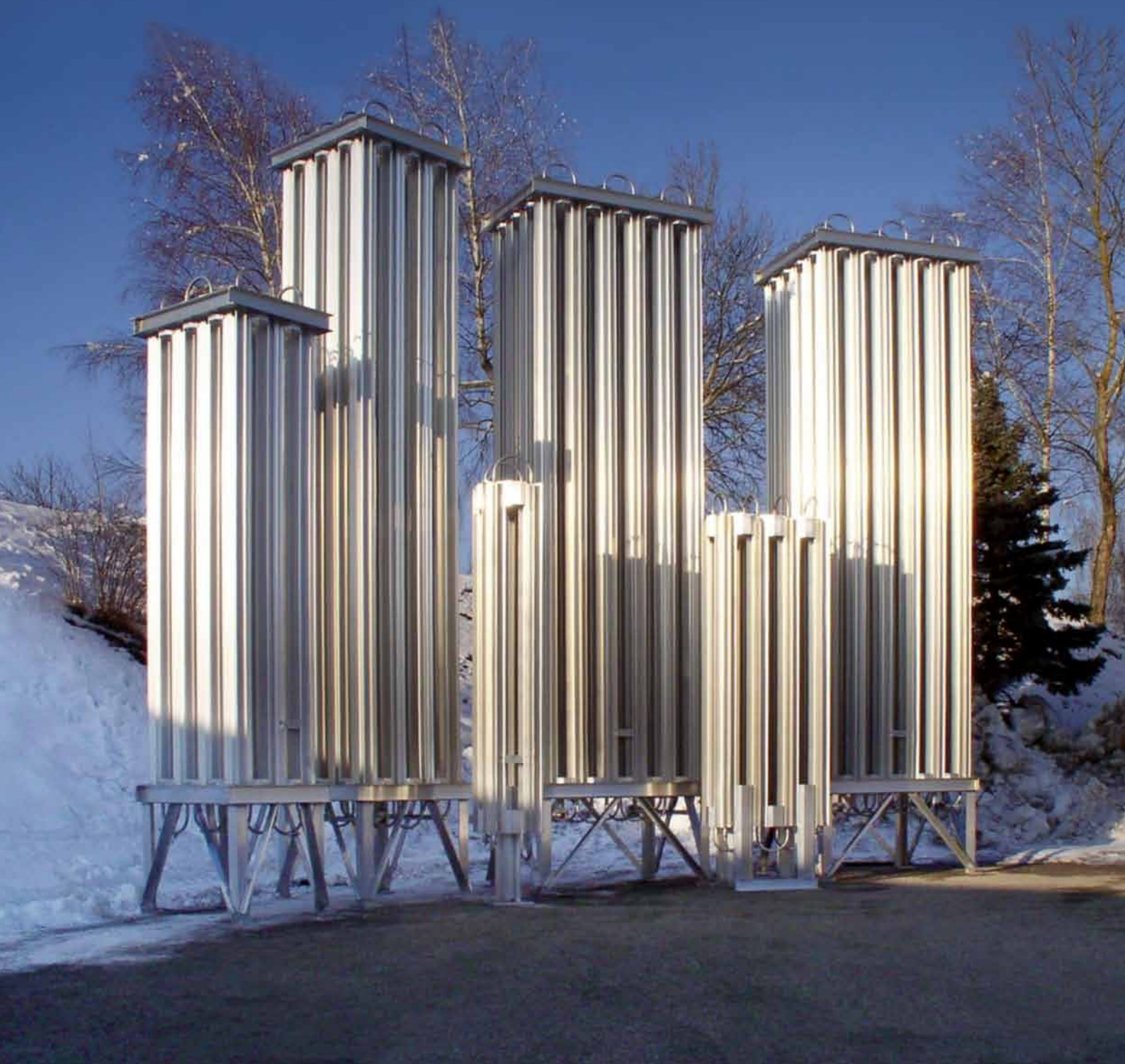


THE LINDE GROUP

*Linde*

# Air-heated Vaporisers



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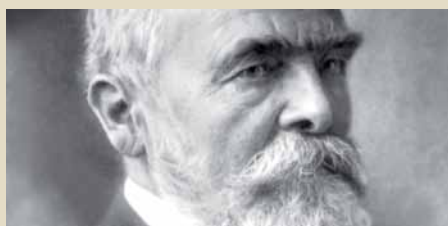
# Introduction.

Carl von Linde - gifted engineer, scientist, entrepreneur, company's founder and eponym of the Linde AG.

With air liquefaction, Carl von Linde created the conditions needed to produce pure gases using low-temperature processes. Air liquefaction was only the first step for Carl von Linde towards a commercially viable use for his invention. His goal was to separate the liquid air, while re-evaporating it, into its constituents, since only these held promising industrial potential.

