

AXENS' IRAN SEMINAR
TEHRAN - 28 TIR 1396 (19 JULY 2017)

A Complete Range of Solutions for Sulfur Recovery

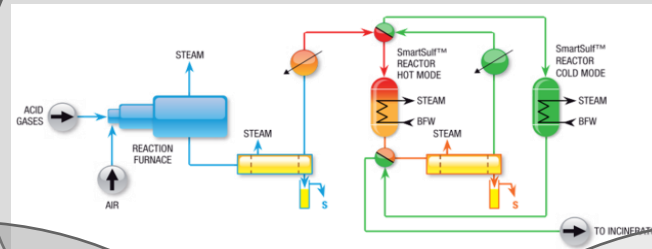


Christian STREICHER, Prosernat

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**



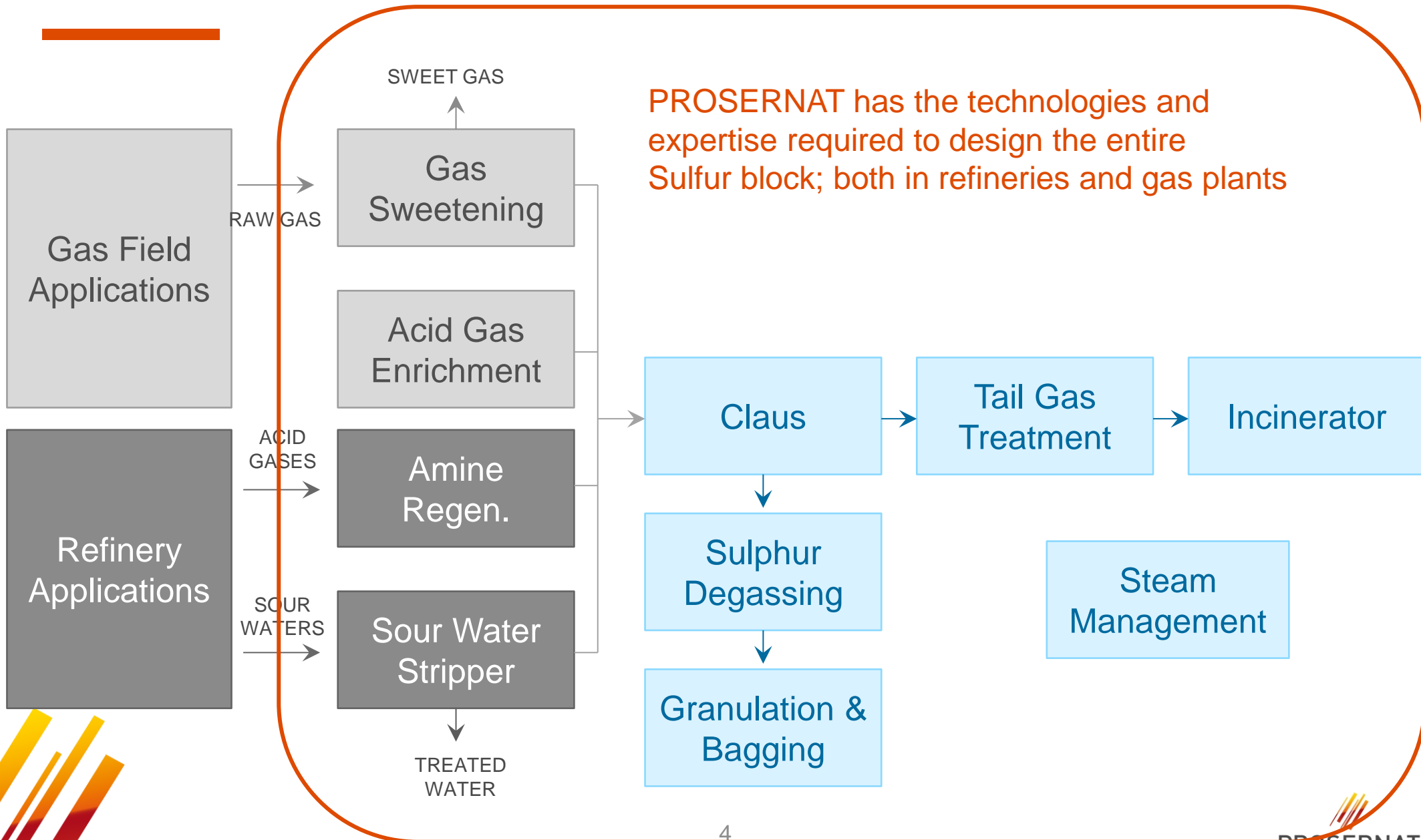
TECHNOLOGY PORTFOLIO

Claus

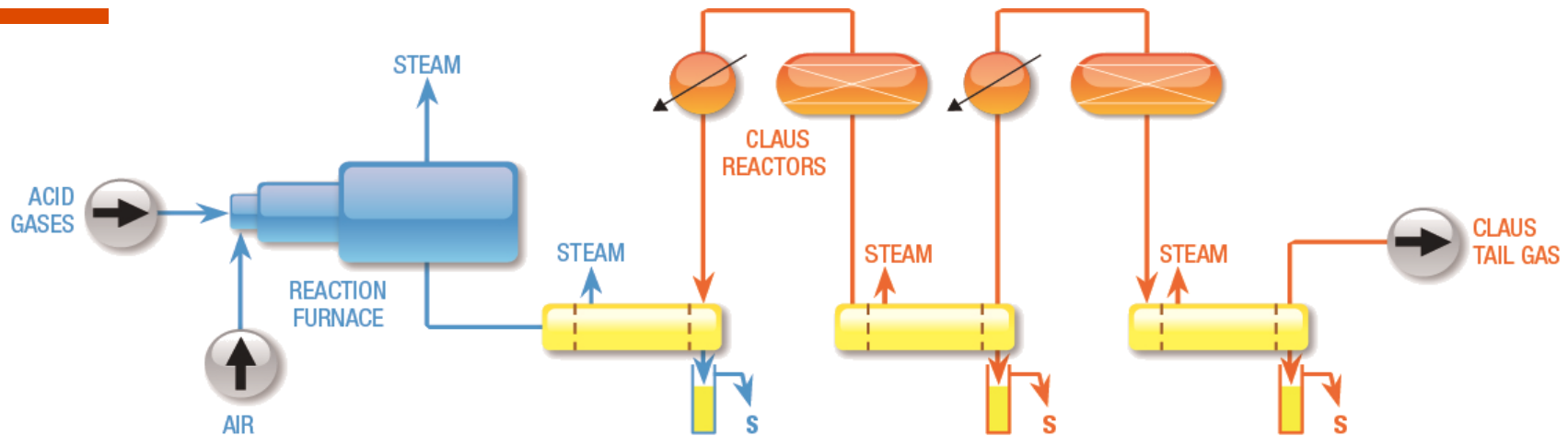
Sultimate™

