

Petrochemicals

Driving productivity, reliability and profitability
while lowering capital and operating costs



Catalytic olefins technologies

Increasing Propylene Production

SUPERFLEX™ is a commercially-proven technology for converting low-value olefinic streams to higher value propylene and ethylene. This technology can be readily integrated into any refinery or petrochemical complex to enhance profitability, operational flexibility and to meet market demand. SUPERFLEX effectively upgrades feeds from a variety of processes, including:

- Mixed C4s from refineries and conventional steam crackers
- Amylenes, TAME feed and mixed C5s
- Cracked naphtha from FCCs, steam crackers, cokers and visbreakers
- Other low-value olefinic streams.

Efficient Plant Design for Flexible Olefins Production

SUPERFLEX technology produces about 50 to 70 percent ultimate yield of propylene plus ethylene and an aromatic rich gasoline stream. This yield is achieved due to the high single pass conversion to valuable products and recycle of higher olefins to extinction.

Discovered and patented by Lyondell Chemicals and licensed exclusively by KBR, SUPERFLEX is built around the high selectivity of ZSM-5 catalysts and the optimal process conditions for high yield of propylene and ethylene.

SASOL enlisted KBR for engineering, procurement and construction management of their SUPERFLEX unit, which included additional patented improvements. Since then, several chemical companies have initiated projects to maximize yields at lower costs and fulfill the ever-increasing propylene demand worldwide.

Commercially-Proven Propylene Plus Ethylene Production

SUPERFLEX technology builds on over 50 years of experience in fluidized bed catalytic cracking (FCC) and cost-effective purification units for ethylene and propylene plants. Our unmatched expertise in efficient plant design for olefins production is leveraged by designing FCC converters to process a wide range of production capabilities. This expertise, combined with our engineering excellence, strategic procurement, premier construction and rigorous project management, provides the right processes for your petrochemical needs.



SASOL's olefins plant in Secunda, South Africa is the first commercial application of SUPERFLEX technology. The plant achieved a successful start-up in 2006.



SUPERFLEX uses KBR's Orthoflow design for robust reactor operation.



KBR's Technology Center experts continue to test and improve downstream technologies like SUPERFLEX on our pilot plants.

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Highest Olefins Yields in the Industry

Selective Cracking Optimum REcovery (SCORE™) combines the expertise and experience of KBR and ExxonMobil to offer advanced steam-cracking technology to the petrochemical industry. Features of SCORE include:



SCORE – steamcracker technology resulting in highest Olefins yields in the industry.

- Safety
- Exceptional reliability & operability
- Highest yield selectivity to valuable light olefins
- Wide feed flexibility
- Low ethylene production cost
- Low maintenance costs
- High on-stream factor
- Environmentally compliant designs
- Low capital investment
- Efficient energy utilization

Selective Cracking is KBR’s pyrolysis furnace technology. SCORE features the short residence time SC-1 furnace design that provides the highest yield selectivity to light olefins in the industry and a highly reliable mechanical design.

Optimum REcovery is KBR’s olefins product recovery section technology. This technology incorporates advanced features so that our clients achieve the optimum balance between operating and capital costs.

Greater Feed Flexibility

The highly selective SC-1 furnace design can be used to crack feeds ranging from ethane through vacuum gas oils.

SCORE Furnaces Give Highest Yields

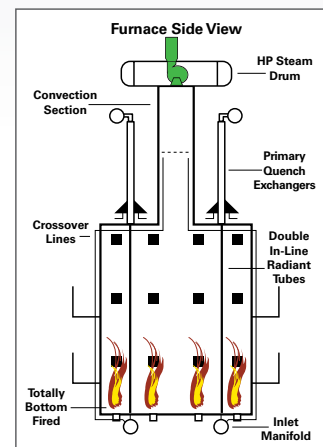
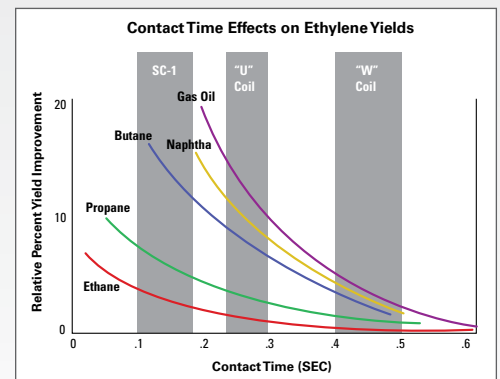
SC-1 furnaces have the following benefits:

- Highest single pass ethylene yield for all feeds
- The same propylene production capability
- Lowest feedstock consumption
- Reduced capital and operating costs

