Ethylene production

Technip is a world leader in Ethylene Technology for both grassroots plants and plant expansions
A world leader in engineering, project management and technologies, serving the energy industry for more than 50 years

A regular workforce of 32,000 people

Confirmed leadership and proprietary technologies in 3 activities:

**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 its portfolio of technologies and industrial and operational assets, Technip offers a unique vertically integrated model in the industry.

The Group has 3 flexible pipe manufacturing plants, 4 umbilical production units, 9 logistics and pipeline assembly bases, and 1 construction yard. Technip’s worldwide leadership is supported by a modern fleet of vessels for subsea construction, pipelay development (rigid and flexible pipes using S-Lay, J-Lay or Reeled technology) and heavy lift applications.

**Offshore**

In the Offshore business segment Technip performs engineering, procurement, construction, installation, commissioning and the refurbishment/upgrading of offshore facilities for the oil & gas industry.

Technip provides these services for fixed platforms in shallow water with conventional sub-structures and self-installing platforms such as the TPG 500 and for deepwater facilities including Spar, semi-submersible, TLP, FPSO and FLNG units. Technip is a world leader in floatover installation of topsides and its R&D effort is focused on technology transfer for local content and new frontier areas such as ultra-deepwater and the Arctic.

**Onshore**

Technip covers the full range of onshore facilities for the oil and gas chain, petrochemicals and other energy industries (nuclear, renewables including biofuels and offshore wind). It holds many proprietary cutting-edge technologies and is the leader in the design and construction of LNG and gas treatment plants as well as ethylene, hydrogen and syngas units.

Technip is also one of the key actors in refining and petrochemical units, and has developed a leadership in the fertilizer industry. Moreover, the Group is very active in non-energy activities such as mining and metals, life sciences, buildings and infrastructures.
Technip is a world leader in Ethylene Technology for both grassroots plants (including mega-crackers) and plant expansions. Since the acquisition of Stone & Webster process technologies, Technip is able to propose either former Stone & Webster ethylene technology or/and Technip ethylene technology. With respectively 70 years of expertise for Stone & Webster and 40 years for Technip and a total of 150 grassroots plants, Technip is the leader in the field of ethylene. The global licensing market share since 2000 is about 50% of the world’s total added capacity.

Ethylene in our daily life

Ethylene, the simplest of olefins, is used as a base product for many syntheses in the petrochemical industry: plastics, solvents, cosmetics, pneumatics, paints, packaging, etc.

Today, the demand for ethylene is over 140 million tons per year with a growth rate of 3.5% per year. The average capacity of production plants, known as steam-crackers, has risen from 300 KTA in the 1980’s to over 1,000 KTA today.
A strategic acquisition

Technip acquired Stone & Webster process technologies and the associated oil and gas engineering capabilities from the Shaw Group. This leading technology-driven engineering, procurement and construction contractor complements and broadens Technip’s existing offering, technology and alliances in ethylene. The Technip Stone & Webster Process Technology team is fully integrated to the onshore business and acts as a transversal key player in licensing onshore technology.

Centers of excellence

Thanks to its highly qualified process engineers and technicians, Technip has acquired sound technological expertise and has the ability to design and develop proprietary technologies. Its centers of Ethylene expertise based in California, Texas, the Netherlands, Italy and France, supported by a global procurement network, place Technip one step ahead of the competition and make it the partner of choice for any ethylene project.

Mega-challenges for mega-crackers

Since the late 1990’s, Technip has strengthened its leading position in the market for mega-crackers used for ethylene production.

Most recent achievements include:
- **Yansab, KSA**: The world’s largest steam cracker with an ultimate capacity of 1.7 Mtpa at term using ethane and propane feedstocks. Designed by Technip, the unit went into operation in 2008 with an initial capacity of 1.38 Mtpa,
- **Rabigh, KSA**: The world’s largest ethane cracker, operating at 1.5 Mtpa ethylene integrated with DCC process to produce large quantity of propylene (1 Mtpa), designed and built by Technip.
- **Sadara, KSA**: The world’s largest mixed cracker (ethane, LPG, naphta), operating at 1.5 Mtpa ethylene and 0.5 Mtpa propylene, designed by Technip.
- **Ras Laffan, Qatar**: Large ethylene plant with a capacity of 1.3 Mtpa based on ethane cracking.
- **Sharq, KSA**: Large ethylene plant with a capacity of 1.3 Mtpa based on ethane cracking.
- **The world’s largest cracking furnaces**: 210 kilotons per year of ethylene based on ethane and 175 kilotons per year of ethylene based on liquids designed and built by Technip.

