

THE LINDE GROUP

*Linde*

# Packaged Air Separation Plants





# 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.





## Packaged air separation plants

Packaged air separation plants are modular designed plants for the production of up to 500 T/d (\*) (13,000 Nm<sup>3</sup>/h) oxygen (GOX and LOX), up to 1,000 T/d (30,000 Nm<sup>3</sup>/h) nitrogen (GAN and LIN) and argon (GAr and LAr). The plant modules are workshop prefabricated to a maximum extent.

### GOX 3000

for production of 115 T/d  
(3,000 Nm<sup>3</sup>/h) GOX  
in Rauha, Finland



### GOX 6000 Ar

for production of 225 T/d  
(6,000 Nm<sup>3</sup>/h) GOX  
in Shlobin, Belarus



### GOX 9000 Ar

for production of approximately 340 T/d  
(9,000 Nm<sup>3</sup>/h) GOX  
in Hwasung, South Korea



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

# The process.

The process selection is adapted to customer requirements using Linde's extensive knowledge of air separation plant operation. All state-of-the-art air separation technologies such as internal compression for GOX and GAN and cryogenic argon production are available. The schematic illustrated below shows a typical configuration of a packaged air separation plant.

Air is drawn through an air filter to remove dust and other particles before entering the main air compressor.

Downstream from the main compressor, the air enters the process air cooling stage, where it is washed and cooled in countercurrent against a stream of water. This washing process also removes harmful components of the process air such as  $\text{SO}_2$ ,  $\text{SO}_3$  and  $\text{NH}_3$ .

Remaining contaminants in the process air such as water vapor,  $\text{CO}_2$ ,  $\text{N}_2\text{O}$  and potentially hazardous hydrocarbons are adsorbed from the air by passing through one of the two molecular sieve adsorbers. One adsorber is in operation while the other one is in regeneration mode.

