

# Licensed Technologies

Innovative | Proven | Value-adding

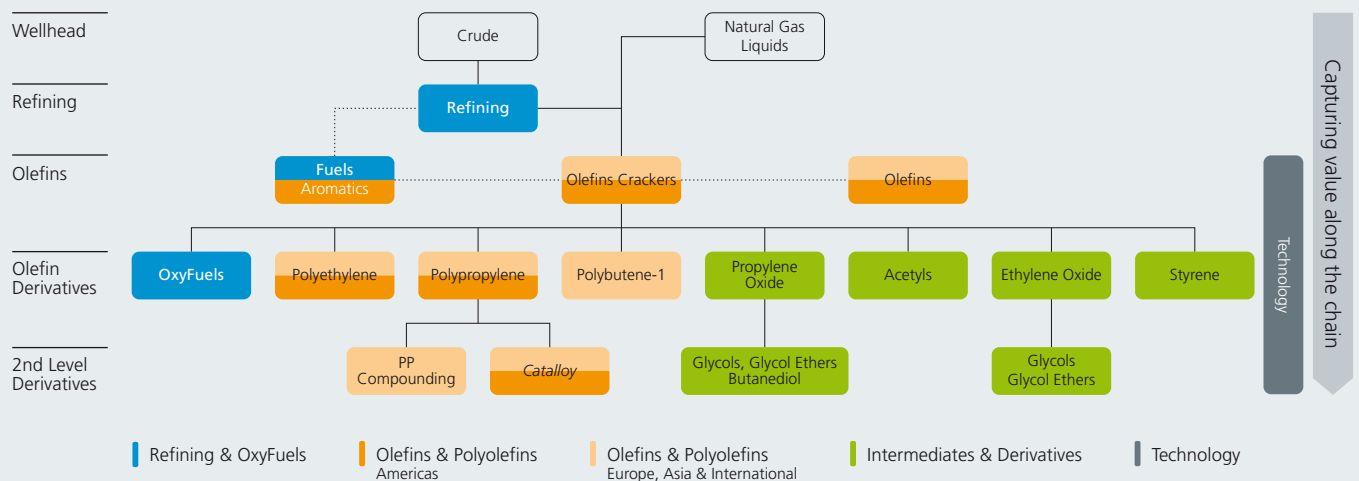


Saudi Ethylene and Polyethylene Company (SEPC),  
Al-Jubail Industrial City, Kingdom of Saudi Arabia



LyondellBasell is the world’s third-largest independent chemical company. We have annual revenues of approximately \$30.8 billion and more than 14,000 employees worldwide. Our vertically integrated facilities, broad product portfolio, manufacturing flexibility, superior technology base and reputation for operational excellence enable us to deliver exceptional value to our customers across the petrochemical chain – from refining to advanced product applications.

Product diversity and vertical integration allow LyondellBasell to capture value at every step of the petrochemical chain.



# A global leader

in polyolefins and chemicals technology,  
production and marketing



## About LyondellBasell

With major administrative offices in Houston, Texas, and Rotterdam, The Netherlands, LyondellBasell has combined annual revenues of approximately \$30.8\* billion and more than 14,000 employees worldwide.

At LyondellBasell, we clearly recognize the importance of being a responsible corporate citizen in our communities. We are committed to operating our businesses with the highest principles of integrity, ethics and corporate responsibility, as well as the highest standards of health, safety and environmental performance.

Our vertically-integrated facilities, advanced technology base and licensing portfolio, broad product range, manufacturing flexibility, and reputation for operational excellence allow us to deliver exceptional value to our customers – from refining through to advanced product applications.

As the only licensor worldwide offering process technologies for the production of all polypropylene and polyethylene product families, LyondellBasell also provides a selective range of chemical technologies based on in-house manufacturing, product development and process design expertise.

LyondellBasell's technologies are some of the most reliable, efficient and cost effective in the world. With over 280 licensed lines around the globe based on various LyondellBasell technologies, we have an unmatched track record of licensing and know-how transfer that helps our customers to explore new opportunities across the entire petrochemical value chain.

