



# Hydrogen Technology

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**Technip**

*take it further.*



## Technip at a glance

Technip is a world leader in project management, engineering and construction for the oil and gas industry.

With a global footprint, our talents constantly offer the most innovative technologies and best solutions to our clients to optimize their investments and meet the world's energy challenges.

Our mission is to deliver safe, sustainable and quality projects across the world.

We operate in three main businesses:

### Subsea

In subsea hydrocarbon field development, Technip's activities include the design, manufacture and installation of rigid and flexible subsea pipelines and umbilicals.

Thanks to our portfolio of technologies, industrial and operational assets on all continents and a state-of-the-art fleet, we offer a unique vertically integrated model in the industry.

### Offshore

In the Offshore business, our activities include engineering, procurement, construction (EPC) and installation of fixed and floating platforms.

We use a complete range of technological solutions to answer the challenges faced by our clients. We are leveraging our expertise in full-range of offshore facilities, as well as our strong know-how with added-value process skills and proprietary platform design.

### Onshore

In the Onshore business, we deliver to our clients all the experience we have acquired for almost 60 years, combined with a large technology solutions portfolio. We are working on onshore facilities that the energy sector needs, in particular for oil and gas industry players. Technip is one of the global leaders for the refining business and petrochemical units. We also reinforced our position on project management consultancy (PMC) activities, by leveraging our expertise in the management of complex projects.



## Hydrogen: our expertise and the backbone of your business

Hydrogen is the most widely used industrial gas in the refining, chemical and petrochemical industries. Hydrogen is mostly regarded as a utility, to be always available when required.



Austria - 30,000 Nm<sup>3</sup>/h Hydrogen

Achieving the on-stream reliability levels expected of a utility requires an extensive understanding, experience and expertise in the design, engineering and construction of a hydrogen facility. A substantial amount of operational feedback is also needed in order to continuously enhance the critical design aspects of a hydrogen plant, and to exploit state-of-the-art advancements. Based on this experience and know-how, Technip's hydrogen plants have demonstrated their high on-stream reliability in the industry.

### Hydrogen is our business

Technip offers its well known and widely proven technology for industry's hydrogen needs and has been consistently recognised as the market leader in this field over the past decade. Technip has provided more than 240 hydrogen units worldwide. Technip has supplied more than 250 reformers. Recognising that every user's situation is unique, we offer the most effective and tailored solutions, often leading to industry "firsts".

Having built hydrogen-synthesis gas plants on every continent, we understand the need for flexibility not only in plant operation, but also in the scope of work and the form of contract, ranging from reimbursable to lump sum turnkey projects.

A world-ranking EPC company, Technip is in a very strong position to offer its clients a single-point responsibility from concept to commissioning.

Moreover, Technip offers service contracts to its clients to provide operations support, maintenance and training.

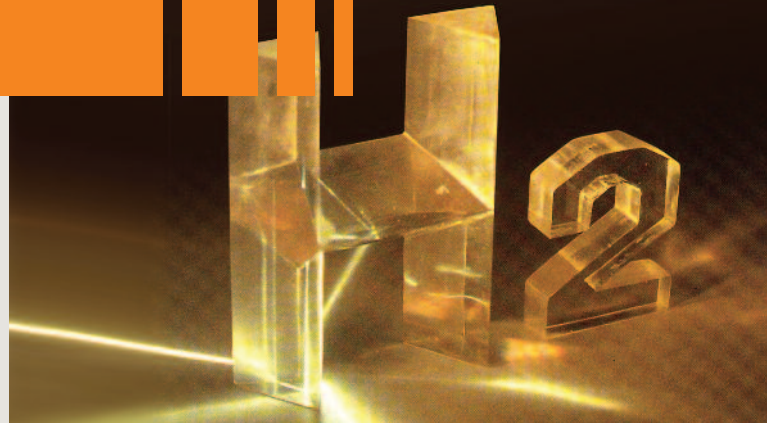
### Continuous product development

Since pioneering the steam reforming process in the early sixties, Technip has been constantly advancing its process technology to maintain cutting edge excellence in hydrogen plant design. Recent, commercially proven developments include:

- Enhanced energy efficiency flow sheet together with MTS (Medium Temperature Shift) conversion and extended heat recovery.
- Advanced Gas Turbine combined cycle integration for steam-power synergy and reliable captive power.
- Value-added features for reduced unit cost of hydrogen (UCH) and higher reliability.
- Specific design concept for smaller capacity hydrogen plant (<10 MMSCFD).
- Regenerative reforming (using high level processed heat for part reforming), particularly for capacity revamps offering up to 30% additional hydrogen from existing units.
- Largest single-train plant for 224,000 Nm<sup>3</sup>/h (200 MMSCFD) hydrogen including co-generation.
- Advanced plant modularisation for faster and more cost-effective execution, especially for cold-climate and high labour-risk regions.
- Specific plant flowsheets for high quality export steam, especially in terms of ammonia and total organic carbon.

## Engineered solutions to fit your hydrogen needs

Most hydrogen production facilities are based on steam reforming of hydrocarbon feedstocks.