Unique, Reliable Mechanical Design

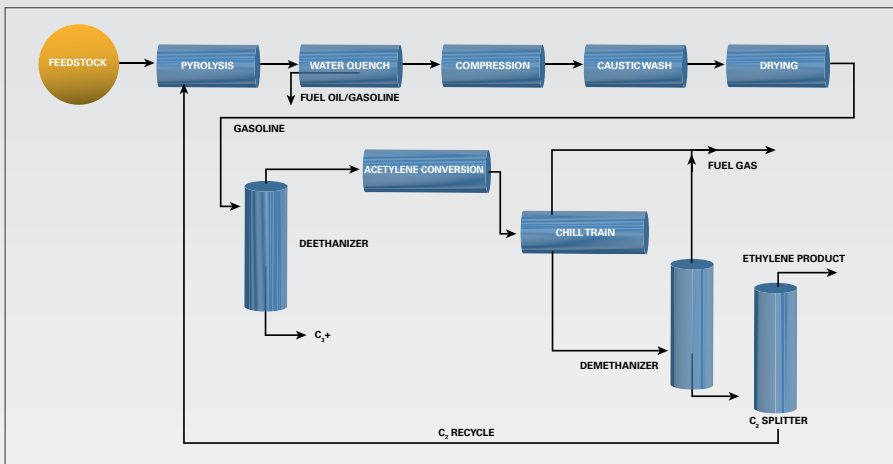
SC-1 furnaces have a unique and reliable design featuring:

- Design commonality for all feedstocks
- Capability to run multiple feedstocks in one furnace
- No mechanical cleaning of in-line quench exchangers
- On-line decoking while furnace remains in production
- Total floor firing



SCORE recovery section technology

SCORE recovery section technology features front-end acetylene converter flow schemes, optimized for project specific needs. The Deethanizer First design is utilized primarily for ethane-based crackers and the Depropanizer First is used for heavier feeds. These schemes have low equipment count, capital cost and maintenance, with high on-stream availability. They utilize low pressure fractionation towers and highly selective acetylene reaction systems. KBR can also offer a conventional Demethanizer First flow scheme that provides wide feedstock flexibility. Regardless of the flowscheme, KBR recognizes and engineers reliability in its designs.

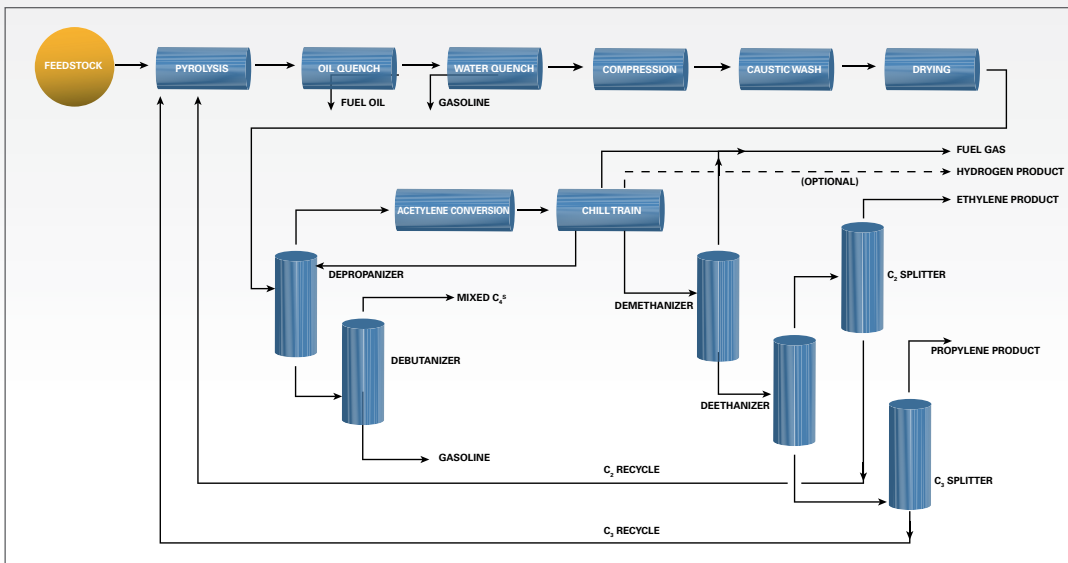


Deethanizer First

Other Services

KBR maintains a group of ethylene technology specialists from a broad range of engineering disciplines. This team provides efficient execution of new projects and responsive client support and technical services after start-up.

KBR has the experience and capability to extract the maximum economic capacity from existing ethylene plants via revamp projects.