SmartSulf™

Sulphur Block Management

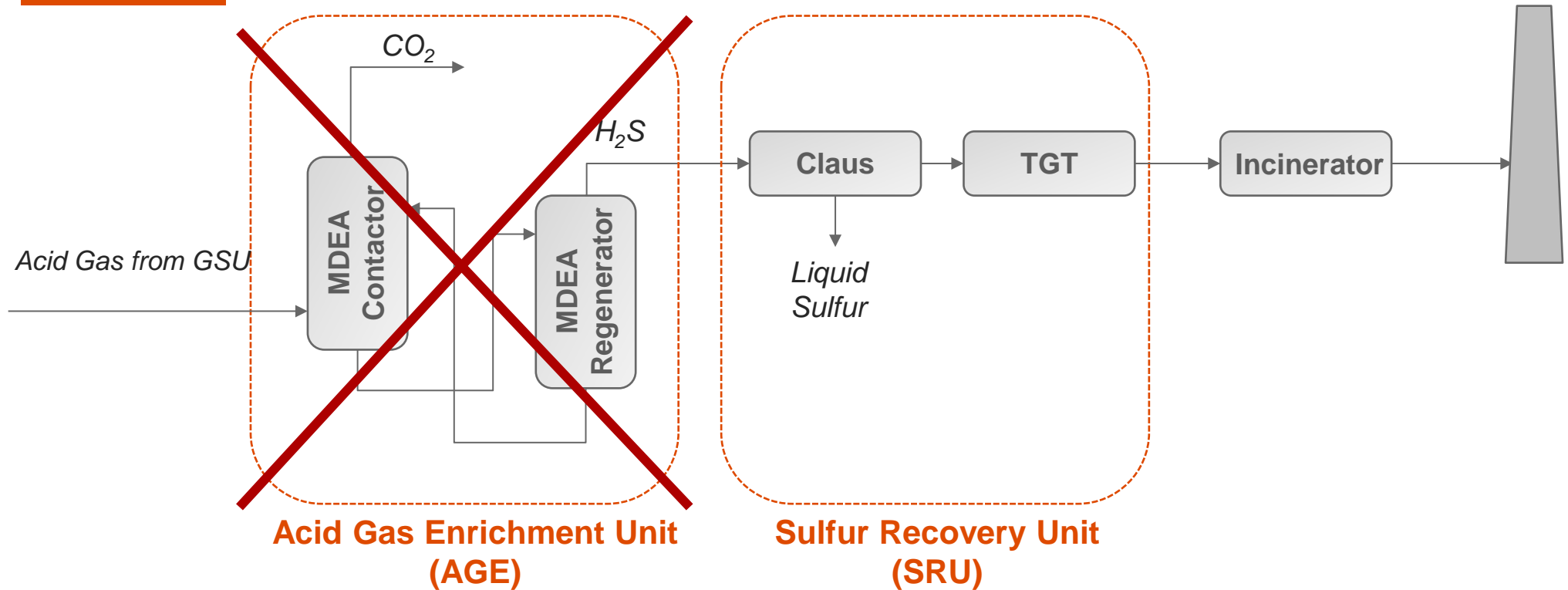


Claus Process



- 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

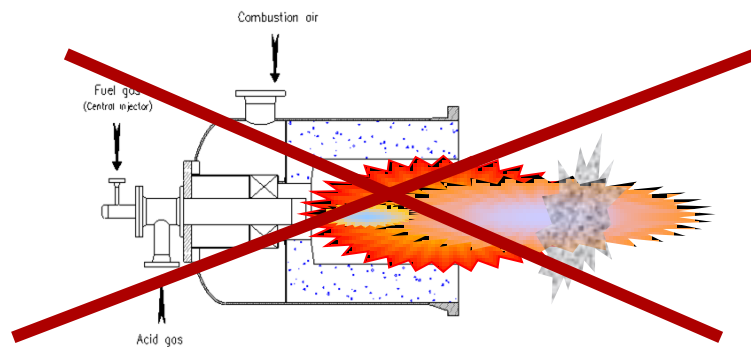


The key features of cofiring technology are:

- Excellent burning of Acid Gas Feed and Fuel Gas with PROSERMAT 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

