

Spheripol

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

With over 130 licensed lines around the globe and a licensed capacity of more than 35 million tonnes, LyondellBasell has pioneered the *Spheripol* polypropylene process since it was invented by Giulio Natta back in 1953. Today, the *Spheripol* process is the benchmark polypropylene process technology which is providing licensees with an simple, outstanding reliable, energy efficient, low environment impact and leading cost process to produce a wide range of premium-quality polypropylene grades.

LyondellBasell's development of a fifth generation high-yield, high-selectivity catalyst has dramatically simplified the *Spheripol* process steps and significantly improved product quality.

Additional breakthroughs have subsequently occurred in

the process design through the refinement of the bulk-polymerization and gas-phase reactors.

The latest-generation *Spheripol* process design utilizes the newest catalysts, enabling the production of market-leading, reactor-based product families with improved properties that reinforce the technology's industry benchmark status.

The *Metocene* PP process is a metallocene catalyst based polypropylene add-on technology for the *Spheripol* process delivering polypropylene grades with broad viscosity range ex-reactor ($0,5 < \text{MFR} < 2500 \text{ g}/10'$), narrow molecular weight distribution and cleaner polymer (low xylene solubles, low catalyst residuals, low oligomers, low extractables).

Key characteristics of *Spheripol* process technology

Safety and environment

- A safety record among the best in the industry
- Leading resource consumption, monomer efficiency and emissions
- No undesired by-products from the reaction

Product capability and versatility

- Wide range of homopolymers, random copolymers and heterophasic impact and specialty impact copolymers, as well as terpolymers for all polypropylene applications
- Unmatched product quality with minimum property variation due to excellent process stability and catalyst performance
- Non-phthalate catalyst is available to produce grades for all relevant application fields (including food and medical)

Reliability

- Average overall operability rate is approximately 98% – in an average of 2% downtime, less than 1% is due to process features

Design flexibility

- Single-line capacities, from 40 up to 600 kt/a are available for homopolymer, random copolymer and heterophasic impact copolymer production
- Tailored design for chemical or polymer grade monomer feedstock

Modular flexibility

- Expansion achievable through minor adjustments
- Extension of product range possible through introduction of *Metocene* PP process as an add-on technology
- Flexible modular design facilitates low investment costs

Economics

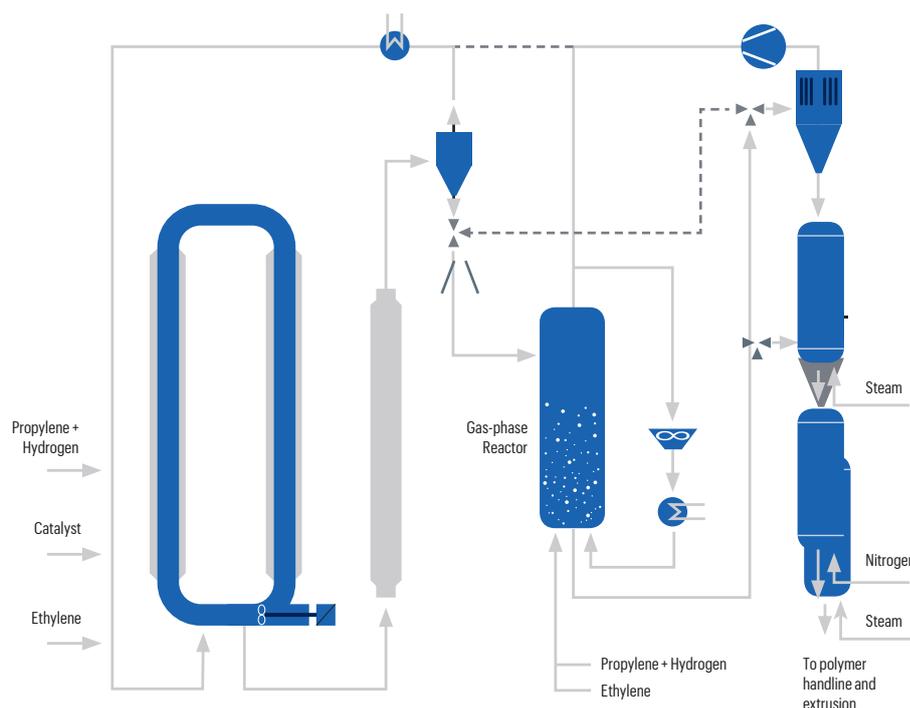
- Capital costs are competitive with currently available polypropylene processes
- Lowest operating costs of any PP process and high transition efficiency

Spheripol process description

The *Spheripol* process is a modular technology consisting of three main process steps – catalyst and raw material feeding, polymerization and finishing. The catalyst, liquid propylene and hydrogen for molecular weight control are continuously fed into the loop reactor. Ethylene and/or 1-butene can also optionally be fed to the reaction section to produce random copolymers and terpolymers. The bulk polymerization occurs in one or two tubular loop reactors filled with liquid propylene and optional gas-phase copolymerization reactors for ethylene-propylene bi-polymer incorporation. Reduced reactor residence time and economically optimized equipment sizing can be achieved relative to other technologies, due to the high monomer density and increased catalyst activity.

The finishing section consists of separation of the unconverted monomers, and complete recycling of the monomers back to the reactor. Complete polymer degassing and

Spheripol simplified process flow diagram



highly efficient volatiles and light oligomers removal is then achieved in a Steaming section, which grants complete monomers recovery without the need of a membrane system.

A leading advantage of the *Spheripol*

process, in combination with *Avant* catalysts, is its unique ability to produce polymer spheres directly in the reactor. Spherical polypropylene provides superior process reliability and best in class operability.

Spheripol process – Capabilities and product properties

The *Spheripol* technology produces a complete portfolio for use in the full range of polypropylene applications. Many *Spheripol* process resins are recognized as industry-leading products in many application areas.

Spheripol polypropylene homopolymers range from grades with a fractional melt flow rate for pipe and sheet extrusion applications to very high flow specialty grades for melt blown applications. The

comprehensive product portfolio includes a vast number of tailor-made products for a variety of film and fiber applications.

Spheripol polypropylene random copolymers are characterized by excellent optical properties and extremely low catalyst residues. The product portfolio also includes specialty grades for pressure pipe applications and copolymers with very low seal initiation temperatures.

Spheripol polypropylene heterophasic copolymers have outstanding low-temperature impact strength. The product portfolio includes a broad range of grades for specialty applications such as pipes and automotive bumpers, and reactor-grade, high-flow heterophasic copolymers for thin-wall injection molding applications.

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