Membrane nitrogen plants and packages

Turn-key construction of nitrogen generation plants
GRASYS AT A GLANCE

The Russian research and production company Grasys is the leading developer, manufacturer and EPCM contractor in the field of air and gas separation active in CIS and Eastern Europe.

To date Grasys has implemented more than 700 projects for 350 companies in various industries. The equipment manufactured by Grasys is used by such companies as Gazprom, Rosneft, Lukoil, Surgutneftegaz, Slavneft, Tatneft, Gazprom neft, Transneft, NOVATEK, RITEC, Khim-mash, Sibur, Eurochem, Irkutsk Oil Company, Samara-Nafta, Neftisa, Belorusneft, Naftogaz of Ukraine, Russneft, Oil Industry of Serbia, Turkmenogaz, KazMunaiGaz, Kazakhmys, Zarubezhneft, Exxon Mobil, Shell, Enel, Eni, ConocoPhillips, Petrofac etc.

The company is proud to employ the leading specialists and graduates of the best Russian technical and economic institutions. Among its staff are PhDs and Doctors of engineering. The unique experience and knowledge gained over 12 years of hard work help them develop innovative solutions and provide dynamic growth of the company for more than 12 years.

RPC Grasys has all the necessary permitting documents and certificates for carrying out its activities. The company quality management system complies with international standards ISO 9001:2008.

RPC Grasys manufactures its equipment in accordance with the ASME, CE standards as well as the corporate standards of Total, Gazprom develops and issues documentation in line with the world standards generally adopted for EPCM contracts.

RPC Grasys core business lines:
- Development and manufacture of air separation and gas separation equipment
- Treatment of natural (NG) and associated petroleum gas (APG), APG utilization
- Engineering and design
- Turn-key implementation of integrated projects (EPC and EPCM contracts) with a focus on air and gas separation, APG utilization, NG and APG treatment
Over the 12 years of business operations, Grasys has accumulated a unique experience in implementing projects of any complexity and the industrial application.

RPC Grasys is the only Russia based engineering company possessing the unique and wide experience in manufacture of nitrogen plants and packages. Due to the use of the intelligent control system “GRASYS Intelligent Control-7”, improved design of the gas separation unit, use of compressors of the world leading manufacturers, Grasys nitrogen systems are recognized as the most reliable, efficient and advanced equipment on the market.

Today, more than 400 nitrogen plants and stations made by Grasys are being in operation across Russia and CIS, their superior quality confirmed by multiple Customer references.
Grasys specialists are continuously searching and implementing new technical and engineering solutions in the field of membrane separation. Grasys is a holder of patents for inventions and utility models in the membrane technologies.

Testing and upgrading of the membrane process used in the nitrogen plants and packages is performed at the test benches developed by RPC Grasys as one-of-a-kind appliances in Europe.

The company continuous scientific research in the field of membrane and adsorption technologies of air and gas separation gives start to new solutions facilitating development of science and industry.

A special emphasis in Grasys is laid on quality of its products. The company equipment is manufactured at its in-house modern production site in Stupino, Moscow region, which includes: manufacturing shops, warehouses, utility areas, office space, research laboratory. The daily produc-
tion activities of Grasys are carried out by its high-professional employees employing the most recent project management methods for manufacturing organization, equipment assembly, quality control and acceptance.

The of RPC Grasys production system meets the highest up-to date standards of independent auditor companies (Swiss Engineering Group (SEG), Moody’s) involved in technical audit and expediting activities (control of manufacturing timelines and scope, assessment of order related risks) for our Clients.

Each company membrane module undergoes the multi-stage quality control during manufacture, functional testing and computer-aided simulation of its operation as part of the membrane unit.

All company nitrogen plants and packages have the «Permit for use» issued by the Federal Service for Environmental, Technological and Nuclear Supervision (Rostekhnadzor).
**MEMBRANE GAS SEPARATION TECHNOLOGY**

**Gas separation principle**
The operation of membrane systems is based on the principle of differential permeation rate of gas components through membrane substance. The driving force of the gas separation process is the difference in partial pressures on the membrane surfaces.

Since the beginning of commercial utilization of the membrane gas separation technology, the membrane performance has been continuously improved. The modern gas separation membrane used by Grasys is of a hollow-fiber configuration, which replaced flat membranes of the previous generation. A hollow-fiber membrane consists of porous polymer fiber with a gas separation layer applied to its outer surface.

**Flow diagram of membrane nitrogen plant**

**Membrane cartridge**
Polymer hollow-fiber membranes are structurally wound around a spool to form a cartridge. The pressurized gas is fed into the membrane fibers, where separation takes place due to the difference in partial pressures on the external and internal membrane surfaces.

Nitrogen has a low rate of membrane permeation and is discharged from the cartridge as product gas through one of the outlet lines almost without pressure loss.
Commercial membrane nitrogen systems with “in-fiber” air injection have the following principle of operation: The compressed air from the compressor output is fed into the air pretreatment system for removal of mechanical impurities, condensed moisture and oil. The pretreated air is supplied to the electric heater for optimal temperature maintenance during the separation process in the membrane modules. The air heated to the required temperature is delivered to the membrane gas separation modules for gaseous nitrogen recovery. The compressed air entering though the inlet connection of each membrane module flows inside the hollow fibers partially permeating through them and absorbing oxygen and water vapors.