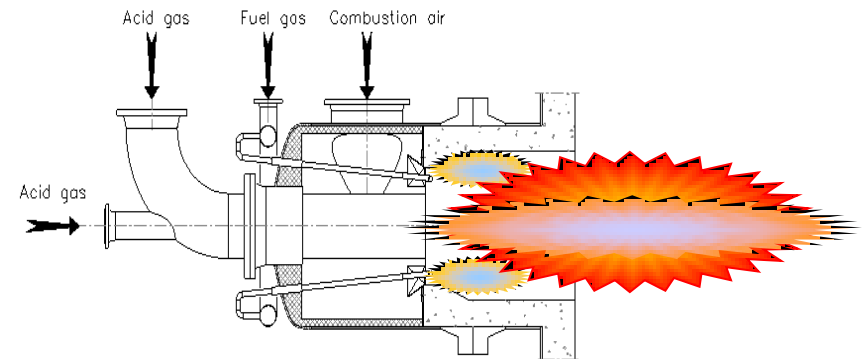
Cofiring Process for Lean Acid Gas

Conventional cofiring technology



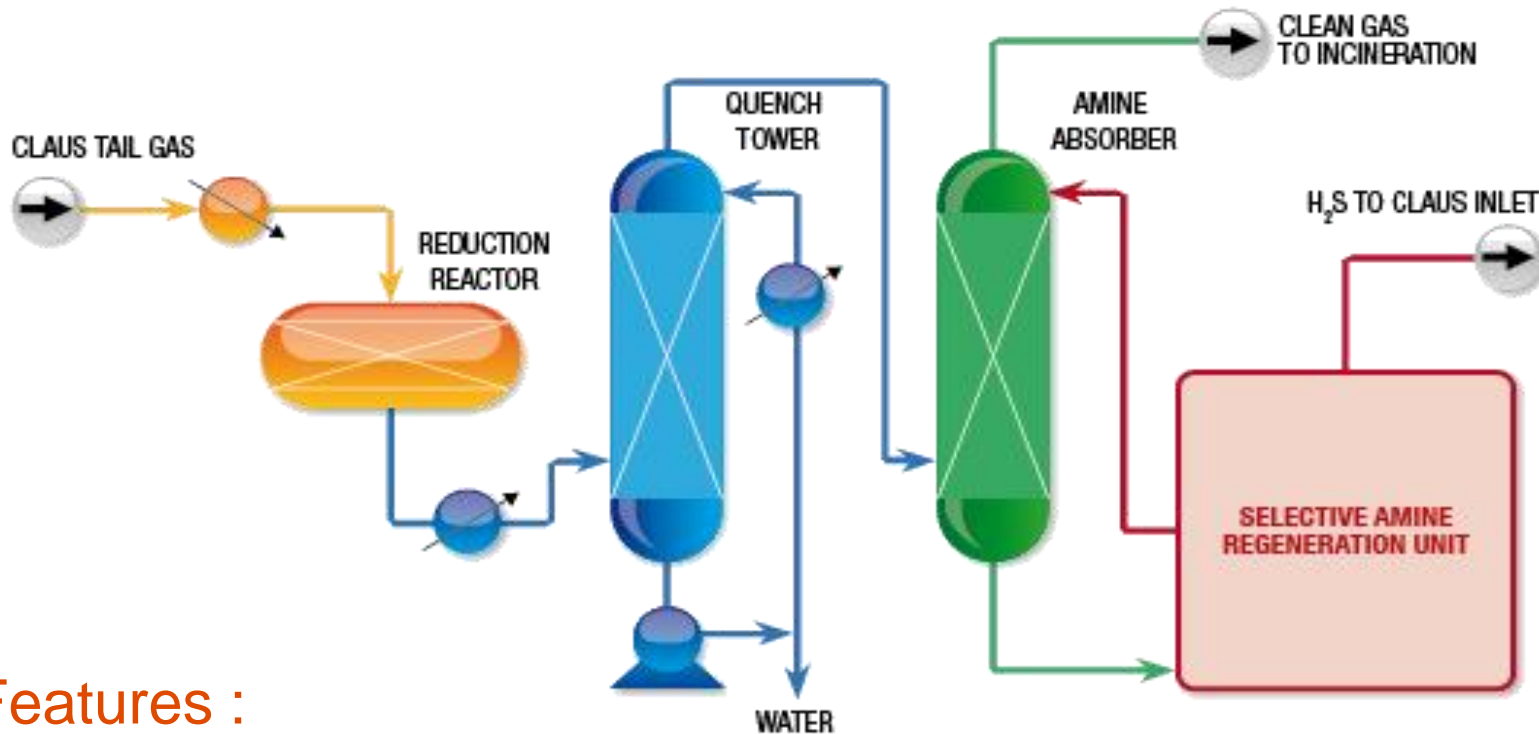
- The burner makes a single and compact flame
- The additional fuel gas is often supplied in the center of the burner and injected in the acid gas
- The fuel gas combustion is carried out under sub-stoichiometric conditions causing :
 - Unburnt HC ,
 - Soot emissions
 - COS/CS₂ increase

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)

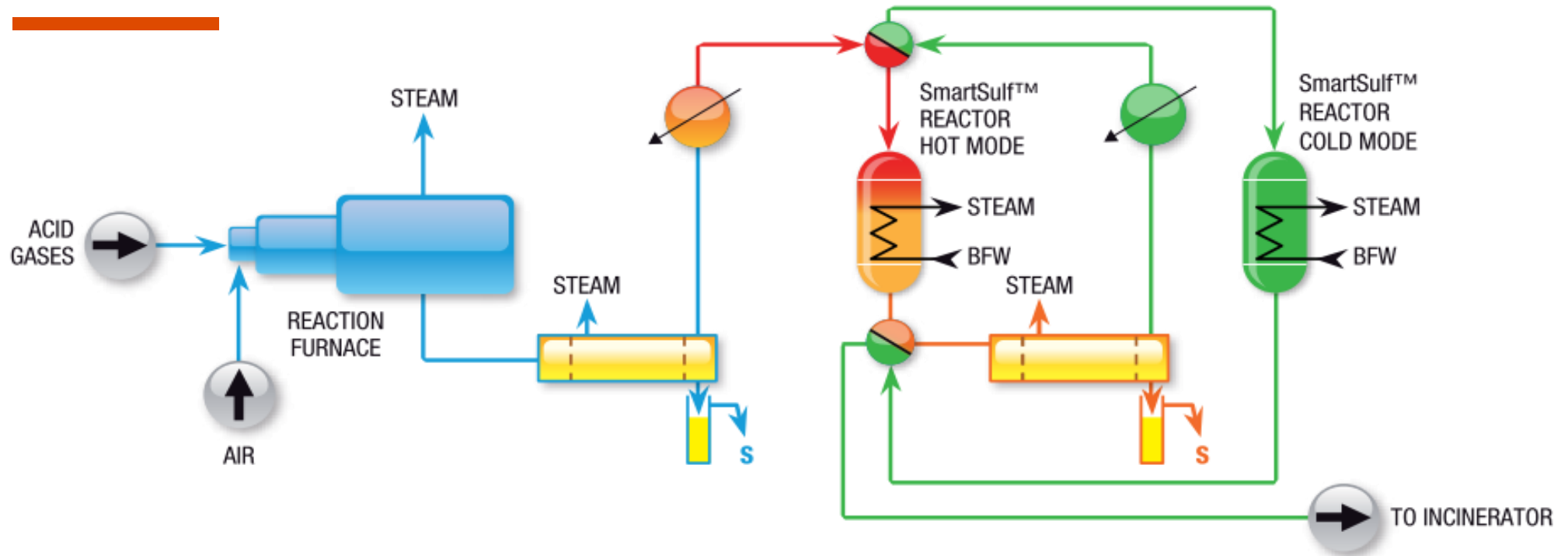
Sultimate™ Process



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



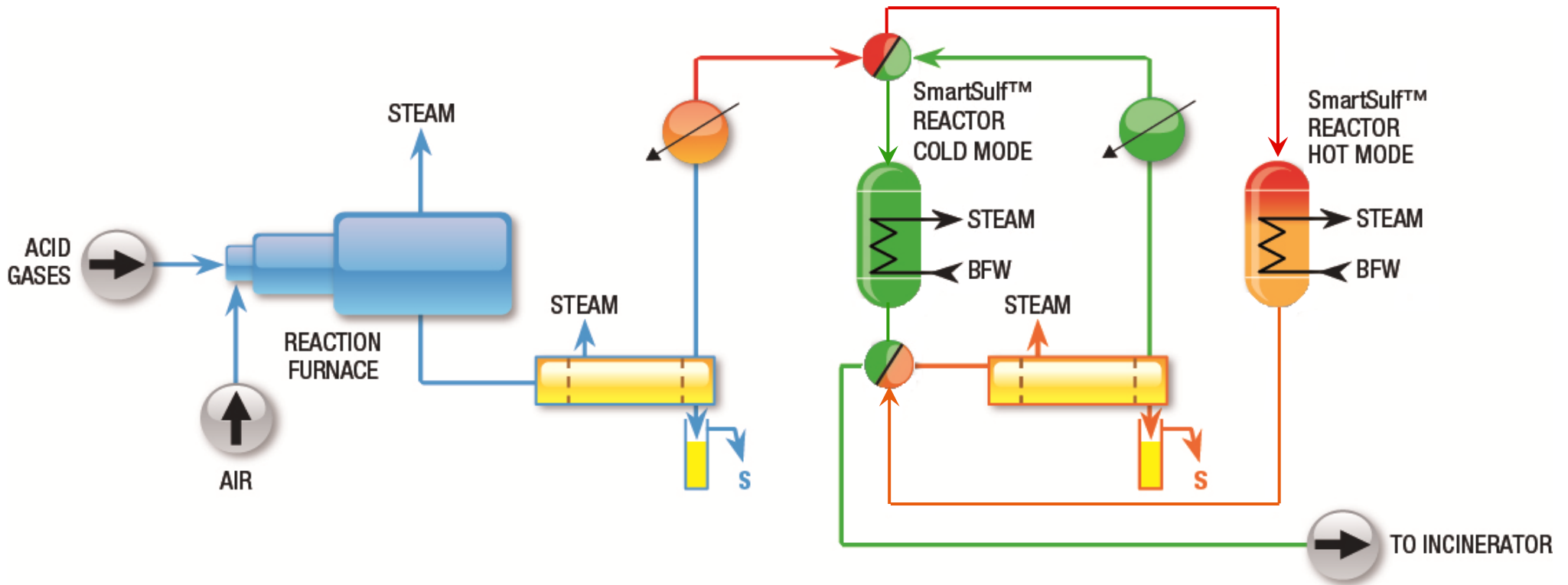
Thermal stage: strictly identical to conventional Claus thermal stage.