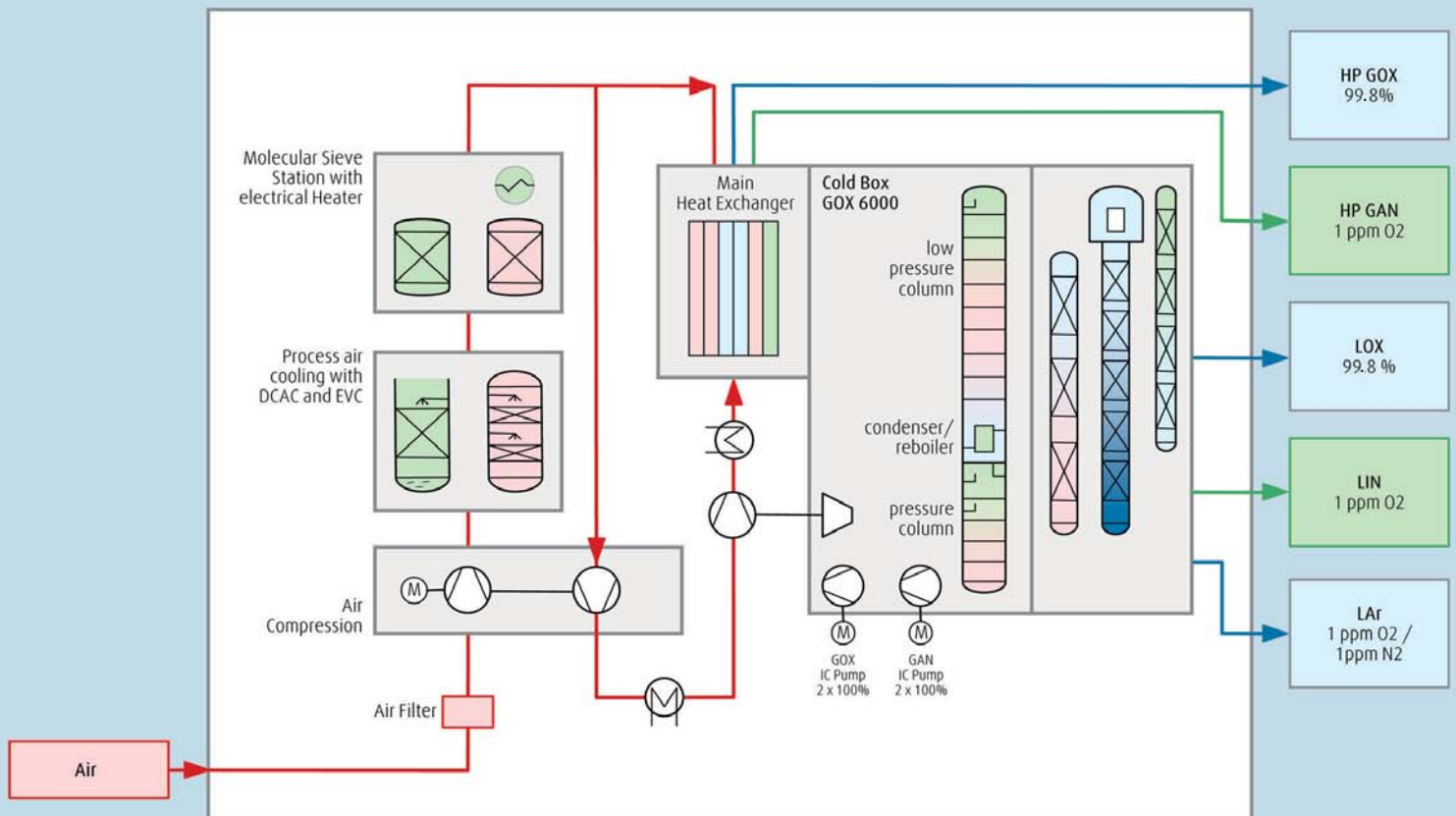
After further cooling of the dry, pure air in the main heat exchanger, the air enters the pressure column where it is separated into pure nitrogen, yielding at the top and oxygen enriched liquid at the bottom. The required reflux for rectification is provided by condensation of gaseous nitrogen against boiling oxygen in the condenser/reboiler.

A part of the liquid nitrogen is used as reflux for the pressure column; the remainder is sub-cooled and passed to the top of the low pressure column. Liquid nitrogen for the customer is then drawn off and sent out to the LIN tank. Liquid oxygen is taken from the bath of the condenser and fed to the LOX tank.

Liquid oxygen and liquid nitrogen are pumped through the main heat exchanger and vaporized at the customers' specified gas pressure for GOX and GAN.

Refrigeration needs of the plant necessitated by insulation losses, heat exchanger losses and removal of cold liquids out of the low temperature section are mainly met by isentropic expansion of air in the expansion turbine.

Typical process configuration of a packaged plant



# Features of packaged plants.

Plant designs are created with the use of advanced engineering tools including process calculation and modeling with Linde's in-house developed OPTISIM simulation program as well as 3D CAD modeling (including isometric and material list generator for plant design and model review).

The highest quality standards are achieved via a stringent quality system in accordance with ISO 9000 for engineering design and manufacturing.

Erection and start-up time is minimized with pre-packaged and tested units (i.e. air compressor, refrigeration unit, molecular sieve valve skid and cold box units). Electrical and control equipment are ready installed in containers ready for "plug and play" installation.

