A Complete Range of Solutions for Sulfur Recovery

Christian STREICHER, Prosernat
Axens Group : A Complete Range of Solutions for Sulfur Recovery

Advanced Technologies based on > 60 years of operational experience

The widest range of benchmark Catalysts for SRU & TGT applications

The supply of critical/proprietary Equipment up to fully Modularized Units
TECHNOLOGY PORTFOLIO

Claus
Sultimate™
SmartSulf™
Sulphur Block Management

PROSERNAT has the technologies and expertise required to design the entire Sulfur block; both in refineries and gas plants.
Claus Process

- Modified Claus Process with 98% sulphur recovery
- Special High Ammonia content design
- Oxygen Enrichment for debottlenecking
- Expertise in the treatment of lean acid gases down to 20% H₂S by cofiring of acid gas with proprietary burners
- Turndown Ratio down to 10%
Cofiring Process for Lean Acid Gas

The key features of cofiring technology are:

- Excellent burning of Acid Gas Feed and Fuel Gas with PROSERNAT proprietary burner
- Complete destruction of BTX and mercaptans
- No sulphur losses in AGE: all sulphur species are routed to SRU
- No heating requirement compared to AGE: Low OPEX
Cofiring Process for Lean Acid Gas

Conventional cofiring technology

- The burner makes a single and compact flame
- The additional fuel gas is often supplied in the center of the burner and injected in the acid gas
- The fuel gas combustion is carried out under sub-stoechiometric conditions causing:
  - Unburnt HC
  - Soot emissions
  - COS/CS₂ increase

PROSERNAT cofiring technology

- The additional fuel gas is supplied peripherally and injected in the air
- The acid gas is supplied through a double impulse acid gas injector
- Staged combustion which fits with the Claus combustion / reaction kinetics
  - First stage: fuel-gas combustion in air excess
  - Second stage: H₂S Combustion
  - Third stage: Claus reaction (H₂S + SO₂)
Sultimate™ Process

Key Features:
- Sulphur Recovery: 99.9+%  
- Amine based process
- AXENS Low Temperature catalyst: no inline burner (100 Refs)
- PROSERNAT Amine Expertise for high selectivity (50 Refs)
- High Absorber Perf.: < 10 ppmv H₂S achievable with proprietary solvents
**SmartSulf™ Process Description**

**Thermal stage:** strictly identical to conventional Claus thermal stage.

**COS and CS₂ hydrolysis:** COS and CS₂ from the process gases are hydrolyzed at high T in top zone of the first SmartSulf™ reactor

**Claus Reaction:** Claus reaction in isothermal conditions in the second zone of the first reactor increases S conversion.

**Sub-Dewpoint Claus reaction:** is performed in the second reactor producing liquid S which is trapped on catalyst, with high S recovery.
Cycle switch: when cold mode SmartSulf™ Reactor is saturated with liquid sulphur, a switch between hot and cold mode is performed automatically by rotating the two coupled 4 way valves, enabling the beginning of a new cycle.
Proprietary Items
# SmartSulf™ References

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<th>Company</th>
<th>Country</th>
<th>Location</th>
<th>Plant Type</th>
<th>Total Capacity (T/D)</th>
<th>Start-Up Date</th>
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### Smartsulf™ vs Claus + MDEA based TGT

**Basis**
- SRU capacity is 100 TPD
- CO2 equivalent is calculated by conversion of main utilities
- Acid gas quality is 95% vol. H2S
- OPEX are calculated according to following table:

<table>
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<th>OPEX</th>
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<td>Electrical</td>
<td>509</td>
<td>363</td>
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<td>(0.0875 USD/kWh)</td>
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<td>(0.00616 USD/m3)</td>
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<td>Hydrogen</td>
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<td>(510 USD/MT)</td>
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<td>HP steam</td>
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<td>(4.9 USD/MT)</td>
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<td><strong>TOTAL</strong></td>
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<td><strong>670</strong></td>
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<td><strong>k USD / year</strong></td>
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Comparison SmartSulf™/Amine TGT

- **Economics**

- **Environmental**

For only 8kg/h SO2 less, the amine based TGT emits more than 1 T/h more CO2
SmartSulf™-DO process

One stage direct oxidation, for the treatment of lean acid gases (NG production, biogas, shale gases...)

