

Linde Gas

*Linde*

Solutions that are ideally suited  
to the needs of the plastics industry.



# Don't be satisfied with solutions that are anything less than perfectly adapted to your needs.

The plastics industry, divided into a number of processing segments, has today an increasing need for competitive technical solutions to achieve increased productivity, meet high product quality and environmental demands.

To fulfil the processing industry needs, Linde offers know-how and a specific product portfolio for each market segment, which supports the customer with all gas-related technologies and creates the customer value in the form of increased capacity, product quality and profitability.

## Linde Gas Offer

- Total gas supply solutions
- High-pressure systems
- Metering systems
- Cooling technologies
- Patented solutions

## Plastics Industry Processes

- Injection moulding
- Extrusion
- Foaming
- Blow moulding

## Customer Benefits

- Better efficiency
- Lighter parts
- Higher product quality
- Increased profitability
- Fulfilment of environmental demands



# Get the most from innovations in gas technology.

## Injection Moulding Processes – higher efficiency and reduction of cycle time.

### Gas Injection Moulding (GIM)

offers improved product quality, part weight reduction, cost savings on resin and reduced cycle times. In GIM nitrogen is injected under high pressure in the melted polymer in order to create hollow parts.

### GIM inner cooling

gives cheaper, lighter and stronger parts. It can be used for any product where the hollow is shaped like a pipe. It will allow nitrogen at high pressure, already available in the GIM, to flow through the product and remove heat from the inside.

This type of cooling reduces the cycle time and improves efficiency. The inner surface of the product is smoother and the dimensional accuracy of the product is improved.

### Spot cooling

can be applied to all types of products where the cooling time shall be reduced and the product quality has to be high. It is mainly used to improve the cooling of very thin parts of the mould, e.g. cores. By controlled injection of liquid CO<sub>2</sub> into a cavity placed in the mould towards a hot spot, an extra cooling effect is created to balance the total cooling of the part.

Spot cooling installation is cheap and simple.

### Microcellular foaming

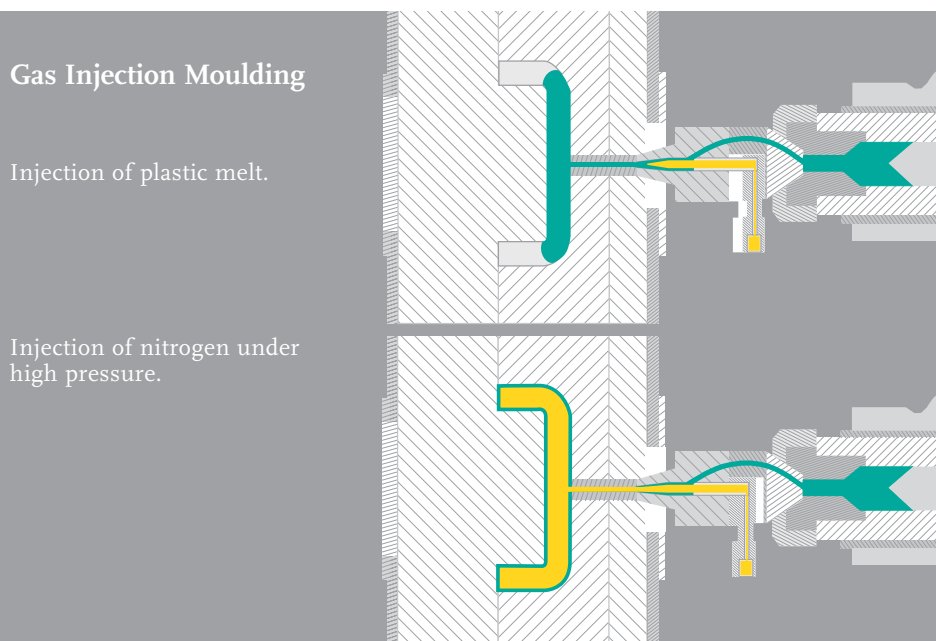
uses CO<sub>2</sub> or nitrogen as foaming agents. It gives very small and uniform bubbles. This gives considerable reduction of density with satisfying mechanical strength.

The savings are obvious on material and the product weight is reduced. Besides that, the clamping force is lower and the cycle time is reduced. The technology has been developed for injection moulding but it can also be used in extrusion.

