts, including the only titania-CoMo tail gas catalyst available on the market today. Thanks to our long history within this industry we can offer high quality products that are backed up by excellent technical support, customer service and the swift responsiveness that is required in this branch of the petrochemical industry.



Through the years we have built an extensive portfolio of several catalysts and support materials that are used in sulphur recovery processes such as the modified Claus, sub-dewpoint Claus, Hydrogenation/Hydrolysis + Amine, and sulphur degassing processes.



Due to our large pool of technical expertise and years of experience with the Claus process, a vast network within the industry and outstanding sulphur recovery products, our catalysts have been installed in numerous SRUs all over the globe.

This brochure will guide you through our product portfolio and shows what products and after sales services we offer our valued customers.

## Euro Support - Sulphur Recovery Catalysts

### A Complete Range of our Sulphur Recovery Catalysts

We offer the complete package of sulphur recovery catalysts and after sales support:

Application	Product	Form	Main characteristics
Claus catalyst	S-2001/ESM-221	Activated alumina spheres	<ul style="list-style-type: none"> <li>High performance Claus catalyst</li> </ul>
	S-501/ESM-251	Promoted alumina spheres	<ul style="list-style-type: none"> <li>Enhanced COS and CS<sub>2</sub> hydrolysis</li> <li>Improved catalyst life</li> </ul>
	S-7001/ESM-271	Cylindrical titania extrudates	<ul style="list-style-type: none"> <li>Maximum COS and CS<sub>2</sub> hydrolysis at lower temperature</li> <li>Longest life</li> </ul>
Claus oxygen scavenger	S-601/ESM-261	Promoted alumina spheres	<ul style="list-style-type: none"> <li>Protection of main catalyst against poisoning from excess oxygen</li> </ul>
Sub-dewpoint TGTU	S-2001/ESM-221	Activated alumina spheres	<ul style="list-style-type: none"> <li>High catalytic activity at low temperature</li> <li>Maximum capacity for adsorbed sulphur</li> </ul>
SCOT-type TGTU	S-4001(PS)	CoMo promoted spheres	<ul style="list-style-type: none"> <li>Conventional temperature range</li> </ul>
	S-8001(PS)	CoMo promoted extrudates	<ul style="list-style-type: none"> <li>Low temperature range</li> </ul>
Bed support and topping	ESM Ceramic Support Balls	Ceramic spheres	<ul style="list-style-type: none"> <li>Strong and durable support</li> <li>Inert</li> </ul>
	ESM-100	Activated alumina spheres	<ul style="list-style-type: none"> <li>Provides additional Claus activity</li> </ul>
	ESM Hi Alumina Balls	Inert alumina spheres	<ul style="list-style-type: none"> <li>Strong and durable support</li> <li>Suitable for low silica applications</li> </ul>

Further information about these products is included in the following product information sheets. If of interest, please feel free to ask for the relevant product data sheets.

### Advanced Technical Support

Our unique test units can operate as any configuration of Claus- and tail gas treatment processes. The services that are offered together with our catalysts include:

- Spent catalyst analysis
  - Analysis of surface area, sulfate loading, sulphur and other species as required
  - Helps to understand unit performance and (potential) problems
  - Estimate remaining activity/lifetime
- Computer Modeling
  - Simulation of Claus unit using Sulphur Experts' SulSim<sup>®</sup> software and proprietary software
  - Based on feed- and processing conditions (form available for gathering required data)
  - Helps with unit analysis, performance evaluation and optimization
- Troubleshooting Assistance
- Pilot plant performance testing
  - 4-reactor unit
  - Claus and tail gas processes



## Euro Support - Sulphur Recovery Catalysts

### S-2001/ESM-221 Alumina Claus Catalyst

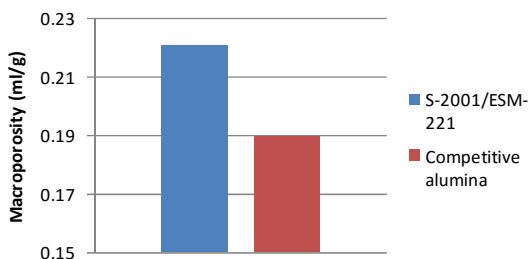
The S-2001/ESM-221 is an activated alumina Claus catalyst, engineered and produced to provide optimal performance in both regular Claus and sub-dew point applications.



