Steam cracking: Ethylene production
Technip Profile

Listed on Euronext Paris

Revenues: 7.9 billion euros in 2007

23,000 people worldwide

One of the five world leaders in engineering, technology and project management for oil and gas, petrochemical and other industries

Confirmed leadership and proprietary technologies in 3 business segments:

**Subsea**
- Design, manufacture and supply of deepwater flexible and rigid pipelines, umbilicals and riser systems
- Subsea construction and pipeline installation services
- Five state-of-the-art flexible pipe and umbilical manufacturing plants
- Five spoolbases for reeled pipeline fabrication
- A constantly evolving fleet strategically deployed in the world’s major offshore markets

**Offshore**
- Engineering and fabrication of fixed platforms for shallow waters (TPG 500, Unideck®)
- Engineering and fabrication of floating platforms for deep waters (Spar, semi-submersible platforms, FPSO)
- Leadership in floatover technology
- Management of construction yards

**Onshore**
- Gas treatment and liquefaction (LNG), Gas-To-Liquids (GTL)
- Oil refining (refining, hydrogen and sulphur units)
- Onshore pipelines
- Petrochemicals (ethylene, aromatics, olefins, polymers, fertilisers)
- Biofuel and renewable energies
- Non-oil activities (pyrotechnics, life sciences, metals, buildings and infrastructures)
Technip is a world leader in Ethylene Technology for both grassroots plants (including mega-crackers) and plant expansions. Technip has designed over 500 cracking furnaces. Since the year 2000, Technip has designed and implemented 7 Mtpa of ethylene production representing 30% of 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 125 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.

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:
- A large 1,000 KTA grassroots plant, started up in 2007
- The world’s largest plant (1,400 KTA) on mixed feed, started up in early 2008
- 4 grassroots facilities under construction in 2008 including 2 large mega-crackers in Qatar and Saudi Arabia, with a capacity in the range of 1,300 KTA each
- 8 large capacity furnaces in Thailand

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, 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.
Through its proven proprietary technologies, Technip provides plant operators with ethylene facilities that are reliable easy to operate and maintain, resulting in a very efficient, cost-saving, olefin unit with the lowest environmental emission levels.

**SMK™ COIL TECHNOLOGY FOR GAS FEEDS**

Technip’s SMK™ technology has become the preferred choice of various ethylene producers for cracking gas feeds. It is applied in new, large capacity furnaces. Since the end of the 1990’s, Technip’s SMK™ technology has been installed in 88 furnaces, delivering a capacity of 12.6 million tons per year equivalent to 10% of current world ethylene production capacity.

**GK® COIL TECHNOLOGY FOR LIQUID FEEDS**

Technip’s GK® technology is applied for liquid feed in new furnaces and for the modernization of existing furnaces. It allows operation on a range of feedstocks from naphtha to heavy oils, with high selectivity and long on-stream time. Since the year 2000, Technip’s GK6 technology has been applied in 66 furnaces, delivering a production capacity of 5.4 million tons per year. Today, the largest capacity SMK™ furnace is 220 KTA and the largest capacity GK6 furnace is 150 KTA. However limits of this technology have not yet been reached.

**ULTRAFUR TECHNOLOGY**

In the future, plant capacities are expected to grow beyond 2,000 KTA requiring even larger capacity furnaces. Technip is ready for these large size furnaces with the ULTRAFUR technology which integrates decades of expertise.
SPYRO® is Technip's proprietary model for steam-cracking yield prediction and complete furnace simulation of either gas or liquid feedstock. Since its introduction in 1978, SPYRO® has been adopted by 80% of ethylene producers worldwide.

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 optimisation. 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.
Technip’s progressive separation technology reduces energy consumption thereby lowering CO₂ 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 1ppm) 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 deethanizer or front-end dep propane rizer is available for gas or liquid crackers. This technology is being applied in the plant currently under construction in Kuwait.

- **Back-end hydrogenation** coupled with front-end demethanizer is applied for either gas or liquid crackers. The technology is applied in the plants under construction in Qatar and in Saudi Arabia.

For both of these technologies, current equipment limits the maximum capacity of each unit to approximately 1,800 KTA of ethylene.
Proprietary separation technologies

This portfolio of technologies enables Technip to provide the best adapted solution for each case.