Recent award:
- **Jamnagar, India**: The world’s largest cracker based on refinery off-gases under design, which will produce 1.4 Mtpa.
Proprietary furnace technologies

Thanks to a variety of associated proprietary technologies, Technip Stone & Webster Process Technology offers ethylene producers the ability to meet the toughest production-related challenges, reduce capital costs of new furnaces and improve operational efficiency of existing furnaces.

The furnace technologies contain a wide range of design options, giving our clients reliable, flexible and highly selective solutions best suited to their operational needs. Standard design features radiant coils, combustion system, quench exchangers and multi-level shutdown.

Today, the largest single cell gas cracking furnace (SMK™) is 220KTA, and the largest single cell liquid cracking furnace (GK6©) is 170 KTA. Limits of these technologies have not yet been reached.
**Gas cracking:**
SMK™ and USC© M-coils are preferred for high-capacity, low-cost for gas cracking.

**Liquid cracking:**
GK6© and USC© U-coils are designed for short-residence-time for liquids cracking.

**Recent developments:**
- **SMK™ coil technology** for gas feed: The SMK™ technology enables selectivity optimization and to obtain very large capacity furnaces. The largest capacity furnace in the world uses SMK™ technology and has a capacity of 210,000 tons per year of ethylene (per furnace cell). Over the last 10 years, SMK™ technology has been installed in more than 100 furnaces.
- **USC© coil technology** for gas feed: The USC© coil technology for gas might be either M coil assembly or W coil assembly. Over the last 10 years, USC© coil technology has been installed in 60 furnaces.

- **GK6© coil technology** for liquid feed is applied in new furnaces and for the modernization of existing furnaces. GK6© technology has been applied in more than 76 furnaces in the last 10 years.
- **USC© coil technology** for liquid feed: The USC© coil technology for liquids might be either U™ coil assembly or SU™ coil assembly. Over the last 10 years, USC© coil technology has been installed in 110 furnaces.
- **A unique linear quench exchanger** arrangement, which eliminates offline cleaning requirements, is matched for all coils types.

- **SFT© (Swirl Flow Tube) Technology** which uses helical tubes that enable improved thermal exchange coefficients can be used in all furnaces and further improves performance (selectivity, capacity and run-length).
**SPYRO® furnace design and optimization software**

SPYRO® simulates the pyrolysis reactions of the cracking process inside the radiant coil of an ethylene furnace together with the complete furnace model. It is applied for feedstock selection, process scheduling and production optimization. It allows accurate prediction of yield patterns for feed stocks ranging from gases to heavy (or treated) gas oils at all current operating conditions.

A large number of ethylene plants run on-line control and optimization systems with a SPYRO® programme embedded in their system software. SPYRO® can also be applied for stand-alone simulation.

**A determining factor in plant configuration and revamp scenari**

SPYRO® provides detailed information on yields and furnace availability which can also be used to set up revamp scenari for the furnace and downstream sections of the plant.

For optimum design of large capacity GK® and SMK™ furnaces, Technip applies SPYRO® linked with CFD (Computational Fluid Dynamics), enabling the best design of burner arrangement, cracking coil layout and flue gas ducting.

**Technology developments**

Technip continues to develop a range of olefin-related technologies. Recent technology developments include cracking furnace intensification, improved cryogenic schemes with associated equipment advances, anti-fouling quench systems, and a spent caustic pre-treatment/oxidation process. Ongoing flow scheme evolution/simplification and significant alternative approaches to cracking technology are under development.
U coil/SLE combination
Technip has exclusive design and patents with BORSIG allowing direct combination of two passes coils (U™ coil or GK6e) with SLE (double pipe quench exchanger).

Ripple Tray™ Technology
Technip’s high-capacity Ripple Trays are used in fouling services and/or increase production capacity. It has been applied for 50 years in 470 applications worldwide.

