Technical Article

Efficient & Easy Elastomer Processing

Conventional polymerisation in the production of elastomers has been the norm for decades. 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 has yielded extremely promising results.

Engineers and polymer chemists at LIST AG have developed an energy-efficient Direct Devolatilisation technology to significantly reduce 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. The authors provide insights into various technical aspects of this technology and discuss why this is relevant today, and for the future of elastomer processing.

Solution and emulsion polymerisation 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. Each individual step is energy-intensive and results in large quantities of solvent in the waste stream that need to be incinerated. This requires specialised equipment that requires sizable facility space and a significant investment in CAPEX.

"Direct Devolatilisation process of elastomers contained in polymer solutions" developed by LIST AG is an alternative and promising solution to reducing polymerisation steps.

Figure 1 presents comparisons between the patented Direct Devolatilisation process and conventional techniques.

Conventional vs. Direct Devolatilisation
Conventional elastomeric polymerisation processes use aliphatic or aromatic hydrocarbons which must be removed once polymerisation is complete. 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's Direct Devolatilisation, illustrated in figure 2 (on next page), 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 Devolatilisation produces the same high quality elastomer with all the desired specs – while enabling elastomer producers to reduce energy and water consumption, plant footprint and the temperature/treating time ratio.

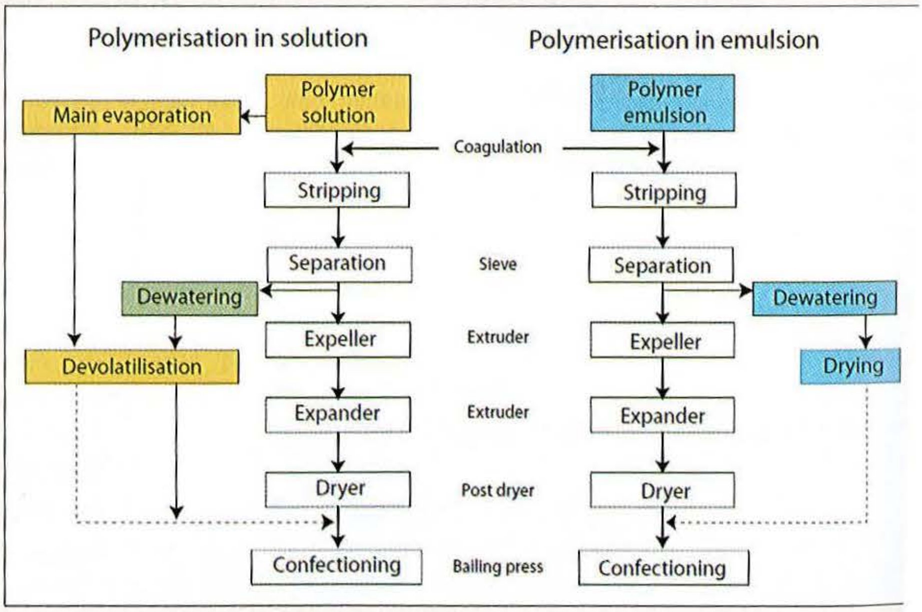

Figure 1: Block diagrams of existing technologies and the simplification introduced with the new process solutions for the separati of elastomers from solvents and emulsifying agents