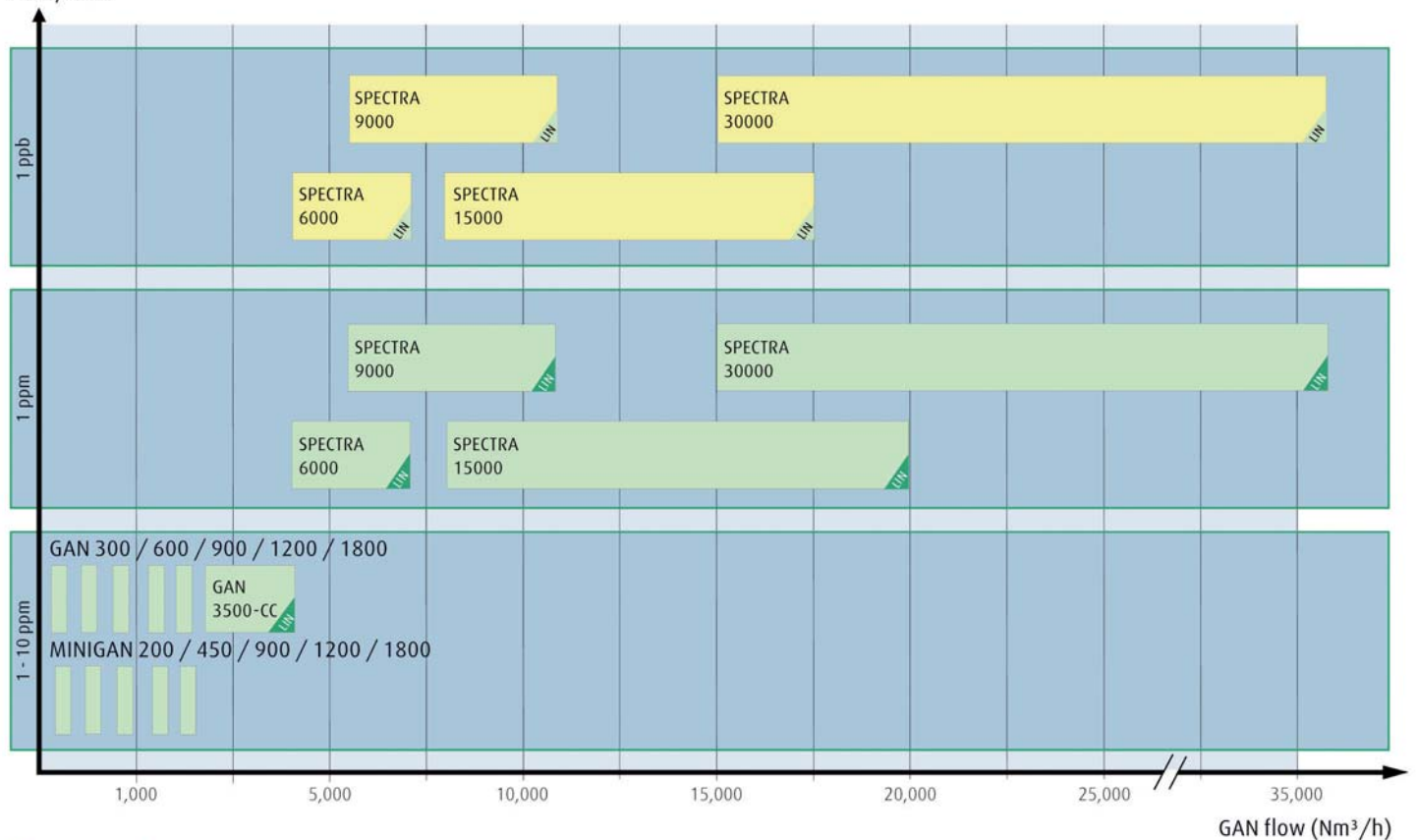
Sophisticated interlock functions protect the plant against unforeseen failures or mal-operation and maintain the plant in a safe condition in the event of power failure.

Highly developed and proven control philosophy and software ensures reliable, convenient and economic plant operation.

Personal protection measures are applied wherever the safety of operating personnel may be jeopardized by the process, rotating machinery or exposure to extreme temperatures.