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.

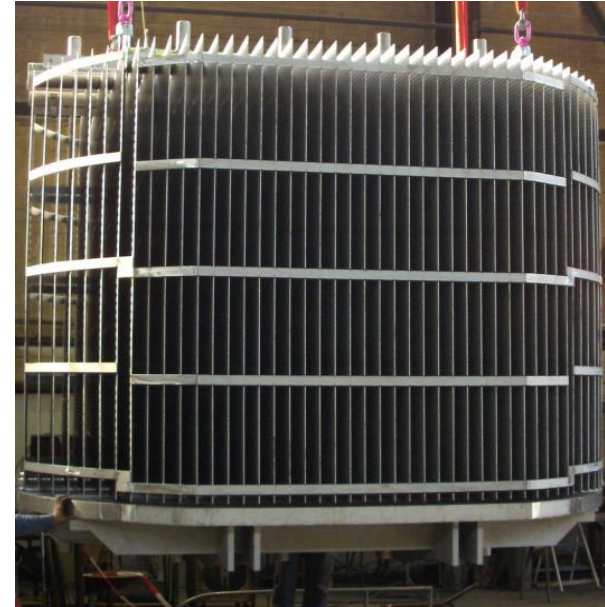
Sub-Dewpoint Claus reaction: is performed in the second reactor producing liquid S which is trapped on catalyst, with high S recovery.

SmartSulf™ Process Description



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

Company	Country	Location	Plant Type	Total Capacity (T/D)	Start-Up Date
SPETCO	Kuwait	Jurassic EPF	Natural Gas	2x100	Under constr.
PEMEX	Mexico	Cadereyta	Refinery	135	Under constr.
Transbunker Vanino	Russia	Khabarovsk	Refinery	15	Under constr.
PEMEX	Mexico	Minatitlan	Refinery	2 x 60	Under constr.
JSOC Bashneft	Russia	Oufa	Refinery	115	Under constr.
PEMEX	Mexico	Salamanca	Refinery	80	2014
Petrochina	China	Changqing	Natural Gas	15	2007
Petrochina	China	Changqing	Natural Gas	7.7	2004
Petrochina	China	Dianjiang	Natural Gas	16	2002
Huainan General Chemical Works	China	Huainan	Chemical	11	2001
RWE Energie	Germany	Berrenrath	Refinery	0.1	1996
Nynaes	Sweden	Nynaeshamn	Refinery	16 & 25	1995
Lucky Goldstar	South Korea	Naju	12 Chemical	8.3	1993

Smartsulf™ vs Claus + MDEA based TGT

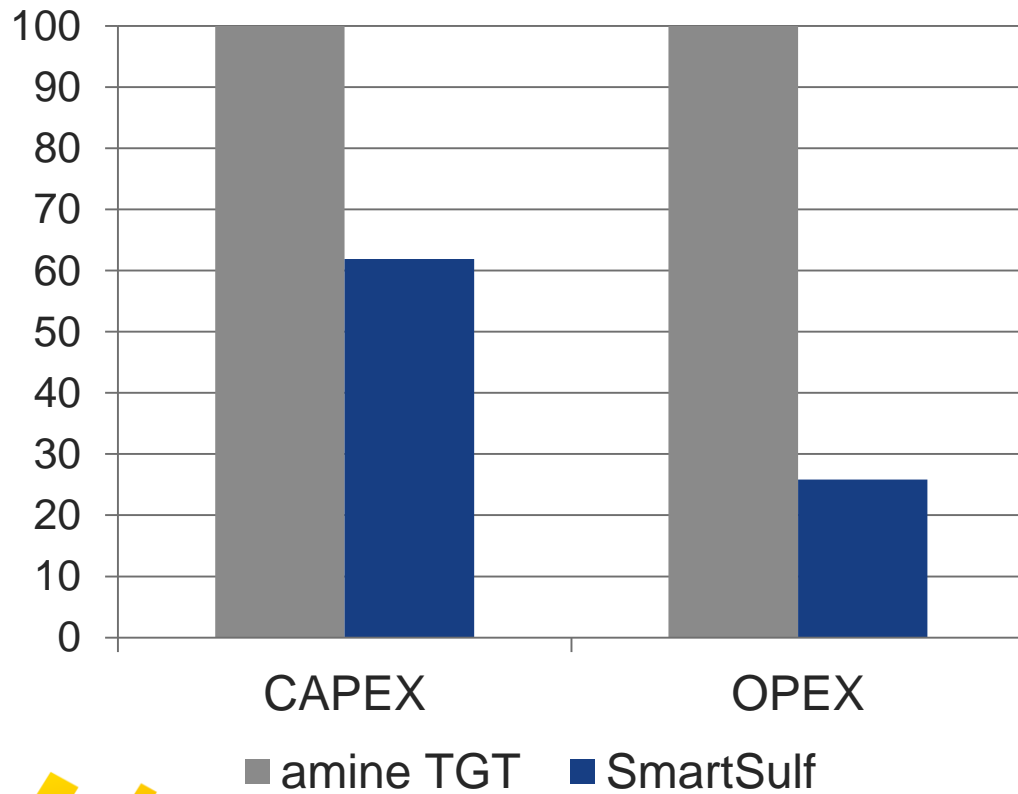
Basis

- 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:

