

# Licensed polyolefin technologies and Services

## Lupotech

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

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Under the trademark *Lupotech*, LyondellBasell offers high-pressure tubular and autoclave process technologies for the production of low density polyethylene (LDPE) and ethylene vinyl acetate (EVA) copolymers. The *Lupotech T* process is the leading high pressure tubular reactor technology for the production of LDPE and standard EVA, while *Lupotech A* is the high-pressure autoclave reactor process technology for the production of specialty LDPE, EVA copolymers with very high VAM content and various acrylic based copolymers and terpolymers. Worldwide, more than 60 licenses for these technologies with a total capacity of over ten million tonnes per year have been granted, with proven single-line capacities of up to 450 kt/a for *Lupotech T*. Products from the *Lupotech* processes cover the entire range of melt flows and densities, and can be used in the production of typical LDPE applications including a wide portfolio of EVA grades.

### A breakthrough in polyethylene technology

Low density polyethylene was discovered in 1933 and attained commercial importance because of its electrical insulation, optical and mechanical properties. Through a continuous commitment to R&D, developments in high-pressure materials and equipment, process safety and environmental impact reduction programs, the *Lupotech* process has retained a high level of attractiveness and is firmly established as a world-class technology.

With the introduction of modified, high-pressure steel that provides increased toughness as a base material for the tubular and autoclave reactor and piping, a significant breakthrough in terms of capital cost reduction and operating window has been achieved. This has resulted in superior plant integrity and also enabled higher operating pressures, which expanded the LDPE grade range into higher-density resins with improved properties for film applications.

Organic peroxides were then introduced, which led to both higher conversion rates and more efficient process control. This development was crucial to design the LyondellBasell *Lupotech T* plant in Aubette, France, as the first plant to achieve a world-scale capacity of more than 300 kt/a.

With the start-up of the world's largest LDPE plant in Al-Jubail, Saudi Arabia, *Lupotech* technology has achieved another milestone in 2009. Based on advanced process simulation, which has been validated in existing plants and has proven its capabilities with the scale up of the 450 kt/a LDPE plant, LyondellBasell is well-positioned to offer leading benchmark economics while meeting specific customer needs.

### Key Characteristics of *Lupotech* process technologies

#### Safety and environment

- Latest safety design utilizing the experience gained from more than 50 million tonnes of LDPE produced with *Lupotech* technology
- Ethylene polymerization without process solvent
- Plants using the *Lupotech* process technology are in full compliance with environmental and safety requirements
- In the *Lupotech* process, non-reacted monomers are constantly recovered and recycled

#### Economics

- Leading operating costs with lowest raw material and energy consumption
- Low investment costs due to highly efficient design
- Steam is generated and can be used elsewhere in the petrochemical complex
- High-performance products with the potential to achieve premium market prices

#### Product capability and versatility

- Complete range of LDPE products, including EVA and acrylic-based comonomer modified LDPE
- Fast grade changes ensure off-grade material is kept to a minimum
- Exceptional homogenous product quality with very low gel levels
- Eliminates need for blending/homogenizing silos due to the inherent consistency of the product quality delivered from the reactor

#### Operational performance

- Excellent operability rate around 98%; of an average of 2% downtime, less than 1% is due to process features

#### Design flexibility

- Single-line capacities of up to 450 kt/a for tubular and 125 kt/a for autoclave process technologies are available
- Proven scale-up design philosophy