Carl von Linde created a new industry within just a few decades: refrigeration. His company was characterised from the very first beginning by innovativeness and close customer relations. This is what Linde stands for – in the past, today, and in face of future challenges, world-wide.

Linde as the world leader in adsorption technology has designed and supplied more than 400 PSA plants – including the world's largest units and units with highest availability.



*Dr. Carl v. Linde.*

# General.

The recovery of large quantities of gases such as oxygen, nitrogen and argon is carried out through cryogenic decomposition of air. In the cryogenic (very cold) then condensed (liquid) states, these gases only take up around 1/800 of the volume they would require in the gaseous state which is the reason why storage for consumers is carried out as a fluid in thermally-insulated tanks at temperatures down to minus 269°C. If required, the liquid gas is vaporised in a downstream vaporiser.

The technical principle is simple and fail-safe: The vaporisers work without external energy through exchange of heat with the surrounding air. This way, the liquefied gas is vaporised, warmed to almost the surrounding temperature, and finally led to the users in its gaseous state.

One thing we know:  
Optimal efficiency, great ease of maintenance,  
operating safety, environmental compatibility  
and quality, combined with long life, are the  
decisive factors in your satisfaction as a customer.





## Lead-VAP

### The new generation.

Save energy costs and investments with the new generation of Lead-VAP for cryogenic gases. This generation of all aluminium vaporisers ensures maximum air circulation due to optimized fin and vaporiser geometrics.

A full range of ambient air heated vaporisers in different versions and for different customer applications.

#### Design

- According to PED 97/23/EC; CE-marked
- Max. allowable working pressure 40 bar
- Cleaned for oxygen service
- Wind-loads up to 160 km/h (100 mph)
- Seismic requirements acc. to uniform building code-zone 4
- Low pressure drop
- Efficient fin tube design
- Optimised external and internal surfaces for optimum convection

#### Benefit

- Maintenance-free aluminium design
- Low weight
- Corrosion and temperature resistant
- Easy to assemble - no welding or brazing required
- Screwed connections at in- and outlet for models up to 350 Nm<sup>3</sup>/h
- Space-saving design, intensive convection
- Long lifetime

## Special-VAP

### Quality for special use.

For special requirements, use the well proven vaporisers from our Special-VAP series.

For operating pressures up to 400 bar, you can select your high-pressure vaporiser from three standard sizes; for more stringent requirements on the purity of gases, we offer standard vaporisers in special "High Quality"

design. Clip-on vaporisers and pressure build-up evaporators round off our product range.

#### Design

- According to PED 97/23/EC; CE-marked
- Max. allowable working pressure 40 bar (for high pressure types 400 bar)
- Cleaned for oxygen service
- Low pressure drop
- Efficient fin tube design

#### Benefits

- Low weight
- Corrosion and temperature resistant
- Easy to assemble
- Space-saving design, intensive convection
- Long lifetime



# Standard design.



The vaporisers are suitable for a design overpressure = max. allowable working pressure (PS) of 40 bar and a allowable operating temperature range (TS) of +50/-269°C.

Design and testing was carried out in accordance with the directive 97/23/EC concerning pressure equipment, AD 2000-Merkblätter and DIN EN. The connecting flanges are DIN EN compliant.

The Linde finned tubes and connecting flanges are made of aluminium alloy and the seals formed according to Linde standards. Variations defined by specific order instructions are possible. The stressing of the materials used, at low temperatures for example, was taken into account during their selection.

## Explanation of type designation:

- L = air heated
- 40 = max. permissible working overpressure: 40 bar
- 8 F = number of Finned tubes: 8
- 3 = length of single finned tube: 3 m

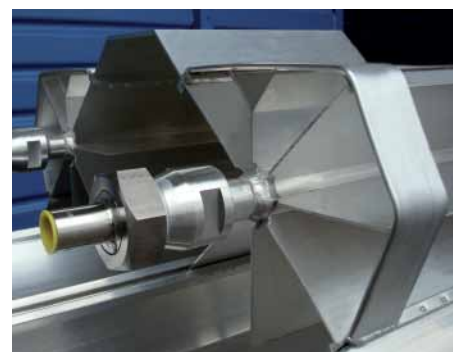
Partly the vaporisers have different foot stand of length, evident by an additional characteristic letter (-S; -L) of the type designation, for example L 40 - 30 F 6 - S.