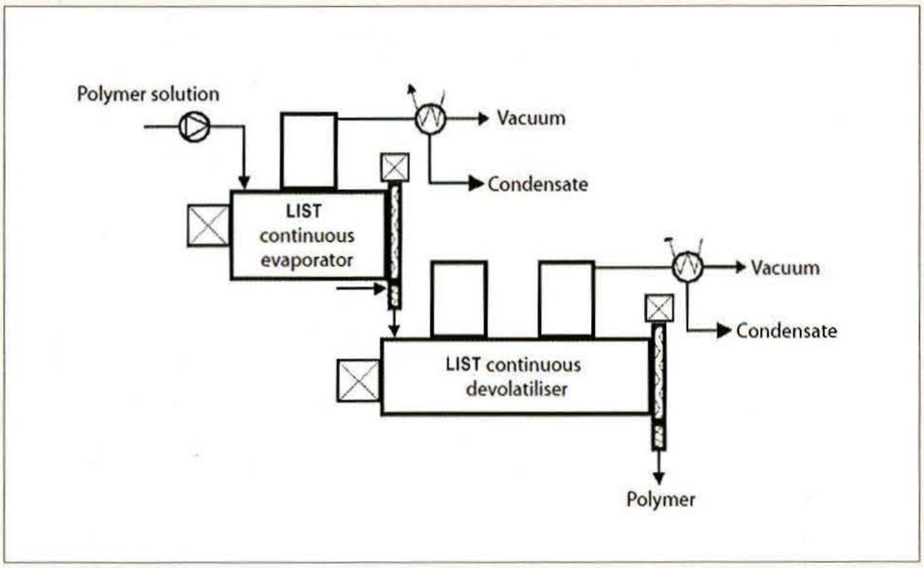

Figure 2: Direct Devolatilisation process

The Direct Devolatilisation process involves four steps:

1. Pre-concentration removes large amounts of solvent from the polymerisate 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 devolatilisation transfers the highly concentrated elastomer to the final expected elastomer quality
4. Confectioning forms the expected product shape to provide a saleable product

Direct Devolatilisation can separate 99 per cent of the solvent and 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 polymerisate, the residual organic volatile content is less than 100 parts per million (ppm), and the ash content does not increase during the process.

Most elastomers are temperature sensitive, hence temperature control is critical to prevent overheating or self-ignition. Direct Devolatilisation effectively removes the solvent at temperatures below 100 degree celsius without elastomer degradation. Conventional technology has reached its limits when processing new elastomer grades because of higher adhesiveness. LIST's Direct Devolatilising process is able to overcome this disadvantage. It allows the development of new high performance grades which are impossible, or very difficult to process, with conventional technology.

Controlled Finishing

The ability to carry out final devolatilisation under carefully controlled conditions is important in order to obtain the desired elastomer product quality and minimise the risk of overheating or self-ignition. Direct Devolatilisation technology processes the highly viscous elastomer without overheating or degradation, while enabling processors to achieve the expected Mooney viscosity and final volatile content.

During Direct Devolatilisation, a small amount of water is added to the devolatiliser. 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 per cent of the total solvent is contaminated. The water/organic volatiles mixture is condensate in a closed system and can be completely recycled. LIST's Direct Devolatilisation is a completely enclosed process for more than 8000 hours of continuous operation. Self-cleaning metallic surfaces consistently produce high quality product with low volatile content.

Simple is Efficient

Process efficiency is judged by a variety of parameters, including thermal energy and water requirements,

