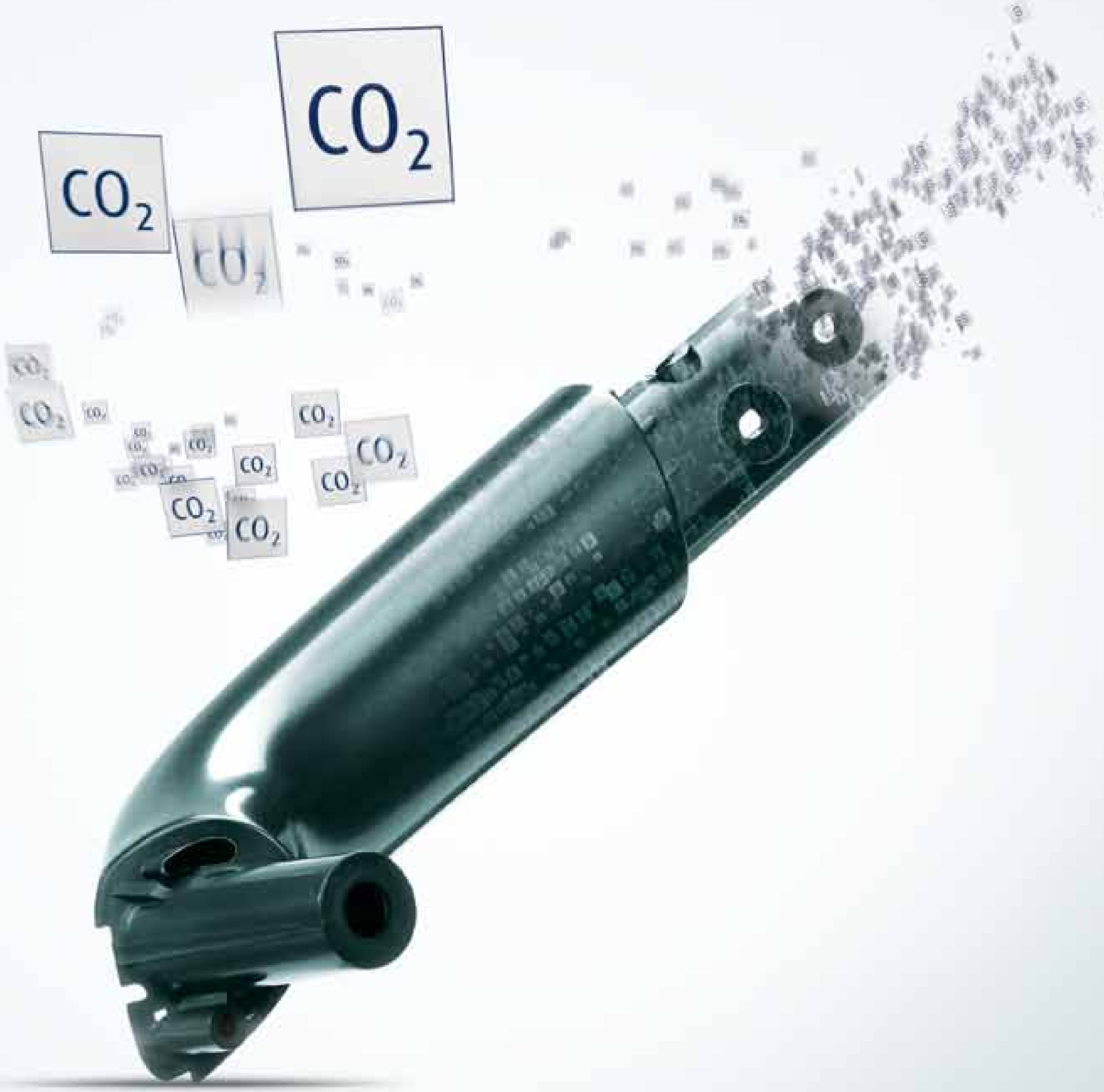
THE LINDE GROUP

Linde

PLASTINUM® GIM C.

Gas injection moulding with improved productivity and reduced cycle times.