## Explanation:

- S = short version = 600 mm footing <sup>a)</sup>
- L = long version = 900 mm footing



Flange - counter flange connection DN 40 / PN 40



Screwed connection M40 x 2 as well as pipe connection. To protect the operating staff when connecting the intervening pipelines, Linde evaporators are fitted with edge protection.

vaporiser type	dimensions approx.			weight empty	nominal capacity*)	connections (inlet/outet)	Linde ident-no.
	depth [m]	widht [m]	height[m]	[kg]	N <sub>2</sub> [Nm³/h]	[mm]	
L 40 - 30 F 6 - L	1,84	1,54	7,14	788	1000	flange/counter flange DN 40 / PN 40	M83562
L 40 - 30 F 6 - S	1,84	1,54	6,84	778			M59970
L 40 - 24 F 6 - L	1,84	1,24	7,14	644	800		M83563
L 40 - 24 F 6 - S	1,84	1,24	6,84	635			M69789
L 40 - 16 F 6 - L	1,24	1,24	7,14	450	520		M83564
L 40 - 16 F 6 - S	1,24	1,24	6,84	442			M69785
L 40 - 16 F 4 - L	1,24	1,24	5,14	3,27	350	screwed: M40 x 2 pipe: DN 25 (33 x 2,4) socket welding end: ø 28,3	M76127
L 40 - 16 F 4 - S	1,24	1,24	4,84	320		M69784	
L 40 - 12 F 4 - L	1,24	0,94	5,14	259	260	screwed: M40 x 2 pipe: DN 15 (21,3 x 1,5) socket welding end: ø 18,2	N08413
L 40 - 12 F 4 - S	1,24	0,94	4,84	250			M70106
L 40 - 8 F 3	0,72	1,12	3,86	111	130		M71496
L 40 - 4 F 3	0,72	0,52	3,84	58	62		M71591

\*) The capacity is based on an ambient temperature of 20°C, 70 % rel. humidity, 15°C temperature difference between ambient and gas outlet temperature at a continuous 8-hours-operation

a) Standard vaporiser design is the long version; price and delivery time for the short version available on special request



Range of Lead-VAP run production,  
beginning in front with type L 40 - 4 F 3



# HQ-standard design.



The Special-VAP HQ-standard design is specially designed for higher quality fluids.

The vaporisers are suitable for a design overpressure = max. allowable working pressure (PS) of 40 bar and a allowable operating temperature range (TS) of +50/-269°C.

Design and testing was carried out in accordance with the directive 97/23/EC concerning pressure equipment, AD 2000-Merkblätter and DIN EN. The material of the pipes, pipe bends and caps is corrosion-resistant austenitic CrNi-steel.

In general air heated vaporisers consist of light metal tubes with longitudinal ribs (finned tubes with star-shaped cross-section). HQ-vaporiser are made in "duplex"-design, consisting of CrNi-steel pipes inserted into aluminium finned tubes for increased transfer of heat.

Factory-made, the inlet and outlet openings of the HQ-vaporiser are sealed gas-, dust- and moisture tight with shutter caps as well as in condition of low overpressure by protective gas.

Explanation of type designation:

- L = air heated
- 40 = max. permissible working overpressure: 40 bar
- 8 F = Number of Finned tubes: 8
- 3 = length of single finned tube: 3 m
- HQ = to be suitable for Higher Quality fluids

Remark: standard vaporiser design is the long leg version (L = 900mm)



Left image shows the conventional construction of a finned tube with star-shape cross-section; right image shows the "duplex"-design consisting of an austenitic steel pipe inserted into a aluminium finned tube.



Inlet and outlet openings are sealed gas- and dust tight with caps, which must cut off prior installation. For highest purity and in order to avoid moisture tight in the course of carriage and stocking the HQ-vaporisers are delivered in condition of low overpressure by a protective gas.

vaporiser type	dimensions approx.			weight empty	nominal capacity*)	connections (inlet/outlet)	design	Linde ident-no.
	depth [m]	widht [m]	height[m]	[kg]	N <sub>2</sub> [Nm <sup>3</sup> /h]	[mm]	[mm]	
L 40 - 30 F 5,8 - HQ	1,84	1,54	6,976	960	660	pipe: DN 40 (48,3 x 2) material: stainless steel	“duplex” (CrNi-steel pipes inserted into aluminium finned tubes)	L06453
L 40 - 24 F 5,8 - HQ	1,84	1,24	6,976	796	530			N23418
L 40 - 16 F 5,8 - HQ	1,24	1,24	6,976	550	340			N47708
L 40 - 16 F 4 - HQ	1,24	1,24	5,106	399	230	pipe: DN 15 (21,3 x 2) material: stainless steel		N47706
L 40 - 12 F 4 - HQ	1,24	0,94	5,106	312	170			N53823
L 40 - 8 F 3 - HQ	1,12	0,72	3,826	139	85			N47675
L 40 - 4 F 3 - HQ	0,52	0,52	3,836	72	40			N43865

\*) The capacity is based on an ambient temperature of 20°C, 70 % rel. humidity, 15°C temperature difference between ambient and gas outlet temperature at a continuous 8-hours-operation



Type L 40 - 30 F 5,8 - HQ still without connecting piping between the finned tubes. At all time during fabrication internal purity is guaranteed by protective covers.



