Efficient and eco-friendly polymerization of elastomers

By Andreas Diener, Product Manager at List AG

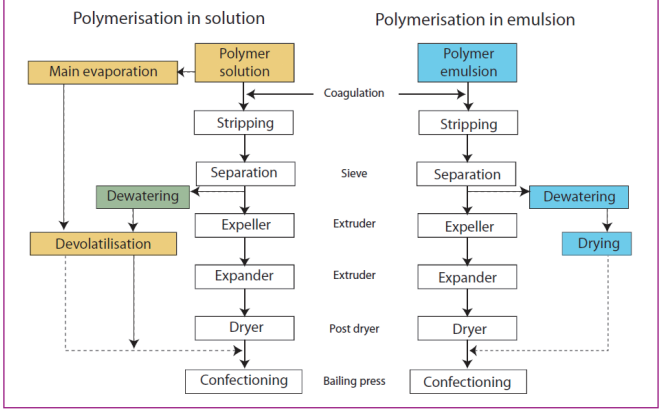
For decades, conventional polymerization in the production of elastomers has been the norm. The time and cost involved in removing and treating solvents in the final stages of production, for example, were acceptable. But as pressure builds on manufacturers to reduce operating costs, there is greater urgency to develop processes that can help streamline cost and production. One such effort by List AG has yielded promising results.

Switzerland-based List AG have developed an energy-efficient Direct Devolatilization technology that reduces costs associated with energy, cooling and water consumption, as well as the processing time and plant footprint required for processing elastomers.

Polymer chemistry opens new opportunities for new elastomer properties; and this technology makes it possibility to separate new elastomer grades from solvent without any degradation.

Elastomer processing

Solution and emulsion polymerization are the conventional routes for elastomer synthesis. In the last step of polymer production, the polymer must be separated from the solvent or emulsifying agent. This typically involves several process steps, including coagulation, stripping, various mechanical separation stages, and drying.



Comparisons between List AG's patented Direct Devolatilization process and conventional techniques.

Each individual step is energy-intensive and results in large quantities of solvent in the waste stream that need to be incinerated. This requires specialized equipment that consumes sizable facility space and a significant investment in capital expenditure (CAPEX).

"Direct Devolatilization process of elastomers contained in polymer solutions" developed by List AG is an alternative solution to reducing polymerization steps.

Conventional vs. direct devolatilization

Conventional elastomeric polymerization processes use aliphatic or aromatic hydrocarbons which must be removed once polymerization is completed. A water-based coagulant is used to separate the elastomers from the solvent, using steam stripping, and then to separate the elastomer from the water phase using mechanical and thermal processes.

List AG's Direct Devolatilization is a completely enclosed, continuous process that directly separates and simultaneously recovers solvent from the elastomer. As a result, it completely eliminates the intermediate steps, such as water coagulation, steam stripping, mechanical dewatering and drying.

Compared to conventional processing, Direct Devolatilization produces the same elastomer quality with all the desired specs, while enabling the reduction of energy and water consumption, plant footprint and the temperature/treating time ratio.

The Direct Devolatilization process involves four steps:

1. Pre-concentration removes large amounts of solvent from the polymerizate using thermal energy to increase the efficiency of the overall process.

2. Main evaporation removes the solvent and transfers the highly viscous pre-concentrated elastomer solution. Evaporative

cooling keeps the product at the necessary temperature level.

3. Final devolatilization transfers the highly concentrated elastomer to the final expected elastomer quality.

4. Confectioning forms the expected product shape to provide a saleable product.

If necessary, a polymerizate washing step can be added before pre-concentration to remove residual catalyst parts.

