

Lupotech

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

Under the trademark *Lupotech*, LYB 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 65 licenses for these technologies with a total capacity of over 12 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 highpressure 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.

The adoption of modified high-pressure steel with superior toughness as the base material for tubular reactors, autoclaves, and piping systems marks a significant innovation enabling an expanded operational window and supporting industry-leading nominal single-line capacities at superior plant reliability and integrity.

LYB *Lupotech T* technology reached a major milestone at the Berre site in France becoming the first plant worldwide to achieve a single-line capacity exceeding 300 kt/a, setting a new benchmark for large-scale production in 2000.

Today *Lupotech T* technology sets industry benchmarks with the successful start-up of the world's largest LDPE plants in Al-Jubail, Saudi Arabia (2009) and Jamnagar, India (2017).

Backed by advanced process simulation, these milestones demonstrated world-scale single-line capacities of 450 kt/a reinforcing *Lupotech's* position as the leading high-pressure technology with outstanding economics tailored to customer needs.

Key characteristics of *Lupotech* process technology

Safety and environment

- Latest safety design utilizing the experience gained from more than 80 million tonnes of LDPE produced with *Lupotech* technology
- Ethylene polymerization without process solvent and catalyst
- Plants using the *Lupotech* process technology are in full compliance with environmental and safety requirements
- The *Lupotech* process fully recovers non-reacted monomers

Leading economics

- Leading operating costs with lowest raw material and energy consumption
- Lowest investment and operational cost by combining highly efficient design with operational simplicity
- The heat of polymerization is recovered as steam that can be utilized at integrated sites reducing the site's energy consumption
- High-performance products with the potential to achieve premium market prices

Product capability and versatility

- Complete range of LDPE, EVA and acrylic-based comonomer products
- Fast grade changes keep transition grade material at minimum
- Exceptional homogenous product quality with very low gel levels

Operational performance

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

Design flexibility

- Single-line *Lupotech* capacities of up to:
 - 500 kt/a for LDPE products
 - 360 kt/a for EVA products
 - 300 kt/a for Acrylate copolymers
 - 100 kt/a for autoclave process technologies are available
 - Proven scale-up design philosophy

Lupotech process description

The *Lupotech* technology comprises of a series of process steps units including Pre-compression, compression to reaction conditions, polymerization reaction, polymer/ gas separation, recycling of unreacted gases, extrusion, pelletizing, degassing, storage and packaging.

Lupotech T

In the *Lupotech T* process, the entire reaction mixture is routed from the hyper compressor through a preheater into the inlet of the first reaction zone of the tubular reactor.

The polymerization reaction occurs at pressures between 2600 and 2800 bar initiated by peroxides. For the production of copolymers, comonomers such as vinyl acetate or acrylates are polymerized together with ethylene.

The polymerization process is initiated through the injection of organic peroxides at multiple points along the reactor. This precise dosing of peroxides establishes a controlled temperature profile, which is key to defining the product properties

Lupotech A

In the *Lupotech A* autoclave reactor technology, compressed reaction mixture is delivered from the secondary compressor to the autoclave reactor via reaction mixture flow splitters. Organic peroxides are injected at temperature controlled reaction zones to initiate a continuous polymerization. The resulting polymer product is discharged through a let-down valve into downstream polymer-gas separation systems.