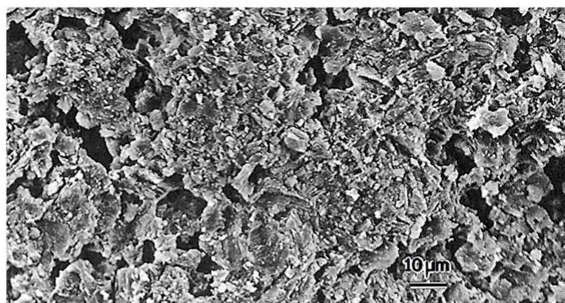
#### Excellent porosity

The S-2001/ESM-221 catalyst consists of activated alumina. The catalytic activity is provided by the active surface of the alumina itself.

S-2001/ESM-221 Claus catalyst offers a high surface area (typically about 360 m<sup>2</sup>/g) on which the main Claus reaction and COS and CS<sub>2</sub> hydrolysis take place. The key is to provide a well-developed pore structure, through which reactants can enter, and products diffuse out of the catalyst spheres. For this purpose, the S-2001/ESM-221 offers very high macro porosity:



The image below shows the large channels that run through the S-2001/ESM-221 catalyst, providing highways that lead to the inside of the catalyst sphere.

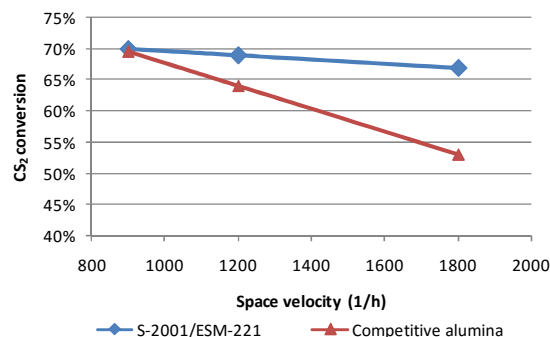


#### Low Density

The high porosity is linked to a low density (about 10% lower than most alumina catalysts), which translates to a cost savings on the required mass of catalyst.

### High COS and CS<sub>2</sub> hydrolysis

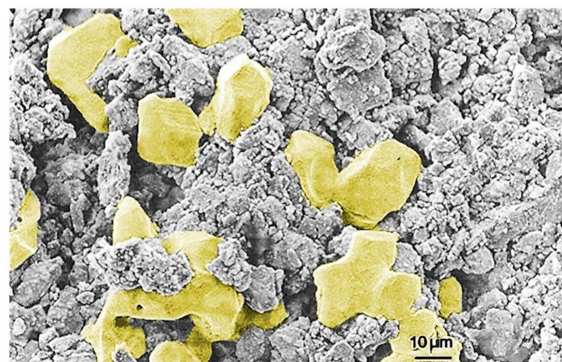
The physical properties of the S-2001/ESM-221 provide it with a high activity for the hydrolysis of COS and CS<sub>2</sub>. The following figure shows the performance after severe catalyst aging:



### Exceptional performance in sub-dewpoint units

The high porosity of the S-2001/ESM-221 is also advantageous for application in sub-dewpoint units, such as MCRC, CBA, Sulfreen and Maxisulf. Here, the activated alumina is working both as adsorbent as well as catalyst. The cycle length is determined by the capacity for condensed sulphur that is reached before the catalytic activity decreases due to blockage of the pores. Increasing the cycle length decreases emissions and improves catalyst lifetime.

The image below was taken from the center of an S-2001/ESM-221 catalyst sphere after sulphur condensation in an industrial unit. It shows that even in the most center part of the sphere, sulphur crystals have formed. Heating to conventional regeneration conditions was sufficient to completely restore the catalyst's activity.



## Euro Support - Sulphur Recovery Catalysts

### S-7001/ESM-271 Titania Claus Catalyst

The S-7001/ESM-271 was developed to complement UOP and Euro Support's range of Claus products with a titania Claus catalyst. It can withstand any comparison with alternative products – both in terms of characteristics and performance – and was designed with all practical matters related to the use of Claus catalysts in mind. It offers the following advantages:

- Long catalyst lifetime
- Maximum sulphur recovery
- High COS and CS<sub>2</sub> hydrolysis rates
- Excellent resistance against sulphation
- Uniform particle size

#### Shape

The 3.2 mm cylindrical shape in combination with high strength offers an enhanced external surface area, while conserving low pressure drop characteristics.



#### Less is more

The loaded density of S-7001/ESM-271 is about 12.5% lower than that of other titania Claus catalyst. This means that the mass required to fill the same volume of catalyst is about 12.5% lower, without sacrificing catalytic activity. This translates directly to cost savings when installing or replacing a catalyst bed.

