Oil refining

A major engineering and construction group providing leading-edge solutions to the oil refining industry worldwide
With a workforce of 40,000 around the world, we constantly offer the best solutions and most innovative technologies to our clients to meet the world’s energy challenges. We operate in three main businesses:

**Subsea**

In subsea hydrocarbon 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 and 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 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 position in the fertilizer industry. Moreover, the Group is very active in non-energy activities such as mining and metals, life sciences, buildings and infrastructures.
A world-class player in oil refining

- 30 grassroots refineries with capacities up to 400,000 bpsd since 1958
- Over 100 major expansion or revamp projects in more than 75 countries
- One of the few engineering companies in the world to have built 6 grassroots refineries since 2000
- Extensive experience with any type of process unit in the oil refining industry totaling over 840 individual process units

Major refinery expansions & grassroots – Start-up and/or FEED end dates

Technological strengths

In addition to licensing through Technip Stone & Webster Process Technology, Technip, through close collaboration with the other international licensors and a strong expertise in refinery modelling and energy savings in refining process, has optimized third-party technological schemes, thus producing considerable energy and operational savings, safety improvements and easier maintenance.

A full range of services

Technip manages all aspects of oil refining projects from conceptual design to turnkey delivery:

- Market orientation studies
- Refinery profitability master plans
- Financial engineering
- Technology licensing and/or evaluation and selection
- Hydrogen and CO₂ management studies
- Conceptual design
- Cost estimates
- Project risks assessment
- Basic design
- Front-End Engineering Design (FEED)
- Project Management Consulting (PMC)
- Detailed engineering
- Dynamic simulation & plant operation optimisation
- Hazard & Operability Analysis (HAZOP)
- Procurement of equipment/materials
- Erection and construction
- Training of personnel
- Pre-commissioning, commissioning and start-up
- Operation & maintenance
Technip is the ideal partner for Clients during the critical phase of planning and optimizing future investment.

With a strong track record in refinery optimization projects, Technip has gained experience and competence in all the technological fields that impact present and future developments in oil refining.

**Technology selection**
Based on decades of cooperation with the most highly renowned technology licensors and catalyst suppliers and with its strong technological expertise, Technip ensures a completely independent selection of the best technologies to meet specific Project/Client targets.

**Cost estimates, value engineering, project risk management**
Technip’s vast experience in executing lumpsum turnkey contracts means that its Clients benefit from realistic cost estimates, value engineering and project risk management capabilities.

**Refinery profitability master plans**
Refinery profitability master plans, based on the linear programming modelling technique, are extensively used to support the conceptual design of grassroots refineries and to rank the profitability of different processing options in revamping strategies.

Typically, an integrated study includes:
- Market analysis
- Refining scheme optimization with PIMS linear programming tool
- Technology selection
- Conceptual definition of new units, utilities & offsites
- Plot plan investigation
- Investment cost estimate
- Economic and financial evaluation
Technip has developed in-house technologies and know-how to improve product quality and maximize energy savings.

Crude and vacuum distillation units
Technip has delivered nearly 70 atmospheric distillation and over 50 vacuum distillation units, most of which based on in-house technology and know-how.

Improved product quality is the result of optimization studies carried out by Technip on internals, trays, grids, random packing and structured packing.

Energy savings are maximized, by in-house developed software using Pinch technology to optimize heat exchange.

Open-art technologies and know-how

Progressive crude distillation *
Limited high-level heating and reduced operating pressures.

The progressive crude distillation process has a three-point solution to the energy dissipation issue.

The first point consists in splitting the crude pre-heating operation and separating, at intermediate heat levels, the cuts vaporized at these temperatures. This avoids “superheating” the light cuts and degrading the thermal levels associated with the draw offs of the heavy cuts. Such design limits high level heat input and increases the thermal level of the heat that can be recovered at pump arounds and draw offs.

The second point considered is to operate the columns at the lowest possible pressures to reduce both the heat levels required for separation and the necessary heat inputs.

As third point, the number of fractional crude distillation stages is determined so that withdrawn streams meet the refinery requirements.

In revamp projects, the progressive distillation concept is a very efficient and economic solution for increasing greatly the crude capacity of an existing ADU/VDU unit without replacing or modifying any major pieces of equipment (heaters, main towers, overhead condensing systems, feed pumps, etc.)