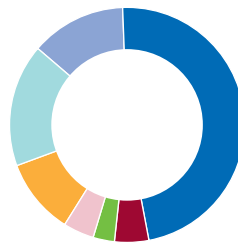
In comparison with other hydrocarbon-based processes, steam reforming delivers the maximum hydrogen product yield for a given feed rate. It has been the predominant technology of choice for hydrogen production, being simple, flexible, efficient and well proven.

Steam reforming technology consists of four essential process steps:

- feed pretreatment
- steam reforming
- shift conversion
- purification

Heat integration and specific thermal efficiency are important factors in the overall design of a hydrogen plant. In-house software and tools utilise the powerful pinch technique to optimise the heat recovery network towards the final objective of high efficiency, low-cost, hydrogen production.

Global Leader  
in Hydrogen



**Technip**

Integration of hydrogen plants with other units can be achieved through a variety of options. The amount of export steam required, as well as its pressure and superheat conditions can easily be adapted. In several hydrogen units involving co-generation, the exhaust gases from gas turbines can also be used as combustion air for the reformer unit.

In cases where steam has low credit, the adiabatic pre-reforming step is employed, whereby part of the reformer duty is shifted to its convection zone, thus serving the dual purpose of reducing both fuel and steam export.

Most refinery hydrogen plants today require the flexibility of multiple feedstocks (ranging from refinery offgases, and natural gas to LPG and naphtha) to suit long-term economic and operational flexibility needs. The application of pre-reforming steps enables the plant to achieve the desired feedstock flexibility. Technip has extensive experience in applying pre-reforming in its plants, addressing various case-specific needs. Also, advanced control configurations have been implemented for automatic changeover of feedstocks without affecting production capacity.

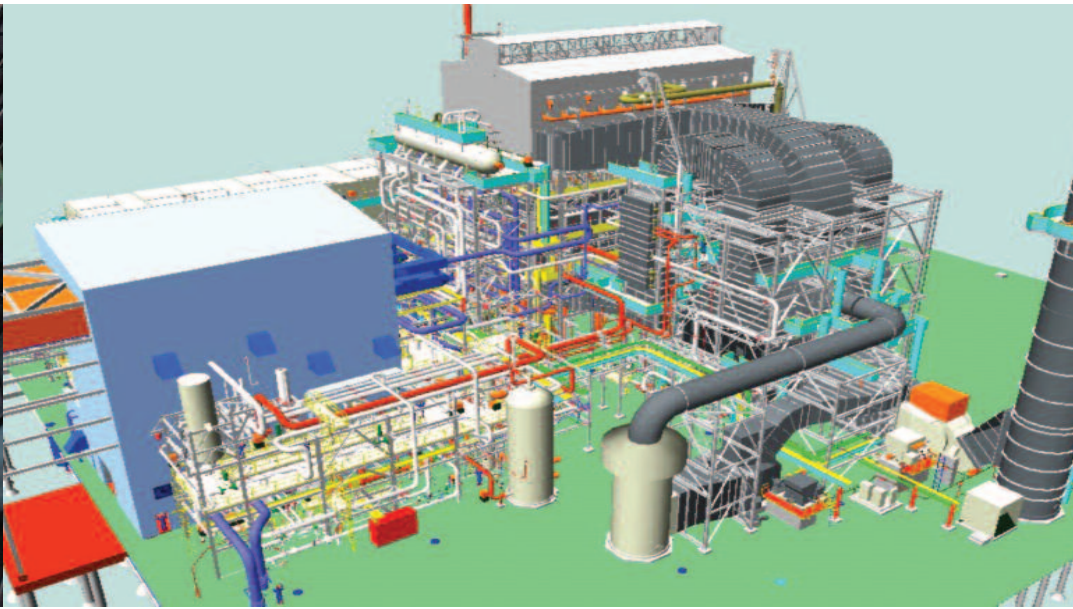


France - 97,000 Nm<sup>3</sup>/h Hydrogen



India - 77,000 Nm<sup>3</sup>/h Hydrogen





Spain - 16,000 Nm<sup>3</sup>/h Hydrogen

Canada - 224,000 Nm<sup>3</sup>/h Hydrogen and 75 MW power

## Financial benefits from careful process selection

The economics of hydrogen production can be influenced favourably by incorporating one or more commercially proven process options.

A variety of options have successfully been incorporated in plant designs for value enhancement based on project-specific requirements or facility-specific potential. These include CO<sub>2</sub> recovery as a sellable by-product, refinery off-gas utilisation to replace higher premium feedstock, captive power generation etc. This calls for early assessment and timely interactions between the owner and the design contractor for effective implementation.

The type of reformer design can have a significant impact on the capital and operating costs of a hydrogen plant. In the majority of plants, especially large capacity units, the top-fired arrangement is preferred. Side-fired and bottom-fired (cylindrical) units, however, have their specific applications, usually more suited for smaller capacities. Technip has the expertise to design and build all types of reformers and is thus capable of recommending the best arrangement for each case.

The efficiency with which the reformer operates is a critical factor and becomes more important as the feedstock and fuel costs grow and the plant size increases. In cases where fuel costs are high, designs incorporating pre-reforming or post-reforming process steps are attractive.