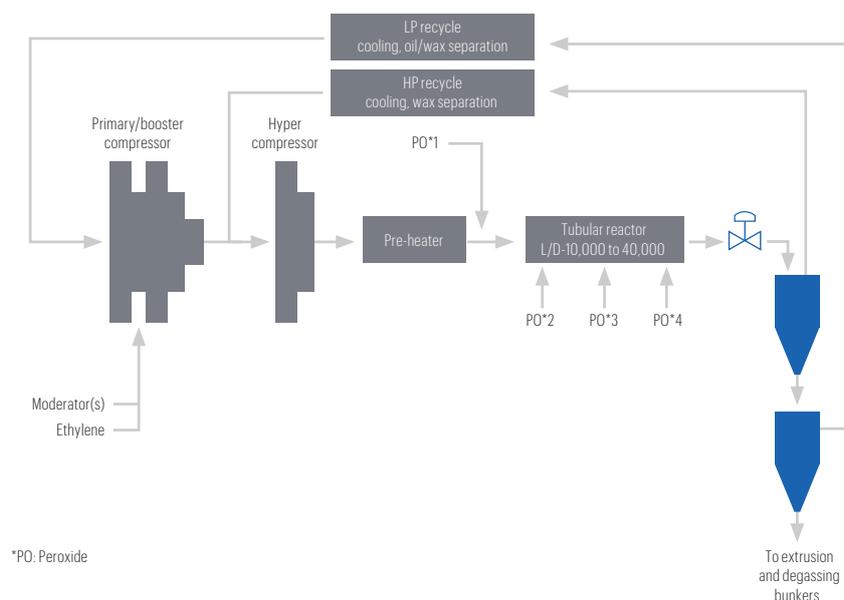
Lupotech process capability and product properties

Lupotech process technology offers single-train capacities of up to 500 kt/a for tubular reactors and up to 100 kt/a for autoclave reactors. The flexible system configuration is tailored to meet specific product requirements, ensuring optimal performance and efficiency.

LYB *Lupotech* processes deliver the most competitive high-pressure polymerization products, covering the full portfolio from

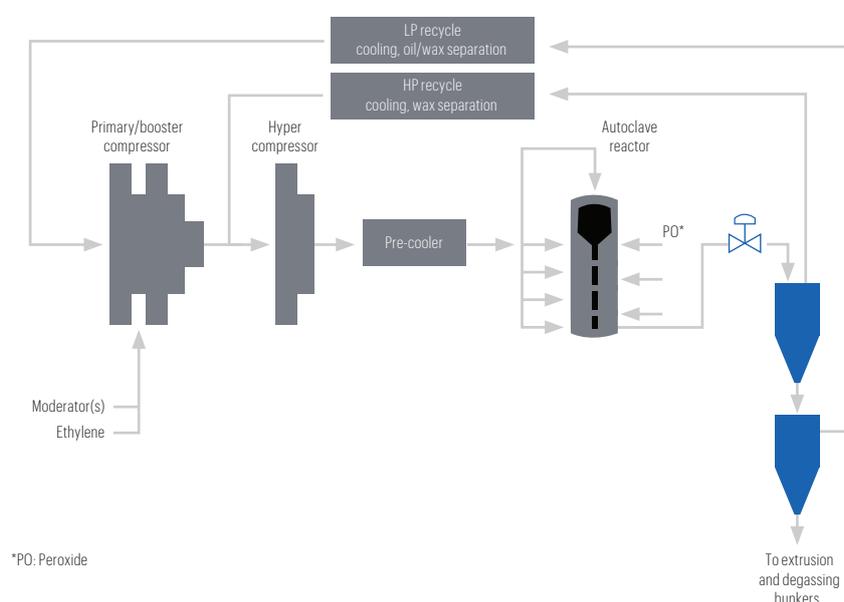
Lupotech T simplified process flow diagram

Figure 1



Lupotech A simplified process flow diagram

Figure 2



standard LDPE grades to EVA and acrylic copolymers.

With no limitations on the number of reactor grades, the process offers unmatched flexibility, allowing the product mix to be tailored to market demand and optimized for economic performance.

Commercial *Lupotech T* LDPE homopolymer grades cover a wide melt flow range from 0.15 up to over 36 and

densities between 0.918 and 0.934 g/cm³.

The *Lupotech A* copolymer portfolio includes EVA grades with up to 40% vinyl acetate content and acrylic copolymers with up to 20%.

Additionally, commonly available additives can be introduced during the extrusion stage to fine-tune final product properties to meet specific application needs.

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