

membrane
nitrogen plants
and stations

economically
viable solution



ABOUT COMPANY

We are in to maximize your success

GRASYS is the leading engineering company engaged in manufacture of advanced facilities for process gases production and separation. Company ranks among the major European producers of industrial gas production and separation systems based on non-cryogenic technologies.

GRASYS produces a wide range of air separation and gas separation plants integrating the advanced membrane and adsorption gas separation technologies.

Competence

GRASYS mobile and stationary plants designed to produce and separate gases prove the most advanced and efficient gas separation systems, highly recognized in Russia, CIS and the Baltic States as well as in other regions of the world.

Among Company customers are more than 250 large reputable companies. GRASYS products are used by such majors as Shell, ExxonMobil, ConocoPhillips, Solvalub, Enel, Eni, Gazprom, Rosneft, TNK-BP, LUKOIL, Salym Petroleum Development N.V., NOVATEK, Surgutneftegaz, RITEC, Tatneft, Slavneft, TVEL, and many others.

Nitrogen plants

One of the Company priority lines is the manufacture of membrane nitrogen plants and stations – stationary and mobile air-to-nitrogen production complexes. Technically, GRASYS nitrogen complexes represent exceptionally powerful systems for nitrogen production from air. In advanced economies, membrane nitrogen plants have almost ousted alternative methods of process nitrogen generation in all cases where nitrogen is not required in commercial volumes.

Manufacture

GRASYS places a special emphasis on the quality of its products. Company equipment is produced at the plants comprising the Defense Enterprises Association. Rigorous quality control, covering both materials and component parts, is exercised at all production stages, as well as modules quality control is applicable at every fabrication and assembly stage. All systems are provided with the “Permit for Application” issued by the Federal Environmental, Engineering and Nuclear Supervision Agency (Rostekhnadzor).

Technologies

GRASYS conducts continuous scientific researches and undertakes engineering developments aimed at the improvement of its equipment in close collaboration with the leading western companies specialize in advanced gas separation technologies.



APPLICATIONS



Optimal effect

Nitrogen is widely used in flow processes of petroleum, chemical, petrochemical, paint-and-varnish, and metallurgy industries. One of the nitrogen key applications across the industries is the provision of explosion and fire safety through displacement of oxygen-bearing air in headspace with the help of inert gaseous nitrogen.

Petroleum industry

In petroleum industry, nitrogen appears an indispensable component in a number of manufacturing processes. Most commonly, nitrogen is used to create inert environment for ensuring process explosion and fire safety and to support transportation and transfer of hydrocarbons. Additionally, nitrogen is used for pipelines testing and purging, cleaning technological vessels in liquefied gas carriers and hydrocarbon storage facilities.

Metallurgy

Metal industry generally utilizes nitrogen as a means of ferrous and non-ferrous metals protection during annealing. Also, nitrogen is helpful in such standard industry processes as neutral tempering, cementing, hard brazing, stress relieving, cyanide hardening, metal-powder sintering, extrusion die cooling etc.

Chemical and petrochemical industries

The primary and very important application of nitrogen in chemical and petrochemical industries is the provision of inert environment aimed at ensuring general industrial safety during cleaning and protection of process vessels. Besides, nitrogen is used for pipelines pressure testing, chemical agents transportation, regeneration of used catalysts in technological processes, etc.

Paint-and-varnish industry

The paint and varnish production uses nitrogen for creation of inert environment in process vessels to ensure production safety, as well as for oxygen displacement during packing in order to prevent polymerization of drying oils.

Pharmaceutical industry

In pharmaceutical industry, nitrogen finds application in pharmaceuticals packaging, and ensuring explosion and fire safety in activities where fine dispersed substances are used.