## Fast facts

- Vertically-integrated facilities enable conversion of crude hydrocarbons to materials for advanced applications
- Global reach and scope to compete effectively worldwide
- Business segments: Technology; Olefins & Polyolefins; Intermediates & Derivatives; and Refining & Oxyfuels
- A technology business that leads its industry in process technology licensing and catalysts
- Annual revenues of \$30.8 billion\*
- 59 manufacturing sites in 18 countries on five continents
- Sales in more than 100 countries

\*Based on 2009 revenues

## Global capacity positions

Polyolefin Licensing	1st
Polypropylene Catalysts	1st
Polyolefins and Polypropylene Compounding	1st
Polypropylene	1st
Oxygenated Fuels	1st
Propylene Oxide	2nd
Polyethylene	3rd
Ethylene	4th
Propylene	4th
Refining capacity	373,000 barrels per day

# Innovation

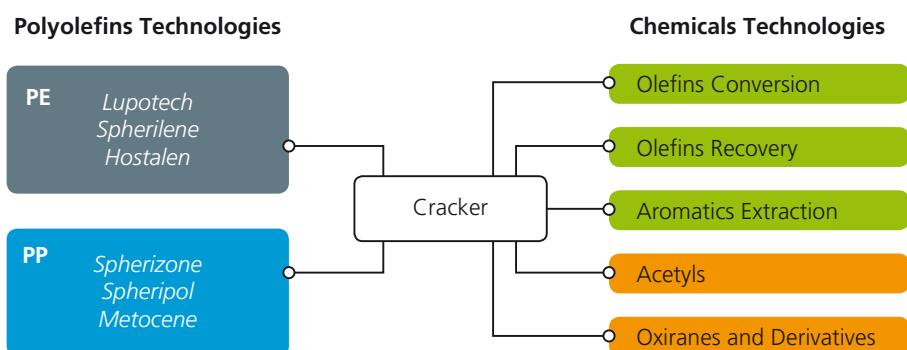
makes the difference for polyolefins,  
catalysts and chemical technologies



## A continuing customer relationship

LyondellBasell's customers continue to benefit from our R&D advancements and integrated know-how in catalysts, processes and products that enhance your manufacturing capabilities.

# A comprehensive portfolio of licensed technologies



## A sustainable competitive advantage

Intense competition, cyclical over-capacity and ongoing restructuring are among the many business pressures facing the chemical industry today. LyondellBasell understands that there is no simple formula that meets the needs of each and every company. Our strategic focus is to create innovative polyolefin and chemical products with flexible process technologies which deliver superior performance and cost-effective solutions to meet the changing requirements of our customers.

LyondellBasell offers process technologies and associated services for the entire PP and PE portfolio.

Our customers benefit from LyondellBasell's *Avant* family of polyolefin catalysts and the integrated know-how we have in catalysts, processes and products that enhance your manufacturing capabilities.

## Heritage

It began with the polyolefin catalyst discoveries of Karl Ziegler and Giulio Natta, who were awarded the Nobel Prize in 1963. This legacy has continued through five revolutionary generations of *Avant* Ziegler-Natta catalysts to the development of a new metallocene-based polypropylene catalyst, *Metocene*.

These developments have been pivotal in the success of the *Spheripol* PP process and the latest *Spherizone* multi-zone reactor PP technology innovation.

## Pioneering

LyondellBasell pioneered the high-pressure tubular LDPE market with *Lupotech T*, and in 2000 invested in the first world-scale plant in Aubette, France. LyondellBasell's *Hostalen* technology, which was first commercialized in 1964 and now produces a globally established product range, has been further enhanced with the multimodal *Hostalen* ACP configuration for high-performance HDPE products.

From the first industrial polypropylene and polyethylene processes to the latest *Spherizone* multi-zone circulating reactor and *Spherilene* gas-phase polyethylene platform, LyondellBasell and its predecessors have delivered state-of-the-art polyolefin catalysts, technologies, and products to customers worldwide.

