Univation TECHNOLOGIES

Capacity Expansion Technology

As the most widely licensed and trusted approach to polyethylene production, the UNIPOL™ PE Process has been chosen by producers around the world for its proven capabilities, efficiencies and for the continuing value and innovation that Univation Technologies delivers to the PE industry.

Long-time experience with the world's leading UNIPOL PE Process producers — our licensees — enables Univation to solve challenges from a customer's perspective and to develop solutions tailored to their specific needs using our Capacity Expansion Technology.

Delivering Value When and How You Want It

UNIPOL PE Process licensees can access a complete package of capacity-expanding retrofit technologies ranging from simple reactor debottlenecking solutions to advanced Super Condensed Mode Technology — a revolutionary innovation for dramatically increasing heat removal capabilities, enabling increased capacity. These offerings allow UNIPOL PE licensees to meet their specific capacity expansion goals with considerably less investment and resources than those required for new reactor construction.

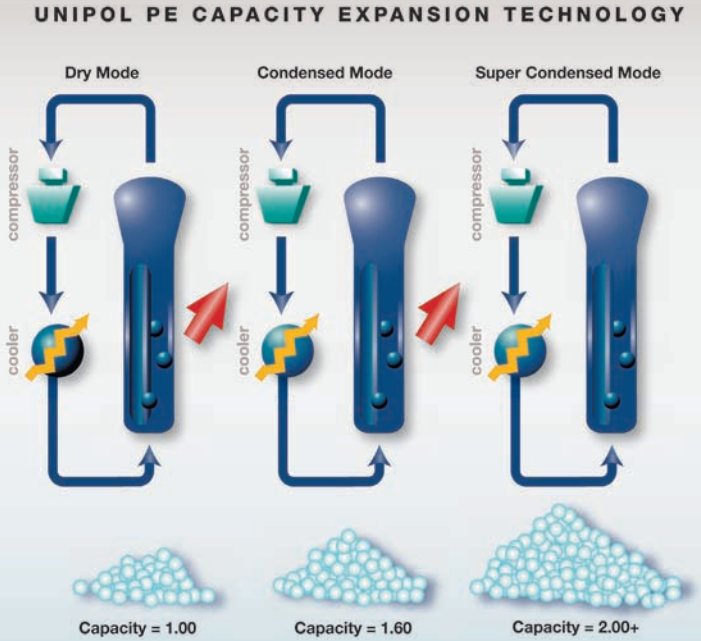
Why Retrofit with Univation?

Univation's retrofit technologies offer expansion opportunities if your space constraints prevent construction of a new reactor line.

Expanded Capacity at a Lower Cost

Retrofitting your existing lines can increase productivity by leveraging your current investment.

Debottlenecking for increased capacity can involve a fraction of the time and capital investment required for new reactor construction.



Lotte Daesan Petrochemical Corporation will implement Super Condensed Mode Technology (SCM-T) to expand their linear low density polyethylene plant. The 130 kta increase in expansion will make the Lotte plant a world-scale facility producing 290 kta. SCM-T was chosen by Lotte for its advantages in investment and operating costs.

Flexibility and Adaptability

Now you have the ability to add capacity faster and in smaller increments than would be possible through new reactor construction. Our retrofit solutions enable you to phase in additional capacity at a pace that lets you grow with the market. Incremental capacity expansion gives you the flexibility to manage your markets and respond quickly to new opportunities.

Complete Customization

We will help you examine the full array of retrofit alternatives available and recommend the solution that best meets your needs. Our capacity expansion technology is independent of product mix. That means our retrofit technology has application across the full range of UCAT™ Conventional Catalyst systems, including Ziegler-Natta and chromium-based catalysts, XCAT™ Metallocene Catalysts and our new PRODIGY™ Bimodal Catalyst. Expansion capacity can vary across individual catalyst families.

Retrofit options start with conversion to Condensed Mode and extend all the way to Super Condensed Mode.

Unrivaled Expertise

No one in the industry has more experience with gas-phase PE process technology than the professionals at Univation Technologies. You have the confidence of knowing that our retrofit solutions have been proven in plants around the globe. Over 100 reactor lines in use or under construction in 25 countries produce more than 20 million tonnes of PE annually (mta) using the UNIPOL PE Process. Univation has helped debottleneck many of these facilities with our proven capacity-increasing innovations. We have been involved in the expansion of 22 lines, resulting in an increase of more than 3 million tons of added capacity. Expansion increases range in size from 30% to 200% plus of original design capacity.

Warranted Capacity Improvements

We stand behind our work and offer warranties with your capacity retrofit license based on your chosen product mix. We provide the confidence that comes with working with the world leader in gas-phase PE process technology.

Demonstrated Service and Support

The service and support you receive with your capacity expansion retrofit license will be as comprehensive as that provided to new licensees. It includes thorough documentation and advisory support, comprehensive training, on-site commissioning support and consultation services well beyond project start-up.

