

THE LINDE GROUP

*Linde*

# Tonnage Air Separation Plants



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"Linde is committed to provide a superior level of service and value to customers worldwide, a commitment which comes from the executive management.

We give our top priorities to Health, Safety and Environment (HSE). The Engineering Division considers HSE Management to be a core factor for maintaining competitiveness in industry.

The safe way is the only way."

# Introduction.

The Linde Engineering Division is a leading international manufacturer of capital goods and equipment.

Linde's activities cover design and construction of turnkey industrial plants together with a full range of engineering work for process plants. To date, the Engineering Division has built nearly 3,800 plants and has numerous patents registered in the Linde name.

Extensive engineering expertise coupled with many years of experience in project management and contracting qualify the Engineering Division as an expert partner in international plant construction.





Engineering Division, Pullach, Germany



# Engineering and fabrication facilities world-wide

The Engineering Division - A global company with development of technology and plant concepts combined with global engineering and fabrication centers under the leadership of the Munich center of competence.

Linde Engineering/Selas Fluid, Blue Bell, PA USA



Linde-KCA Dresden GmbH, Germany



Linde Engineering (Hangzhou) Co. Ltd., P.R. China



### Engineering Division, Pullach, Germany

Headquarters of Linde Engineering Division.  
Located in Pullach, 6 miles south of Munich, approximately 1,800 engineers and other specialists. Global competence center for air separation plants.

- Central research and development
- Global product management
- Sales
- Basic and detailed engineering
- Site services

### Linde-KCA-Dresden GmbH, Germany

Engineering center for Eastern Europe and CIS with 530 engineers and other specialists.

- Sales
- Detailed engineering
- Site services

### Linde Engineering (Hangzhou) Co. Ltd., P.R. China

Engineering center for China and South-East Asia, located 75 miles south of Shanghai.

Approximately 130 engineers and other specialists.

- Sales
- Detailed engineering
- Site services

### Engineering Division, Schalchen Plant, Germany

Global competence center fabrication, approximately 700 skilled craftsmen and engineers.

860,000 SF floor space. Fabrication of:

- Cold boxes
- Rectification columns
- Structured packing
- Plate-fin heat exchangers
- Coil-wound heat exchangers
- Other plant components

### Selas Fluid Processing, Blue Bell, PA, USA

Engineering center for US and NAFTA, approximately 150 engineers and other specialists.

- Sales
- Detailed engineering

### Linde Engineering India Pvt. Ltd.

Global detail engineering center, engineering center for India.

Approximately 300 engineers and other specialists.

- Detailed engineering
- Site services

### Linde Process Plants Inc., Tulsa, OK, USA

Fabrication center for NAFTA area, approximately 160 skilled craftsmen and engineers. Workshop area with about 165,000 sf (35,750 sf sheltered).

Fabrication of packaged air separation plants.

### Linde Engineering (Dalian) Co. Ltd., P.R. China

Fabrication center for China, approximately 230 skilled craftsmen and engineers. Total area of 936,000 sf (323,000 sf sheltered). Fabrication of:

- Cold boxes
- Rectification columns/condensers
- Direct contact/evaporation coolers
- Molecular sieve adsorbers
- Coil-wound heat exchangers

Engineering Division, Schalchen Plant, Germany



Linde Process Plants, Inc. Tulsa, OK USA



Linde Engineering (Dalian) Co., Ltd. P.R. China



Linde Engineering India Pvt. Ltd.



# General Products.

## Air separation plants

For production of oxygen, nitrogen, argon and - in some special cases - other rare gases (krypton, xenon, helium, neon) through cryogenic rectification of air. The products can be produced in gaseous form for pipeline supply or as cryogenic liquid for storage and distribution by truck.

Linde has built approximately 2,800 cryogenic air separation plants in more than 80 countries and leads the market for air separation plants. This position results from the outstanding technology of our plants coupled with effective contract execution.

**Packaged air separation plants** are modularly designed cryogenic plants with a daily production capacity of up to 500 T/d (\*) (13,000 Nm<sup>3</sup>/h) of oxygen or up to 1,000 T/d (30,000 Nm<sup>3</sup>/h) of nitrogen. If required, these plants can also produce argon. Within the last 20 years, Linde has built approximately 500 packaged air separation plants. For a detailed description please refer to our packaged air separation plant product information.