## Extensive experience

In terms of chemical technologies, LyondellBasell benefits from a rich heritage of breakthroughs and achievements in the design and operation of processes. LyondellBasell commercialized its *Vacido* Vinyl Acetate Monomer (VAM) technology in 1969 with the first-generation

QVAM-1 catalyst. This legacy has continued with the recent development of the next-generation, highly-efficient QVAM-2 catalyst technology, which offers a leading operating-cost position and a catalyst life three times that of alternative technologies.

The same *Glacido* Acetic Acid process first commercialized by LyondellBasell in 1980 now incorporates LyondellBasell's latest proprietary "low-water" catalyst promoter system technology. This technology can deliver optimum process economics, material selection enhancements and economies of scale while producing more than double the original capacity.

The strength of LyondellBasell's proven *Trans4m* process technologies lies in the simplified modular approach to achieving a complete solution. The *Trans4m* chemical processes include catalytic technologies for the selective conversion, separation, purification and isomerization of low-value, mixed-olefin streams from crackers. The comprehensive *Trans4m* process technology range includes Butadiene extraction; skeletal isomerisation of C4 and C5 olefins; etherification of isobutene to MTBE and ETBE; separation of saturated C4 products, isomerization of C4 and C5 olefins; and separation and purification of isoprene, piperylene and dicyclopentadiene (DCPD).

# Polyolefin technologies

Sustained leadership in polyolefin processes



LyondellBasell is a global leader in the development and licensing of polyolefin processes and related catalysts for the production of the entire polyethylene and polypropylene product portfolio. A leading share of the world's polyolefins capacity is based on the six key LyondellBasell polyolefin technologies: *Lupotech*, *Spherilene*, *Hostalen*, *Spherizone*, *Spheripol* and *Metocene*.



## Licensed polyethylene technologies and services



*Lupotech*

Leading high-pressure tubular and autoclave processes for the production of LDPE and EVA copolymers

- ▮ More than 10 million tonnes of total licensed capacity\*
- ▮ State-of-the-art 400 kt/a single-line tubular plant in Saudi Arabia
- ▮ Wide grade slate, including EVA-copolymers with up to 40% VA content
- ▮ Low investment and operating costs
- ▮ Stable, flexible and optimized operability
- ▮ Single-line autoclave capacity >100 kt and tubular capacity up to 450 kt/a



*Spherilene*

Flexible gas-phase process technology for the production of LLDPE, MDPE and HDPE

- ▮ Simple process design
- ▮ Extended process flexibility, very competitive capital costs and very low operating costs
- ▮ More than 3.5 million tons of licensed capacity
- ▮ Eleven lines in operation and two lines under construction or in start-up
- ▮ Proprietary *Avant* catalysts for the entire range of products
- ▮ Entire range of products covering the full density range from 0.918–0.965 g/cm<sup>3</sup>
- ▮ Single-line capacity up to 600 kt/a
- ▮ Single-reactor and dual-reactor configurations



*Hostalen*

Low-pressure slurry process for high-performance multimodal HDPE

- ▮ High-performance grades using multimodal HDPE including film, blow molding and pipe applications
- ▮ Eight million tonnes of global bimodal and multimodal HDPE capacity
- ▮ Forty-one licensed lines and nine lines under construction\*
- ▮ Excellent operability
- ▮ Proven single-line capacities up to 400 kt/a

\*as of May 2010

## Polyethylene Catalyst Portfolio

### *Avant Z*

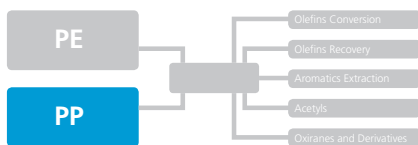
Catalyst for leading bimodal and multimodal HDPE grades in slurry technologies. Controlled morphology catalysts for full range of LLD+MD+HD products in gas-phase technology



### *Avant C*

Chromium-based catalysts for a broad range of MDPE and HDPE applications in gas-phase technology





## Licensed polypropylene technologies and services



*Spherizone*

Latest-generation polypropylene process technology, based on a multi-zone reactor for the production of polypropylene and novel polyolefins