* Patented process developed by Technip in partnership with Total (former ELF company)
Technip has acquired strong experience in building dynamic models for units such as crude distillation units, light hydrocarbon cuts splitters, aromatic complexes as well as hydrotreatment reaction loops.

The rigorous application of an in-house developed methodology coupled to the use of dynamic simulation can be applied:

- To revamps and may demonstrate the possibility of accommodating additional relief loads within existing flare headers, resulting in substantial savings on overall investments.
- To large high conversion refineries, since the engineering design stage, and may lead to considerable reductions of the number of relief valves, the main header sizes, the flare radiation diameter, and their associated installation costs.

Dynamic simulation and flare load reduction

Modelling of emergency scenarios allows predicting realistic relief loads and accurately assessing the required flare system capacity.
Market leader in Hydrogen

Since pioneering the steam reforming based process in the early sixties, Technip has continually been advancing its process technology and know-how to maintain cutting edge excellence in hydrogen plant design & execution in respect of safety, efficiency, cost-effectiveness and environmental compliance.

Technip has provided more than 250 hydrogen units worldwide with unit capacities ranging from 1,000 to 224,000 Nm³/h, mainly geared for refinery applications thus needing high reliability performance.

Global alliance with Air Product

An alliance between Technip and Air Products was established in 1992 for the design and supply of hydrogen plants for all of their “over-the-fence” supply needs worldwide. The alliance has proven to be very successful with 30 plants in operation or under implementation to-date, supplying more than 2,000 mmscfd (2.2 million Nm³/h) of hydrogen, mainly to major refiners.

Fluid Catalytic Cracking/Resid Fluid Catalytic Cracking

Technip Stone & Webster Process Technology’s fluid catalytic cracking (FCC) process, developed jointly with Axens, IFP and Total, offers refiners superior operating performance, increased profitability, and considerable feedstock and product flexibility. To date, we have licensed 52 grassroots units and performed more than 220 revamp projects.

Deep Catalytic Cracking

The deep catalytic cracking (DCC) process provides a cost-effective and commercially proven option for maximizing the production of polymer-grade propylene from a catalytic cracker. DCC was developed and commercialized by SINOPEC Research Institute of Petroleum Processing (RIPP) in China. Technip sells the DCC technology outside of China for the institute. Technip and the institute have licensed a total of 16 DCC units with a total feed rate of approximately 20 million tons per year.
Catalytic Pyrolysis Process

Catalytic pyrolysis process (CPP) is a high-severity catalytic process that has the advantage of maximizing the production of both ethylene and propylene in varying proportions from heavy, low-value feedstocks. CPP was developed and commercialized by SINOPEC RIPP. Technip is a licensor of this process outside of China. The first commercial CPP unit achieved startup in 2009.

Maximizing Iso-Paraffins Technology

Maximizing iso-paraffins technology (MIP) is an advanced FCC technology that converts heavy feedstocks into high-yield clean gasoline with more iso-paraffins and less olefins, sulfur and benzene than conventional FCC gasoline. MIP is applicable as an upgrade of existing FCC units or as a new grassroots unit and can help refiners meet the challenges of clean gasoline regulations. The MIP unit can be designed to switch the desired operation mode, based on market demand, from either a maximum gasoline mode or best balanced mode for both gasoline and maximum propylene mode. As of 2010, there are 17 commercial CGP units in operation. CGP was developed and commercialized by SINOPEC RIPP. Technip licenses the technology outside of China.

Clean Gasoline and Propylene Technology

The clean gasoline and propylene (CGP) process is a new generation FCC technology for catalytically cracking heavy feedstocks into clean gasoline and propylene. Its propylene yield is significantly higher than high-severity FCC, while its gasoline quality is dramatically improved. The technology provides operators with flexibility to switch the desired operation mode based on market demand, either operated in maximum gasoline mode or increased propylene mode. As of 2010, there are 17 commercial CGP units in operation. CGP was developed and commercialized by SINOPEC RIPP. Technip licenses the technology outside of China.