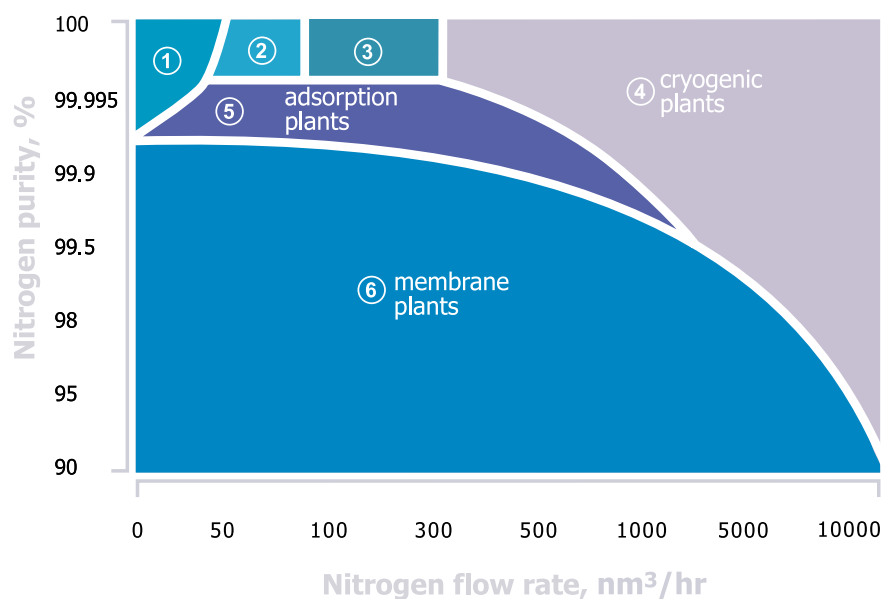
Electronics

In electronics, nitrogen serves as an antioxidant in manufacture of semi-conductors and electric circuits, heat treatment of finished products, as well as in blowing and cleaning.

Glass industry

In glass production, nitrogen proves efficient as a cooling agent for bow oven electrodes, oxidation inhibitor during process procedures, as well as air cooler.

Economic expediency of various methods of nitrogen delivery and manufacture



- ① cylinder nitrogen
- ② cylinder or liquefied nitrogen
- ③ liquefied nitrogen
- ④ cryogenic plants
- ⑤ adsorption plants
- ⑥ membrane plants

Our technologies can boost your efficiency

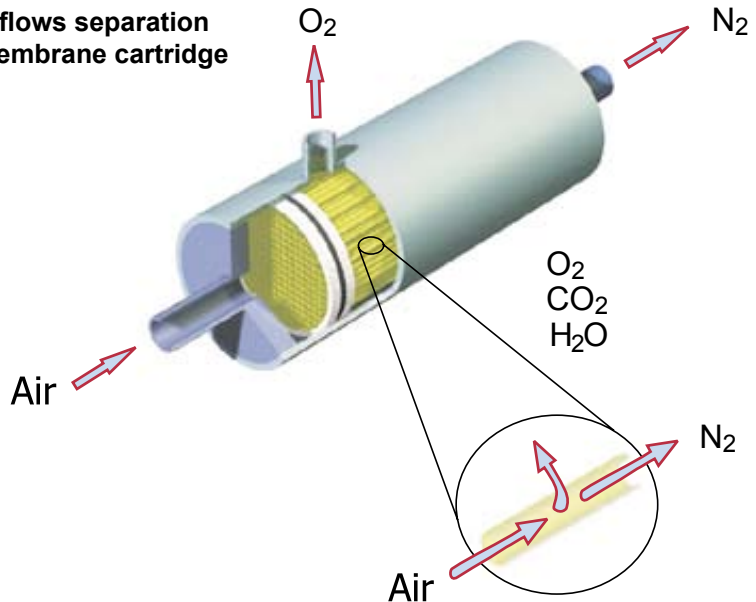
GRASYS is one of the leading European producers of industrial gas and air separation plants based on the hollow-fiber membrane technology. The adoption of the most recent fifth generation membranes ensures outstanding economic performance of company products.

Gas separation concept

The operation of membrane systems is based on the principle of differential velocity with which various gas mixture components permeate membrane substance.

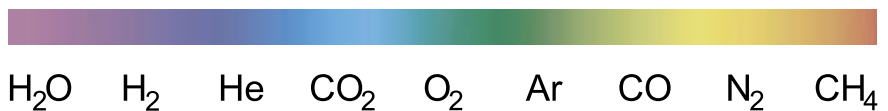
The driving force in the gas separation process is the difference in partial pressures on different membrane sides.