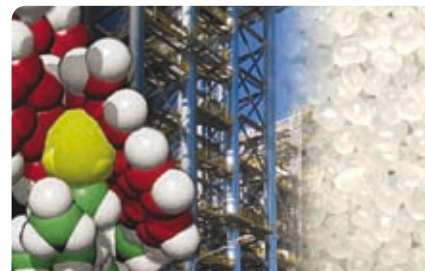
- More than three million tonnes of licensed capacity, with eight lines in operation and three lines under construction\*
- Multi-zone circulating reactor technology creating bimodal products in single reactor
- Superior and expanded product range including novel and premium products
- Excellent operability
- Optimized investment and operating costs
- Single-line capacity up to 500 kt/a



*Spheripol*

Leading polypropylene process technology for the production of homopolymer, random and heterophasic copolymers

- More than 22 million tonnes of licensed capacity\*
- More than 100 licensed lines / 13 lines under construction / start-up\*
- Excellent product range and quality
- Superior operability
- Outstanding investment and operating costs
- Unmatched safety record
- Single-line capacity up to 600 kt/a



*Metocene*

Innovative add-on technology for the production of specialty polypropylene products using single-site catalyst systems

- Implementation in existing and newly built plants
- Technology enhancement for *Spheripol* and other PP processes
- Single-site catalyst chemistry
- Added value products across many applications
- Strong variability of properties within an extended performance range

\*as of May 2010

## Polypropylene Catalyst Portfolio

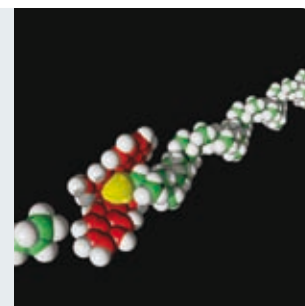
### *Avant ZN*

Multi-purpose catalysts (3rd–5th generation) for a broad range of demanding value applications



### *Avant M*

Single-site catalysts for the production of specialty polypropylene products





LyondellBasell *Spherizone*  
process plant, Brindisi, Italy



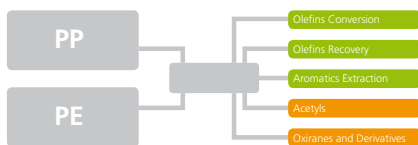
# Chemicals technologies

From an experienced chemicals producer



Extensive experience in design, best-in-class operation, optimum economical configurations and development of products for a diverse market are the driving forces behind the success of our own chemicals business and that of our customers.

LyondellBasell applies its own expertise in know-how transfer for its chemicals technologies, which are available for license.



## Licensed chemicals technologies and services



### Olefins Conversion

Catalytic process technologies for the selective conversion of low-value, mixed-olefin streams from crackers to ethylene, propylene and butenes

- *Trans4m S* skeletal isomerization of C4 and C5 feedstocks applying a unique, highly selective zeolite-based catalyst forming isobutylene and isoamylenes, respectively
- *Superflex* process technology for the selective conversion of Propylene from a mixed low-value feedstock, applying a fluidized catalytic reactor
- *Prodflex\** metathesis of ethylene and butene-2 to maximize propylene production



### Olefins Recovery

Comprehensive set of process technologies for the separation and purification of C4 and C5 olefins including extraction of butadiene and high-purity isoprene

- *Trans4m BD* extractive distillation technology of mixed C4 for the recovery of polymer-grade butadiene
- *Trans4m C5* extractive distillation technology for isoprene, piperylene and DCPD separation
- Dicyclopentadiene (DCPD) production applying dimerization of a mixed C5 stream



### Aromatics Extraction

Processes for the extraction and conversion of high-purity benzene, toluene and xylenes from liquid cracker pygas streams and coke oven light oils

- High-purity recovery of aromatics applying sulfolane extraction, including TDI grade toluene and cyclohexane grade benzene
- Technology designed for catalytic reformat, pyrolysis gasoline and coke oven light oils (COLO) feedstocks
- Hydrodealkylation technology and paraxylene crystallization



### Acetyls

*Glacido* (acetic acid) and *Vacido* (vinyl acetate monomer – VAM) process technologies using highly-selective, low-pressure catalytic processes