Refrigeration Offgas Recovery

By using proprietary technology, Technip is able to recover valuable products from refinery offgases. We have revamped existing refinery offgas units and designed grassroots units for increased capacity and recovery of olefins. Our advanced contaminant removal technology applications ensure product quality for downstream petrochemical processes, acting as a bridge between refining and petrochemicals.

Propylene Recovery Units

Based on extensive C3 splitter experience with proven vapor/liquid equilibrium and demonstrated contaminant removal knowledge, Technip Stone & Webster Process Technology designs propylene recovery units that produce on-spec polymer-grade propylene and reduce energy consumption and capital investment costs. Additionally, Technip process technologies has expertise in C3 splitter heat pump designs, as well as conventional C3 splitter designs using low-level heat sources.

BenzOUT™ Gasoline Benzene Reduction Technology

BenzOUT™ is a reformate alkylation process and catalyst technology that helps our refining clients meet new benzene regulations. The technology reduces benzene and increases gasoline octane without using hydrogen. Developed by ExxonMobil Research and Engineering Company, BenzOUT™ is licensed by Badger Licensing LLC.

Refining Proprietary Equipment

Technip Stone & Webster Process Technology’s proprietary equipment offerings for FCC technologies include the following:

- Trouble-free, high-efficiency feed injectors for optimal yields,
- Riser termination devices (RS2) and/or vapor quench to minimize undesirable post-riser reactions,
- Stripper structured packing for high catalyst flux and reduced steam consumption,
- Well-proven catalyst coolers with individual tube isolation for reliability,
- Low-maintenance high-efficiency combustion air rings,
- Spent catalyst distributors for improved catalyst maintenance and NOx reduction.
Once the project has been optimized, Technip can provide engineering, procurement and construction services for its implementation, worldwide.

Design development is supported by the most advanced optimization methodologies and techniques, including constructability analysis, energy audits, HAZOP studies, dynamic simulation and plant reliability analysis.

**Project management**
For over 50 years Technip has demonstrated its ability to successfully manage industrial projects of all types and sizes, in all parts of the world.
Our project management experience covers all types of services and contracts, ranging from project management consultancy services to lumpsum turnkey contracts as well as all types of contractual relationships.

**Procurement**
A key element in the execution of any project, procurement at Technip is managed by a force of approximately 1,000 individuals assigned to project task forces. They are in charge of sourcing new suppliers, buying, expediting orders, inspecting the manufacturing of equipment and bulk material as well as organizing delivery and logistics.
Technip is a global player that sources competitively worldwide and can provide support to clients through the provision of dedicated procurement services.

Technip is one of the few contractors capable of delivering complete world-class refineries.

**Construction**
Technip has unique expertise in the management of simultaneous mega-projects. Sharp methods and processes enable us to deliver projects to customer satisfaction and the highest standards in safety and quality.
This competence in designing and managing construction activities is shared across all Technip operating centers (Paris, Rome, Abu Dhabi, Kuala Lumpur...) in order to ensure the best knowledge of the local construction market and is deployed through Technip site teams on every Technip project.
Construction at Technip includes a Construction Methods Center located in Abu Dhabi. This center aims to increase Technip’s supervisory resources, to develop construction methodologies and processes as well as to foster long-term construction partnerships, providing Technip with an additional edge in construction activities.
Increased crude conversion to motor fuels and further processing of the “bottom-of-the-barrel” is today, and will be even more so in the future, a main driver in the development of the oil refining industry.

In this field, Technip has acquired, particularly over the past decade, significant experience, technological competence and references. Technip is specialized in modelling refinery configurations for “bottom-of-the-barrel” processing in view of selecting the most appropriate economical technical solution for the Client.