Gas flows separation in membrane cartridge



Fast gases

Slow gases



Technology

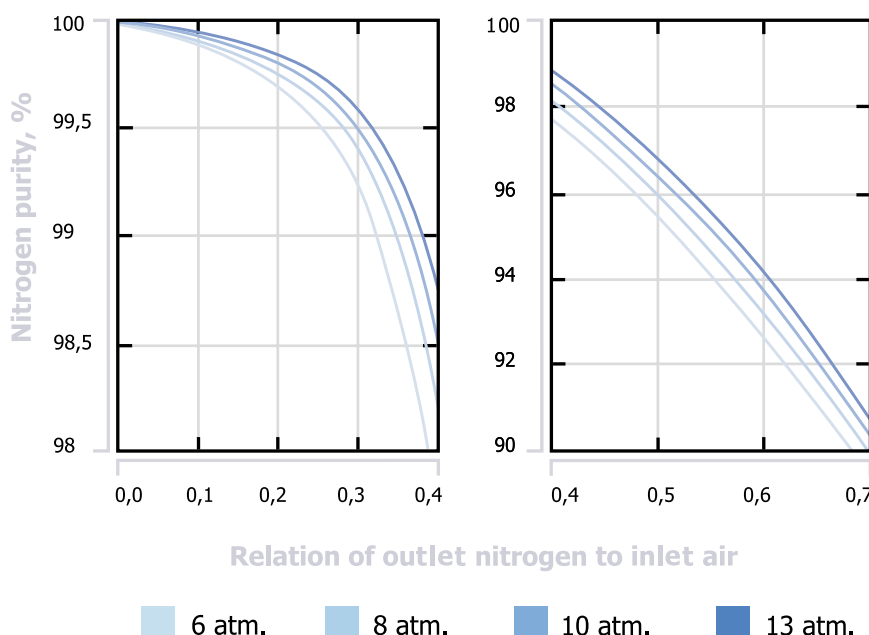
Since the membrane gas separation technology was brought on

stream, membrane characteristics have been continuously perfected. Gas separation membrane currently used by GRASYS consists of hollow fiber instead of conventional plate or film. A hollow-fiber membrane consists of hollow polymer fibers with a gas-separating coating applied to their external surface.

Membrane cartridge

Structurally, a hollow-fiber membrane represents a cylindrical cartridge functioning as a spool with specifically reeled polymer fibers. Gas flow is supplied under pressure into a bundle of membrane fibers. Due to the difference in partial pressures on the external and internal membrane surface gas flow separation is accomplished.

Nitrogen purity dependence on output-input air flow ratio



ADVANTAGES



Multi-stage quality assurance

All GRASYS systems are subject to a mandatory three-stage quality control procedure that helps guarantee their enhanced dependability and longevity in the harshest environs.

Economic benefits

- By substitution of out-of-date cryogenic or adsorption systems nitrogen production savings generally exceed 50%.
- The net cost of nitrogen produced by nitrogen complexes is 20 to 30 times less than the cost of cylinder or liquefied nitrogen.

Engineering documentation and permits

The engineering package includes a detailed operation manual and all technical passports and certificates. All systems are provided with the "Permit for Application" issued by the Federal Environmental, Engineering and Nuclear Control Agency (Ros-tekhnadzor).



Customization

GRASYS designs and manufactures its nitrogen plants and stations individually, based on each customer specific task. This approach in the design of nitrogen systems makes it possible to deliver to customer an optimal solution, with the equipment specifications precisely matching customer's individual requirements.

Module design

The advantage of modularity makes GRASYS plants especially beneficial for Company customers.

Where necessary, the output capacity of a plant may be increased at the minimum cost. This option appears all the more useful where a project envisages subsequent increase in enterprise capacity.

Dependability

Gas separation units have no moving component parts, thus ensuring the exceptional reliability of Company plants. Membranes are highly resistant to vibration and shocks, chemically inert to greases, moisture-insensitive, and capable of operating over a wide temperature range of -40°C to $+60^{\circ}\text{C}$. With appropriate maintenance, membrane unit useful life ranges between 130,000 and 180,000 hours (15 to 20 years of continuous operation).

Simplicity and ease of operation

GRASYS membrane nitrogen plants are fully automated and require no manned operation. Plants starting and stopping procedures take only a few minutes. Product nitrogen purity can be adjusted within the range of 90.0% to 99.9% while the system is in service.



