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Polypropylene Impact Copolymer

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Abstract

This report consolidates and updates the IHS Chemical Process Economics Program's technical and economic analyses of propylene impact copolymer manufacturing technologies from 2010 to the present. The current global production of over 75 million metric tons polypropylene (PP) per year is forecast to increase by about 19–20% over the next four to five years. Braskem, LyondellBasell, and ExxonMobil are the main producers of PP in the Americas. Total is the largest producer of PP in Europe, and Reliance produces similar quantities of PP in India. Sinopec (China Petroleum & Chemical Corporation) is by far the leading producer of PP in Asia. Modern world-scale PP plants operate with single train capacities of about 250,000 to 500,000 tons per year.

Development of Ziegler-Natta catalysts in the 1950s and beyond enabled commercial production of stereoregular, isotactic polypropylene that is lightweight, thermoplastic, and has relatively high tensile strength, rigidity, and melting point. When a comonomer such as ethylene is included in the polymerization process, very high toughness and resistance to impact can be achieved. Polypropylene impact copolymers are used in diverse applications including automotive parts, pipe applications, household and food containers, toys, and appliance parts. The technologies and economics involved in producing ethylene-propylene impact copolymers are the subject of this report.

The PP processes are differentiated most by the phase of the polymerization reaction medium and the reactor design. Impact copolymer is produced in two chemical steps in two or more reactors. A matrix of PP homopolymer is prepared and then treated with ethylene and more propylene to provide a copolymer having elastomeric regimes within the PP matrix. Often the same Ziegler-Natta catalyst can be used for both chemical steps. Ziegler-Natta catalyst system compositions vary but have similar features in the different processes. Metallocene catalysts are also used, to make a small percentage of commercial ethylene-propylene copolymer having specialized properties.

Technical descriptions and economic analysis are provided herein for the following processes:

- The UNIPOL® process of W. R. Grace, using fluidized-bed, gas-phase technology,
- The Novolen® process of CB&I, using vertical stirred-bed, gas-phase technology,
- The Innovene™ process of INEOS, using horizontal stirred-bed, gas-phase technology,
- The Innovene process of INEOS with INstage H_2-control technology,
- The Spherizone™ process of LyondellBasell, using multizone circulating-bed, gas-phase, and fluidized-bed technology, and
- The Spheripol™ process of LyondellBasell, using bulk slurry-phase and fluidized-bed technology.

Production of polypropylene impact copolymer is reviewed, with characterization of the patent portfolios for these six technologies and all other commercial PP processes over the past decade. Full patent reviews are provided for both Ziegler-Natta and metallocene catalyst systems. The industry status is updated, and a summary of the modern processes is provided in terms of comparative economics and the key process indicators (KPI) of capital intensity, energy intensity, carbon efficiency, and carbon intensity. Lastly, an interactive module is included—the iPEP™ Navigator Polypropylene tool—that provides a snapshot of economics for each process and allows the user to select the process, units, and region of interest.

While the processes presented herein represent the IHS Chemical Process Economic Program (PEP's) independent interpretation of the literature and may not reflect in whole or in part the actual plant configurations, we do believe that the conceptual designs sufficiently representative of plant configurations to enable Class III economic evaluations.

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