- Leading operating economics in *Glacido* (acetic acid) and *Vacido* (VAM) investments
- High-performance, extended-life, acetoxylation catalyst for VAM production
- High-yield MeOH carbonylation route for acetic acid production
- Highly optimized on-line acetic acid reactor control system



### Oxiranes and Derivatives

Leading processes for the production of propylene oxide\* and its derivatives including butanediol, tetrahydrofuran (THF), gamma-butyrolactone (GBL) and n-methyl-2-pyrrolidone (NMP)

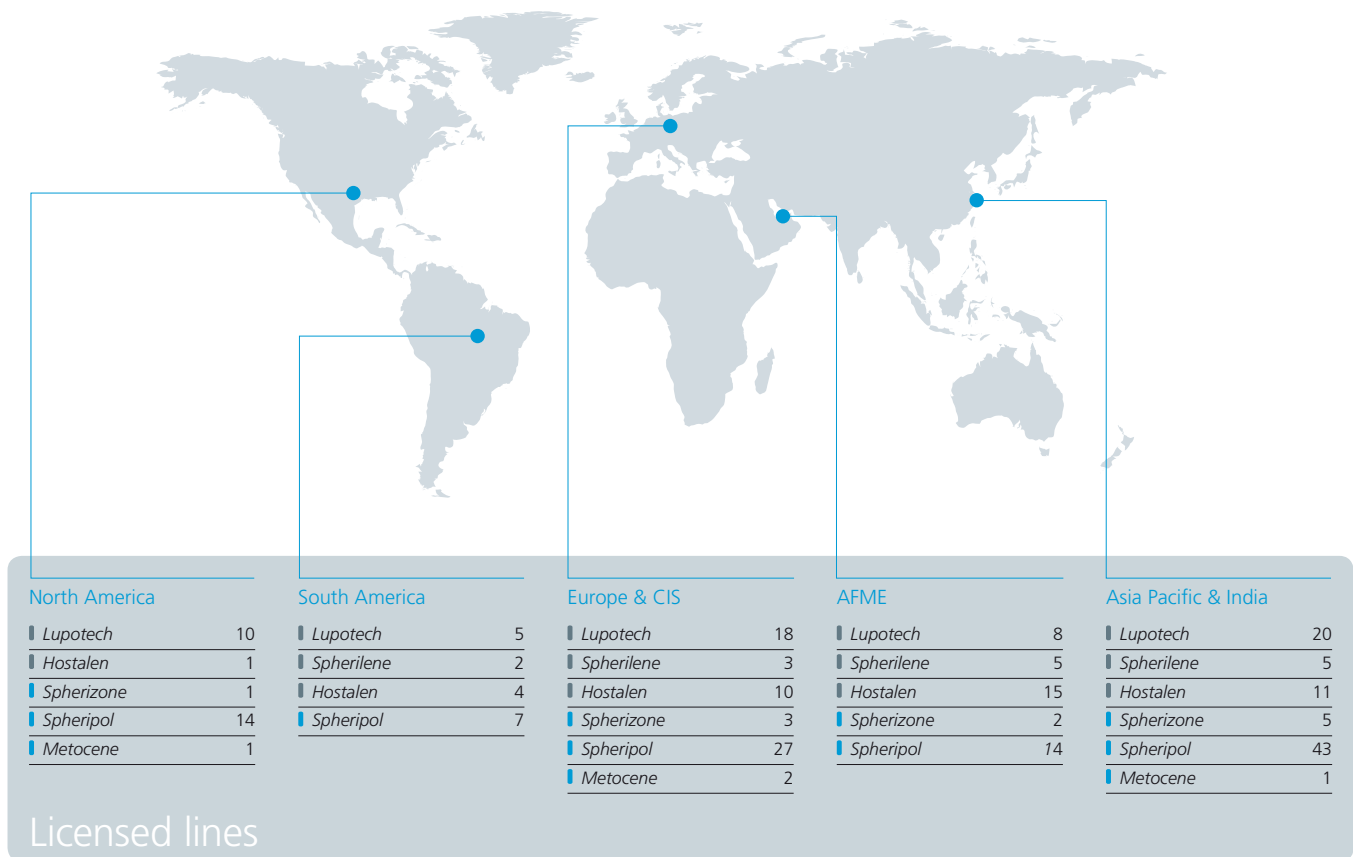
- Seven LyondellBasell plants across the globe
- Ethylbenzene route producing styrene monomer as co-product
- Isobutene route producing t-butyl alcohol (TBA) as co-product leading to methyl t-butyl ether (MTBE) and ethyl t-butyl ether (ETBE) derivatives
- Butanediol conversion, applying highly selective catalyst and separation technologies, to THF, GBL and NMP