### ToolVac®

patented technology for cooling of the mould by using porous steel to let CO<sub>2</sub> evaporate in the mould.

® ToolVac is a registered trademark of the Linde Group.



## Extrusion Processes

### Extrusion inner cooling – increased capacity and quality

In addition to external cooling with water, extruded profiles with hollow chambers or pipes can be cooled internally with carbon dioxide.

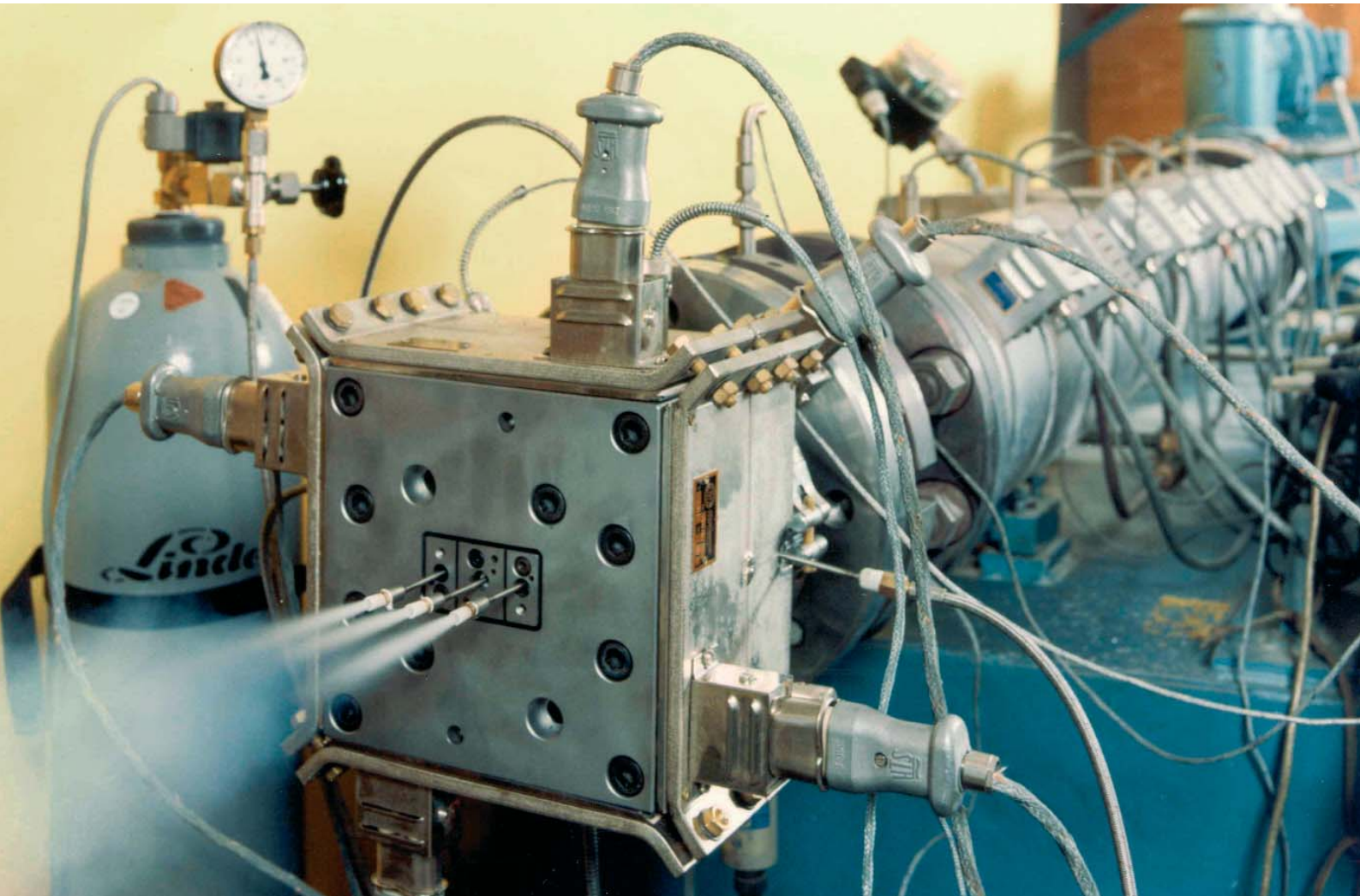
Liquid carbon dioxide flows in small tubes through the hot extrusion die. The expansion of liquid CO<sub>2</sub> inside the profile creates a cold gas jet, which removes heat from the

inner walls of the profile. The warm gas is discharged from the profile at the end of the production line.