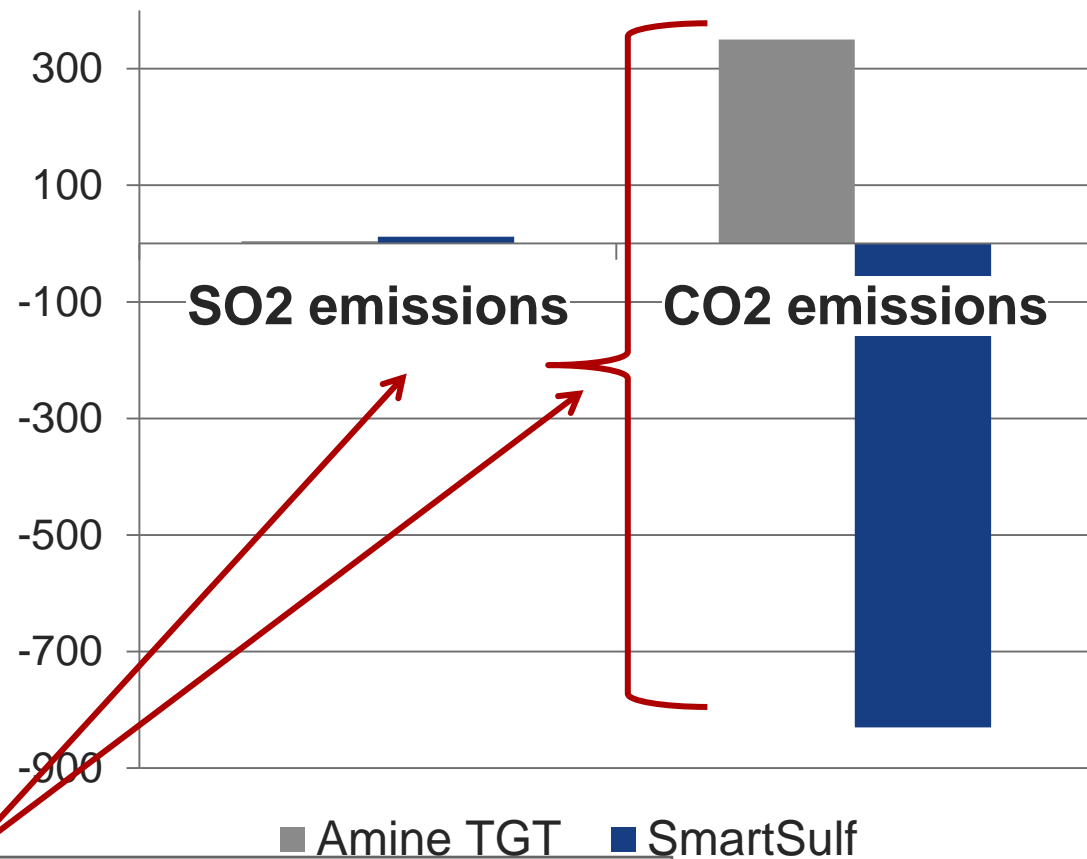
OPEX k USD / year	Claus + MDEA based TGT	Smartsulf
Electrical (0.0875 USD/kWh)	509	363
Cooling water (0.00616 USD/m3)	20	0
Hydrogen (2240 USD/MT)	1004	0
Fuel gas (510 USD/MT)	1562	1448
HP steam (5.6 USD/MT)	-547	-585
LP steam (4.9 USD/MT)	46	-557
TOTAL k USD / year	2594	670

