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## Gas Processes Overview

# Axens Solutions

## Key Figures



Over  
**3,000**  
industrial units  
under license



Over  
**70,000**  
tons of catalysts and adsorbents each  
year coupled with catalysts services



Over  
**500**  
modular units  
references



Over  
**2,000**  
furnaces references



Offices in  
**15**  
countries

**F**rom 22% in 2018, natural gas will represent 25% of the world global energy mix in 2040, according to the latest forecast released by IEA.

In the light of this strong demand and evolution of governmental legislations, as well as stricter gas transport specifications, lower levels of impurities and emissions, and associated operational issues, Axens offers solutions to overcome these complex challenges while maintaining the lowest levels of CAPEX and OPEX.

To that end, Axens provides comprehensive and integrated solutions to support operators' projects, big or small, from conceptual studies, basic design and technology selection, modularization studies and equipment supply through complete modularized units, including technical support, start-up, training and troubleshooting/revamping. For all main processing areas, from wellheads to export pipelines or liquefaction unit inlets, Axens offers a unique range of fit for purpose specialty products and/or licensed technologies, the latest of which are detailed in the following sections.

By merging Axens' product portfolio with Prosernat's gas treatment technologies offer, Axens has acquired all the treatment and purification technologies needed for the production of natural gas that meets the specifications of end-users, including the strictest specifications required as feedstock for Liquefied Natural Gas (LNG) processes. With a record of more than 500 modular gas treatment units and a similar number of licensed units worldwide, Axens is a leader in MEG recovery, gas sweetening, gas drying, NGL recovery and sulfur recovery.

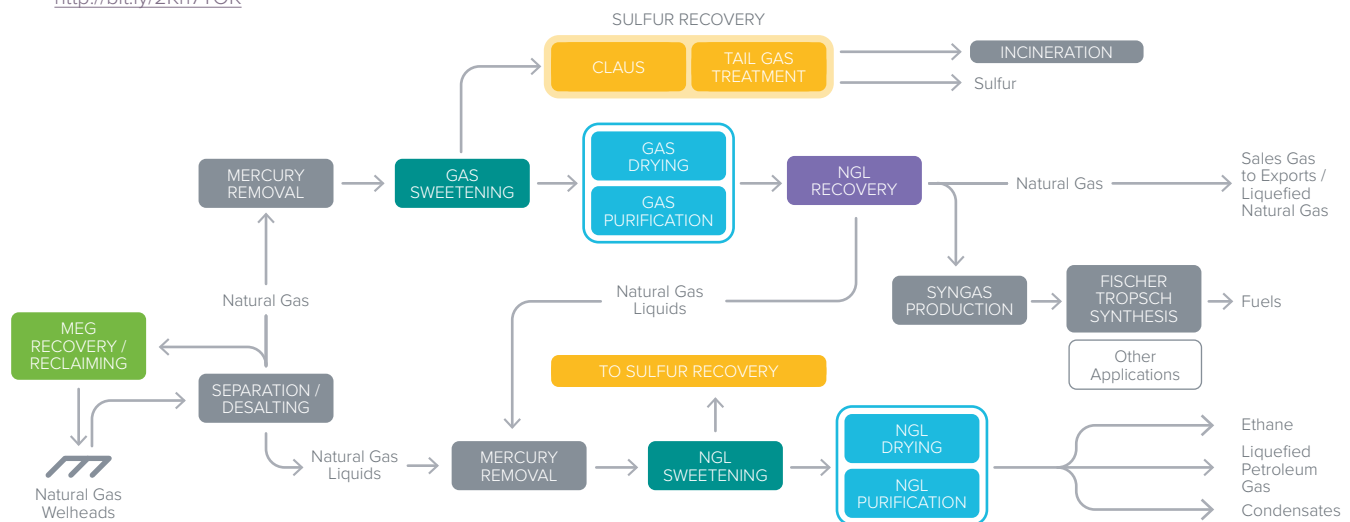
# A Complete Portfolio for Natural Gas Processing