The inner cooling technology increases extrusion capacity while investment costs are very low. The homogeneous cooling of the profile decreases warp and the product quality is improved. There are no residues and no moisture inside the profile.

This patented technology is mainly interesting for profiles or pipes with thick walls and walls that cannot be cooled directly from the outside or for extrusion lines with limited cooling sections.

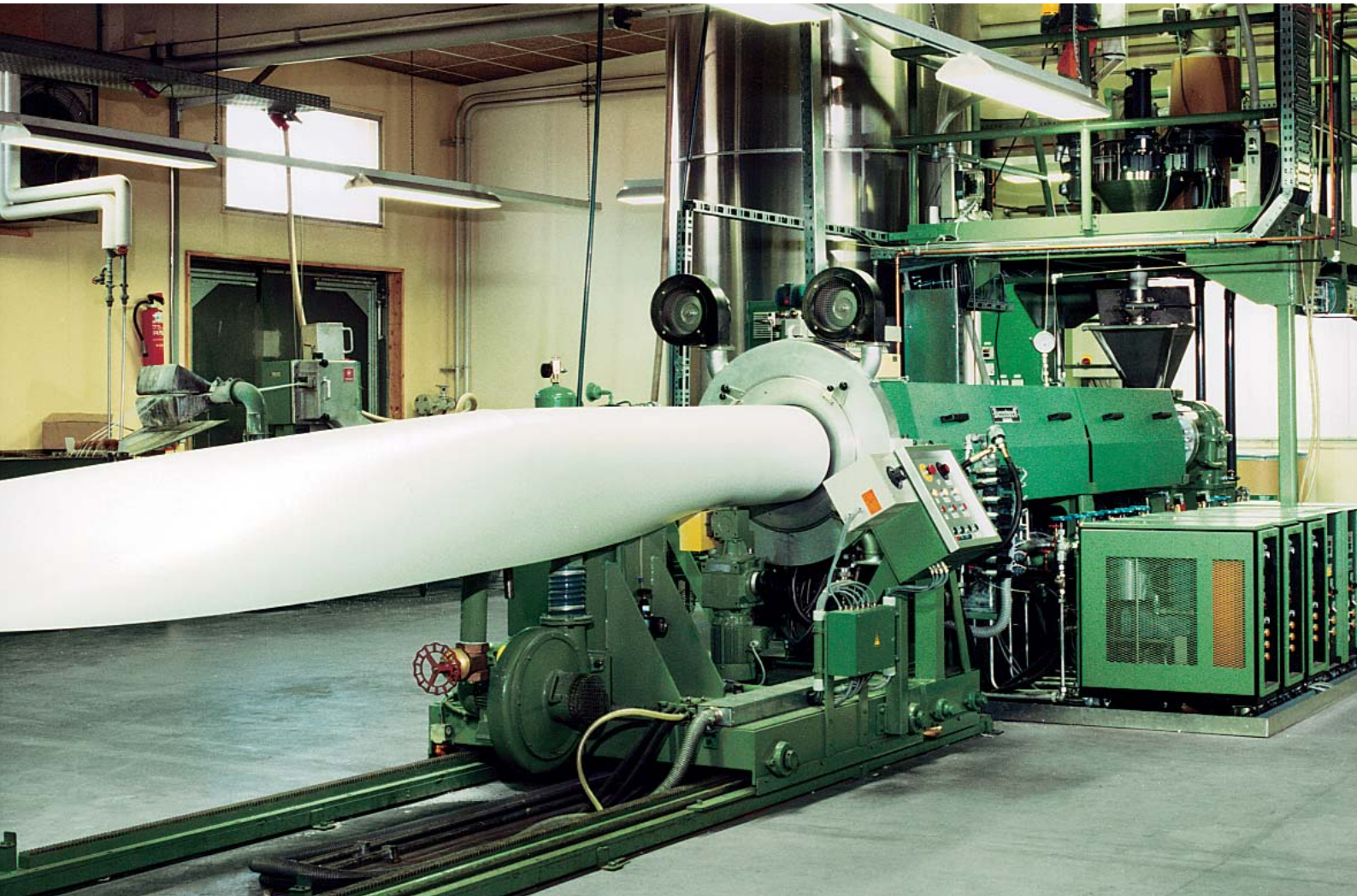
Furthermore, the cooling effect is controlled very precisely, which gives possibility to use the process even for small chambers.