**Tonnage air separation plants** are individually designed for the specific demands of our customers. These plants can produce oxygen, nitrogen, argon, krypton, xenon, helium and neon. Daily oxygen production capacities are between 500 T/d (13,000 Nm<sup>3</sup>/h) and 7,600 T/d (200,000 Nm<sup>3</sup>/h). Linde has built approximately 100 tonnage air separation plants in the last 20 years.

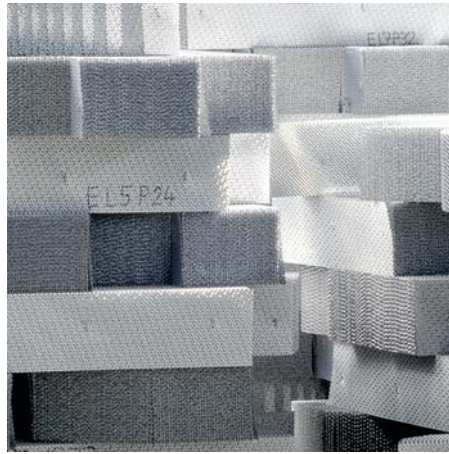
(\*) All tons refer to short tons. 1 short ton = 2,000 lbs.

Air separation plant in Leuna, Germany





Aluminum plate-fin heat exchanger



Packings



Tray columns

## Longest track record in air separation.

### Superior plant availability

- Use of robust plant and component concepts with proven reliability in many Linde plants.
- Sophisticated, proven control and redundancy philosophy to guarantee continuous production.
- Long established relationship with well-known and reliable sub-vendors, especially for rotating equipment.
- Design of cryogenic core components by Linde with fabrication in Linde's own workshops incorporating high standards of quality (ISO 9000 and ISO 9001 certified).



Air separation plant in Aiken, South Carolina

## Key features.

### Maximum efficiency

- Advanced engineering tools and methods for process design and optimization.
- Optimized efficiency for static and rotating equipment.
- Linde advanced process control system for continuous optimization of plant production adjusted to consumer requirements or power costs.

### Smooth plant operation and maintenance

- Plants designed for robust operation and easy maintenance.
- State-of-the-art plant automation system to ensure smooth plant operation and equipment protection automatically without intervention of the operating personnel.
- Highly sophisticated advanced process control functions that allow automatic start-up of the plant and fast, easy adjustment of plant production without operator interaction.
- Global remote support with direct access to plant control systems by Linde specialists.

### Protection of health and environment

- Design of all Linde plants worldwide follow international safety regulations and recommendations (IEC, OSHA, EIGA, CGA), German safety rules (UVV) and Linde's own stringent safety standards.
- Controlled process with continuous review of plant design to ensure safety of personnel and the environment.
- Numerous safety awards received from international authorities.

## References.

Air separation plant supplying the major industrial complexes in Saudi Arabia.

### Customer:

Saudi Basic Industries Corporation (SABIC)

Plant	Status	Oxygen T/d	Nitrogen T/d	Other Products
Al Jubail 3	in operation since 1993 (turnkey)	1,320	990	argon
Yanbu	in operation since 1999 (turnkey)	1,320	1,650	argon
Al Jubail 5	in operation since 2004 (turnkey)	3,520	1,914	argon, krypton, xenon
Al Jubail 6	in operation since 2007 (turnkey)	3,960	-	-
Al Jubail 7	in operation since 2008 (turnkey)	3,520	2,046	-
Yanbu 3	in operation since 2008 (turnkey)	3,520	2,046	-



## References

The largest multi-train air separation plant in the world, supplying nitrogen for enhanced oil recovery in Mexico

### Customer:

Pemex

- Turnkey project
- 5 trains in operation
- Product capacity of 69,300 T/d nitrogen
- (19,250 T/d oxygen equivalent)





## References

One of the largest steel works in China supplied with oxygen, nitrogen and argon from Linde air separation plants.