# HD-standard design.



The Special-VAP HD standard design is specially designed for high pressure use.

The vaporisers are suitable for a design overpressure = max. allowable working pressure (PS) of 400 bar and a allowable operating temperature range (TS) of +50/-269°C.

Design and testing was carried out in accordance with the directive 97/23/EC concerning pressure equipment, AD 2000-Merkblätter and DIN EN.

The material of the pipes, pipe bends and caps is corrosion-resistant austenitic CrNi-steel.

HD-vaporiser are made in "duplex"-design, consisting of CrNi-steel pipes inserted into aluminium finned tubes for increased transfer of heat.

Factory-made, the inlet and outlet openings of the HD-vaporiser are sealed gas-, dust- and moisture tight with shutter caps.

Explanation of type designation:

L = air heated

400 = max. permissible working overpressure:  
400 bar

8 F = number of Finned tubes: 8

3 = length of single finned tube: 3 m

HD = to be suitable for high pressure use

Remark: standard vaporiser design is the long leg version (L = 900 mm)



For twenty years, we have offered vaporiser for high pressure use



Just like the HQ-types the openings of the HD-vaporiser are sealed gas-, dust- and moisture tight with covers, which must cut off prior installation.

vaporiser type	dimensions approx.			weight empty [kg]	nominal capacity*) N <sub>2</sub> [Nm <sup>3</sup> /h]	connections (inlet/outlet) [mm]	design [mm]	Linde ident-no.
	depth [m]	width [m]	height[m]					
L 400 - 30 F 5,8 - HD	1,84	1,54	6,976	957	660	pipe: DN 15 (21,3 x 2,9) material: stainless steel	"duplex"	Q76115
L 400 - 16 F 5,8 - HD	1,24	1,24	6,976	536	340			Q28666
L 400 - 8 F 3 - HD	1,12	0,72	3,826	139	85			Q76114

\*) The capacity is based on an ambient temperature of 20°C, 70% rel. humidity, 15 °C temperature difference between ambient and gas outlet temperature at a continuous 8-hours-operation





# Pressure build-up.



The vaporisers are suitable for a design overpressure = max. allowable working pressure (PS) of 40 bar and a allowable operating temperature range (TS) of +50/-196°C (HQ-type +50/-269°C).

Design and testing was carried out in accordance with the directive 97/23/EC concerning pressure equipment, AD 2000-Merkblätter and DIN EN.

The Linde finned tubes and connecting flanges are made of aluminium alloy and the seals are formed according to Linde standards. The HQ-type is made in "duplex"-design, consisting of CrNi-steel pipes inserted into aluminium finned tubes.

## Please take into consideration:

The data on the performance - that is, the withdrawal quantity of the product gas - depend on the operating pressure, and must therefore be requested separately.

## Explanation of type designation:

- LD = air heated - pressure build-up
- 40 = max. permissible working overpressure: 40 bar
- 5 F = number of Finned tubes: 5
- 4 = length of single finned tube: 4 m
- HQ = to be suitable for Higher Quality fluids