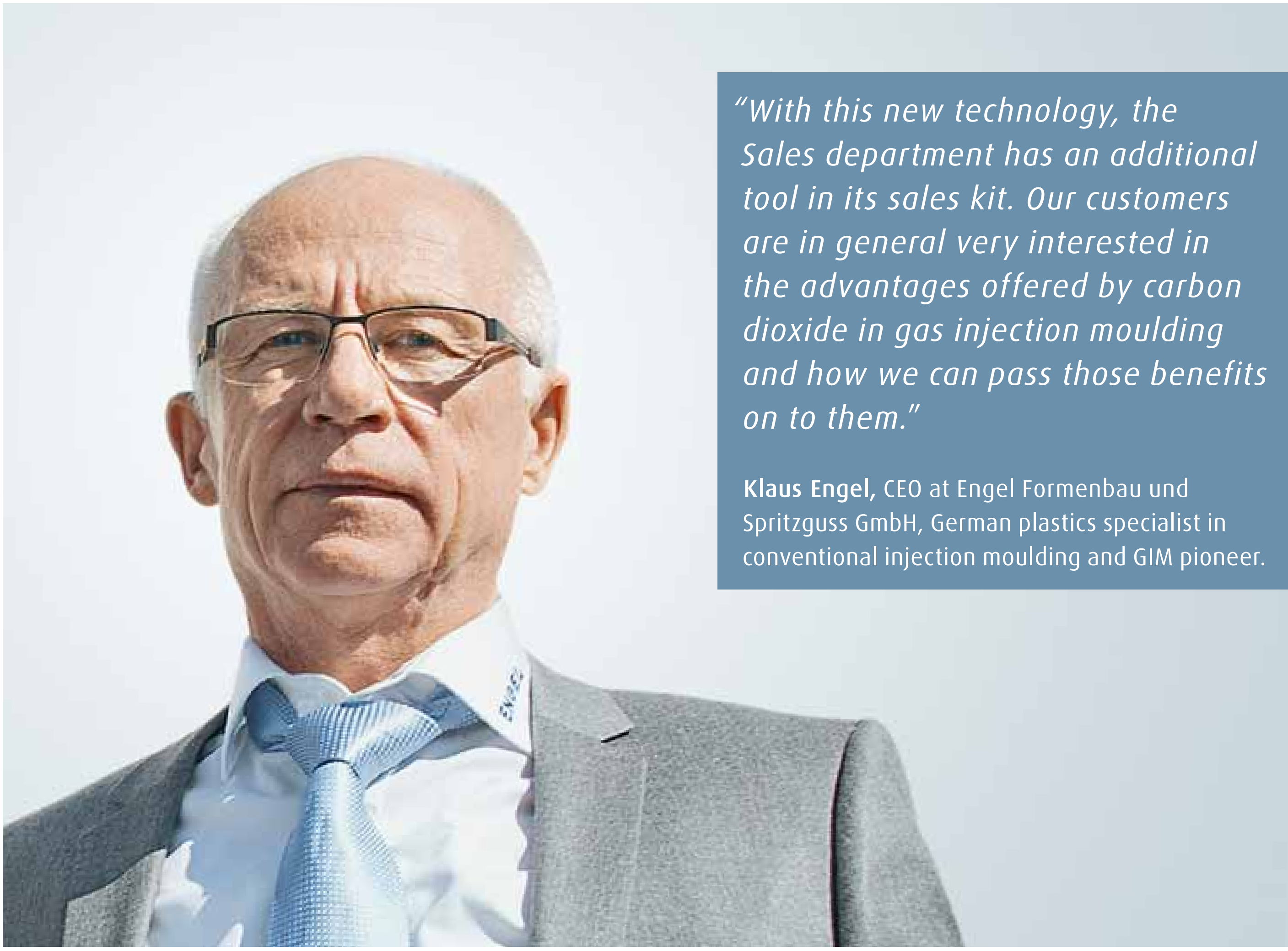
Meeting today's challenges in plastics.