Direct Devolatilization can separate 99% of the solvent and

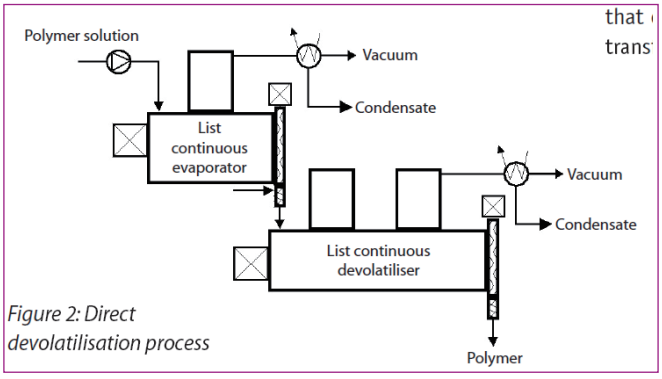


Figure 2: Direct devolatilisation process

List's Direct Devolatilization is a completely enclosed, continuous process that directly separates and simultaneously recovers solvent from the elastomer.

non-converted monomer without contamination with additional products. Depending on the solvent, the thermal processes can operate at vacuum or slightly overpressure. The final elastomer has the same properties as conventional treated products. The Mooney variation is less than +/-1 compared to the polymerizate, the residual organic volatile content is less than 100ppm, and the ash content does not increase during the process.

Most elastomers are temperature sensitive, so temperature control is critical to prevent overheating or self-ignition. Direct Devolatilization effectively removes the solvent at temperatures below 100°C without elastomer degradation.

Conventional technology has reached its limits when processing new elastomer grades because of higher adhesiveness. List AG's Direct Devolatilizing process is able to overcome this disadvantage, allowing for the development of new high performance grades.

Controlled finishing

The ability to carry out final devolatilization under controlled conditions is important in order to obtain the desired elastomer

quality and minimize the risk of overheating or self-ignition.

During Direct Devolatilization, a small amount of water is added to the devolatilizer. As the water bubbles, the organic volatiles get trapped in the bubbles. By destroying the bubbles the organic volatiles are captured and removed. The process can be compared to closed and concentrated stripping in which a small amount of water is used and only 1% of the total solvent is contaminated. The water/organic volatiles mixture is condensate in a closed system and can be completely recycled.

The Direct Devolatilization process was implemented on a semi-industrial scale at the Fraunhofer Gesellschaft in Germany.

List AG's Direct Devolatilization technology enables the processing of highly viscous elastomer without overheating or degradation, while achieving the expected Mooney viscosity. Its self-cleaning metallic surfaces consistently produce high quality product with low volatile content, respectively very low organic volatile content.

Simple is efficient

Process efficiency is judged by a variety of parameters, including thermal energy and water requirements, equipment and environmental footprints, quantity of effluent, and CAPEX and operational expenditure (OPEX) costs.

In this regard, List AG's Direct Devolatilization requires far less energy than conventional processing. The only energy requirements are for evaporation and condensation of the solvent. By eliminating the separate processes for coagulation, stripping, mechanical water separation and drying it also eliminates the need for the mechanical or thermal energy needed for these multiple steps. Energy recuperation in between increases this effect further.

By achieving 99% solvent separation without any additional agents, Direct Devolatilization prevents the generation of effluent water and eliminates the need for off-gas treatment. The result is a highly streamlined process that delivers significant energy savings, limits environmental impact and reduces operating costs for a higher return on investment.

Benefits of LIST Process	Challenges of LIST process
Efficient processing of sensitive elastomers with highly adhesive nature	Impurities from catalysts and/or initiators that are generally removed in traditional stripping, may remain in elastomer mass using List technology.
Flexibility to process new high performance grades; New catalyst developments are possible	
Closed process with no significant air or water contamination	
Low energy and cooling water consumption	
Technology can be applied for large scale continuous elastomer processes	
Self cleaning provide long operation without cleaning interruption.	

Benefits and Challenges of LIST Direct Devolatilization Technology vs. Conventional Process.

Scaling up the process from bench to commercialization

List AG and Fraunhofer Institute in Schkopau, Germany, worked together to develop this technology. The team installed a fully automated mini plant at List AG's headquarters in Arisdorf, Switzerland for trial.

The Direct Devolatilization process was then scaled up for implementation on a semi-industrial scale at the "Pilot Plant Center for Polymer Synthesis and Processing" at the Fraunhofer Gesellschaft, an independent research and development institute in Schkopau.

The fully automated continuous operating Mini-Plant at List AG's headquarters in Arisdorf, Switzerland is able to process 20-30kg polymerizate per hour and the Pilot Plant Center in Schkopau, Germany is designed for continuous operation during 8,000 hours, and the testing capacities range from 200-500kg polymerizate per hour (30-50kg/h final product). ■