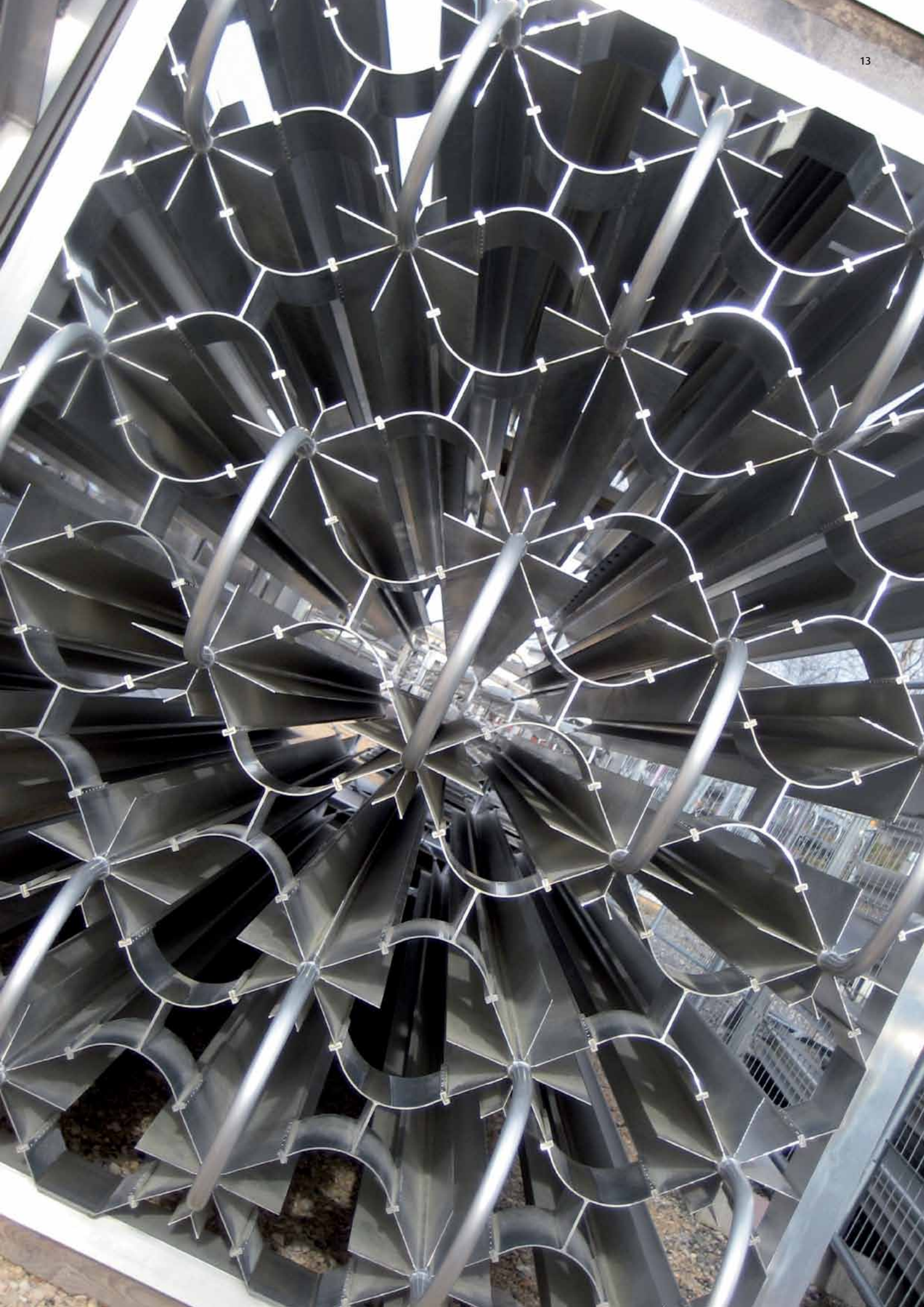


Horizontal evaporators ensure high circulation forces.  
The image shows the types LD 40 - 5 F 4 and LD 40 - 5 F 2.

vaporiser type	dimensions approx.			weight empty [kg]	external heat surface m <sup>2</sup>	connections (inlet/outlet) [mm]	design [mm]	Linde ident-no.
	depth [m]	width [m]	height [m]					
LD 40 - 5 F 4	4,174	0,655	0,58	44	8,8	pipe DN 25 (28 x 2) for connection to reducing braze-on flange DN 40/25 PN 40	Al-finned tubes	J46389
LD 40 - 5 F 2	2,171	0,655	0,58	37	4,4			J46390
LD 40 - 4 F 1,6	1,25	0,5	2,085	90	13,3			J46391
LD 40 - 5 F 2 - HQ	2,171	0,74	0,58	50,5	4,4	pipe DN 40 (48,3 x 2)	"duplex"	K47971
LD 40 - 5 F 4 - HQ	4,174	0,74	0,58	80	8,8	pipe DN 40 (48,3 x 2)	"duplex"	R56440
LD 40 - 4 F 1,5 - HQ*)	1,153	0,5	2,034	60	9,5	pipe: DN 40 (48,3 x 2)	"duplex"	871321

\*) Allowable operating temperature range (TS) for +50/-269°C





# Operational efficiency.

The nominal operational efficiency of the vaporiser is based on a reference ambient temperature of +20°C for N<sub>2</sub> (see tables of technical data). In this case, the difference in temperature between the ambient temperature and gas outlet is ≤15°C.

The operational efficiency is dependent on various boundary conditions such as ambient temperature, wind velocity, air humidity, air circulation, ingress of sunlight, period of operation and the medium used.

The following diagrams show how the nominal output is affected by the medium used (Fig. 1: Conversion factor), the ambient temperature (Fig. 2: Correction factor) and the period of operation (Fig. 3: Power factor).

**Note:**  
As the boundary conditions are subject to large fluctuations, the information provided should be regarded as average, approximate values.

In Fig. 4, calculations are shown by way of example for determining the anticipated nominal efficiency taking the operating medium, ambient temperature and period of operation into account.

Air heated vaporisers have a modular construction principle and can be connected together individually according to the required output.