Figure 3: Specialised LIST pilot scale polymer-finisher

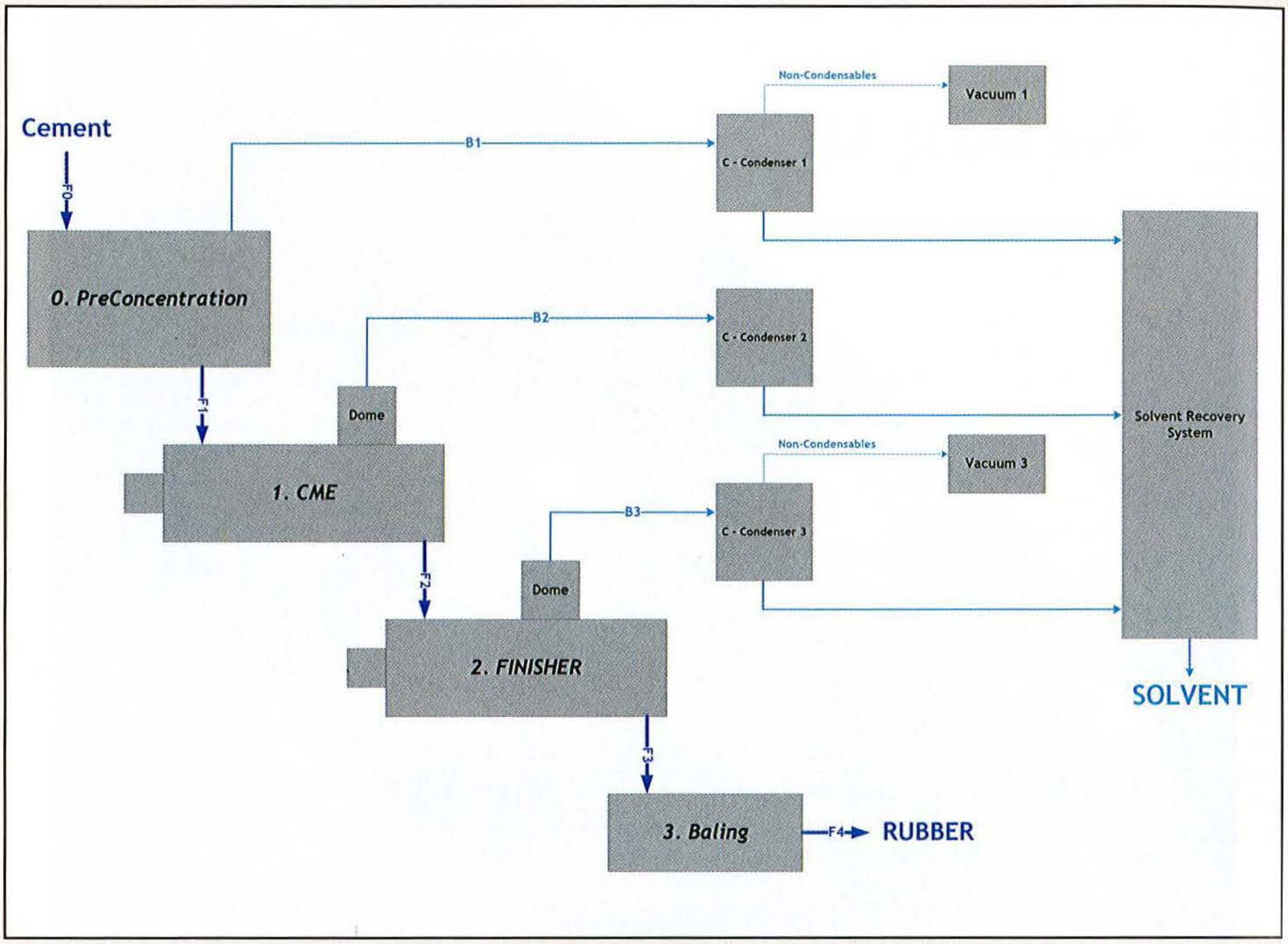

Figure 4 : LIST Direct Devolatilisation technology

equipment and environmental footprints, quantity of effluent, and CAPEX and OPEX costs. When measured against these variables, LIST's Direct Devolatilisation ranks extremely well.

Direct Devolatilisation 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.

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

Figure 5 provides a case study comparing the benefits of LIST's patented Direct Devolatilisation process to a conventional process in a plant in Western Europe.

Scaling up the Process from Bench to Commercialisation

LIST AG and Fraunhofer Institute in Schkopau, Germany, worked together to develop the Direct Devolatilisation process. Research teams followed a step-by-step approach that included initial investigations in the laboratory and then small pilot scale units.

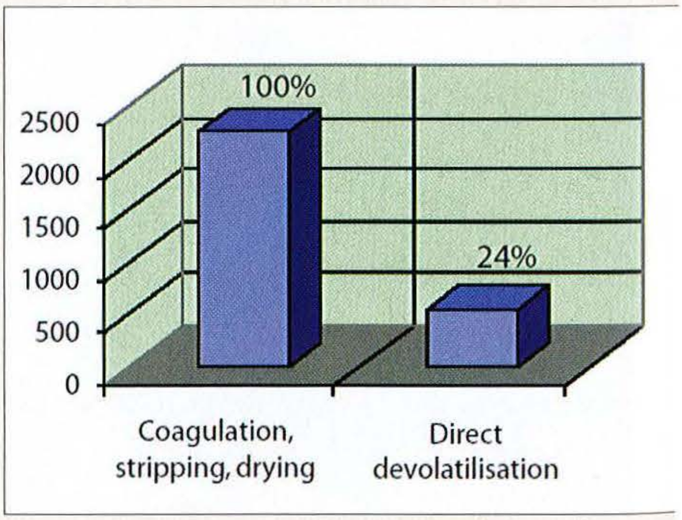

Figure 5: Comparison of the energy consumption between elastomer treatment technologies

Benefits of LIST Process
Efficient processing of sensitive elastomers with highly adhesive nature
Able 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.