Advanced nitrogen production systems

Basic performance specifications

Product nitrogen characteristics

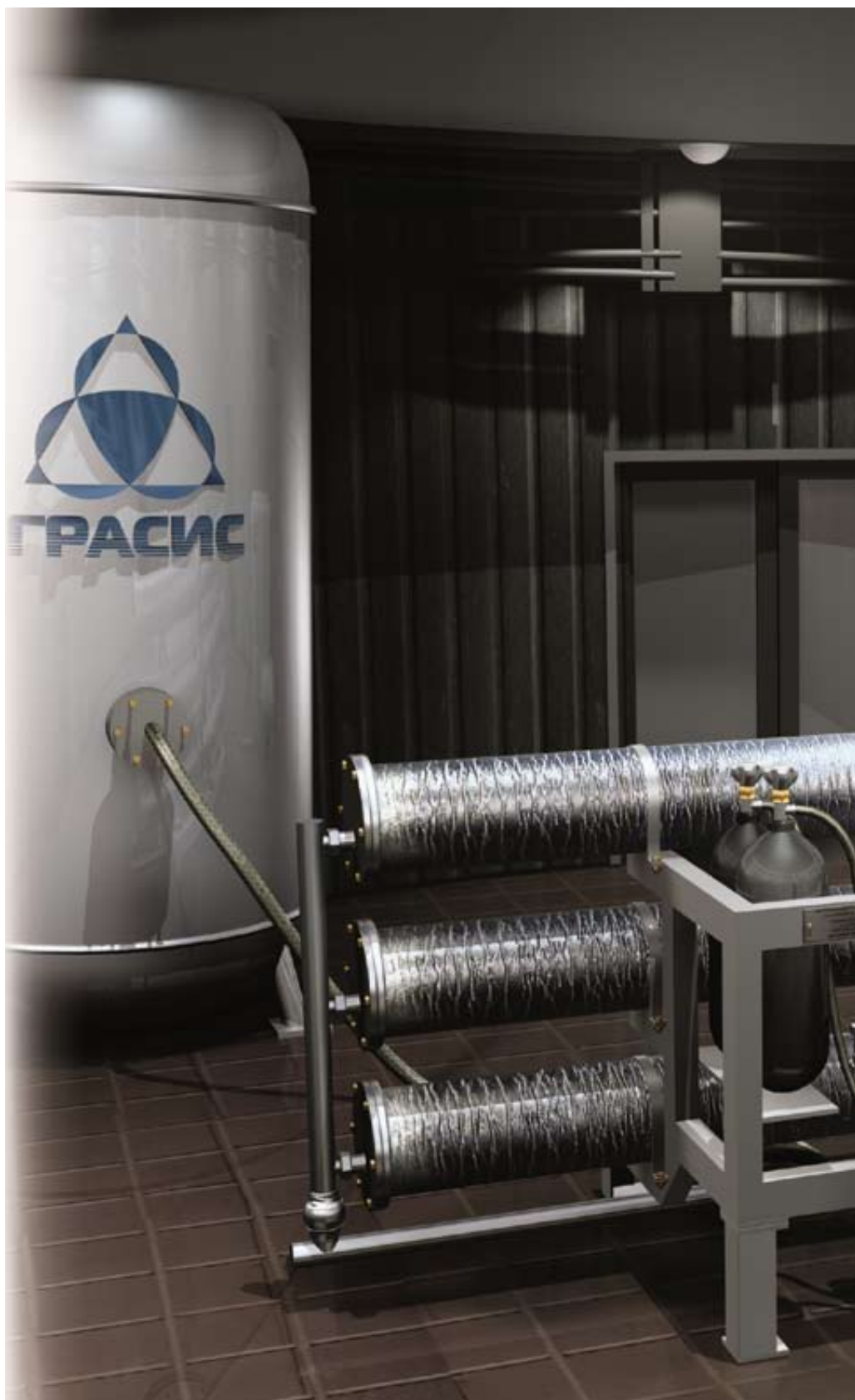
purity, %	95 – 99.95
capacity, nm ³ /hr*	5 – 5,000
pressure, barg	5 – 40
dew point, °C	-40 – -60