\*For LyondellBasell joint ventures only

# Polyolefin technologies

## Licensee locations

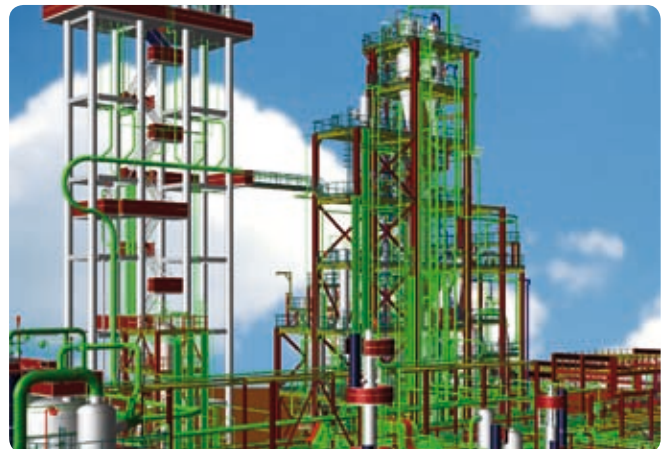
From the world's leading licensor of polyolefin technologies



### Licensed lines



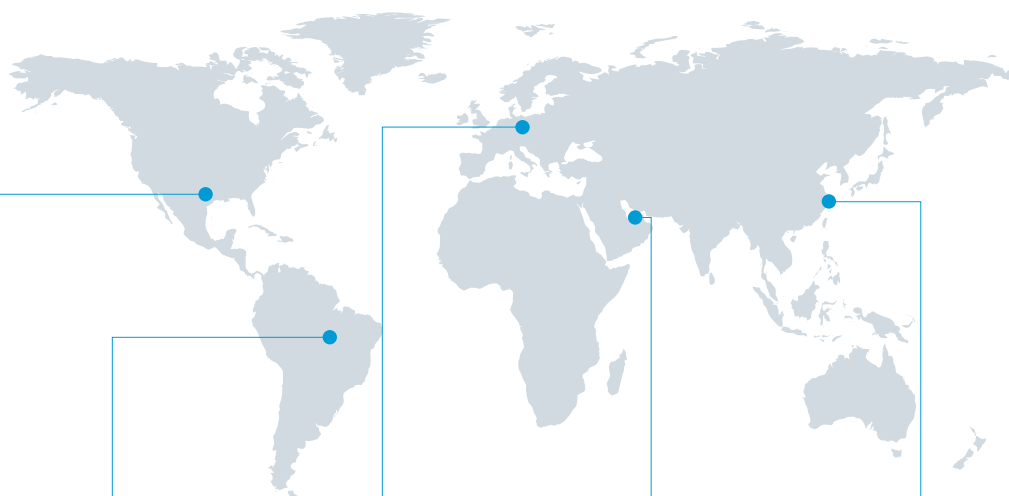
Spherizone plant, SamsungTotal, Daesan, South Korea



# Chemical technologies

## Licensee locations

From an experienced operator of chemical technologies



### North America

Olefins Conversion	2
Olefins Recovery	6
Aromatics	9
Acetyls	1
Oxiranes and Derivatives	4

### South America

Aromatics	7
Acetyls	1
Oxiranes and Derivatives	1

### Europe & CIS

Olefins Recovery	1
Aromatics	13
Oxiranes and Derivatives	3

### AFME

Olefins Conversion	1
Olefins Recovery	1
Aromatics	5
Oxiranes and Derivatives	1

### Asia Pacific & India

Olefins Conversion	2
Olefins Recovery	4
Aromatics	36
Acetyls	1
Oxiranes and Derivatives	4

## Licensed lines



LyondellBasell Corpus Christi Complex, Texas, USA



LyondellBasell Channelview Complex, Texas, USA

# Technology services



## Support

LyondellBasell's Technology Services provide extensive support for licensees before and during start-up, and for the entire life of a plant.