	Contaminant Removal						Product Recovery			
	H <sub>2</sub> O	CO <sub>2</sub>	H <sub>2</sub> S	COS	RSH	Hg	Sulfur	NGL	MEG	
<b>MEG RECOVERY</b>										
ADVAMEG™	✓ (including salts)								✓	
<b>GAS SWEETENING</b>										
ADVAMINE™ PORTFOLIO										
ENERGIZED MDEA		✓	✓	✓						
MDEA			✓							
HYSWEET™		✓	✓	✓	✓					
SWEETSULF™			✓				✓			
SPREX®			✓							
COSWEET™			✓	✓	✓					
<b>GAS DRYING</b>										
DRIZO™	✓									
TEG	✓									
<b>NGL RECOVERY AND TREATMENT</b>										
IFPEXOL™	✓							✓		
SULFREX™			✓	✓	✓					
PROSERPACK (proprietary equipment)								✓		
<b>SULFUR RECOVERY</b>										
ADVASULF™ PORTFOLIO										
CLAUS							✓			
SMARTSULF™							✓			
SULTIMATE™			✓							
<b>CATALYSTS AND ADSORBENTS*</b>										
AXSORB®	✓	✓	✓	✓	✓					
AXTRAP™			✓	✓	✓	✓				
CLAUS AND TGT CATALYSTS							✓			

\* More info on these products:



<http://bit.ly/2Kh7TOK>



# MEG Recovery

Deliver a clean lean MEG suitable for reinjection into flow lines thanks to AdvaMEG™, a pioneering highly reliable and cost-effective technology, for MEG regeneration and reclamation.

A surge in natural gas demand is leading to the development of deeper offshore gas projects, longer subsea pipelines, higher pressures and lower temperatures.

Under these conditions, hydrate formation generates a greater risk of blocked flowlines, plant shutdowns and consequently a significant increase in OPEX. MonoEthylene Glycol (MEG) injection at the wellhead is operators' preferred solution to prevent hydrate formation and ensure gas flow and continuous production.

## AdvaMEG™, a robust and versatile process

The reclamation technology uses a vacuum distillation and purification system protected by several patents which allows the removal of water from the Rich MEG, as well as all types of salts, coming from formation water and from flow assurance loop.

Axens tailors each design to client requirements and specifications. Thanks to its experience, Axens is able to offer all types of scheme (integrated and slipstream configuration) and a stage-investment approach in order to optimize CAPEX in the early stages of a project.



High MEG Recovery

> 99.5 %



Proven long-term operability and reliability with successful hours of operation exceeding

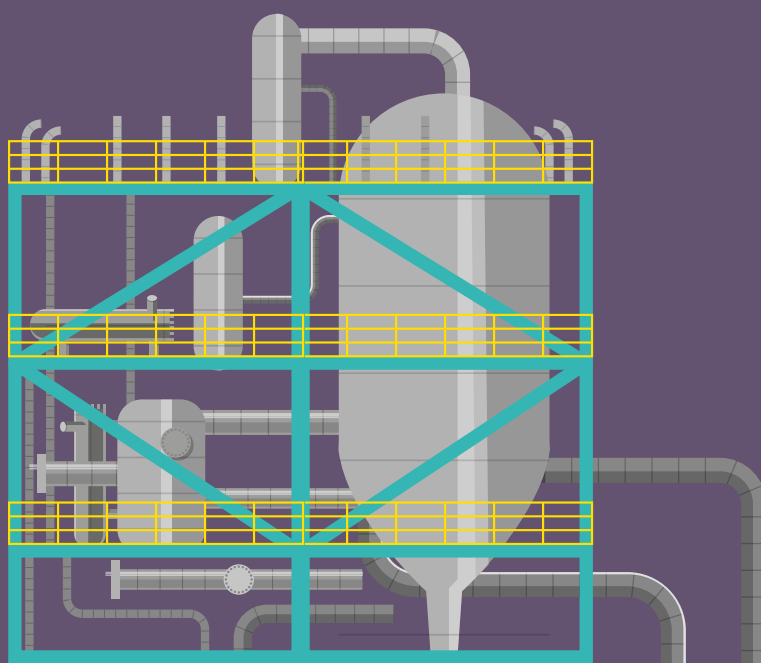
> 350,000 h



References

with large capacities

> 250 m<sup>3</sup>/h



## Axens, the partner of choice for MEG recovery



Extensive reclaiming operating experience inherited from CCR Ltd, a pioneer in MEG reclaiming, which first brought its commercial units on stream in 1999.