## Product range

Purity class

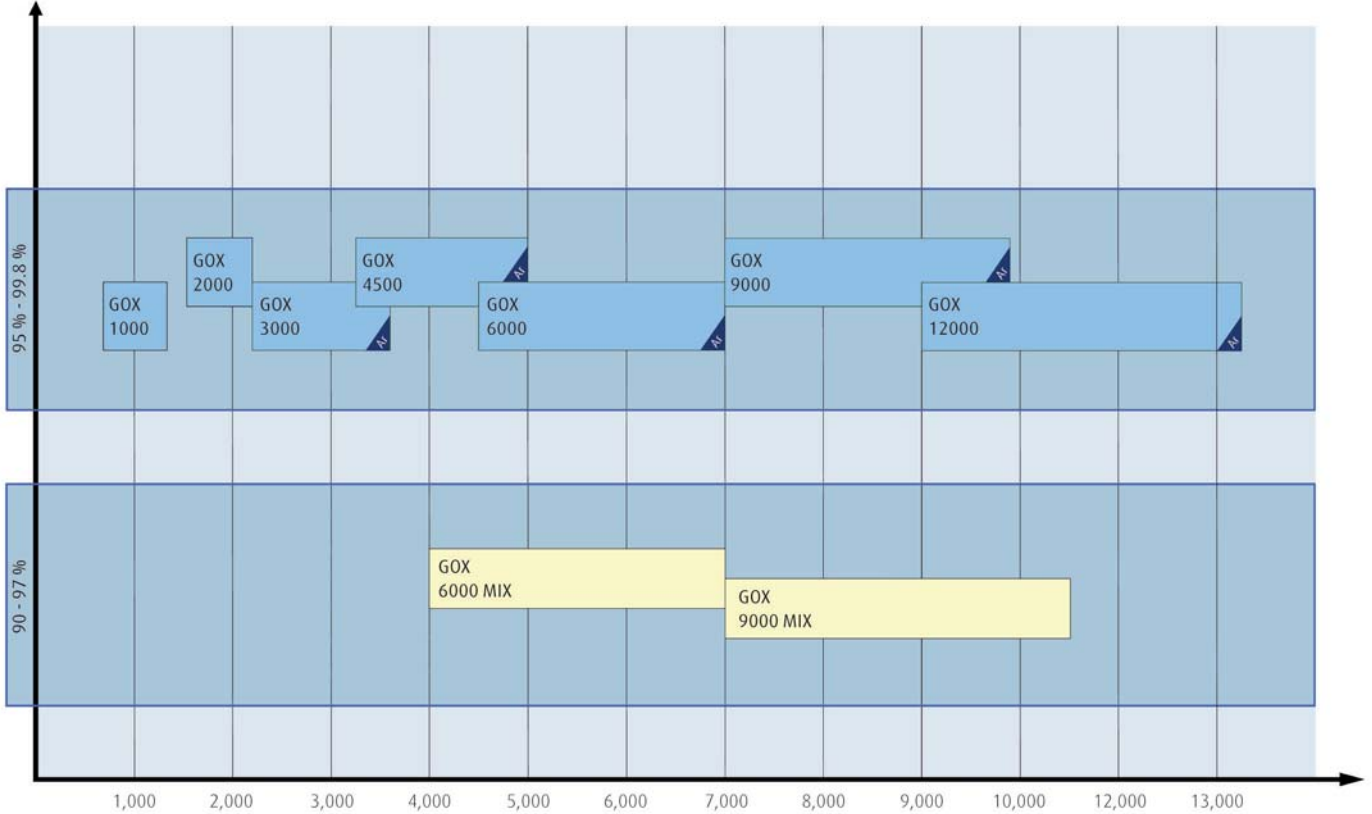


Nitrogen generators

Note: 1,000 Nm<sup>3</sup>/h of GAN is equivalent to 33.03 T/d



Purity class





## In-house manufacturing of key components.

The capability to manufacture essential plant components in-house contributes to Linde's reputation as a first class supplier and preferred vendor for air separation plants.