**T-PAR®: TECHNIP-PROGRESSIVE ACETYLENE REMOVAL**

T-PAR® is a new process developed and patented by Technip. Tests performed with proven catalysts have been successful.

This process combines the advantages of the Front-End and Back-End hydrogenation technologies:
- safety with no run away of the chemical reactions
- reliability with low sensitivity to variations of the operating conditions and impurities
- operability
- reduced maintenance
- reduced power consumption
- predicted savings on investments of 5 to 8%
- possibility of reaching up to 2,000 KTA per unit.

T-PAR® complements the Group’s technological portfolio. Technip can fulfil the needs of its customers in the ethylene field providing very competitive alternative solutions.
Project execution: the Technip way

With its proprietary 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
- Feasibility studies
- Conceptual design
- Cost estimating
- Project planning and scheduling
- Licensing
- Front-End Engineering and Design (FEED)
- Detailed engineering of equipment, piping, civil, instrumentation, electrical and automation
- Procurement including purchasing, expediting and inspection
- Construction
- Start-up services
- Environmental permitting
- HAZOP and HASAN
- Safety studies
- Assistance in Authority Approval and Permit procedures
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 ton 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 scenarios, 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 MODERNIZATION**

- **Capacity:** Equipment technology
  - Capacity target
  - Client's objective
  - Equipment technology

- **Energy:** Process technology, Key Energy users
  - Energy target
  - Furnace technology
  - Process technology
  - Heat exchange network
  - Rotating machinery
  - Performance data

- **Investment:** Key equipment cost & schedule
  - Economic target
  - Equipment cost
  - Plot plan arrangement
  - Scheduling
  - Erection cost

**FEASIBILITY REPORT**
The successful execution of major projects reinforces Technip’s position as a world leader in mega-crackers

**MAP TA PHUT**
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 and 1 SMK™ cracking furnace technology and is scheduled for operation in 2010.

**OLEFIN 5**
NPC has awarded Technip the design, engineering and procurement of a 500 KTA steamcracker in Assaluyeh. Technip provided its progressive separation technology and 5 proprietary SMK™ gas furnaces.

**YANBU**
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. 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. Completion of this project is scheduled for early 2009.

**RAS LAFFAN**
In 2005, Qatar Petroleum, ChevronPhillips Chemical Company LLC, Qatar Petrochemical Company and Total Petrochemicals entrusted Technip with 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 project is scheduled for completion in early 2009.
SHUAIBA

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 project is due for completion at the end of 2008.

10TH OLEFIN COMPLEX

With a production capacity of 1,400 KTA of ethylene, the world’s largest steam-cracker is the core unit of the 10th Complex engineered by Technip for NPC at the industrial site of Assaluyeh, on the northern coast of the Persian Gulf.
Technip provided its in-house ethylene technology: 4 GK® liquid furnaces and 6 SMK™ gas furnaces as well as its progressive separation technology. The plant came on stream in early 2008.
This unit delivers the largest output of ethylene to-date in the world and is the only large capacity steam-cracker using both gas and liquid as feedstocks to produce ethylene and propylene. It runs with an unusually low energy and utilities consumption, demonstrating the high efficiency of Technip’s steam-cracking process.

9TH OLEFIN COMPLEX

In late 2001, NPC awarded Technip the design, engineering and procurement of its 1,000 KTA ethane cracker in the 9th Olefin Complex at Assaluyeh.
Technip provided 9 SMK™ furnaces and progressive separation technology.
The plant is in operation since mid-2007.
Technip is a world leader in the fields of project management, engineering and construction for the oil & gas industry, offering a comprehensive portfolio of innovative solutions and technologies. With 23,000 employees around the world, integrated capabilities and proven expertise in underwater infrastructures (Subsea), offshore facilities (Offshore) and large processing units and plants on land (Onshore), Technip is a key contributor to the development of sustainable solutions for the energy challenges of the 21st century.

Present in 46 countries, Technip has operating centers and industrial assets (manufacturing plants, spoolbases, construction yard) on five continents, and operates its own fleet of specialized vessels for pipeline installation and subsea construction. The Technip share is listed on Euronext Paris exchange and over the counter (OTC) in the USA.

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