The specified nominal performance figures apply to eight-hour permanent operation; after that, the performance of the vaporisers may drop because of frosting. For longer periods of operation it is therefore advisable to arrange the vaporiser modules in parallel. While one vaporiser group is working, the other vaporisers can regenerate. This prevents non-productive intermissions – gas withdrawal is assured at all times.

medium	conversion factor
N <sub>2</sub>	1
Ar	1,15
H <sub>2</sub>	1,75
O <sub>2</sub>	0,92
CH <sub>4</sub>	0,76
CO <sub>2</sub>	0,33
He	3,10

Fig. 1: Conversion factor for the nominal efficiency of various media

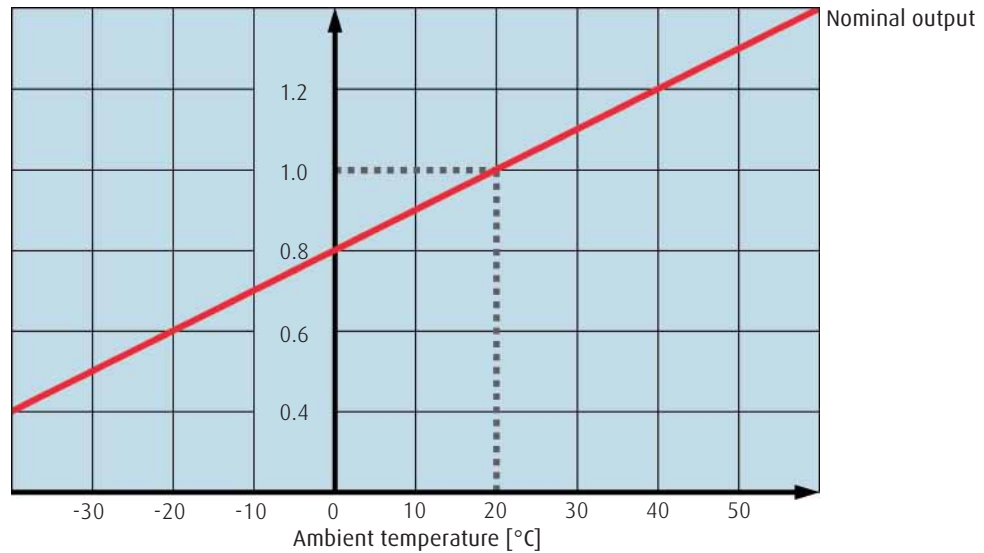


Fig. 2: Correction factor - for the nominal operational efficiency as a function of ambient temperature

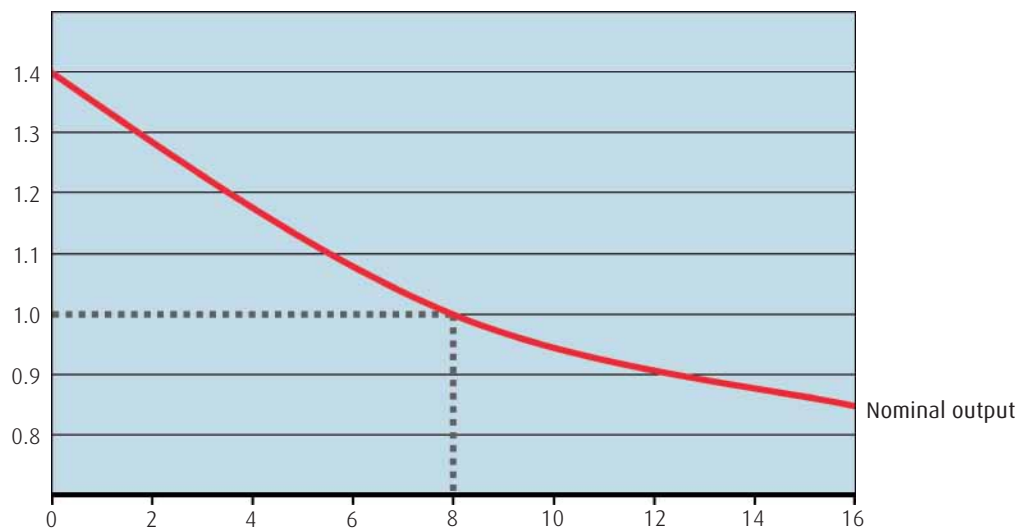


Fig. 3: Power factor - for the nominal operational efficiency as a function of operational duration

Examples for vaporizer type L40 - 8F 3; nominal output at +20°C according to Fig. 1 = 130 Nm<sup>3</sup>/h:

Example 1: For N<sub>2</sub> at +20°C and 8 h duration of operation:

$$\text{Nominal output} = 100 \% \times \text{conversion factor } 1 \times \text{correction factor } 1 \times \text{power factor } 1 = 100 \%$$

$$\text{i.e. nominal output (N}_2\text{)} = 130 \text{ Nm}^3/\text{h}$$

$$\text{actual output (N}_2\text{)} = 130 \text{ Nm}^3/\text{h} \times \text{factor } 1 = 130 \text{ Nm}^3/\text{h}$$