## Start-up

Prior to start-up, highly experienced staff at LyondellBasell's training centers (Ferrara and Brindisi, Italy; Bayport and Houston, USA; and Aubette, France) train licensees' operations team on operations, quality control, maintenance, applications and safety.

A start-up team comprised of LyondellBasell operators provides assistance during pre-commissioning and commissioning of the plant. After completion of the commissioning,



LyondellBasell HSE experts participate in a Plant Safety Audit to verify adherence to LyondellBasell's Safety Design Criteria, with special attention to health and environmental matters.

## Sharing

For the life of the investment, LyondellBasell continues to share safety information and enhancements in order to further improve the safety standard of each technology.

In addition, in order to further benefit from LyondellBasell's technical knowledge and developments, licensees can enter into a Technical Support Agreement (TSA) with LyondellBasell. If market conditions change and the capacity of the plant needs to be increased



or a variation in the product grade slate needs to be made, LyondellBasell can assist in the engineering activities needed to upgrade the plant accordingly.

## Improvements

We will undertake detailed analysis of your operations and the products that your customers demand. Then we can help identify improvement opportunities and optimize your existing polyolefin assets by leveraging LyondellBasell's extensive worldwide experience in tandem with the special skills of your organization. LyondellBasell Technology Services can help you increase plant utilization, reduce costs, improve product quality and meet your customers' application requirements, while maintaining a strong focus on safety.

# Environment and safety



LyondellBasell's core values of environmental protection and the efficient use of resources are demonstrated within our technologies, with a focus on the continual reduction of environmental emissions and waste generation. Additionally, we have a responsibility to design processes that can be operated safely to protect the employees and communities in which our technologies are operated.

LyondellBasell technologies reflect our "Operational Excellence" philosophy as a basis for achieving superior health, safety and environmental performance through high reliability operations. This in turn helps our customers achieve measurable improvements within their businesses. Reliable technology and safety are intrinsically linked, and LyondellBasell's technologies have a safety record that is



among the best in the chemicals industry. In addition, we have implemented best practice environmental design to create technologies which lead in the industry in the minimization of resource consumption and the prevention of process emissions.

Below are some examples that demonstrate our commitment to Health, Safety and Environment:

## Process safety

- Our *Spheripol* process technology has a track record of nearly seven million hours without a major incident.
- Our *Lupotech* process technology incorporates highly effective reactor safety and plant shutdown systems to protect the plant.



## Environment

- In the design of *Lupotech* process technologies, we limit hydrocarbon emissions through selected waste gas streams that are processed using thermal or catalytic catalysts.
- Our *Spherilene* process technology has the most efficient raw material consumption compared to alternative polyethylene processes.
- For more than 40 years, we have demonstrated full environmental compliance with USA benzene requirements in aromatics technologies.

LyondellBasell La Porte Complex, Texas, USA



## LyondellBasell

Technology – Licensing  
Industriepark Hoechst  
Building B852, 5th floor  
65926 Frankfurt am Main  
Germany

You can find out more about us by visiting  
our website at: [lyondellbasell.com/technology](http://lyondellbasell.com/technology)

LyondellBasell is one of the world's largest plastics, chemical, and refining companies. The company manufactures products at 59 sites in 18 countries. LyondellBasell products and technologies are used to make items that improve the quality of life for people around the world including packaging, electronics, automotive parts, home furnishings, construction materials and biofuels. More information about LyondellBasell can be found at [www.lyondellbasell.com](http://www.lyondellbasell.com)

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