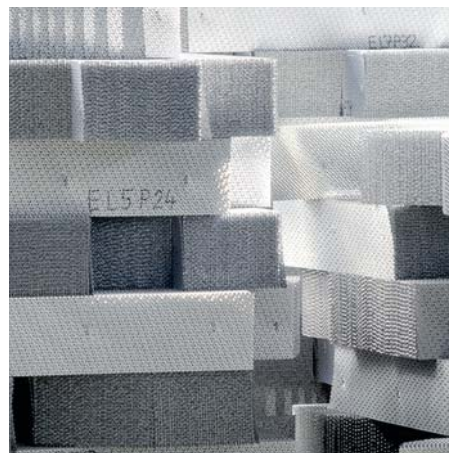
Decades of experience in the field of cryogenic process plant design are the basis for state-of-the-art technology in the assembly of packaged air separation plants.

Linde manufactured key components such as plate-fin heat exchangers, packings and columns are the foundation for long-term, trouble-free operation of a Linde air separation plant.

Aluminum plate-fin heat exchanger



Packings



Tray columns



## Pre-fabricated equipment

In-house manufactured components such as plate-fin heat exchangers and columns are installed to self-supporting steel casings. The sizes of the cold boxes are designed for road transportation, and site handling is simplified.

Other modules such as molecular sieve valves, cryogenic pumps are installed onto skids to the maximum practical degree for pre-fabrication and testing.

The plant control system together with operator station(s) and analyzing equipment are supplied in an air-conditioned container, ready-cabled and shop-tested with the configuration of the DCS completed.

A separate shop-assembled container is supplied for all electrical medium voltage switch gears, step-down transformers and low-voltage switch-gears including VFD's for pumps and other electrical equipment.

All above mentioned plant modules and skids are equipped with remote I/O modules for easy bus connection.

This high degree of prefabrication and testing results in short erection periods with minimized start-up times.

Prefabricated molecular sieve valve skid



Prefabricated and workshop-tested control and sub-station container including cabinets, power equipment, operator station and analyzers.