PREMIER™ *Products and Services*

Univation's PREMIER™ Products and Services program offers other options for expanding the value and efficiency of your UNIPOL PE Process line, including:

- *Advanced Process Control (APC+™) Software — a proven, integrated process control package ensuring your plant runs at optimal efficiency and productivity. APC+ allows you to decrease control variability, increase aim-grade production and maximize production rates.*
- *Operations Training with simulation tools — faster skill assimilation for new hires and up to 50% reduced training time. Training helps you reach your plant's goals for problem recognition and avoidance, skill enhancement and best-practice behaviors.*
- *Operations Improvement Services — increase aim-grade production rates, reduce downtime and reduce transition time.*

APC+™ Software

At the Qenos Alkatuff plant in Botany, Sydney, Australia, the APC+ software increased output and improved transition efficiency significantly. Qenos selected APC+ for implementation in the UNIPOL PE reactor because it is a cost-effective way to significantly improve plant performance while working within already existing facility constraints.

Expansion Alternatives for a Diverse Set of Needs

With such a broad spectrum of solutions, Univation can help create a plan for increasing your capacity that is customized to your needs, your environment and your budget. And we continue to deliver value to your business by helping you address efficiency issues throughout your plant, not just in your reactor.

Conversion to Condensed Mode

If your plant is not yet operating in Condensed Mode, Univation can help you implement this proven technology successfully and efficiently. With hundreds of reactor years of experience in Condensed Mode and many retrofits completed, Univation is your ideal choice for Condensed Mode conversion. This patented and proprietary technology is now routinely included in the design of all new UNIPOL PE Process plants and is easily implemented in existing plants.

Enhanced Productivity with* XCAT *Metallocene Catalysts

Licensees currently producing hexene-based LLDPE with Ziegler-Natta catalysts will frequently find the bottleneck eventually becomes the reactor gas composition itself. At the limit, there is no more "room" for condensing agent and the hydrocarbons dissolved in the resin start to affect powder-handling behavior. A conversion to XCAT Metallocene Catalysts coupled with Univation expertise allows you to remove this bottleneck and further increase output while producing a higher-value product.

PRODIGY *Bimodal Catalyst*

Univation has achieved another technology breakthrough using PRODIGY Bimodal Catalyst to produce bimodal HDPE resins in a single UNIPOL PE Process reactor. A retrofit solution with PRODIGY Bimodal Catalysts usually requires minimal modification and little disruption to licensee's current production schedules.

PRODIGY *Bimodal Catalysts offer:*

- Product performance equivalent to or better than benchmarked materials produced in multiple reactors
- Capital investment savings for PE producers, compared to existing staged-process technologies

Investment savings can be as much as 40% for a single reactor-versus multireactor technology. This offers substantial investment savings to PE producers who desire to participate in the higher-premium HDPE market segments while at the same time reduce the number of different technologies and grassroots facility investments.

The Highest Standards at Every Step

Key benefits to developing a retrofit solution are the professional analysis, design and customer service. From the initial facility assessment through start-up, we'll provide designs, documentation, training and support of the same quality and caliber as that provided with a new license — exactly what you would expect from the organization that is an industry leader in licensing service and support.

The retrofit process offers:

- Facility assessments to identify areas for capacity increases
- An engineering report of prioritized debottlenecking opportunities based on the facility assessment, and recommendations for action according to your raw-material availability, market situation, cost considerations and product mix
- Cost estimates for implementing the recommended retrofit solution
- Contractor estimates when appropriate
- Process designs for required modifications
- Liaison and support during the retrofit process
- Training and start-up assistance
- Downtime minimization consultation
- Advice on product mix rationalization

Univation Technologies can help you access and implement high-throughput extrusion retrofit technology, allowing you to maximize capacity while avoiding the substantial costs of replacing your extruder hardware. UNIPOL PE process licensees who

are debottlenecking the rest of their plant can apply this know-how to maximize the output of existing extruder trains generally for a fraction of the cost usually required to install all new systems.

And we have reoptimized feed purification systems, reconfigured discharge systems, adjusted purge system operating conditions and more — all to increase capacity at minimum cost and disruption.

Debottleneck Solutions Designed Specifically for You

Our Capacity Expansion Technology services include a complete analysis of your existing facility with options and recommendations for overcoming bottlenecks.

Whether the bottleneck is in raw materials purification, product purging, vent recovery or elsewhere in the plant, we can help you find the most cost-effective path to increased throughput. By combining our diverse technologies and services to create customized solutions, Univation can help each licensee find the best route to capacity expansion.

Super Condensed Mode Technology (SCM-T)

SCM-T technology is an exciting innovation offered by Univation Technologies. SCM-T can provide significant increases to your existing plant capacity. By increasing the amount of condensate in the circulating stream, SCM-T provides more heat removal per unit of reactor volume without destabilizing the fluid bed. SCM-T has been shown to produce major capacity increases at less than 50% of the costs of new reactor construction. SCM-T is the process of choice for ExxonMobil Chemical Company, which successfully operates several plants with SCM-T and eventually plans to add this capability to multiple UNIPOL PE gas-phase facilities around the world.

ExxonMobil's affiliate, Imperial Oil Limited, a polyethylene plant located in Canada, introduced Super Condensed Mode Technology as part of a four-phase project to debottleneck their UNIPOL PE plant. The net result was a capacity increase from the original noncondensed capacity of 135 kta up to 430 kta with SCM-T for an investment of only 40% of the cost of a new plant of similar capacity. Total downtime across the four separate construction projects was only six weeks. ExxonMobil is currently implementing this technology at multiple UNIPOL PE units. This exciting capacity solution is available to Univation's licensees.

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