Axens' engineering expertise with a flexible approach, from process licensing up to supply of a modular turnkey unit.



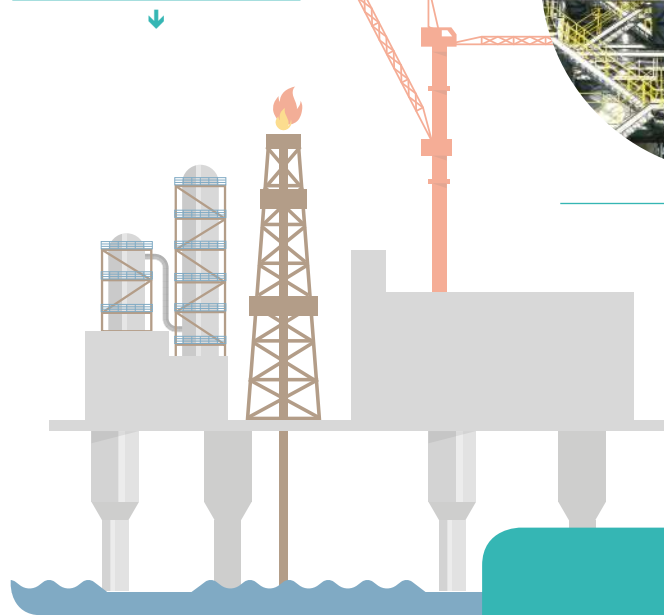
Continuous improvement of AdvaMEG™ technology with IFP Energies nouvelles unique R&D capabilities.

# Gas Sweetening

60 years of experience treating all types of natural sour gas for every specifications.

Contaminants like CO<sub>2</sub>, H<sub>2</sub>S, Mercaptans, COS, and CS<sub>2</sub> are often found in natural gas. The removal of these impurities is critical, in part because they are responsible for toxicity, corrosion and freezing issues, but also in order to meet transport/liquefaction specifications and comply with environmental regulations. Axens' gas sweetening technologies rely on a unique and long-term cooperation between a recognized licensor, Axens; an innovative R&D center, IFP Energies nouvelles; and TOTAL, a world-leading operator with more than 60 years of gas sweetening experience. Axens' portfolio provides tailor-made solutions for the removal of natural gas contaminants, meeting the strictest environmental regulations and market specifications while minimizing capital expenditure and operating costs.

Offshore design  
Axens offers tailor-made solutions for offshore application (FPSO, FLNG, platform).



Advamine™  
4x300 MMSCFD  
Yoloten  
Turkmenistan

## Portfolio of solutions to treat all types of natural gas and meet specific requirements

**ADVAMINE™** Amine-based processes for all gas sweetening applications  
*Developed by TOTAL, IFP Energies nouvelles & Axens*

- Energized MDEA** Formulated MDEA for total H<sub>2</sub>S and COS removal and total or controlled CO<sub>2</sub> removal for all applications including LNG
- MDEA** Selective H<sub>2</sub>S removal with CO<sub>2</sub> slippage for natural sour gas treatment

**HYSWEET™** Hybrid solvent sweetening process for simultaneous RSH, CO<sub>2</sub>, H<sub>2</sub>S, and COS removal with low hydrocarbon coabsorption  
*Developed by TOTAL*

**COSWEET™** COS hydrolysis process for removal of COS from sour natural gas  
Simultaneous removal of COS and H<sub>2</sub>S with/without CO<sub>2</sub> slippage when associated with AdvAmine™ processes

**SPREX®** Cryogenic process for H<sub>2</sub>S bulk removal from highly sour gases - Suitable for acid gas reinjection  
*Developed by TOTAL & IFP Energies nouvelles*