Comparison SmartSulf™/Amine TGT

• Economics



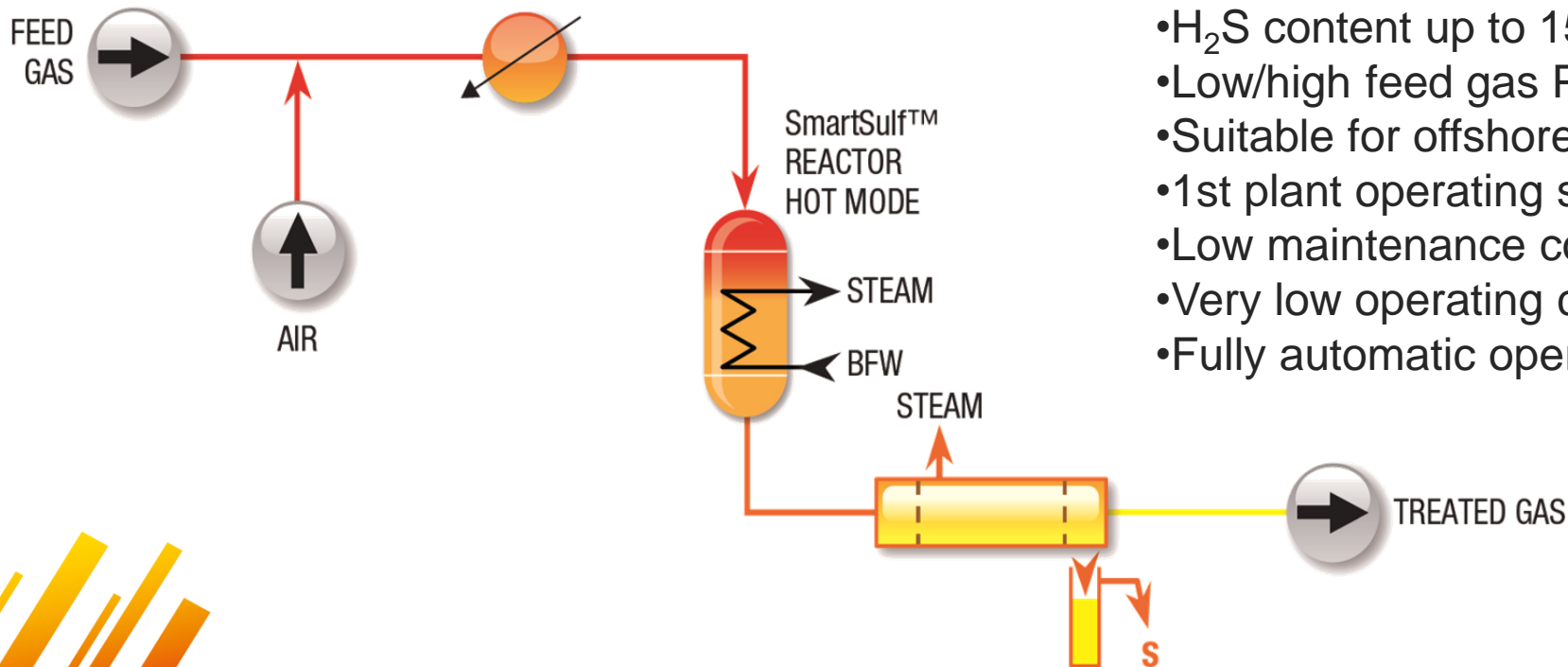
• Environmental



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



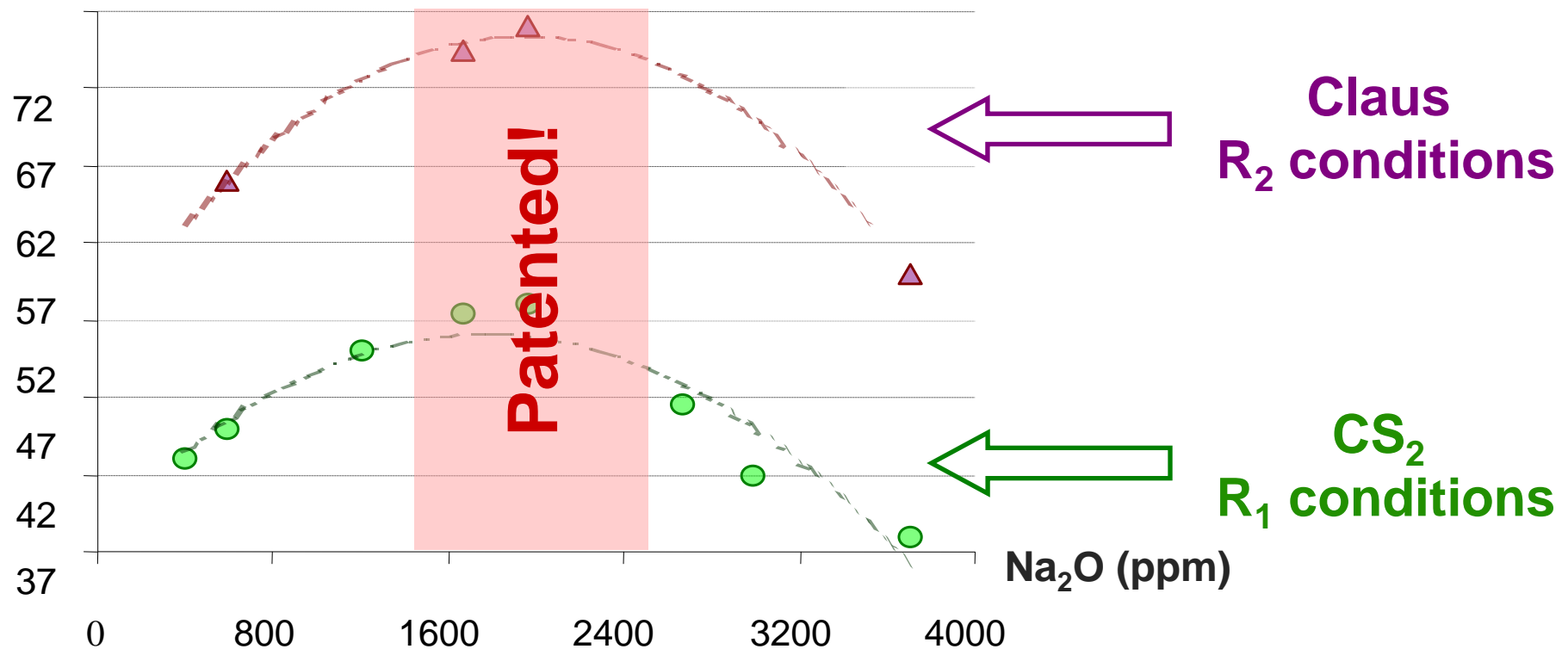
Tail Gas Treatment Catalysts

- **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**



CR-3S Patented Soda Content

Conversion, %



Na₂O content has to be in between 1500 and 2500 ppm:

Competition products + CR contain 3500 ppm Na₂O

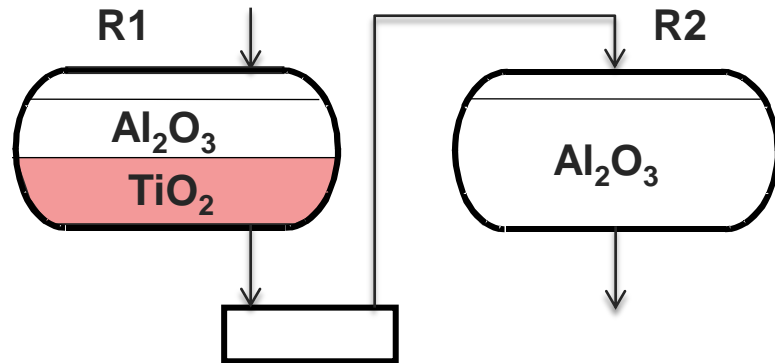
Additional step required to manufacture CR-3S