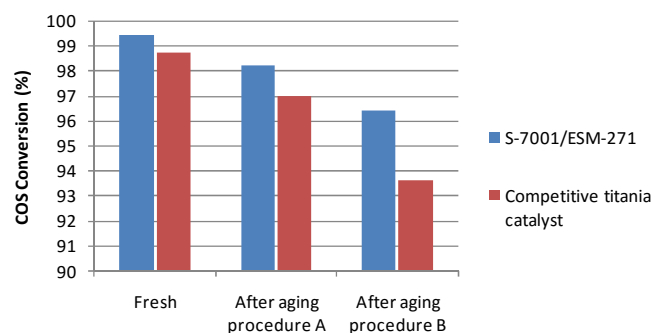
#### Purity = Activity

The higher the purity of the titania catalyst the more active material is present and thus the higher the performance. Normally a calcium sulfate binder is added to provide structural integrity for the titania catalyst, unfortunately this calcium sulfate is not catalytically active so part of the performance of the catalyst is lost. Euro Support found a way to produce a pure titania Claus catalyst, without the use of additional binders; our S-7001/ESM-271.

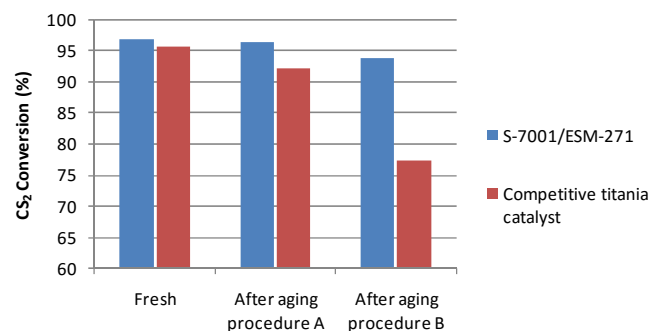
#### Maximum performance

Testing has shown that the S-7001/ESM-271 performs better for COS and CS<sub>2</sub> conversion. The indicated performance applies to a temperature of 300°C and a space velocity of 1832 h<sup>-1</sup>. Note that the performance is measured on equal volume basis, which means that the mass of loaded catalyst was about 12.5% lower for the S-7001/ESM-271 than for the competitive catalyst.

#### COS Conversion



#### CS<sub>2</sub> Conversion



Although the performance level of the fresh catalysts is quite similar, the S-7001/ESM-271 shows a significant advantage as aged catalyst. This is especially apparent after the more severe aging of procedure B. Pure titania catalysts remain active even after severe aging.

## Euro Support - Sulphur Recovery Catalysts

### S-501/ESM-251 Promoted Claus Catalyst

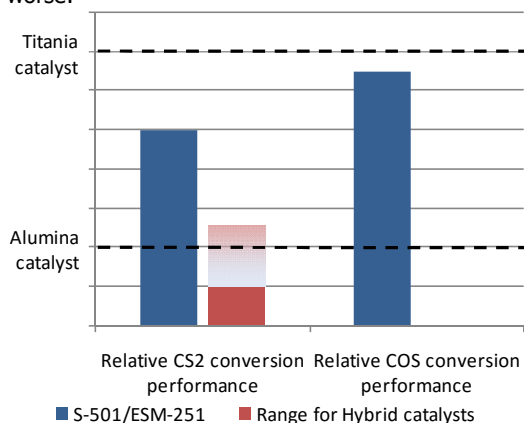
The S-501/ESM-251 offers a performance level that lies between that of an activated alumina and that of a titania Claus catalyst. Compared with an activated alumina catalyst, it offers the following advantages:

- Improved CS<sub>2</sub> hydrolysis
- Excellent COS hydrolysis
- Longer lifetime
- Higher resistance to sulphation



#### **NOT** a hybrid

In efforts to get a catalyst that provides a performance and price level between those of alumina and titania catalysts, so called "hybrid" catalysts have been developed. These consist of a mixture of alumina and titania. However, even an optimized titania distribution has not yielded a catalyst that offers the desired level of performance. Actual reported performance of hybrid catalysts at typical first reactor conditions are similar to those of regular alumina catalysts, and sometimes even worse:



The S-501/ESM-251 is radically different. It employs a proprietary promoter to achieve a CS<sub>2</sub> conversion performance that is significantly higher than that of an alumina catalyst. The COS conversion performance is even more remarkable, and comes close to that of a titania catalyst.

Similarly, hybrid catalysts have been shown to be much more sensitive to poisoning by sulphates from free oxygen than pure alumina. The S-501/ESM-251 can tolerate up to three times as much sulphate than a pure alumina catalyst before showing signs of reduced activity.