## Lupotech process description

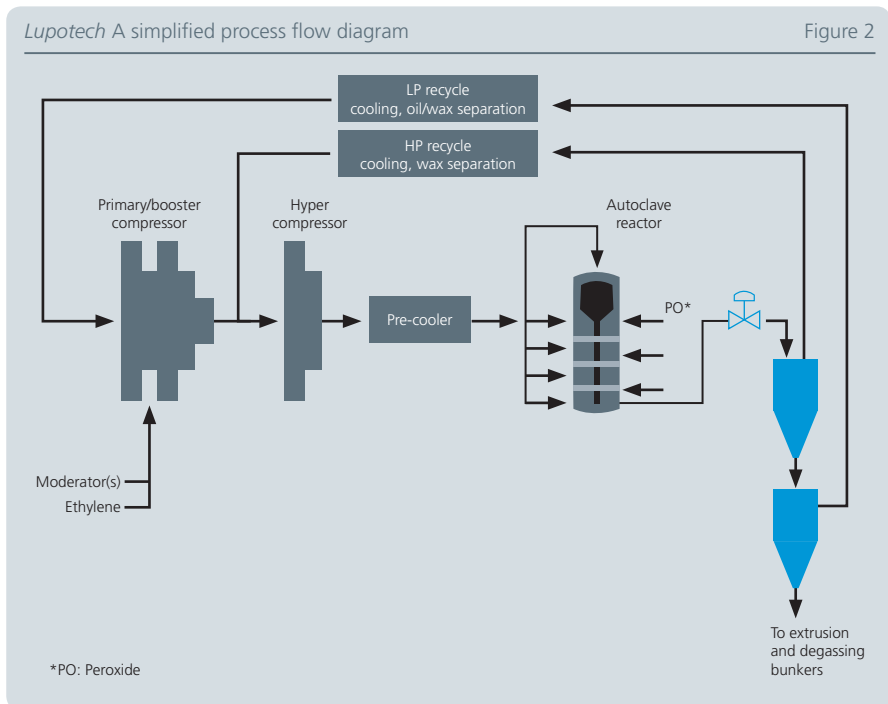
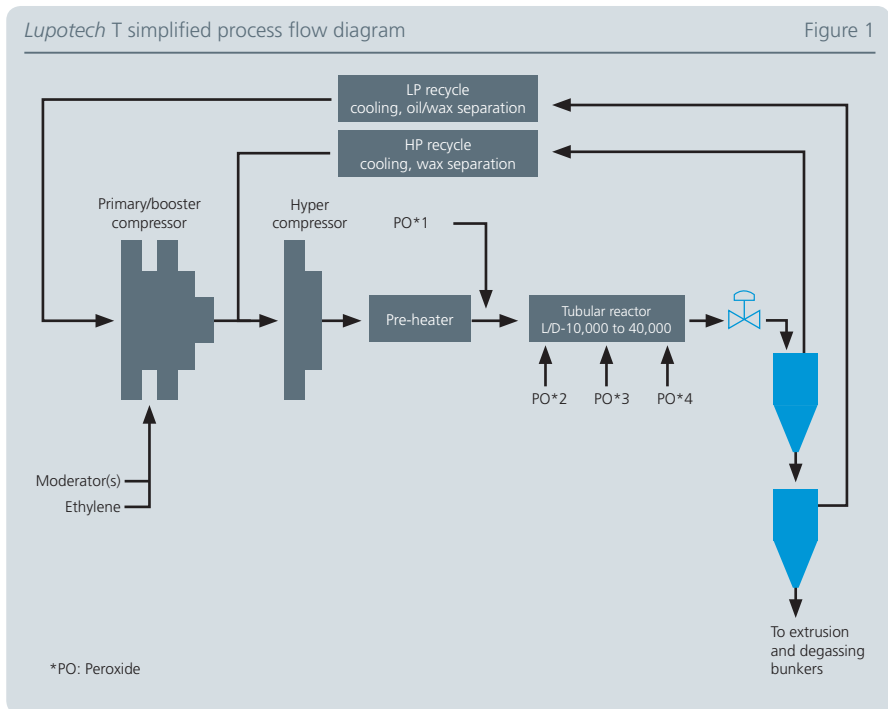
The overall manufacturing process can be divided into the following process units: Pre-compression of ethylene, compression to reaction conditions, polymerization reaction, polymer/gas separation, recycling of unreacted gases, extrusion, pelletizing, degassing, storage and packaging.

The *Lupotech T* tubular reactor receives the total ethylene flow from the hyper-compressor into the inlet of the first reaction zone, preheated to 150–170°C and at pressures between 2000 and 3100 bar. For the production of copolymers, specific comonomers such as vinyl acetate or acrylic-based monomers are used. Reaction is initiated by injection of organic peroxides in the reactor, at multiple locations after each reaction peak, optimizing the temperature profile of the reaction mixture. The *Lupotech A* autoclave reactor receives compressed ethylene from the secondary compressor through flow splitters to designated reactor points. An organic liquid peroxide initiator is injected to maintain a continuous polymerization reaction at controlled temperature zones. A comonomer modifier is injected to control product properties. Reactor effluent is discharged through a product cooler to the high-pressure separator.

## Lupotech process capability and product properties

The *Lupotech* process technology covers single-train tubular capacities of up to 450 kt/a and autoclave capacities of up to 125 kt/a. The process system configuration is designed to meet specific product requirements.

A comprehensive low density PE product portfolio can be obtained using the *Lupotech* process, ranging from standard LDPE grades to high EVA copolymers and high acrylic components containing copolymer. The process has no limitations regarding the number of reactor grades it can produce, and the product mix can be adjusted to match market demand and economical product ranges. Reactor grades from a MFR of 0.15 to > 40 and from a density of 0.917 to 0.934 g/cm<sup>3</sup> can be prepared accordingly. EVA and acrylic-modified copolymers of up to 40% for the autoclave configuration are available.



Commonly available additives, which are used around the world in LDPE manufacturing, are directly incorporated into the product to achieve final property requirements.

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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