**Recent experience in EPC and FEED projects for VGO conversion**

<table>
<thead>
<tr>
<th>Total N° Units in the last 15 years</th>
<th>Client</th>
<th>Unit Capacity bpd</th>
<th>Licensor</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrocracker 15</td>
<td>SATORP</td>
<td>59,000</td>
<td>CLG</td>
<td>2013</td>
</tr>
<tr>
<td></td>
<td>Confidential</td>
<td>30,000</td>
<td>UOP</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td>GRUPA LOTOS</td>
<td>41,000</td>
<td>SHELL</td>
<td>2010</td>
</tr>
<tr>
<td></td>
<td>TOTAL (Gonfreville)</td>
<td>53,000</td>
<td>AXENS</td>
<td>2007</td>
</tr>
<tr>
<td>FCC 15</td>
<td>SATORP</td>
<td>32,700</td>
<td>AXENS</td>
<td>2013</td>
</tr>
<tr>
<td></td>
<td>SRC IRAQ</td>
<td>35,000</td>
<td>S&amp;W/AXENS</td>
<td>2014</td>
</tr>
<tr>
<td></td>
<td>ŠK, ULSAN</td>
<td>60,000</td>
<td>UOP</td>
<td>2014</td>
</tr>
<tr>
<td></td>
<td>SCOP</td>
<td>31,500</td>
<td>UOP</td>
<td>2010</td>
</tr>
<tr>
<td></td>
<td>REFICAR</td>
<td>35,000</td>
<td>ExxonMobil</td>
<td>2010</td>
</tr>
</tbody>
</table>
Recent experience in EPC and FEED projects for BOB (Bottom of the barrel) Upgrading

<table>
<thead>
<tr>
<th>Total N° Units in the last 15 years</th>
<th>Client</th>
<th>Unit Capacity bpd</th>
<th>Licensor</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed coker</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SATORP</td>
<td>100,500</td>
<td>FOSTER WHEeler</td>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>CANADIAN NATURAL</td>
<td>156,000</td>
<td>ABB LUMMUS</td>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>MIDOR</td>
<td>30,000</td>
<td>CONOCO PHILLIPS</td>
<td>2001</td>
<td></td>
</tr>
<tr>
<td>SK, ULSAN</td>
<td>60,000</td>
<td>UOP</td>
<td>2010</td>
<td></td>
</tr>
<tr>
<td>HYUNDAI OB</td>
<td>52,000</td>
<td>UOP</td>
<td>2012</td>
<td></td>
</tr>
<tr>
<td>Residue FCC</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SONATRACH</td>
<td>20,000</td>
<td>UOP</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>QATAR PETROLEUM</td>
<td>60,000</td>
<td>AXENS</td>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>Visbreaker</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PREEMRAFF</td>
<td>50,000</td>
<td>SHELL GLOBAL SOLUTION</td>
<td>2009</td>
<td></td>
</tr>
<tr>
<td>Solvent deasphalting</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRUPA LOTOS</td>
<td>330 t/hr</td>
<td>KBR (Rose)</td>
<td>2010</td>
<td></td>
</tr>
<tr>
<td>Residue HDC/HDT</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LUKOIL BURGAS</td>
<td>47,000</td>
<td>AXENS (H-Oil)</td>
<td>2010</td>
<td></td>
</tr>
<tr>
<td>NIOEC</td>
<td>81,000</td>
<td>AXENS (Hyvahl)</td>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>QATAR PETROLEUM</td>
<td>51,000</td>
<td>AXENS (Hyvahl)</td>
<td>2008</td>
<td></td>
</tr>
</tbody>
</table>
Gasoline

Current requirements are for sulphur-free gasoline, with a trend towards reduced benzene, olefins and aromatics content while maintaining RON specifications.

Specification/Technical solution

Benzene (1% vol.)
- Pre/post fractionation

Aromatics (35% vol.)
- Benzene saturation
- Isomerization/Reforming integration
- Blending optimization

Sulphur Content (50-10 ppm wt max.)
- FCC feed pretreatment (Mild Hydrocracking) and FCC gasoline selective hydrogenation

Recent experience in EPC and FEED projects for Implementation, within a refinery, of a complete set of technologies for the gasoline pool

<table>
<thead>
<tr>
<th>Client</th>
<th>Refinery capacity (bpd)</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>SONATRACH (1)</td>
<td>81,000</td>
<td>2014</td>
</tr>
<tr>
<td>SCOP (2)</td>
<td>140,000</td>
<td>2010</td>
</tr>
<tr>
<td>CUVENPETROL (3)</td>
<td>165,000</td>
<td>2010</td>
</tr>
<tr>
<td>SATORP (4)</td>
<td>400,000</td>
<td>2009</td>
</tr>
<tr>
<td>PETROVIETNAM (5)</td>
<td>148,500</td>
<td>2009</td>
</tr>
</tbody>
</table>