Ambient temperature

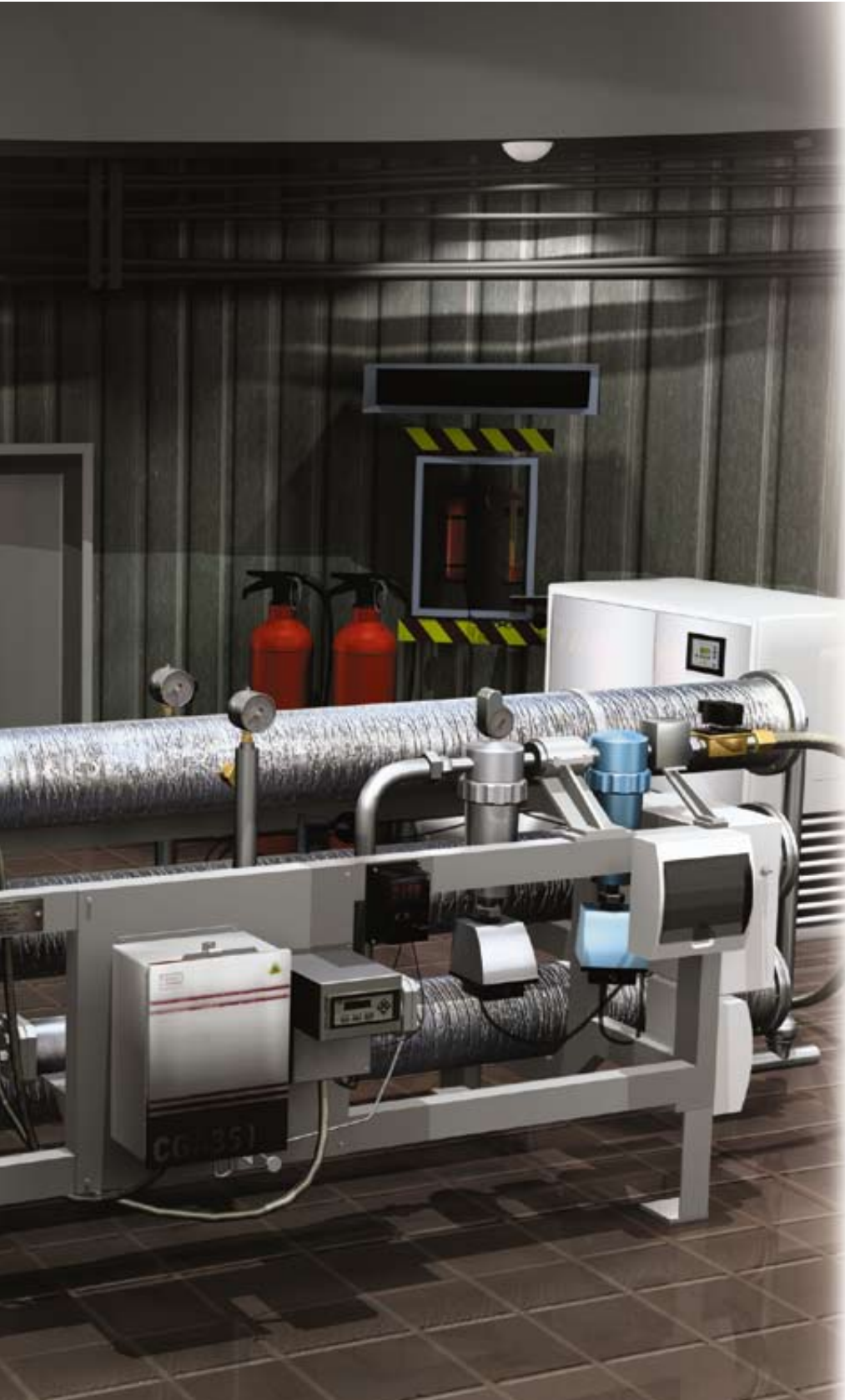
during operation, °C	+5 – +40
during storage, °C	-20 – +50

Warm-up period, not over, min 10

Membrane modules useful life (capacity reduction of 10%), ths. hrs 130 – 180



* Capacity is referenced to standard conditions (t=20 °C, P=1.013 bar)



Advantages delivered by GRASYS nitrogen plants:

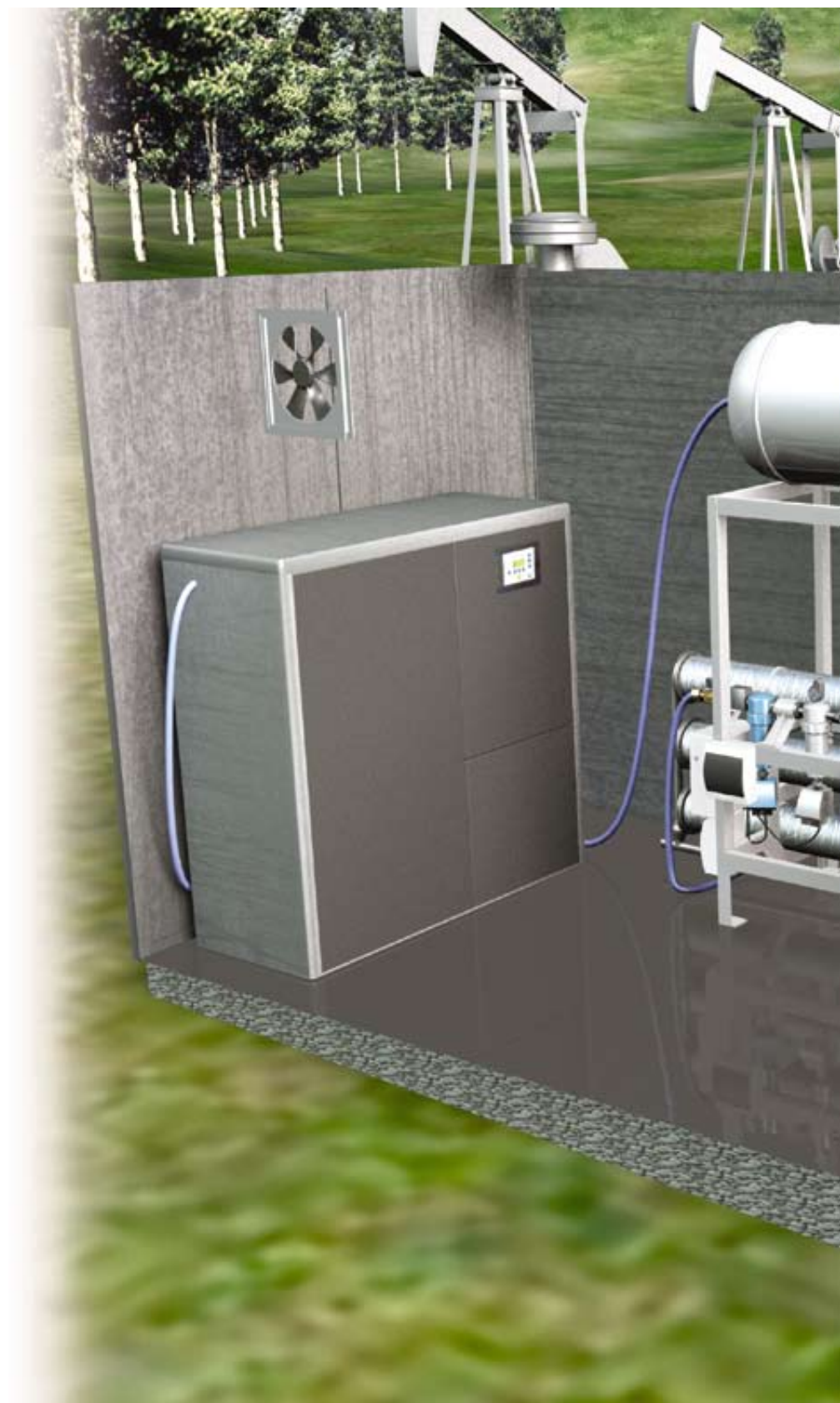
- ⚠ Low net cost of product nitrogen
- ⚠ Complete automation and improved serviceability
- ⚠ Enhanced failure safety
- ⚠ Low operating costs
- ⚠ Quick starting and stopping
- ⚠ Moderate dimensions and weight
- ⚠ No special workshop requirements
- ⚠ Low noise level
- ⚠ Extended operational life
- ⚠ Flexible adjustment of nitrogen purity and capacity rates
- ⚠ Easy rig-up and integration in existing air system