Higher resistance to sulfation, higher performances

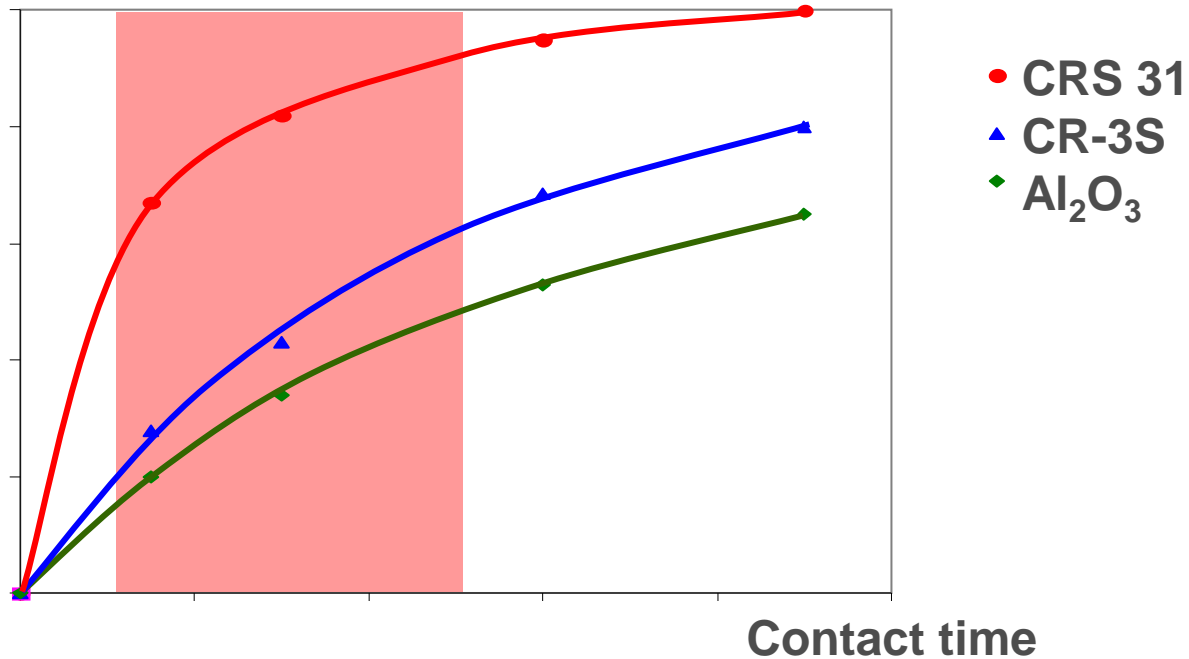
Purpose of CRS 31

CRS 31 bottom layer in R1

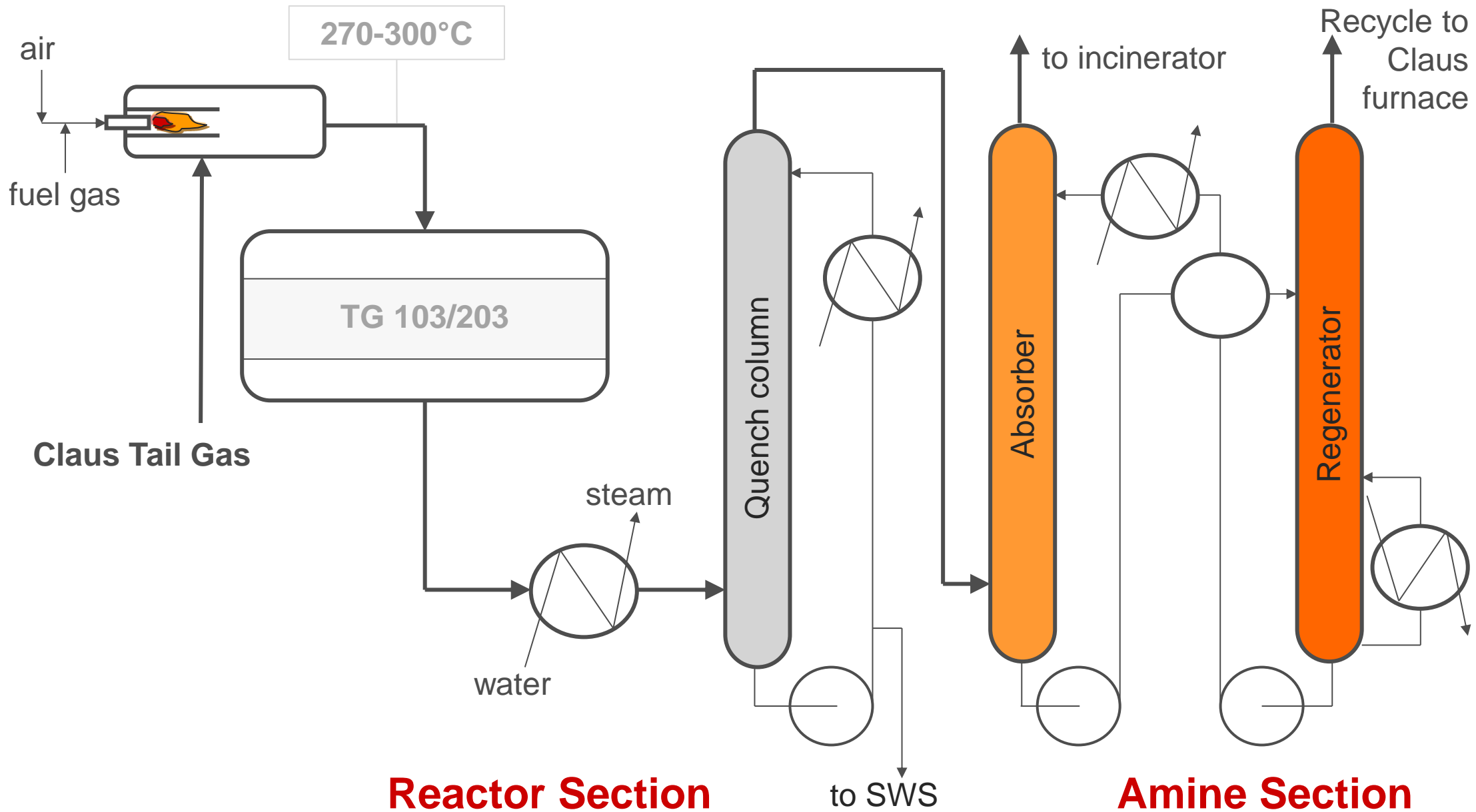
- » Full COS-CS₂ hydrolysis
- » Higher overall recovery
- » No need to replace CRS 31 every TA