The Vapor Flute™
Technip’s proprietary Vapor Flute™, an important component of many Quench Oil or Quench Water tower revamp projects, increases operational efficiency by acting as a first line of defense against liquids and coke that enter the tower.

Quench Fitting Technology
Technip’s Quench Fitting technology is a unique device that provides high-efficiency, direct-contact quenching of furnace effluent gas with a process hydrocarbon liquid stream to obtain the desired mixing, quickly and completely.

Anti-Coking Heavy Feed Mixer™
Technip’s Anti-Coking Heavy Feed Mixer™ completely vaporizes heavy hydrocarbon feedstocks using a unique patented anti-coking design. This design greatly minimizes the coking tendency and required length of mixing chamber, thus reducing the upfront capital costs and periodic maintenance of the furnace convection section as much as possible.

High performance exchangers
The recent Technip and Wieland agreement to jointly market innovative enhanced heat exchangers for ethylene plants allows further reduction of energy consumption as well as CO₂ emissions. These exchangers can be used either for boiling or condensing applications.
Technip’s progressive separation technology reduces energy consumption thereby lowering $\text{CO}_2$ emissions. This technology is available for all types of acetylene separation processes.

**Acetylene elimination**

Ethylene plant operators aim at a very pure output from steam crackers: 99.95% ethylene, with a very low content (below 1 ppm) of extremely reactive molecules such as acetylene.

To achieve this, Technip has developed a sophisticated sequence of separation and purification of the high value products in the steam cracker.

Two methods of acetylene elimination are currently implemented:

- **Front-end hydrogenation** coupled with either front-end deethaniser or front-end depropaniser is available for gas or liquid crackers. The technology is applied in many plants in operation such as Rabigh and Sadara projects in KSA.

- **Back-end hydrogenation** coupled with front-end demethaniser is applied for either gas or liquid crackers. The technology is applied in many plants in operation such as Yansab in KSA.

- **Acetylene extraction** can also be proposed.

For both of these technologies, current equipment limits the maximum capacity of each unit to approximately 1,800 KTA of ethylene.
Lowering CO₂ emissions by maximizing energy efficiency. Over the last 20 years, CO₂ emissions/tonne of ethylene have been reduced by 30%.

**Continuous improvement**

Reduction of energy consumption has been obtained through:

- a better thermal efficiency of the furnaces, above 95%,
- a reduction of the steam demand by reducing compression power required per tonne of ethylene.
With its own proprietary technologies and the acquisition of Stone & Webster process technologies, Technip is a major player in the ethylene business and is one of the few world-class groups capable of providing integrated solutions, from conceptual design to turnkey design and construction of ethylene plants.

There are several challenges inherent in the execution of ethylene complexes. The ever-increasing scale of the equipment, piping and structures makes it necessary to develop new concepts and ensure close teamwork with suppliers.

The Technip offer

Technip has the process expertise and resources to serve the industry through its network of offices.

Technip provides the full scope of services starting from licensing through to EPC projects and full lump sum turnkey project responsibility. This also includes the supply of proprietary technology, start-up capabilities for the olefins plant, its ancillary units and associated off-sites and utility sections.

Project services rendered:
- Financing
- Project management and consulting services
- Feasibility studies
- Conceptual design
- Licensing
- Front-end engineering and design (FEED)
- Detailed engineering of equipment, piping, civil, instrumentation, electrical and automation
- Cost estimating
- Project planning and scheduling
- Procurement including purchasing, expediting and inspection
- Construction
- Start-up services and plant services
- Environmental permitting and assistance in Authority Approval and Permit procedures
- HAZOP and HASAN
- Safety studies
Terneuzen - The Netherlands

Ethylene plant modernization

Technip is the world leader in furnace modernization. For complete modernization of existing plants, including revamp of the cracking section, compression and separation sections, Technip offers a unique proven approach, applied successfully in several recent revamp projects.

Ethylene plant modernization, capacity expansion and revamp projects

Ethylene plant modernization projects vary in scope and size. Existing cracking furnaces, even if they originate from a recent generation, may be redesigned to increase their ethylene capacity by 20% to above 100% of original capacity. At the same time, specific feed consumption is drastically reduced, thereby contributing to an attractive low cost of production per tonne of incremental ethylene.