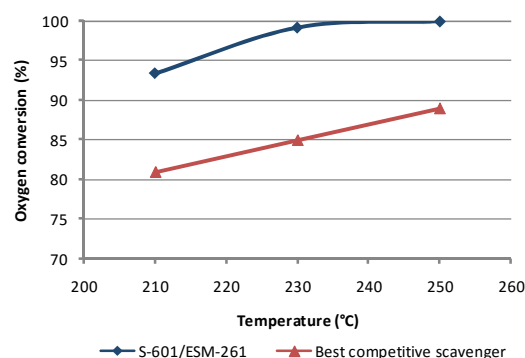
### S-601/ESM-261 Claus Oxygen Scavenger

The potential for excess oxygen coming into the reactor poses a risk to alumina Claus catalysts. This is mainly the case when direct-fired reheaters are used, especially when fuel composition is variable and/or control of the burner difficult. The excess oxygen reacts with sulphur species to form sulphates on the catalyst, which reduce its performance. In such cases the S-601/ESM-261 oxygen scavenger can be used as a guard layer on top of the alumina catalyst.



#### Maximum activity at low temperatures

For a given flow rate and amount of scavenger, the extent of protection against free oxygen depends on the temperature of operation and the intrinsic activity of the scavenger. The most crucial is the performance at typical third Claus reactor conditions. The low temperature of operation poses the highest requirement on the intrinsic activity of the scavenger, while at the same time the risk of sulphation of the alumina catalyst is highest due to the increased stability of sulphates at lower temperature. This is where the S-601/ESM-261 excels: even at contact times below one second, very high levels of oxygen conversion are reached:



An increase of the contact time to about two seconds allows 100% conversion of oxygen to be reached for this whole temperature range.

Replacing part of a bed of alumina Claus catalyst with a scavenger is no concern for the Claus performance, since the Claus activity of the S-601/ESM-261 oxygen scavenger is at the same level as the alumina catalyst.

## Euro Support - Sulphur Recovery Catalysts

### S-4001(PS) CoMo Tail Gas Catalyst

The S-4001 TGT catalyst converts the Claus tail gas sulphur components such as  $S_x$ ,  $SO_2$ , COS and  $CS_2$  to  $H_2S$ . Typical operational temperature is in the range of 240-250°C or higher.  $S_x$  and  $SO_2$  are converted via hydrolysis processes while COS and  $CS_2$  are converted via the route of hydrogenation.



#### Activation of SCOT-type tail gas catalysts

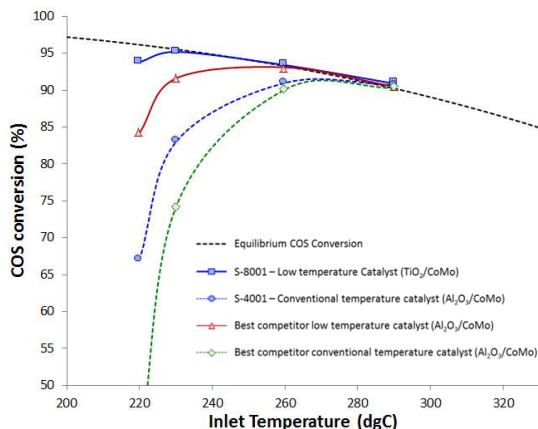
The hydrolysis and hydrogenation reactions that take place in the SCOT-type TGTU, are catalysed by a Cobalt/Molybdenum (CoMo) catalyst. The CoMo oxides need to be sulphided before they are catalytically active; such a sulphided cat is therefore also known as an *activated catalyst*.

The catalyst can be activated via in-situ sulphiding or pre-activated via the TOTSUCAT® method. The latter results in the ready-to-use pre-activated catalyst S-4001 PS.

From experience we know that both the S-4001 and its pre-activated version S-4001 PS perform equally well and preference primarily depends on convenience and capability of in-situ sulphiding.

#### Performance and COS conversion

Although the hydrolysis conversions of  $S_x$  and  $SO_2$  are vitally important to ensure high efficiency of the TGTU, these reactions are mostly near complete. For SCOT type tail gas treatment the conversion of COS is the most challenging and the first one to drop. Therefore it is a good measure to evaluate and compare the hydrogenation activity of different SCOT catalysts.