**SWEETSULF™** Redox desulfurization process for selective H<sub>2</sub>S removal from sour gases and direct production of solid sulfur



### KEY BENEFITS

Make significant solvent cost-savings thanks to a large choice of solvents, including open market chemicals

Benefit from a tailored and optimized design implemented with a unique proprietary software adapted to industrial operating conditions

Reduce CAPEX and OPEX, taking advantage of extensive expertise in highly sour gases using high amine loadings

# Gas Drying

Prevent hydrate formation and free water condensation in transportation facilities and downstream cold processes thanks to Axens gas dehydration technologies and products.

Axens provides operators with the broadest range of dehydration and purification solutions available on the market, from glycol absorption processes to a wide portfolio of dedicated adsorbents.

For deep dehydration and purification applications, Axens offers fixed beds of regenerable adsorbents with AxSorb® series.

This portfolio includes molecular sieve desiccants with high and tunable selectivity, ideally supplemented with optimized activated alumina product.

Thanks to its lengthy experience in the field of gas dehydration, Axens is able to propose a fit-on-purpose and CAPEX-effective solution to best match operators' requirements, whatever the dehydrated gas specifications.

More info on the AxSorb® portfolio:

<http://bit.ly/2Kh7TOK>



↑  
TEG modules  
3x300 MMSCFD  
United Arab Emirates

## A solution for every application

	Water Content in Dry Gas
<b>STRIPPING GAS TEG</b>	< 5 ppmv
<b>DRIZO™</b>	< 1 ppmv
<b>MOLECULAR SIEVE</b>	< 0.1 ppmv

### Drizo™, the most efficient and environmentally friendly glycol dehydration process

- No fuel gas required: vaporized C<sub>3</sub>-C<sub>10</sub> cut absorbed by TEG from feedstock. This C<sub>3</sub>-C<sub>10</sub> cut is used as a stripping agent instead of fuel gas.
- Clean process: less BTEX released with the off-gases
- Very low water dewpoint thanks to higher lean glycol purity

Axens has industry-leading experience in the dehydration of gases with high CO<sub>2</sub>/H<sub>2</sub>S contents, up to pure acid gases. This issue is subject to increased interest in the current context of CO<sub>2</sub> sequestration, an area in which Axens is developing innovative solutions.

## A strong experience

★  
A wide range of gas capacities  
from 5 to 3,000 MMSCFD

★  
Supply of 150 TEG units  
in the last 35 years  
with more than 35 offshore references

★  
Exclusive licensor  
of Drizo™ technology

# NGL Recovery

Take advantage of Axens' proprietary and tailor-made solutions for optimized hydrocarbon (HC) dewpointing, NGL recovery and treatment.

## A comprehensive range of technologies and equipment

<b>IFPEXOL™</b>	Proprietary technology Simultaneous dehydration and hydrocarbon dewpoint control
<b>SULFREX™</b>	Proprietary technology Extraction and conversion of mercaptans to reduce total sulfur concentration in gas condensates and NGLs, under mild operating conditions
<b>PROSERPACK</b>	Proprietary combined Exchanger-Separator allows efficient and compact gas dewpointing in offshore applications while minimizing weight and plot area
Expertise in all open art hydrocarbon processes	

Sales gas specifications and monetization of valuable liquid hydrocarbons require the extraction of NGLs from the natural gas and treatment of the recovered hydrocarbons liquids in order to obtain quality, commercial-grade products.

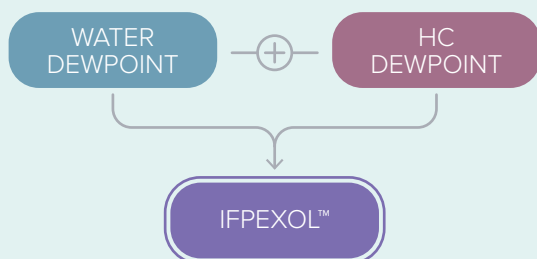
To meet this requirement, Axens offers tailored solutions, for HC dewpointing, NGL recovery and treatment of condensates and NGL's. Axens has considerable experience in all open art and proprietary processes, including the supply of fully modularized units for natural gas dewpointing.