The systematic approach to modernization

The Systematic Approach to Modernization developed and applied by Technip is a project oriented methodology which enables an in-depth evaluation of the technology options and project implementation scenario, leading to the most economical capacity expansion of the existing ethylene plant. With the application of the Systematic Approach to Modernization, bottlenecks in an existing plant are identified and prioritized so that a maximum return on a given investment is obtained.

Main steps involved in the systematic approach to modernisation

- **Capacity**: Equipment technology
  - Furnace technology
  - Process technology
  - Heat exchange network
  - Rotating machinery
  - Performance data

- **Energy**: Process technology, Key Energy users
  - Equipment cost
  - Plot plan arrangement
  - Scheduling
  - Erection cost

- **Investment**: Key equipment cost & schedule

**Client’s objective**

**Capacity target**

**Energy target**

**Economic target**

**Feasibility report**
In October 2012, Braskem Idesa awarded to Technip in a joint venture with Odebrecht and ICA Fluor a contract for the engineering, procurement and construction (EPC) of a petrochemical complex to be built in the Coatzacoalcos/Nanchital region, in the Mexican state of Veracruz. It is planned to be ready for start-up in June 2015. The complex includes a 1,050 KTA ethylene cracker based on ethane, one low density polyethylene and two high density polyethylene units as well as utilities and offsites. The contract follows the FEED for the overall complex awarded in March 2011 to Technip.

Stone & Webster process technologies provided its proprietary ethylene technology and engineering, procurement and construction management for this 1.3 million metric tons per year grassroots ethylene plant located in Al-Jubail, Saudi Arabia. The plant reached full commercial operation in 2010.

The project includes eight proprietary Ultra Selective Conversion (USC©) cracking furnaces.
In late 2005, Technip signed a contract for the construction of an ethylene plant at The Kuwait Olefins Company’s (TKOC) new Olefins-2 Petrochemical Complex in Shuaiba, Kuwait. The plant is based on 8 Technip’s SMK™ cracking furnaces and progressive separation technologies. The facility, with a production capacity of 850 KTA, plays an important role in Kuwait’s program to significantly increase the country’s ethylene derivatives production. The plant has been in production since November 2008.

In 2005, Qatar Petroleum, ChevronPhillips Chemical Company LLC, Qatar Petrochemical Company and Total Petrochemicals awarded Technip the execution on an EPC basis of a stand-alone ethane cracker located at Ras Laffan in Qatar. With a capacity of 1,300 KTA the plant is based on 9 proprietary SMK™ gas furnaces and progressive separation technology. The unit started production in April 2010.

In 2004, the Aramco-Sumitomo joint venture, PetroRabigh, awarded JGC the EPC based on technology provided by Technip Stone & Webster Process Technology for an ethane cracker designed to produce 1,500 KTA of ethylene integrated with the world’s largest DCC unit feeding 92,000 BPSD of hydrotreated VGO and producing 950 KTA of propylene. The complex is located on the Red Sea Coast of Saudi Arabia. The design of the ethane cracker features 11 USC™ M coil furnaces (nine installed for phase I), a front-end acetylene hydrogenation system and a low pressure heat pump C2 splitter. The integrated complex has been in operation since 2009.
In late 2005, Technip signed a contract with Saudi Basic Industries Corporation (SABIC) for the construction of a large-scale ethylene and propylene production plant at the Yansab Complex in Yanbu Industrial City, on the Red Sea coast of Saudi Arabia. The plant is based on 8 proprietary SMK™ cracking furnaces and progressive separation technology, handling both ethane and propane feedstocks. With a capacity of 220 KTA each, these furnaces are the world’s largest. The plant, with a production capacity of 1,380 KTA of ethylene and 400 KTA of propylene, plays a key role in SABIC’s ambitious plan to significantly increase production of basic petrochemicals, intermediates and polymers. The plant is already designed for a future capacity of 1,700 KTA. This facility has been in production since mid-2009.

In late 2006, Technip was awarded a contract by Map Ta Phut Olefins for the construction of the furnace section of a steam-cracker located in Map Ta Phut, Thailand. The plant is based on 7 Technip’s proprietary GK6® for naphtha cracking and 1 SMK™ for ethane cracking technology and successfully started in March 2010. The GK6® are the largest in operation with an ethylene capacity of 175 KTA each.