Demand for injection-moulded plastic parts is rising, as are expectations surrounding the surface quality of such parts. To meet market and design challenges, many manufacturers rely on gas injection moulding (GIM) processes. GIM plastic parts not only consume fewer raw materials and weigh a lot less than solid parts, they are also extremely rigid and offer greater dimensional stability.

Gas injection moulding (GIM) with nitrogen (N_2), for instance, is typically used to manufacture handles for cars and white goods, automotive panels and similar parts with relatively thick cross-sections. However, nitrogen does not contribute to the cooling process due to its low density and specific thermal capacity, with the result that the moulded part is cooled almost only from the outside. In addition, N_2-based GIM systems can be prone to clogging as a result of oxidised residue from polymers and additives building up in the injectors and supply systems, resulting in unwanted downtime.

Water injection moulding (WIM) has the potential to accelerate cycle times. Although it offers good heat removal and pressurising performance, it nonetheless comes with a number of drawbacks. It is more complex and unpredictable than gas-based alternatives, and the required hardware is considerably more expensive. Practical disadvantages include the need for drying and the risk of water leakage, resulting in production stoppages, higher reject rates and – in extreme cases – tool damage.

As a leading supplier of cutting-edge, gas-enabled solutions to the plastics industry, we are committed to overcoming the drawbacks of WIM through gas-assisted alternatives that reduce total cost of ownership, improve reliability and lower scrap rates with similar cycle times. Working in close collaboration with our technology partner Maximator, specialist in high-pressure equipment, we thus enhanced standard GIM methods based on nitrogen with our patented inner cooling process and cavity inerting solution. These highlights deliver value to customers by shortening cycle times and improving the dimensional stability of parts moulded with nitrogen.



"With this new technology, the Sales department has an additional tool in its sales kit. Our customers are in general very interested in the advantages offered by carbon dioxide in gas injection moulding and how we can pass those benefits on to them."

Klaus Engel, CEO at Engel Formenbau und Spritzguss GmbH, German plastics specialist in conventional injection moulding and GIM pioneer.


eco
60°
90°
40°
60°
40°

Infrared picture shows the temperature of a refrigerator handle 16 seconds after opening the mould. With carbon dioxide (right), the part cools down faster than with nitrogen (left).

Reduced cycle time: The production time of refrigerator handles decreased by 36%.

The next level – PLASTINUM® GIM C.

To increase the competitive and technical gains offered by GIM with N_2 even further, we (with Maximator) went on to develop our patented PLASTINUM® GIM C portfolio. By replacing nitrogen with liquid carbon dioxide (CO_2), PLASTINUM GIM C takes efficiency to a whole new level.

While CO_2 matches the heat removal performance of WIM, it has the added advantage of eliminating an additional drying step in the fluid injection cycle. At a minimum pressure of 150 bar, liquid carbon dioxide almost matches the density of water. Additionally, CO_2 – while offering similar pressurising performance to nitrogen-based GIM – has a higher specific heat capacity and creates a lot of additional cooling power when it expands at the end of the pressure cycle.

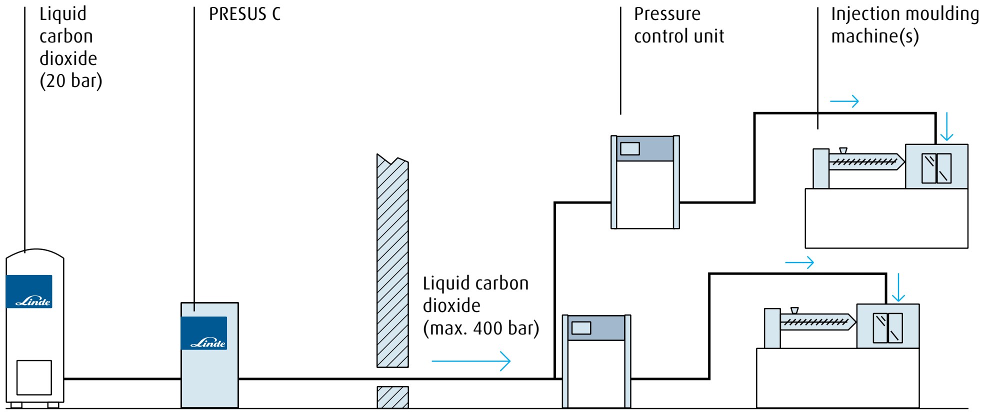
In summary, compared with nitrogen, CO_2 can shorten cycle times for polypropylene and polyethylene parts by 20% on average. In the case of materials such as ABS, PC/ABS, polycarbonate and polyamide, efficiency gains of 30% or even 40% are feasible depending on the installation and part geometry. The larger the moulding machine, the greater the potential saving for plastics manufacturers.