### Extrusion foaming – lighter polymer foams

The use of physical blowing agents technology generally leads to higher degrees of foaming, giving lighter parts and a lower consumption of raw material. A homogeneous cell structure of polymer foamed with physical blowing agents results in lighter products that can be used in a wide range of applications in the packaging, automotive,

electronic and construction industries. CO<sub>2</sub> or nitrogen are mainly used to foam polystyrene (insulation boards or foam sheets), polyethylene (cable insulation) or polypropylene, but also new foamed polymers like e.g. PET.



## Polyurethane (PUR) Foaming

### Lighter foams/better environment

Carbon dioxide for PUR foams is a viable alternative in continuous and discontinuous foaming processes. High-pressure supply systems and metering devices developed by Linde in close co-operation with industrial partners are very efficient and fulfil new technological requirements.

In addition to environmental aspects, the CO<sub>2</sub> technology brings economical advantages of which the main are optimum raw material consumption and reduction of foam scrap. Besides that, the lower densities foams produced with CO<sub>2</sub> as a blowing agent possess very good quality and the homogeneous cellular structure.

## Blow Moulding

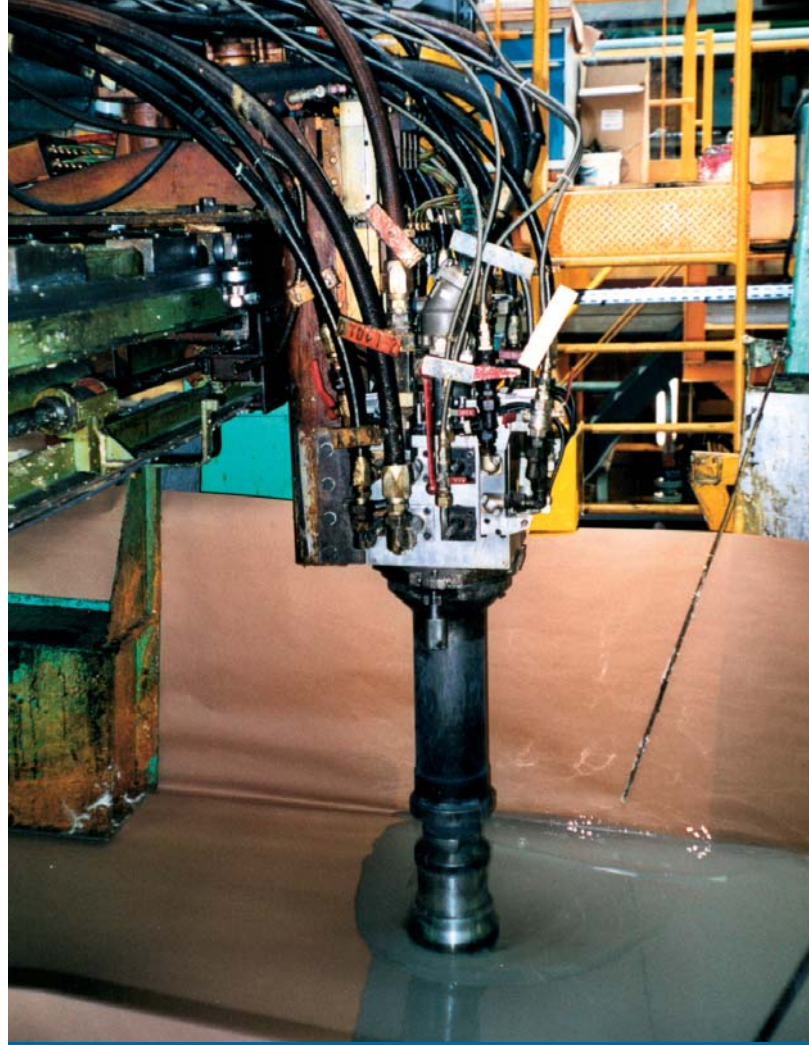
### Increased productivity, better quality

The use of cryogenics for internal cooling, mainly liquid CO<sub>2</sub> or liquid nitrogen, gives much more efficient heat transfer compared with cooled air.