CS₂ conversion



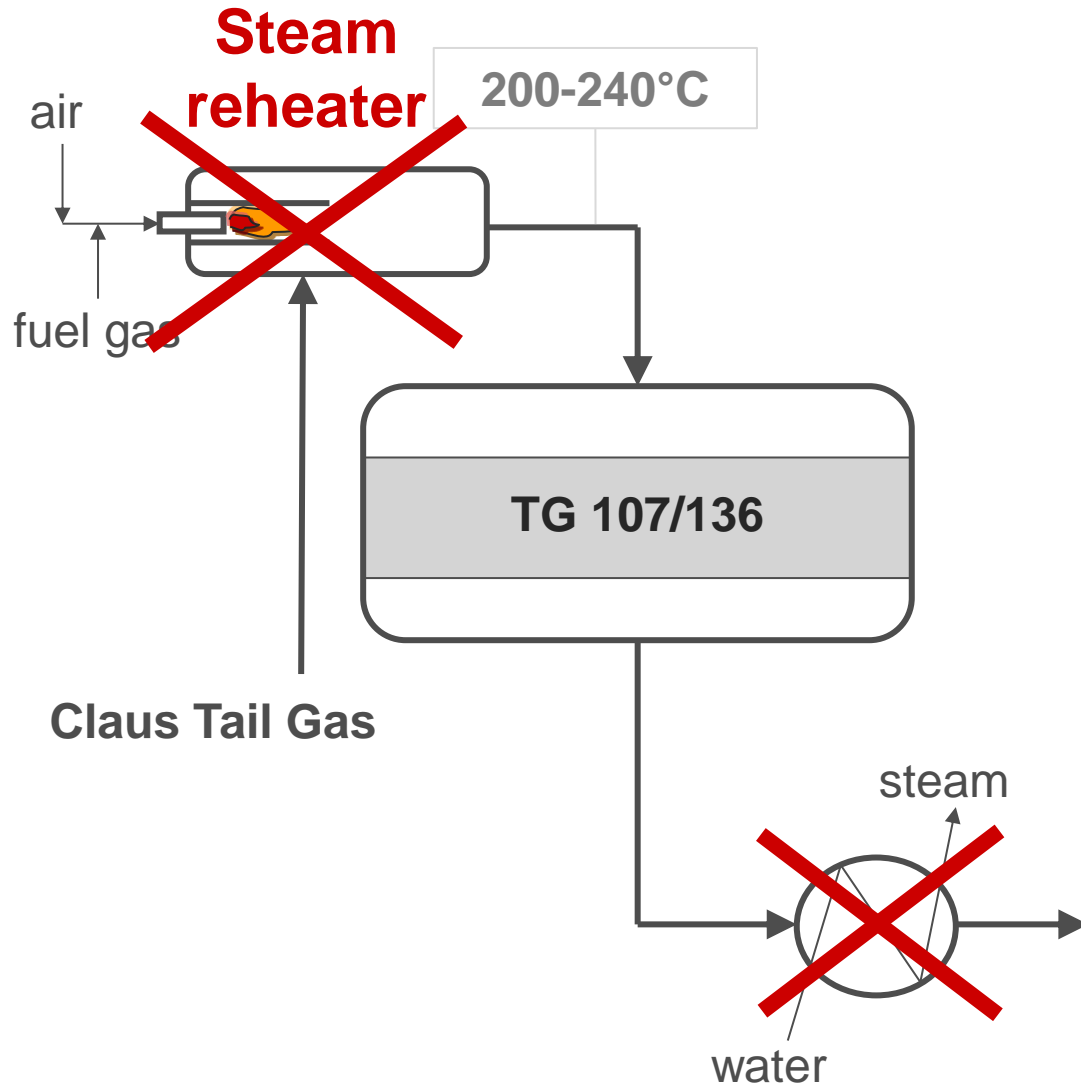
Hydrogenation Based TGTU



Reactor Section

Amine Section

A Revolution for Existing / New Units with LT



Operation at low temperature

- **> 40 % savings on energy**
~150 kW for 20000tS/yr
- **Lower CO₂ 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. 15th 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 : $0,7 \times 10^6 \text{m}^3 / \text{d}$
- **Claus Unit Capacity: 16 T S/d**

Perm, Russia - 2014

Modular Units : Claus

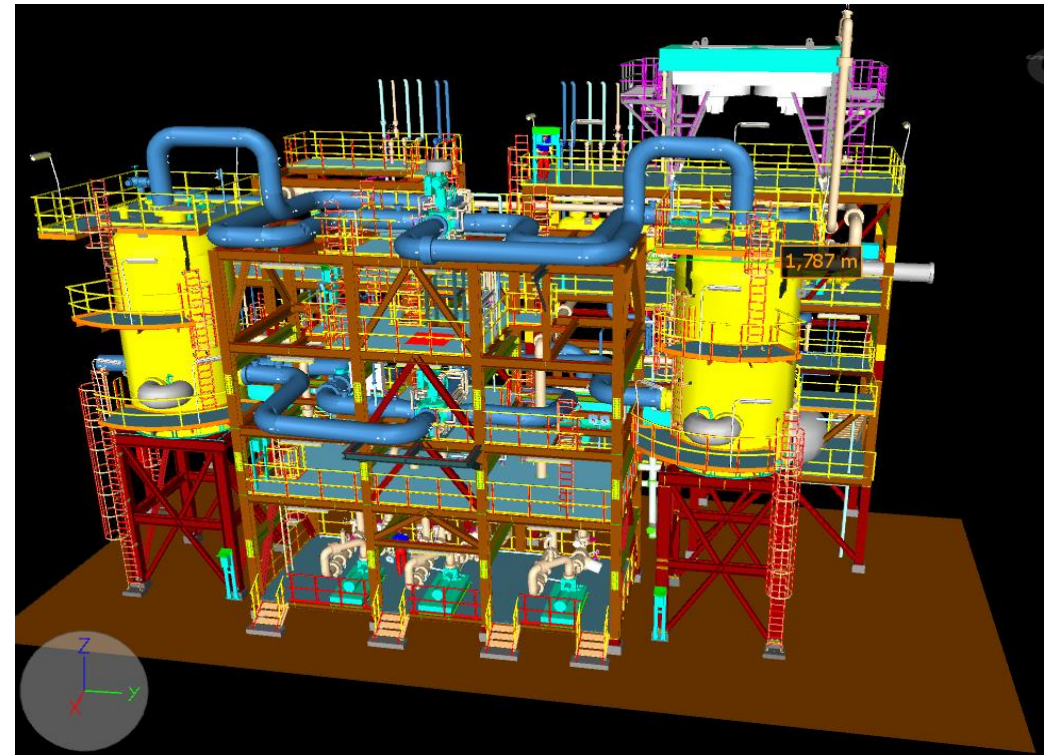
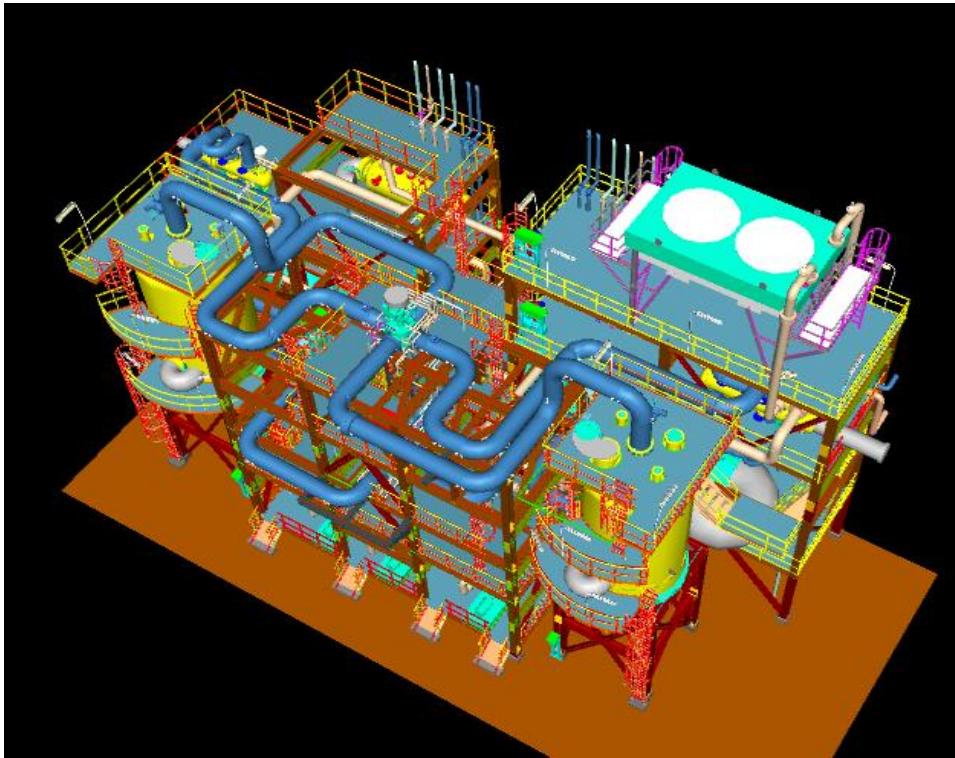
- Transportation:
Sea/River/Rail/Road
- Customer : Lukoil-Chernomorje
- End User : Lukoil-PermNefteGazPererabotka
- Country : Russia
- PROSERNAT's scope : Modular Claus Unit supply
- **Capacity : 10.5 T S/d**
- **Sulfur recovery : 96 %**





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 Sultimate™ 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 SO_x 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