MEMBRANE NITROGEN STATIONS

The ideal solution for remote locations

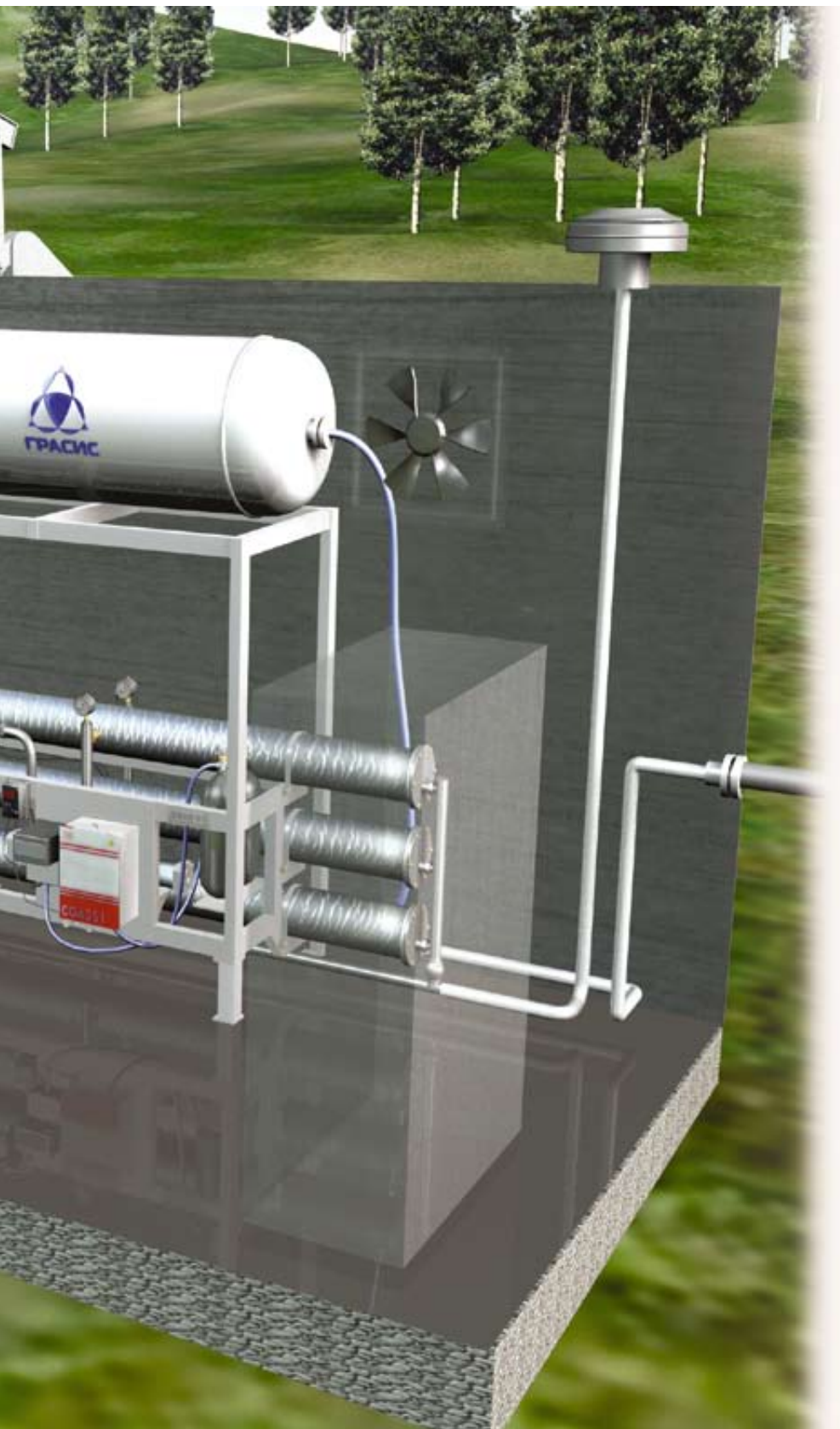
Basic performance specifications

Product nitrogen characteristics	
purity, %	90 – 99.5
capacity, nm ³ /hr*	5 – 5,000
pressure, barg	5 – 40
dew point, °C	-40 – -60
Ambient temperature	
during operation, °C	-45 – +40
during storage, °C	-60 – +50
Warm-up period, not over, min	10
Membrane modules useful life (capacity reduction of 10%), ths. hrs	130 – 180



* Capacity is referenced to standard conditions (t=20 °C, P=1.013 bar)

MEMBRANE NITROGEN STATIONS



Advantages delivered by GRASYS nitrogen stations:

- ⚙️ Enhanced mobility
- ⚙️ Complete self-supportability with diesel version
- ⚙️ Exceptional dependability
- ⚙️ Complete automation and improved serviceability
- ⚙️ No manned operation required
- ⚙️ Compact dimensions and light weight
- ⚙️ Low net cost of product nitrogen
- ⚙️ Quick system starting and stopping
- ⚙️ Operating ability over a wide temperature range
- ⚙️ No special requirements to air quality and improved pollution resistance
- ⚙️ Low operating costs
- ⚙️ Enhanced useful life

PERFORMANCE CHARACTERISTICS

Flawless product as the keystone of your success

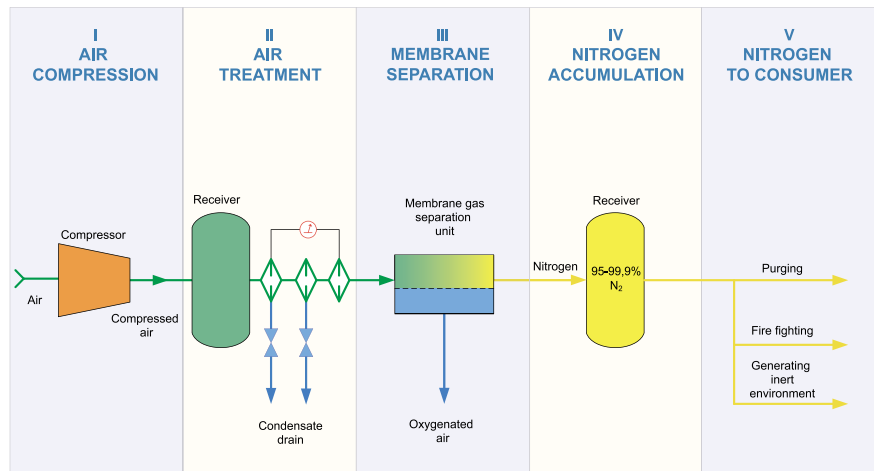
Membrane nitrogen plants and stations generally deliver the optimal solution from the technical and economic perspectives for air-to-nitrogen production processes.