- SmartSulf™ DO can be applied in:
  - Single Reactor for # 90% S yield
  - Two Reactors for # 99% S yield

- H₂S content up to 15% mol.
- Low/high feed gas P applicable
- Suitable for offshore
- 1st plant operating since 1993
- Low maintenance cost
- Very low operating cost
- Fully automatic operation
SRU CATALYSTS

Claus Catalysts
TGT Catalysts
Axens Sulfur Complete Portfolio

### Claus Catalysts

- CR: Claus alumina
- CR-3S: Improved Claus alumina
- DR Series: Active bed supports
- CRS 31: Titanium dioxide catalyst
- AM & AMS: Oxygen scavengers
- CSM 31: BTX management

### Tail Gas Treatment Catalysts

- TG 103: TG hydrogenation catalyst, spherical
- TG 107: Low temperature TG hydrogenation catalyst, spherical
- TG 203: Low density TG hydrogenation catalyst, spherical
- TG 136: Low temperature TG hydrogenation catalyst, extrudate
Na$_2$O content has to be in between 1500 and 2500 ppm:

**Competition products + CR contain 3500 ppm Na$_2$O**

Additional step required to manufacture CR-3S

Higher resistance to sulfation, higher performances
Purpose of CRS 31

CRS 31 bottom layer in R1
- Full COS-CS$_2$ hydrolysis
- Higher overall recovery
- No need to replace CRS 31 every TA

![Diagram showing reaction pathways and conversion curves]
Hydrogenation Based TGTU

Reactor Section

TG 103/203

270-300°C

Claus Tail Gas

fuel gas

steam

water

Quench column

Absorber

Regenerator

Recycle to Claus furnace

to incinerator

to SWS

Amine Section
A Revolution for Existing / New Units with LT

Operation at low temperature
- > 40% savings on energy
  ~150 kW for 20000tS/yr
- Lower CO$_2$ emissions
- Tripled temp. safety margin

From direct to indirect reheater
- Less risk of misoperations (soot or excess air)
- Longer catalyst lifetime
- Equipment downsized 10%
- Capex reduction 10-15%
- OpEx reduction 20%

Ref.: Marco van Son, Sept. 15$^{th}$ 2005
Brimstone, Vail (CO)
EXAMPLES OF MODULAR SRU

Claus Catalysts
TGT Catalysts
Kharyaga Field, Russia - 2013

Gas Sweetening & Sulphur Recovery
- Customer: Globalstroy-Engineering
- End User: TOTAL EP Russia
- PROSERNAT’s scope: Modular Amine and Claus Units for associated gas
- Amine Capacity: 0.7 x 10^6 m³ / d
- Claus Unit Capacity: 16 T S/d
Perm, Russia - 2014

Modular Units : Claus

- Transportation: Sea/River/Rail/Road
- Customer : Lukoil-Chernomorye
- End User : Lukoil-PermNefteGazPererabotka
- Country : Russia
- PROSERNAT’s scope : Modular Claus Unit supply
- **Capacity : 10.5 T S/d**
- **Sulfur recovery : 96 %**
Campana Refinery, Argentina - 2016

- Customer & End User: AXION Energy
- PROSERNAT’s scope: Modular supply of a complete Sulphur Block including Fuel Gas Treating Unit, Amine Regeneration Unit, double stage Sour Water Stripper Unit, Claus Unit, Tail Gas treatment Unit (amine based Sulitimate™ process)
- Capacity: 30 T S/d
- Sulfur recovery: 99.9%
SmartSulf™ JPF; Kuwait, 2017

- Customer & BOT operator SPETCO
- Owner KOC
- Capacity 2x 100TS/d
- S recovery 99.4 %
Conclusion

• Axens Group offers a full range of advanced technologies, products and catalysts for all kind of SRU applications:
  • Technologies to minimize SOx emission and achieve the highest S recovery yields
  • Alternatively the breakthrough SmartSulf™ technology to achieve high recovery yields at minimal CAPEX & energy requirements
  • The most advanced portfolio of sulfur recovery catalysts
  • Completely modularized sulfur plants
  • A full scope of services, from conceptual studies, process design, engineering, procurement, fabrication to the support to plants in operation (trouleshooting, debottlenecking,....)
Thank you! And see you on Axens’ Blog
axens.net/blog