(1) NHDT, CCR, Isomerization, RFCC
(2) NHDT, CCR, Isomerization, VGO HDT + FCC
(3) NHDT, CCR, Isomerization, Mild HCK + FCC
(4) NHDT, CCR, Benzene Extraction, Alkylation, Mild HCK + FCC
(5) NHDT, CCR, Isomerization, RFCC, RFCC Naphtha Sweetening
### Diesel Oil

Diesel specifications require a reduction in sulphur content down to 10 ppmw, improving cetane number, reducing density, polyaromatics and total aromatics content, and reducing 95% distillation point temperature.

### Specification/Technical solution

**Sulphur content, Cetane and Aromatics contents**
- Deep hydro-desulphurization unit

**Density and final boiling point**
- Fractionation and blending optimization

### Recent experience in EPC and FEED project for Hydrotreatment

<table>
<thead>
<tr>
<th>Client</th>
<th>Unit capacity (bpd)</th>
<th>Licensor</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>SATORP</td>
<td>49,450</td>
<td>UOP</td>
<td>2013</td>
</tr>
<tr>
<td>PKN</td>
<td>47,000</td>
<td>TP/ALBEMARLE</td>
<td>2010</td>
</tr>
<tr>
<td>ECOPETROL</td>
<td>57,000</td>
<td>AXENS</td>
<td>2010</td>
</tr>
</tbody>
</table>
Crude oil quality in continual decline means that more and more “synthetic crude oils” from non conventional sources such as heavy crudes and new production from “oil sands” are included in the crude oil pool.

### Heavy crude oils

Extra-heavy crudes are located mainly in Venezuela, in the “belt” bordering the Orinoco river.

Since 1997, Technip has increased its exposure to and expertise within this high added value market by taking part in the design and construction of two upgraders, first the Petrozuata refinery, then for Sincor, one of the biggest extra-heavy crudes production projects in the world.

- The Sincor plant involves a mild hydrocracker and a high pressure hydrotreating unit of unusually large capacity.
- Part of these units was built from modules that were pre-assembled in Singapore and shipped in Venezuela.

Technip is currently executing the FEED for the Petrocarabobo Upgrader in Venezuela.

### Oil Sands

Technip’s involvement in the design and construction of the Alberta oil sands primary upgrading processes in Canada includes diluent recovery, vacuum distillation and delayed coking technologies. Technip has also designed and built hydrogen production units to support the oil sands secondary upgraders.

One particular aspect of all these technologies is the very large capacity of process units such as the delayed coker with a capacity in excess of 150,000 bpsd, or the steam reformers producing 200,000 Nm³/h of hydrogen.
Projects completed recently have been submitted to more and more stringent requirements in terms of gas emissions (including CO₂), water protection, noise and safety.

Hydrogen and CO₂ management

In 2009, Technip launched its optimization tool for Hydrogen and CO₂ Management in refineries: HyN•DT (Hydrogen Network Design Tool). Thanks to this tool, it is possible to integrate in a single model all the hydrogen and CO₂ producers and users within the refinery, to evaluate different production and recovery options and to find the most economically attractive solution. This service, at the crossroads of the refining and hydrogen worlds, utilizes the specific competences of each and will interest new Clients willing to improve the efficiency of their assets.

Sulphur recovery units

Technip applies various technologies in designing sulphur recovery units, with sulphur recovery rates of up to 99.9%. Tail gas clean-up units, process gas absorbers, amine treatment units are all designed on the basis of in-house technology and know-how, applying various types of amine solutions.

Water treatment

Technip has proven experience in conceptual studies for water reuse, involving most recent technologies such as membrane bio reactors or ultra filtration, downstream standard bio treatment, reverse osmosis. Overall water management (taking into account cooling water supply, reused water recycling) allowing to meet the most stringent final reject conditions is within Technip standards for the design of waste water treatment facilities.

Zero flaring

Technip has the experience and capabilities of designing new flare systems as well as checking existing networks, including the application of dynamic simulation and implementation of automatic systems to reduce flare loads. Zero flaring concepts have been successfully applied to most of the recent refining projects.