Nitrogen plants

GRASYS nitrogen plants are stationary systems for nitrogen production designed for indoor operation. The plants are designed as high-technology gas separation systems capable of producing 90 to 99.95% nitrogen at the rate of 5 to 5,000 nm³/hr.

The key plant components are the compressor unit, air-conditioning unit, gas separation unit, and a control system. Gas separation unit consists of specifically config-

Nitrogen plant flow process diagram



ured modules producing required purity nitrogen from ambient air.

Integrating the latest technological developments, GRASYS nitrogen plants prove exceptionally dependable, with the membrane unit useful life of up to 180,000 hours of continuous operation.

Nitrogen plants are completely automated with automatic main-



tenance and control of operating parameters and emergency shut-in. No manned support is required during operation. Another significant advantage of GRASYS nitrogen plants is the option of flexible adjustment of the product nitrogen purity level.



PERFORMANCE CHARACTERISTICS



GRASYS nitrogen stations came as a real breakthrough in the field of manufacture of high-capacity, simple in operation and exceptionally dependable mobile systems for nitrogen production from ambient air. On customer request, nitrogen station may be provided trailer- or sledge-mounted, as well as in self-propelled version.

Nitrogen stations

Specially designed and manufactured for field operation, mobile nitrogen stations represent self-supportable containerized systems for nitrogen production from atmospheric air.

Nitrogen stations are designed to produce 90 to 99.5% nitrogen at the rate of 5 to 5,000 nm³/hr. Mobile nitrogen stations consist of a compressor, driven by a diesel or electric motor, air-conditioning unit, gas separation unit and a control system.



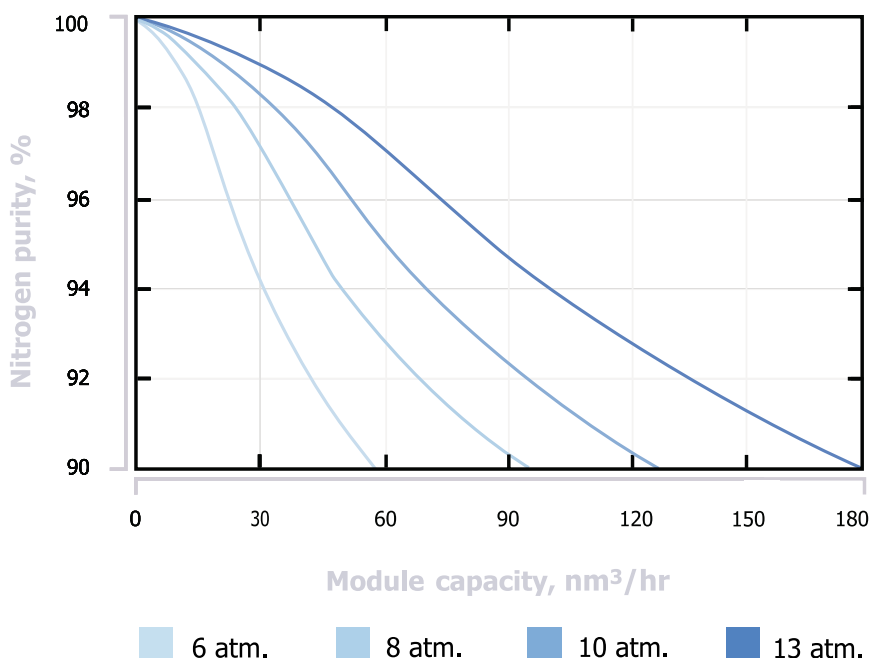
Nitrogen stations, as well as nitrogen plants are completely automated and require no immediate operator involvement to ensure control of working parameters.

Due to the exceptional dependability and high efficiency, all air separation mobile systems for nitrogen production are currently

manufactured on the basis of the membrane technology.

The integration of innovative technologies with long-term experience allows guaranteeing the top quality of the produced air separation stations proof-tested to the world standard under the most demanding conditions of Siberia and the Far North.

Membrane module capacity at various nitrogen purity ratings and pressures



GRASYS products:

Nitrogen plants and stations

Membrane nitrogen plants*

Adsorption nitrogen plants

Cryogenic nitrogen plants

Mobile nitrogen stations*

Self-propelled nitrogen compressor stations

Oxygen plants and stations

Membrane oxygen plants

Adsorption oxygen plants

Cryogenic oxygen plants

Mobile oxygen plants

Cryogenic plants for nitrogen, oxygen and argon production

Nitrogen fire-fighting units

Hydrogen plants

Membrane hydrogen plants

Adsorption hydrogen plants

Hydrocarbon plants

Compressor facilities

Air and nitrogen compressors

Gas compressors

*** Products described in this booklet**



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