Depropanizer First

KBR holds regular petrochemicals conferences where clients from around the world meet to receive updates on the latest ethylene technology developments and network with other owners, operators and suppliers.



Half-century of proven experience

When selecting phenol technology to maximize the return on your capital investment, it makes sense to choose an experienced licensor with a legacy of process innovation. At KBR, our product teams have been involved in leading-edge phenol technology for over 50 years and our execution teams have completed more than 50 phenol projects worldwide. Once your plant is onstream, KBR provides technical services to continually optimize production and meet your goals.

Benefits of KBR's phenol process:

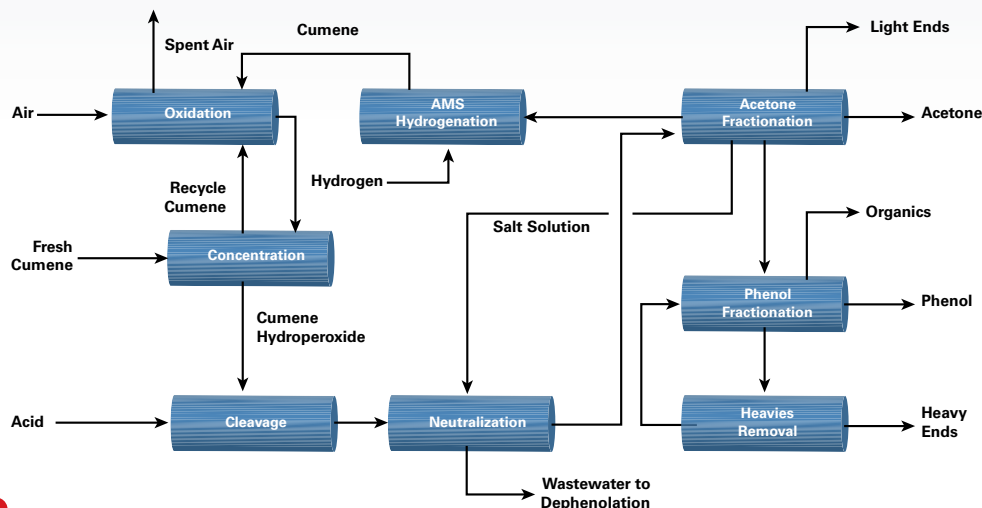
- Increases efficiency and integration
- Maximizes plant reliability and operability
- Offers reduced capital and operating costs
- Produces highest yields and lowest emissions

The KBR phenol process:

Cumene is oxidized with air at high efficiency to produce cumene hydroperoxide (CHP). CHP is then concentrated and cleaved to phenol and acetone in the presence of an acid catalyst using KBR's Advanced Cleavage System. Our experts have optimized reaction conditions to provide high selectivity and safety. Once the catalyst is removed, the cleavage mixture is fractionated to produce high-purity products. The process produces extremely high-quality phenol and acetone suitable for all applications. The fractionation train can be designed to either separate alpha methyl styrene (AMS) as a pure co-product or hydrogenate AMS to cumene for recycle to oxidation. Phenol and, optionally, co-product acetophenone (AP) are recovered from a heavies stream, which is a useful fuel. The aqueous effluent is pretreated to allow efficient biotreatment of plant wastewater.



KBR's phenol technology team provides services to clients including technology licensing and support in the initial planning phase of projects, through process design, engineering and construction of phenol plants.



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Optimized oxidation system

Having an optimized oxidation system in the phenol technology you choose is essential to generate a high oxidation yield. With KBR, our phenol technology employs a highly efficient dry oxidation system, which results in an oxidation yield of more than 95 percent by lowering the formation of by-products. The operating conditions in the oxidation system are optimized weighing all factors such as reaction kinetics and selectivity, air compression and vent gas treatment cost requirements and process safety by minimizing the inventory of CHP.

Highly Efficient Purification Technology

While there are other types of phenol technology, KBR's produces the highest purity phenol in the industry. Total cresols are typically less than 100 ppm, and total organic impurities less than 30 ppm. The highly efficient dry oxidation and advanced cleavage systems employed in KBR's phenol technology result in very high yields of phenol and acetone, thus eliminating the need for a heavy-end cracking system found in some phenol plants. This not only reduces capital and operating costs, but also improves product quality.

Integrated Pollution Prevention and Safety Systems

KBR pioneered the development of many environmental control features used in phenol plants, including the integrated vent scrubbing system, catalytic oxidation of off-gas and efficient dephenolation systems. Many of the benefits from our phenol plants include achieving the lowest emissions, prevention of pollution and meeting the most stringent standards in the industry. KBR developed many of the safety systems used in phenol plants throughout the world. We have continued to develop new systems and improve existing ones as our commitment to safety in each of our phenol plant designs. As a result of this emphasis, KBR phenol plants have an unmatched safety record.