Benefits relative to GIM with nitrogen
→ Up to 40% shorter cycle times
→ Rapid process conversion from N_2 to CO_2
→ Less clogging of gas injectors due to self-cleaning effect of CO_2
→ More efficient to boost pressure of liquid CO_2 than to compress gaseous N_2 due to thermal dynamics

Benefits relative to water injection moulding
→ Greater process control without risk of water leaks
→ Less complex and expensive equipment needed
→ Comparable or even shorter cycle times

GIM with CO_2 is ideal for
→ Parts with wide gas channels and long cycle (cooling) times caused by the gas channels, e.g. large handles (white goods, automotive parts)
→ Parts produced with higher gas injection pressures (at least 150 bar)

Schematic of high-pressure carbon dioxide supply concept with PRESUS C



All-in-one technology package.

PLASTINUM GIM builds on our PRESUS® family of cost-effective, high-pressure gas supply solutions for both N_2 and CO_2.

PRESUS C is an energy-efficient, single-stage pressure boosting unit for CO_2-based moulding processes. It is one of the core building blocks in our end-to-end CO_2 supply concept, rounded off with a liquid storage tank and CO_2 pressure control unit. The entire package has been specially developed to maximise the cooling performance of CO_2. In addition, our plastics experts can work with you to optimise the mould and injector setup to fully exploit the potential of injection moulding with CO_2.

Benefits of PRESUS C

- Simple and inexpensive installation
- No additional pressurising devices required
- High degree of reliability – proven by numerous customer installations
- Up to 95% lower energy consumption
- Oil-free operation compared with gas compressors

The pressure control unit for a stable GIM process and high-quality results is the outcome of ongoing development collaboration between Linde and Maximator.

The PRESUS C ensures a steady supply of high-pressure liquid carbon dioxide for gas injection moulding

The CO_2 pressure control unit offers an intuitive user interface for adjusting process parameters.

Success through close collaboration.

We complement our extensive PLASTINUM suite of technologies with a rich portfolio of hands-on services to ensure you are investing in the technology that offers your specific process flow the greatest optimisation potential. Typical lifecycle services include:

- Feasibility check of your products and processes for CO_2-based GIM
- Selection of a part for CO_2 GIM tests, also changing gas injector if necessary and feasible
- Trials with demo CO_2 compressor control module, supplied with CO_2 cylinder bundle
- Comparisons of the quality and infrared pictures of the moulded parts using the basic N_2 process and the CO_2 process with different trial settings and cycle time reductions
- Cost-benefit calculation based on trial results
- Installation of complete PLASTINUM GIM C system, including CO_2 bulk tank, pressure boosting (PRESUS C) and pressure control solution
- Full commissioning service and support
- Aftersales service / maintenance

For more information, please visit www.linde-gas.com/plastinum or send an email to plastics.rubber.team@linde.com

The environmentally friendly option

Carbon dioxide (CO_2) is used across a broad spectrum of industrial applications, plastics included. Like all gases, it must be stored and used correctly and safely – and this calls for specialist knowledge. We have developed a package of dedicated product stewardship services, which includes education and consulting, to support you in the safe handling and use of this gas. Committed to mitigating the effects of climate change, we seek to minimise our carbon footprint by recycling CO_2 instead of generating new streams of this gas. Consequently, around 80% of the CO_2 that we supply comes from chemical processes where the CO_2 occurs as a by-product – such as ammonia synthesis or ethylene oxide production. And the remaining 20% of the CO_2 we deliver originates from natural sources.

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