### Focus on IFPEXOL™

IFPEXOL™ is a simple and environmentally friendly process using methanol to allow water and HC dewpointing in one step. Suitable for all types of cold processes (down to -90 °C) and all types of natural gas streams including shale gas, this technology has been industrially proven in applications ranging from mild HC dewpointing through high LPG recovery.

- Low OPEX: no need for heating / cooling
- No flaring, no BTEX emissions
- Low CAPEX with minimized equipment items
- Industrially proven experience with more than 20 IFPEXOL™ units

IFPEXOL™ Water & HC Dewpointing Unit  
200 MMSCFD  
Veresen Midstream Partnership Limited  
Canada



# Sulfur Recovery

Combining extensive process licensing expertise with the most widely-recognized sulfur recovery catalysts on the market, the AdvaSulf™ portfolio offers a wide range of SRU processes to meet the most stringent atmospheric emission specifications while matching operators investment capacities.

Atmospheric emission regulations have been tightened to specifications of less than 150 mg of SO<sub>2</sub>/Nm<sup>3</sup>, while gas fields are being developed with increasingly high levels of H<sub>2</sub>S.

With its AdvaSulf™ portfolio, Axens is able to provide reliable, flexible and low-cost solutions for sulfur recovery in refineries and gas plants to meet the most stringent environmental standards, with optimized impact on capital and operating costs.

With a long history inherited from Elf Aquitaine, the pioneer in sour gas treatment since 1957, AdvaSulf™ provides a complete range of processes for any applications: gas plants, refineries, upgraders, biogas, shale gas, etc., in a wide range of single train capacities, from a few tons per day to more than 2,200 tons per day of sulfur produced.



↑  
SRU with Sultimate™ Tail Gas Treatment Unit (TGTU)  
2x300 TS/d, 99,9 % sulfur recovery  
India

## Tailor-made processes to meet any type of specification and level of investment cost

ADVASULF™ PORTFOLIO		SULFUR RECOVERY	COST INDEX
<b>SULTIMATE™</b>	Ultimate sulfur recovery by H <sub>2</sub> S selective absorption in Claus Tail Gas	100% ↑ 99,7%	180
<b>SMARTSULF™ + CAUSTIC</b>	SmartSulf™ technology followed by caustic wash of incinerator flue gas (* Sulfur removal)	100% <sup>(*)</sup> ↑ 99,7%	140
<b>SMARTSULF™</b>	Very high sulfur recovery with 2 catalytic stages subdewpoint process and proprietary internally cooled reactors without installation of a TGTU	99,7% ↑ 99,5%	110
<b>CLAUS</b>	Conversion of H <sub>2</sub> S into elemental sulfur → 1 reaction furnace and 2 or 3 catalytic reactors	97% ↑ 95%	100

### KEY BENEFITS

▼

Achieve the most stringent sulfur recovery specifications of 99.9+% with Sultimate™ TGTU

▼

Achieve 99.5 % sulfur recovery without TGT and with low CAPEX thanks to SmartSulf™ technology

▼

A unique provider of SRU processes and the associated most widely recognized SRU catalysts on the market

▼

Strong experience in treating lean acid gases

Axens has an extensive portfolio of sulfur recovery catalysts, which, pioneered the use of titanium dioxide catalysts to boost the efficiency of the Claus unit, among others. Axens' TGT low temperature catalysts allow major energy and cost savings on the Claus TGT units, bringing about a revolution in their design.



OIL REFINING



PETROCHEMICALS



GASES



ALTERNATIVES  
& RENEWABLES



WATER



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Axens is a Group providing a complete range of solutions for the conversion of oil and biomass to cleaner fuels, the production and purification of major petrochemical intermediates as well as all of natural gas treatment and conversion options. The integrated offer includes technologies, equipment, furnaces, modular units, catalysts, adsorbents and related services, commercialized under “Axens Solutions”, “Heurtey Petrochem Solutions” and “Axens Horizon” brands.