The cryogenic is injected into the blown part, followed by vaporization inside the hollow part and exhausting of the coolant as hot gas through the blow pin exhaust.

This method increases productivity through more effective utilization of machines and quality of the produced article. The dimensional stability of the moulded part is improved as the cooling of the polymer is controlled.

The parts most suitable for cooling with LIN are thick-walled parts with long cycle and cooling times, such as household containers, fuel tanks, drums and garbage cans.



# No matter how varied your processes, choose the best supply. With Linde Gas.

## Total gas supply solutions

For plastic processes Linde can offer the most suitable supply technology based on the customer's specific needs. All economical and technical aspects are taken into consideration.

- Optimal gas supply concept with cylinders or cylinder bundles for tests or at the start phase of production

- Vacuum insulated tanks for liquid nitrogen or carbon dioxide, mainly for full-scale production

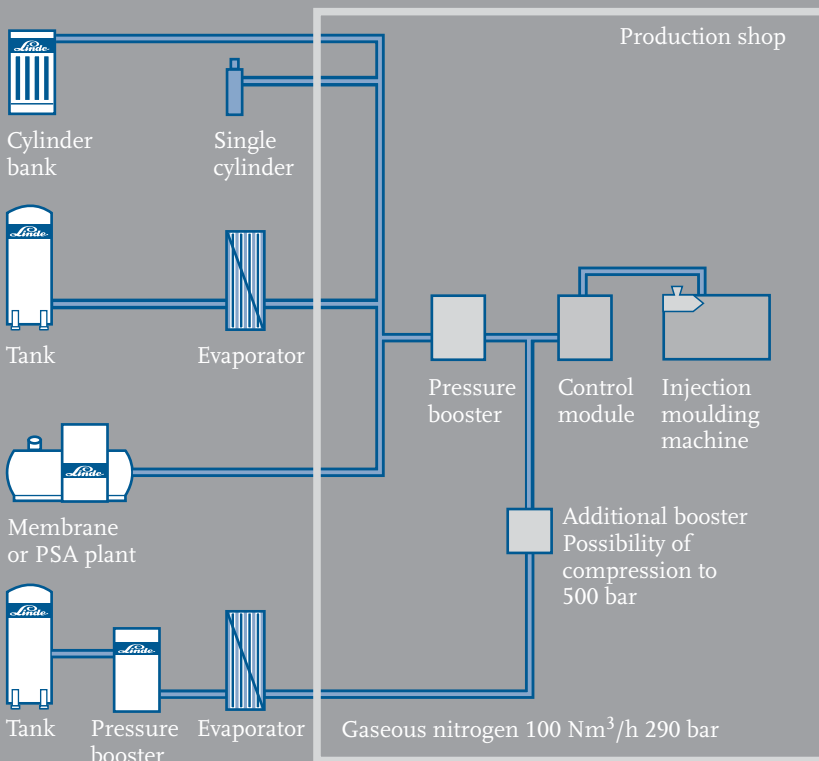
- Nitrogen generators on site with membrane or PSA plants

- Pressure boosting and metering systems for nitrogen and CO<sub>2</sub>

## High-pressure supply and metering systems

The successful use of gases in plastic processes depends on the ability to meet several key process parameters. Of these, the most important is being able to supply the gas to the process in gaseous, liquid or supercritical form and at the required pressure. Linde can offer the most suitable solution for each plastic technology.

### Nitrogen supply solutions for gas injection moulding



### Supply system for Gas Injection Moulding DESY® 300/100

In this system, the nitrogen is compressed up to 290 bar in the liquid state. After the DESY® 300/100, the liquid nitrogen is evaporated in a high pressure evaporator.

For pressure requirements over 300 bar, an additional booster operated with very low energy consumption can be used.