Example 2: For O<sub>2</sub> at -20°C and 2 h duration of operation:

$$\text{Nominal output} = 100 \% \times \text{conversion factor } 0,92 \times \text{correction factor } 0,6 \times \text{power factor } 1,25 = 69 \%$$

$$\text{i.e. nominal output (N}_2\text{)} = 130 \text{ Nm}^3/\text{h}$$

$$\text{actual output (O}_2\text{)} = 130 \text{ Nm}^3/\text{h} \times \text{factor } 0,69 = 90 \text{ Nm}^3/\text{h}$$

Fig. 4: Sample calculations for determining nominal output



# Know-how, quality, inspection, documentation.

Linde is committed to customers satisfaction:  
The only acceptable standard by which we can measure quality success.

Our customers expect us to supply safe and reliable plants and components which operate both economically and in an environmentally friendly manner, reflecting the current state of technology.

Since a period of almost half a century Linde designs and manufactures air-heated vaporisers for cryogenic applications.

The new range of Lead- and Special-Vaporiser is a direct result of our ongoing product development. They conform to the latest technical standards, are proven, effective in performance and simple to use.

There is a permanent on-site-support by the notified body.

A view from above into the blades of a vaporiser shows the detailed sophistication of the technology. The new type of vaporiser is characterised by improved power, compared with the previous model.





Quality management is an indispensable part of our corporate strategy and therefore a managerial responsibility carried out at all levels of the company.

Extensive testing ensures the highest welding quality and safety. The inspections will be carried out by applying the directives and operating instructions of the Linde quality management-system as well as supervised by the independent official notified body.



The cleanliness of our products, even oxygen applications, naturally conforms to the purity requirements of the EN 12300 standard.

Because of the pressures that they will be subjected to in later operation, and the associated risks, units like vaporisers are subject to stringent manufacturing requirements.

All named vaporiser types of these prospectus comply with the essential safety requirements defined in Annex I of directive 97/23/EC concerning pressure equipment.

Each delivered CE vaporiser is unambiguously documented by the EC declaration of conformity, issued by Linde and related to the fabrication number. The associated operating instructions contain a type-relevant data sheet.

Linde vaporisers for air-heated gas transformation – safe, reliable supply made to measure.



Every vaporiser must meet the demands of the required proof test. The final inspection and pressure test are performed exclusively by trained and responsible qualified personnel and monitored by the Notified Body.



All measuring instruments are calibrated and checked periodically.

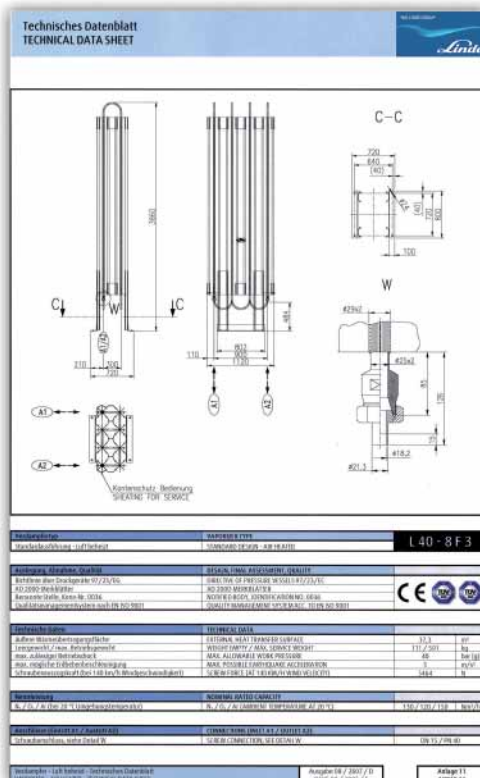
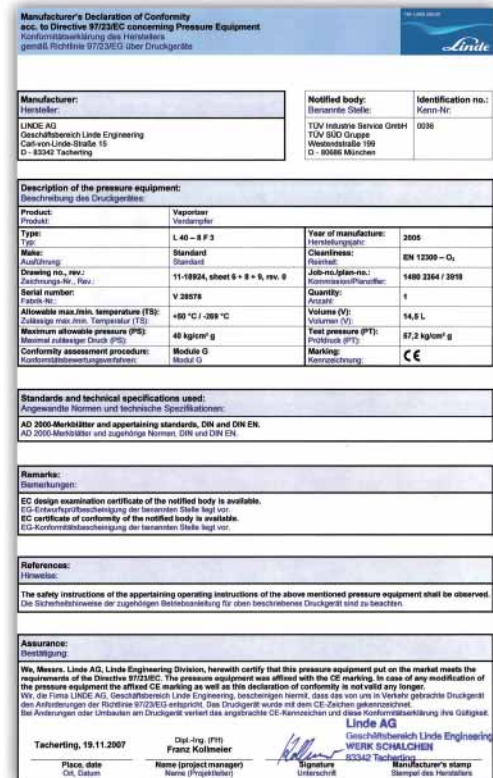


Each vaporiser can be identified by a name plate with its rating, CE seal, the identification number of the notified body responsible for monitoring/acceptance, and an individual fabrication number.