Energy savings are achieved by integrating various heat recovery options. Depending upon the value of fuel and steam, combustion air preheat can provide substantial operating cost savings.

A hydrogen plant also provides an ideal opportunity for co-generation. This integration can have significant merit in improving the economics of hydrogen production as well as the availability and cost of generated electricity.



USA - 105,000 Nm<sup>3</sup>/h Hydrogen



France - 97,000 Nm<sup>3</sup>/h Hydrogen







USA - 48,000 Nm<sup>3</sup>/h Hydrogen

## A safe and reliable Hydrogen process that fully meets HSE requirements

Technip's processes are designed to meet the highest Health, Safety and Environment (HSE) standards.



Poland - 111,000 Nm<sup>3</sup>/h Hydrogen

From process concept to design, operation and maintenance, safety is the foremost consideration, without compromise. It entails material integrity assessment, detailed stress analysis of critical parts, transient conditions impact, advanced operational diagnostics and required Safety Instrumented Systems analysis, plant layout and accessibility evaluation, detailed engineering model reviews etc. Furthermore, extensive HAZOP reviews and safety impact studies are carried out by specialists to ensure a high standard of operational safety.

Technip's hydrogen plants have a proven reliability and on-stream availability rate of more than 99% (excluding turnarounds and forced failures). This is based on extensive reliability assessment and operational feedback from the several modern, state-of-the-art hydrogen plants, including "over-the-fence" hydrogen plants which inherently require a high degree of product reliability.

The main emissions associated with hydrogen plants are NO<sub>x</sub> in the flue gas and impurities in effluent water. To meet the regulations on NO<sub>x</sub> emissions, Technip utilises the best (ultra) low-NO<sub>x</sub> burner technology available. Technip's experience includes retrofitting of existing plants to meet tighter environmental requirements. For more stringent limits on NO<sub>x</sub> emission to a level of 15 ppmV or below, Technip has extensive experience in selective catalytic reduction (SCR) based deNO<sub>x</sub> units, especially applicable in the USA.

For minimising the impact of process condensate disposal, most Technip hydrogen plants re-utilise the condensate within the plant design towards the steam system, thereby also reducing the amount of make-up water. Technip offers appropriate solutions based on the required export steam quality. These involve different stripping (LP/HP) intensities, or segregated steam systems. Process condensate can also be upgraded to process steam by incorporating a patented feed gas saturator (FGS) unit.



USA -  
31,000 Nm<sup>3</sup>/h  
Hydrogen



## “Over-the-fence” hydrogen supply

### Global alliance with Air Products

An alliance between Technip and Air Products has been in place since 1992 for the supply of hydrogen plants for all of their “over-the-fence” supply needs worldwide. The alliance has proven to be very successful with more than 30 plants in operation or in implementation to-date, supplying more than 1,800,000 Nm<sup>3</sup>/h (1,650 MMSCFD) of hydrogen.



Spain - 60,000 Nm<sup>3</sup>/h Hydrogen

### The advantages of “over-the-fence” Hydrogen supply

- Air Products and Technip are fully committed to hydrogen as their worldwide core business.
- The risks of project execution, plant efficiency and on-stream performance lie with the supplier (alliance) and not with the end-user.
- Air Products take care of the initial capital investment of the hydrogen plant.
- Hydrogen cost is lower due to savings provided by the combined strengths of Air Products’ extensive operational experience and Technip’s design expertise.
- Large multi-plant, multi-customer pipeline systems and/or back-up provisions provide unparalleled supply reliability and improved economics.
- HSE as primary focus.

### Hydrogen management

The increased hydroprocessing for lighter and sweeter fuels, combined with the reduced severity of catalytic reforming, as well as increased residue upgrading create substantial demand for more hydrogen in a refinery. Hydrogen management involves optimal utilisation and distribution of hydrogen in relation to the various hydrogen consumers and hydrogen producers in the refinery to best satisfy the hydrogen balance. The hydrogen deficit can be met through recovery from the various refinery off-gases and/or “on-purpose” hydrogen production. The latter involves either expanding existing hydrogen capacity by revamping or creating a new production facility or “over-the-fence” supply.

Though the key objectives of hydrogen management remain overall profitability and reliability, it specifically aims at the following emerging needs:

- Minimised hydrogen losses
- Enhanced (critical) processing efficiency
- By-product integration strategies, especially in the case of petrochemical link-up

HEADQUARTERS

**Technip**

89 avenue de la Grande Armée  
75773 Paris Cedex 16  
France  
Phone: +33 (0)1 47 78 24 00

HYDROGEN TECHNOLOGY  
CENTERS

**The Netherlands**

Technip Benelux B.V.  
Phone: +31 79 3293 600  
Fax: +31 79 3293 700  
E-mail: [tpbenelux@technip.com](mailto:tpbenelux@technip.com)

**USA**

Technip USA Corp.  
Phone: +1 909 447 3600  
Fax: +1 909 447 3700  
E-mail: [sratan@technip.com](mailto:sratan@technip.com)

[www.technip.com](http://www.technip.com)

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