Main advantages are:

- Very low energy requirements due to cost-effective liquid compression
- The DESY® 300/100 pumps exactly the quantity of nitrogen which is required by the user, even when strong fluctuations in demand occur
- The unchangingly high quality of the injection moulded parts is achieved because of the very pure and oil-free nitrogen

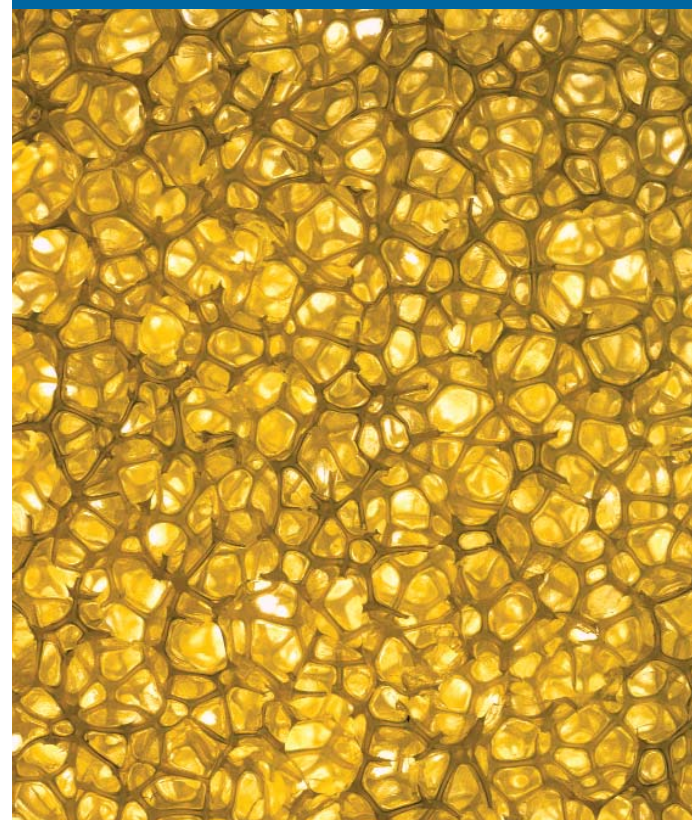
® DESY is a registered trademark of the Linde Group.

### Supply and metering systems for extrusion foaming

- Liquid CO<sub>2</sub> pump system or compressor station – for use with CO<sub>2</sub> tank
- DSD 500 metering device – for use with CO<sub>2</sub> or N<sub>2</sub>, supplied in cylinders, bundles or CO<sub>2</sub> tank

### Supply and metering systems for PUR foaming

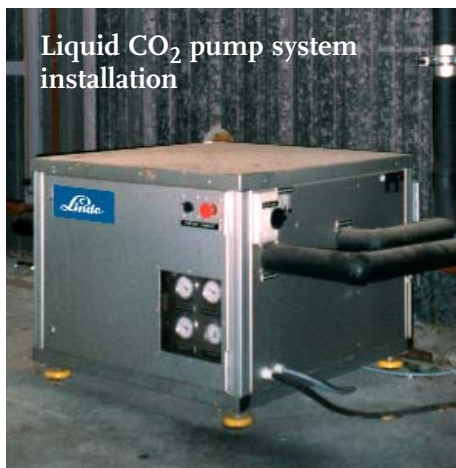
- Continuous process – CO<sub>2</sub> pump system
- Discontinuous process – CO<sub>2</sub> pump system and DSD 500 metering device



## Equipment for foaming

### Liquid CO<sub>2</sub> pump system

This low-pressure pumping system, up to 70 bar, recycles liquid CO<sub>2</sub> between the refrigerated liquid carbon dioxide storage tank and the high-pressure pump of the foaming system. Linde has a wide range of efficient pumping systems. The choice of system will depend on the customer's process requirements.