Table 1: Benefits of LIST Direct Devolatilisation Technology over Conventional Process

The team installed a fully automated mini plant at LIST AG headquarters in Arisdorf, Switzerland. This enabled interested and potential users to test the LIST Direct Devolatilisation process with their own elastomer solution. Customers were able to run their samples and analyse them for consistency and quality on site.

The LIST Direct Devolatilisation process was then scaled up for implementation on a semi-industrial scale at the "Pilot Plant Center for Polymer Synthesis and Processing" (Figure 3) at the Fraunhofer Gesellschaft, an independent research and development institute in Schkopau, Germany. The Pilot Plant Centre is equipped with LIST's specialised Polymer-processing technology, and is capable of performing the newest polymerisation, polycondensation and reactive compounding processes.

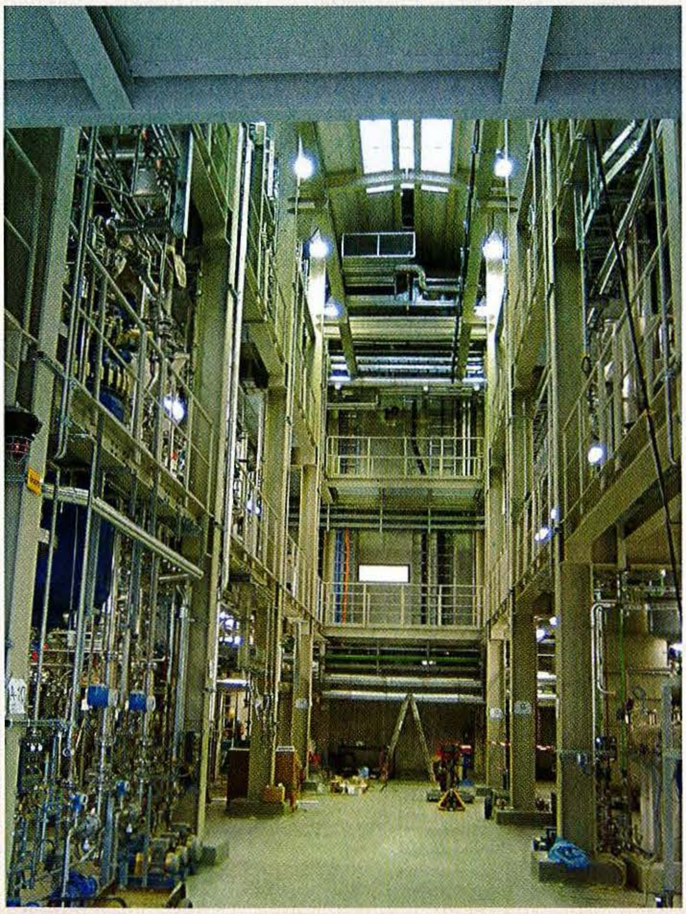

Figure 6: Pilot facility offered by LIST for Proof of Concept (POC)

The Pilot Plant Center installation allows LIST engineers validate the process development from the R&D lab, ve performance on a continuous large-scale pilot proce and closesly evaluate the process during extended peric of operation and with with hunderts of tonnes of elaston solution. It also provides the team with production samp for application testing, validation of time-extensive process and product stability, comparison of different process technologies.

The installed LIST processing technology is designed for continuc and batch operation, and the testing capacities range fr 3 to 50 kg/h final product. ■


Authors' Detail

Andreas Diene

Product Manager and Exper

LIST AG, Switzerlan

E mail: andreas.diener@list.c

Raghunatha Kulkarn

Managing Director - LIST AG Indi

Mumbai, Indi

Email : raghunatha.kulkarni@list.c