### S-8001(PS) CoMo Tail Gas Catalyst



The S-8001 TGT catalyst fulfills the same function as the S-4001 but in a broader temperature range, i.e. 220 °C and higher. It is the only titania based TGT catalyst on the market today which gives it superior activity within the low temperature range. The trilobe shape

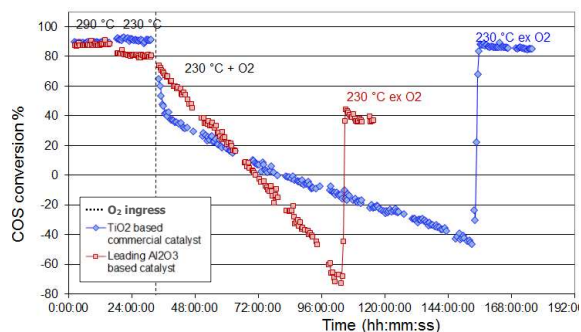
offers an enhanced external surface area while conserving low pressure drop characteristics.

#### Maximum activity at low temperatures

The emphasis in current SCOT catalyst development lies on maintaining high hydrolysis and hydrogenation activity within the lower operating temperature range. Our S-8001 shows excellent hydrolysis and hydrogenation activity till temperatures as low as 215-220°C.

#### Catalyst revival after upset

An additional, and highly practical, advantage of titania based TGT catalyst is the activity revival only using process gas instead of a full presulfiding procedure. Oxidation of the active CoMo-metal sulfides deactivates the catalyst. The titania-CoMo interaction facilitates resulfiding of the oxidised CoMo species using only the process gas at normal operating conditions.



Alumina based catalyst are not as easily revived; they first need to be fully oxidised and then go through the presulfiding procedure again. Fully oxidising the catalyst is very risky due to the possible sintering of the CoMo metals, which could lead to irreversible deactivation of the catalyst. Additionally, during both the oxidation and presulfiding the sulfur emissions will be much higher than usual. These issues are a problem of the past when using our S-8001 titania based TGT catalyst.

## Euro Support - Sulphur Recovery Catalysts

### ESM Ceramic Support Balls

ESM Ceramic Support Balls have the following characteristics:

- Stable support layer or topping
- Low pressure drop
- High strength
- Long life
- No interaction with catalyst or Claus species

#### Bed support

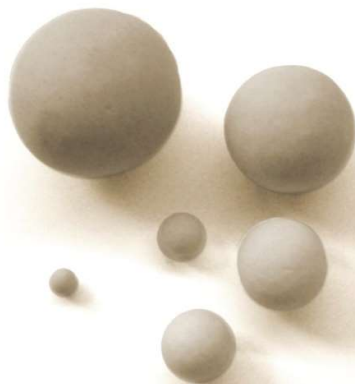
In order to prevent the risk of catalyst falling through the holes in the support grid, most Claus units use one or more layers of support spheres below the catalyst bed. The ESM Ceramic support balls are perfectly suited for this purpose. They are available in a wide range of sizes, offering a solution for any combination of grid and catalyst size.

In order to form stable layers, the difference in size of neighboring layers of catalyst and/or support should not exceed a factor 3. In order to support the inert spheres on the support grid without plugging the holes, the size of the inert spheres should be at least twice as large as that of the holes in the support grid.

#### Bed topping

A top layer of ESM ceramic support balls may be used to improve the distribution of the feed over the catalyst bed. A better feed distribution helps to maximize the utilization of the catalyst volume.

When no effective distributor plate is used, the feed gas to a Claus reactor may displace the light catalyst particles. When a dip in the catalyst bed is formed, this causes an uneven pressure drop over the cross area of the bed, which may lead to flow distribution problems. A layer of ceramic support balls placed on top of the catalyst bed can prevent these problems by holding down the catalyst.



### ESM-100 Active Bed Support

ESM-100 Active Bed Support can usually be used as bed support or topping in Claus reactors. Replacing inert ceramic balls with active bed support offers the following advantages:

- Added catalytic activity
- Lower loaded density

#### More than a support

The ESM-100 active bed support consists of the same material as the S-2001/ESM-221 Claus catalyst. In addition to physical support or topping, the ESM-100 active bed support therefore works as catalyst as well.

The lower density, compared to inert ceramic materials, means that less mass of active bed support is required to provide the required volume of support/topping.



### More Information

For more information please contact us directly via e-mail or telephone.

*Europe, Middle East & Asia*

Euro Support b.v.

E-mail: [info@eurosupport.nl](mailto:info@eurosupport.nl)

Phone: +31 33 465 0 465

*Americas*

ASM Catalysts (a Euro Support company)

E-mail: [info@asm-catalysts.com](mailto:info@asm-catalysts.com)

Phone: +1 (225) 752-4276