### Customer:

Wuhan Iron and Steel Company

Plant	Status	Oxygen T/d	Nitrogen T/d	Other Products
A/B	commissioned in 1975	760	660	-
C/D	commissioned in 1982	760	666	argon
E/F	commissioned in 1992	2,310	1,991	argon, krypton, xenon
G/H	commissioned in 2004	4,609	5,346	argon, krypton, xenon, helium, neon
I/J	commissioned in 2008	4,609	5,346	argon, krypton, xenon, helium, neon





Shell "Pearl" GTL project 140,000 bpd

### References

Air separation plants for the Pearl GTL project in Ras Laffan, Qatar.

**Customer:** Qatar Shell GTL Ltd. (QSGTL Ltd.)

### Design features:

- Cryogenic air separation
- Front-end air purification with MS
- Elevated process pressure
- Double-column system
- Internal compression of oxygen

**Capacity total:** 33,000 T/d oxygen,  
860,000 Nm<sup>3</sup>/h (eight trains)

### Scope of work:

- Turnkey-lump sum
- Basic and detailed design
- Manufacture
- Delivery
- Construction
- Erection
- Commissioning
- Start-up

Commissioned in 2009

# Services.

## General

- The Engineering Division has extensive experience executing large, complex multi-national turnkey projects, particularly for large petrochemical and LNG plants (e.g. Hammerfest LNG plant: 1.6 million engineering hours, 9 construction sites, 120 suppliers, 19 main subcontractors).
- The Engineering Division is the only company with comprehensive experience in turnkey contract execution for air separation plants in China and the Middle East.

## Basic engineering

- Process design and optimization with OPTISIM advanced process simulation software (developed by Linde). The process design incorporates features of numerous in-house patents.
- Design of plant operation and control using Linde's extensive operating experience.
- Specification of rotating equipment in cooperation with world renowned sub vendors.

## Detail engineering

- Mechanical design using 3D CAD software to establish a complete model of the plant.
- Specification of the electrical equipment and design of the power supply networks with specific expertise in large drives (up to 60 MW).
- Specification of control system hardware from well-known international automation companies. Programming of control functions using pre-engineered and pre-tested basic control functions.
- Implementation of advanced control functions (automatic load change, automatic start-up, automatic product adaptation) using the Linde advanced process control system.





Shell "Pearl" GTL project under construction

### Project management

Project managers with extensive experience in complex multi-national/ multi-partner projects.

Advanced tools and methods for project control (scheduling, cost control).

Reliable tools, methods and procedures for global sourcing and material logistics.

### Construction

Extensive experience with turnkey projects for large plants (including Middle East and China).

Methods and experience in controlling complex pre-fabrication and construction activities as well as material flow.

### Commissioning and training

Skilled experienced commissioning teams ensure smooth start-up and hand over of the plant to the customer.

Remote support for the commissioning team on site by specialists in every discipline (e.g. process, control, machinery) provides the full spectrum of Linde expertise.

Extensive safety procedures and safety training ensure safe commissioning and operation of the plant.

### After sales service

Prompt response to customer requests by qualified specialists.

Global remote on-site support to optimize operation and minimize plant downtimes. Plant optimization services to improve plant efficiency.

Remote support for the on-site commissioning team by specialists of every discipline (e.g. process, control, machinery), providing access to Linde expertise.

Extensive safety procedures and safety training, ensuring safe plant commissioning and operation.

# Designing Processes - Constructing Plants.

Linde's Engineering Division continuously develops extensive process engineering expertise in the planning, project management and construction of turnkey industrial plants.

## The range of products comprises:

- Petrochemical plants
- LNG and natural gas processing plants
- Synthesis gas plants
- Hydrogen plants
- Gas processing plants
- Adsorption plants
- Air separation plants
- Cryogenic plants
- Biotechnological plants
- Furnaces for petrochemical plants and refineries

## Linde and its subsidiaries manufacture:

- Packaged units, cold boxes
- Coil-wound heat exchangers
- Plate-fin heat exchangers
- Cryogenic standard tanks
- Air heated vaporizers
- Spiral-welded aluminum pipes

More than 3,800 plants worldwide confirm the Engineering Division's leading position in international plant construction.

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