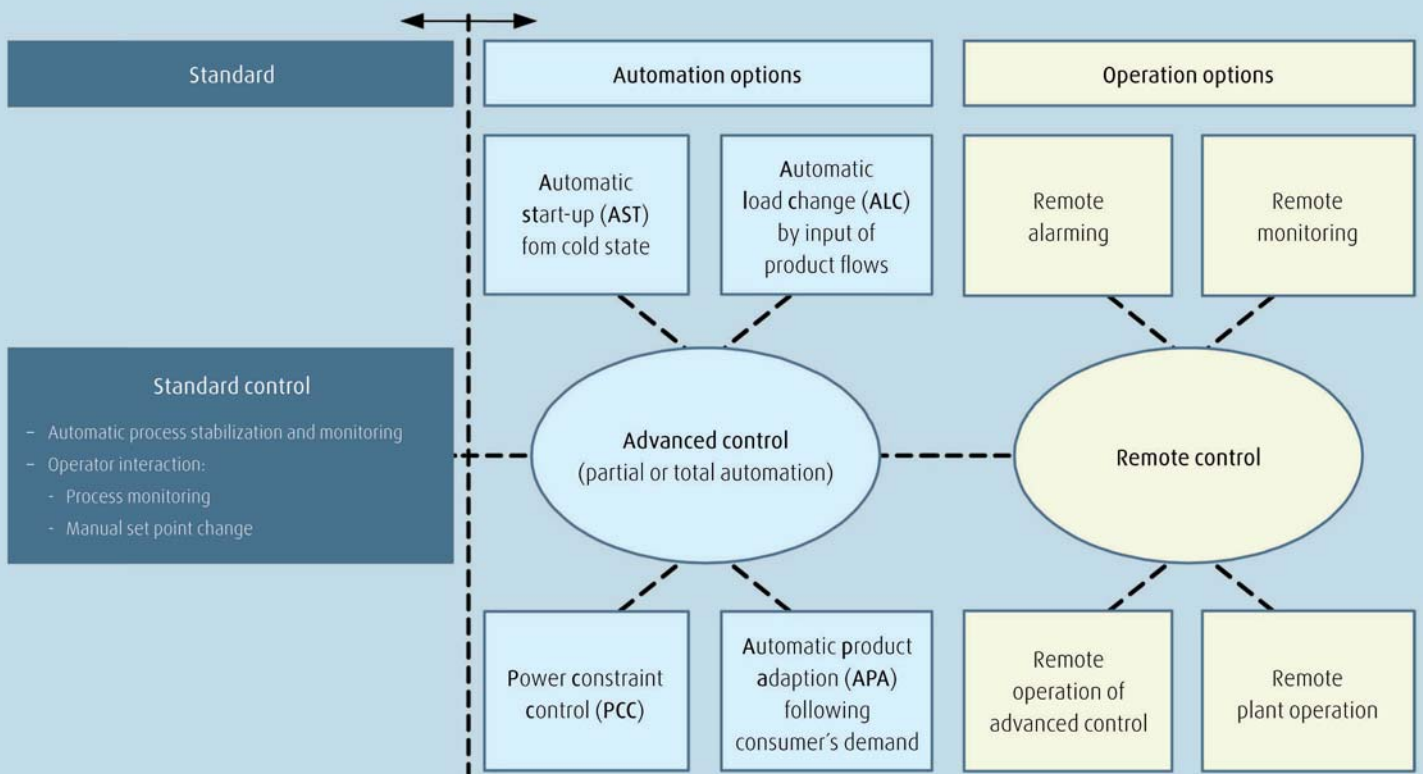
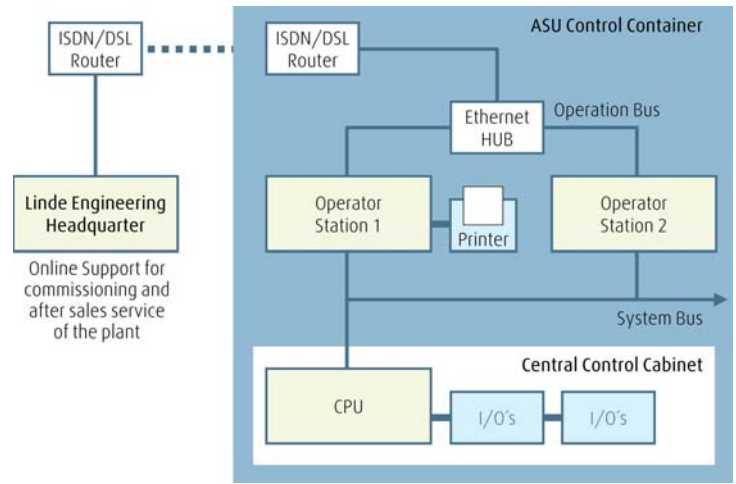
Packaged unit cold box



# Sophisticated plant control.

Instrumentation is selected from internationally renowned manufacturers with regard to highest quality and product reliability. This is connected to a safe and sophisticated process control system using the latest proven design in digital control technology, ensuring optimal reliability and providing easy, economical operation of a Linde air separation plant.

Advanced control functions allow fully unattended operation, automatic start-up from cold condition, automatic load changes and product adaptation. Finally, the remote operation function of a Linde plant fully meets the needs of a state-of-the-art air separation plant.





GOX 6000-IC in Sepon, Laos

### Project execution

Quality, safety, health and environmental protection (QSE) have critical importance in our work. Customers expect us to supply safe, economical plants employing the latest technology. The Engineering Division fully responds to this, both at home and abroad.

Our QSE management fulfils the requirements of our QSE policy of DIN EN ISO 9000 : 2000, ISO 14001, PED 97/23/EC (Module H), OHSAS 18001, SCC checklist and work safety and environmental protection legislation.

# 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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