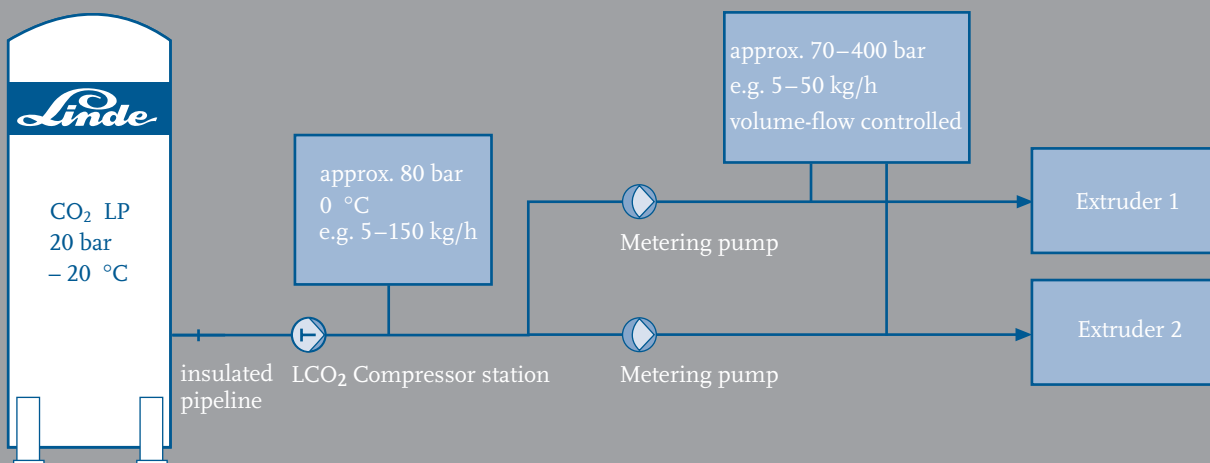


### Liquid CO<sub>2</sub> compressor station

The station pressurizes liquid CO<sub>2</sub> out of a low pressure tank to pressures up to 80 bar, or higher if required. It can be used to supply any kind of dosing pumps with bubble-free CO<sub>2</sub> with decreased compressibility.

The CO<sub>2</sub> pressure can be regulated according to the demand. The output adjusts automatically to the demand, also if the demand is fluctuating. The installation is simple and inexpensive as one pipeline to the following dosing pump is sufficient.

## Liquid CO<sub>2</sub> compressor station





### Inert gas metering device DSD 500

The inert gas metering device DSD 500 enables exact metering of inert gases, especially liquid CO<sub>2</sub> to an extruder, an injection moulding machine or a PUR foaming machine.

The patented DSD 500 consists essentially of a compressor, a flow controller and a special control valve.

The flow rate is measured extremely accurately and independent of pressure, temperature and type of gas. A highly dynamic regulating valve adjusts metering automatically to the pressure conditions in the extruder.

Another advantage compared to other metering systems is that the DSD 500 can also be used to meter gaseous blowing agents, e.g. nitrogen.

### Cooling technologies

During processing of plastics high temperatures are used in order to obtain adequate properties of products. The plastic processing industry can benefit from the use of liquid nitrogen or carbon dioxide as cooling media in various processes. Cryogenic cooling removes heat simply and effectively.

Linde offers customer-designed injection and control systems, suitable cooling nozzles and efficient liquid gas supply in order to eliminate the use of cooling water, refrigerators, or large amounts of cooling air, consequently reducing environmental issues while emphasizing cooling performance.



## As versatile as your products – Linde Gas service portfolio.

### Linde expertise and know-how in gas technology.

Working in close co-operation with customers, Research and Development institutes, and equipment manufacturers, Linde possesses know-how and long experience in plastic processes. Linde's knowledge and gas technologies offer the most suitable and cost-effective solutions to new and existing processes.

For new-coming technologies Linde, in close cooperation with each customer segment optimizes the technology to reach new product requirements.

Our patented solutions create added value for our customers.



# Getting ahead through innovation

With its innovative concepts, Linde Gas is playing a pioneering role in the global market. As a technology leader, our task is to constantly raise the bar. Traditionally driven by entrepreneurship, we are working steadily on new high-quality products and innovative processes.

Linde Gas offers more. We create added value, clearly discernible competitive advantages and greater profitability. Each concept is tailored specifically to meet our customers' requirements – offering standardized as well as customized solutions. This applies to all industries and all companies regardless of their size.

If you want to keep pace with tomorrow's competition, you need a partner by your side for whom top quality, process optimization and enhanced productivity are part of daily business. However, we define partnership not merely as being there for you but, more importantly, with you. After all, joint activities form the core of commercial success.

**Linde Gas – ideas become solutions.**



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