

Spherizone

Latest-generation polypropylene process technology based on a multi-zone reactor that produces high-performance polypropylene and novel polyolefins

LyondellBasell's differentiated *Spherizone* multi-zone circulating reactor process provides an economical and efficient method of manufacturing a wide range of high-quality polypropylene and novel, propylene-based polyolefinic resins. Today, more than 10 million tonnes of the differentiated *Spherizone* polypropylene process technology have been licensed.

For many years, polypropylene process development has focused on bimodality and increasing operating temperatures to improve product properties. In *Spherizone* technology bimodality has been achieved by creating in a

single reactor two reaction zones operating at different operating conditions, resulting in a final polymer blend of different compositions with properties combined on a macromolecular level.

With the ability of the *Spherizone* process to drive products to new property and performance extremes, the technology continues to emerge as the new benchmark for polypropylene production. *Spherizone* process resins have the potential to expand polypropylene's use into entirely new applications and markets.

Key characteristics of *Spherizone* process technology

Safety and environment

- LyondellBasell's process technologies have a safety record among the best in the industry
- Reduction of both resource consumption and emissions and low energy consumption
- Recovery and recycling of non-reacted monomers
- No undesired by-products from the reaction

Product capability and versatility

- Wide range of high-quality PP products possible
- Novel resins, such as homo-raco composites, twin random copolymers, high ethylene containing random copolymers, Low SIT terpolymer, soft HeCo's, high rubber HeCo's and high melt flow HeCo's, with expanded properties and performance
- High product quality, allowing bimodality in MFR and composition
- Minimum property variation due to process stability and LyondellBasell's *Avant* catalyst performance
- Non-phthalate catalyst is available to produce grades for applications such as spunbond fibers, etc.

Reliability

- Structurally identical to the *Spheripol* process, *Spherizone* has demonstrated high reliability

Design flexibility

- Single-line capacities of up to 550 kt/a can be provided
- Homopolymer, random copolymer, terpolymer or heterophasic impact copolymer production designs
- Polymer grade propylene or chemical grade propylene feedstock

Modular flexibility

- A modular design enabling the low-cost addition of a fluidized bed gas-phase reactor for heterophasic impact copolymers

Economics

- Capital costs are competitive with any PP technology currently available
- Best in class operating costs

Spherizone process description

In combination with LyondellBasell's Avant catalysts, the *Spherizone* process produces spherical polymer particles directly in the reactor. The specially designed multi-zone circulating reactor (MZCR) consists of two reaction zones, and the growing polymer particles are circulated between the two different zones. In the riser zone, the polymer particles are moved upward through a dilute monomer. At the top of the riser zone, the polymer particles move to the downer zone. In the downer zone, the polymer particles move downward through a plug flow by gravity. At the bottom of the downer zone, the polymer particles move back to the riser zone and the polymer particles circulation is repeated.

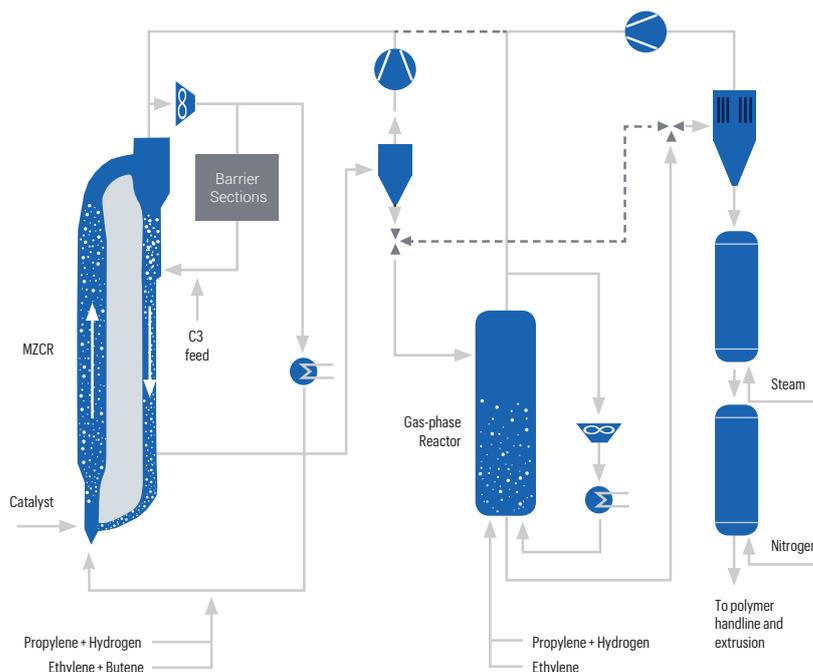
In order to create different reaction conditions in the downer zone compared with the riser zone, a barrier stream is injected in a stripping zone at the top of the downer zone in the polymer particle bed.

The stripping zone is the core of the MZCR, as it guarantees two fully controlled but separate reaction conditions in one single reactor.

The gas-phase copolymerization reactor section (optional) and the finishing section are highly efficient process steps utilizing the well-proven design of the LYB PP process technology.

Spherizone simplified process flow diagram

Figure 1



Spherizone extended product properties

Figure 2

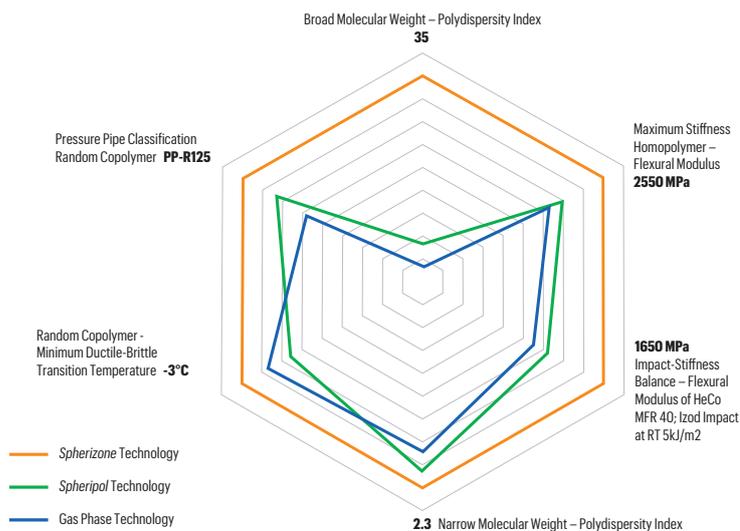
Spherizone process – Product properties and performance

The versatility of the *Spherizone* process is demonstrated by the high-quality product range it produces, which includes all standard polypropylene grades as well as unique polyolefin products. The capabilities of the *Spherizone* process to deliver new performance potential across the entire product portfolio is illustrated by the extended product property graphic in figure 2.

With the MZCR unique revolutionary design excellent product homogeneity can be achieved, which in combination with the broad operating window provides for both improved product quality as well as novel grades which are not feasible with other conventional technologies.

Products from the *Spherizone* process, for example, have surpassed the performance of conventional polypropylene used in pipe applications, including novel random copolymers with PP-R 125 classification and new high-modulus heterophasic copolymers used in sewage and drainage pipe applications.

Spherizone process technology also enables the production of



novel polyolefins, which are being used in entirely new applications previously the domain of traditional materials and competitive plastics. By extending the boundaries of polypropylene performance, the *Spherizone* process manufactures products with a very broad molecular weight distribution as well as products with high comonomer content. These *Spherizone* process polyolefins replace conventional materials used in rigid packaging and other applications where extremely high melt strength is essential.

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