## Documentation

EC Declaration of Conformity; the associated operating instructions contain a type-relevant data sheet, which includes information among other things on attachment to foundations.

The Engineering Division, Schalchen Plant is certified of a Quality Management System according to ISO 9001.





COMPLIES PROVISIONS ACC.  
TO DIRECTIVE CONCERNING  
PRESSURE TREATMENT  
97/23/EC



MONITORED  
OR  
FINAL ASSESSMENT  
BY NOTIFIED BODY



QUALITY  
MANAGEMENT SYSTEM  
ACC. TO  
EN ISO 9001

#### QUALITY

THE LINDE GROUP



LINDE KNOW-HOW

LINDE KNOW-HOW  
OF  
CRYOGENIC PRESSURE  
VESSELS

#### CLEANLINESS

THE LINDE GROUP



EN 12300 - O<sub>2</sub>

COMPLIES REQUIREMENTS  
OF CLEANLINESS FOR  
CRYOGENIC SERVICE;  
OXYGEN SERVICE

# SHEQ - safety, health, environment and quality police.



At the Engineering Division, we do not want to harm people or the environment. We will comply with all applicable legal, regulatory, internal and industry requirements.

We strive to be leading in SHEQ to meet safe, secure and healthy working conditions and supplying safe, compliant and environmentally responsible products and services for our customers.

SHEQ is a key part of The Linde Group's overall strategy and we will also require our contractors and partners to manage in line with this policy.

To achieve this vision,  
SHEQ is 100 % of our  
behaviour,  
100 % of the time.



# Service and guarantee.

## Welcome to the Engineering Division

The Linde Schalchen Plant is located 100 km east of Munich, Germany. 700 engineers and skilled workers design and manufacture components and complete modules for the application in process plants.

Backed up by more than 100 years of production know-how, highly developed plant modules are manufactured. Our innovative technologies and our competitiveness open the door to participation in prestigious plant projects worldwide.

Linde provides complete services on field installation and operation. A specialised service crew is available for immediate and professional repair services.

### Linde AG

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- Office for the distribution of orders  
Phone: +49.8621.85-6432
- Static vacuum insulated cryogenic vessels
- Spiral welded pipes

Do you need further and more detailed information?

Just ask us – we will be pleased to help you.



# Collaborate. Innovate. Deliver.

Linde's Engineering Division is a leading player in the international plant engineering business. Across the globe, we have delivered more than 4,000 plants and cover every step in the design, project management and construction of turnkey industrial facilities. Our proven process and technology know-how plays an indispensable role in the success of our customers across multiple industries – from crude oil, natural gas extraction and refining to chemical and metal processing.

At Linde, we value trusted, lasting business relationships with our customers. We listen carefully and collaborate closely with you to meet your needs. This connection inspires us to develop innovative process technologies and equipment at our high-tech R&D centres, labs and pilot plants – designed in close collaboration with our strategic partners and delivered with passion by our employees working in more than 100 countries worldwide.

From the desert to the Arctic, from small- to world-scale, from standardised to customised builds, our specialists develop plant solutions that operate reliably and cost-effectively under all conditions.

You can always rely on us to deliver the solutions and services that best fit your needs – anywhere in the world.

Discover how we can contribute to your success at [www.linde-engineering.com](http://www.linde-engineering.com)

Get in touch with our component manufacturing team:

Phone: +8621 85-6473, e-mail: [plantcomponents@linde-le.com](mailto:plantcomponents@linde-le.com)

## Core competencies at a glance

### Plant engineering

- Air separation plants
- LNG and natural gas processing plants
- Petrochemical plants
- Hydrogen and synthesis gas plants
- Adsorption and membrane plants
- Cryogenic plants
- Carbon capture and utilisation plants
- Furnaces, fired heaters, incinerators

### Component manufacturing

- Coldboxes and modules
- Coil-wound heat exchangers
- Plate-fin heat exchangers
- Cryogenic columns
- Cryogenic storage tanks
- Liquefied helium tanks and containers
- Air-heated vaporisers
- Water bath vaporisers
- Spiral-welded aluminium pipes

### Services

- Revamps and plant modifications
- Plant relocations
- Spare parts
- Operational support, troubleshooting and immediate repairs
- Long-term service contracts
- Expert reviews for plants, operations and spare part inventory
- Operator training