KBR Phenol Product Quality

Property	Specification
Appearance	Clear
Purity (dry basis)	99.99 wt% min.
Total Organic Impurities	< 30 wt ppm
Water	< 200 wt ppm
Color (APHA)	< 5
Solidification Point (dry material)	40.85 °C min.
Total Carbonyls	< 10 wt ppm
2-Methylbenzofuran (2-MBF)	< 2 wt ppm
Sulfuric Acid Discoloration (SAD) test	95% min.
Iron	< 0.2 wt ppm

Advanced catalytic olefins

The Advanced Catalytic Olefins (ACO™) process, converts lower value paraffinic streams, such as straight run naphtha to high value propylene and ethylene. The ACO process yields a product with a P/E ratio of about 0.8 to 1.1, significantly higher than conventional steam cracking process.

Built on Industry-Proven Process Technology

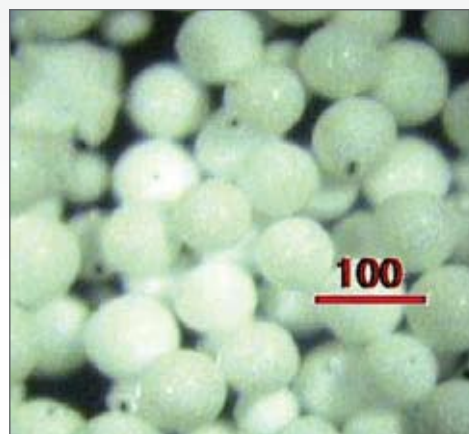
SK Energy developed ACO technology process conditions and proprietary catalysts in their Daejeon R & D facilities. This technology is implemented on KBR's recognized platforms of FCC and efficient ethylene and propylene recovery systems. Both KBR and SK have demonstrated this catalytic conversion technology at their respective pilot testing facilities over extended periods. As the worldwide licensor of this technology, KBR is engineering a unit for SK Energy's facility in South Korea.

Efficient Technology with Higher Yields

Built on a modified zeolite catalyst with proven integrity and patented process operating conditions, ACO provides an efficient technology for greater than 60 percent ultimate yield of propylene plus ethylene from straight run naphtha. Due to the small amount of coke made in the ACO process, KBR uses its proven methodologies to maintain heat balance in the reactor-regenerator system. With the forecasted shortfall in propylene worldwide, ACO technology can help maximize the value addition of propylene and ethylene chains.



ACO shares many similar hardware characteristics as the Sasol SUPERFLEX unit.



The catalyst used in the ACO process has proven integrity and patented process operating conditions.

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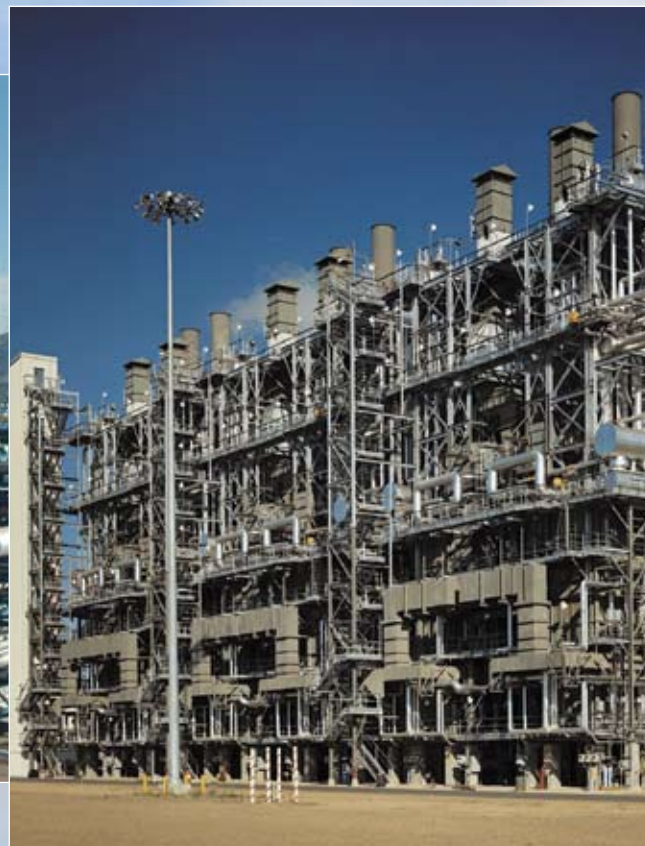
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