The permeating oxygen-rich air accumulated in the inter-fiber space is removed through the side connection of each module and discharged into the atmosphere. The non-permeating part of the air gets enriched with nitrogen along its movement inside the fibers and diverted through the outlet connection on the other side of each membrane module for delivery to consumer. Where necessary, the pressure of the nitrogen produced by the membrane plant may be increased with the use of a booster compressor.

Application

- **Oil and gas industry**
  Nitrogen is used for generation of inert environment for assurance of explosion and fire safety of technological processes; testing and purging of pipelines and process equipment.

- **Chemical and petrochemical industry**
  Cleaning and inerting of process tanks for safety purposes; testing and purging of pipelines; substances transportation by pressure.

- **Paint industry**
  In paint and varnish industry, nitrogen is used for generation of inert environment in process vessels to ensure process purposes and for products packing to avoid oils polymerization.

- **Coal industry**
  Nitrogen is used to effectively prevent and to extinguish fires in hard-to-reach combustion spots within a few hours of the nitrogen plant operation.

- **Metallurgy**
  In metallurgy, nitrogen is mainly used for metal protection during annealing as well as neutral tempering, cementation and brazing.

- **Electronics**
  In electronics, nitrogen is used for prevention of oxidizing of semi-conductors and electric circuits; for hardening of finished products; purging and cleaning.

- **Pharmaceutical industry**
  In pharmaceutical industry, nitrogen is used in packing of medicines and handling of fine-dispersed substances.

Economic efficiency of various methods of nitrogen delivery and production
Membrane nitrogen plants offer the most profitable economic performance solution for nitrogen production from atmospheric air.

Grasys nitrogen plants are stationary systems for nitrogen production designed for indoor operation. The plants are arranged as high-technology complexes capable of producing nitrogen at up to 5,000 m³/h with a purity ranging from 90 to 99.95%.

The plant consists of the following main parts: compressor unit, air pretreatment unit, gas separation units and control system. Grasys membrane modules are composed of highly efficient hollow-fiber membranes resilient to the feed air components. The modules do not require special transportation, storage or operation conditions and are functional even after low-temperature exposures. All this ensures the superior performance of the nitrogen plants. The GRASYS intelligent Control-7 system allows manual, automatic local and remote control and monitoring of process parameters. The plant automatic startup system enhances reliability of the gas separation unit.

The “GRASYS Intelligent Control-7” system guarantees the simple and convenient control of Grasys nitrogen facilities.

Advantages of Grasys nitrogen plants
- Exceptional reliability and high assembly quality due to the company extensive manufacturing experience
- Moderate weight and footprint
- Highly efficient last-generation membrane modules
- Perfect design of membrane units
- State-of-the-art control system “GRASYS Intelligent Control-7”
- Use of components of world leading manufacturers
- Energy efficiency
- Low cost of nitrogen produced
- Quick system startup and shutdown
- Low operating costs
- Long service life

Before operation, the Grasys-designed control system undergoes the factory acceptance testing with program uploading and 100% functionality control. The “GRASYS Intelligent Control-7” system is successfully used in Grasys nitrogen plants and packages supplied to the largest fields and strategic projects in the oil and gas industry.

Among them are the Vankor, Korchagin, Ust-Teguss fields, Nord Stream pipeline facilities, nitrogen packages manufactured at the commission of Gazprom, Rosneft, Lukoil and many other major Russian and foreign companies.

The “GRASYS Intelligent Control-7” system guarantees the simple and convenient control of Grasys nitrogen facilities.
**GRASYS “Intelligent Control-7” system provides:**

- Control of all systems and exclusion of human factor effects
- Opportunity for manual, automatic and remote operation
- Opportunity for Grasys Intelligent Control-7 system integration in the enterprise control system
- Emergency interlocks in case of critical deviation of the main process parameters and operator incorrect inputs
- Switching over to standby mode in the absence of nitrogen consumption
- Wide array of additional options, including remote monitoring, record and regular transfer to the Grasys service center of the process deviations register with remote diagnostics by the company specialists
- Archiving the main plant parameters. The plant control panel has the active LC display and ‘hot’ buttons for quick access to the critical functions.

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**Nitrogen parameters at plant output**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purity, %</td>
<td>up to 99.95</td>
</tr>
<tr>
<td>Capacity, m³/h *</td>
<td>up to 5,000</td>
</tr>
<tr>
<td>Pressure, atmg</td>
<td>up to 350</td>
</tr>
<tr>
<td>Dew point, °C</td>
<td>up to -60</td>
</tr>
<tr>
<td>Warm-up time, min</td>
<td>up to 10</td>
</tr>
</tbody>
</table>

*The capacity is referenced to the normal conditions (t=20 °C, P=1 atm)*
Advantages of Grasys nitrogen generation packages:

- Independence and operational freedom in case of diesel engine
- Exceptional reliability and high assembly quality due to the extensive production experience
- Perfect design of membrane units
- State-of-the-art control system "GRASYS Intelligent Control-7"
- Use of highly efficient last-generation membrane modules
- Use of components of world leading producers
- Minimum adjustment and startup period in case of regular use (quick startup after standby without heating is achieved through accelerated equipment warming-up)
- Standard ready-for-use container
- Comfortable operating and maintenance conditions at any time of year regardless of weather, availability of storage space for tools, spare parts, verification gas mixture etc.
- Dust and moisture protection of equipment, condensate removal
- Fire safety and anti-tamper protection
- Opportunity for transportation with all land and water transport means
- Long-term fail-safe operation
- Energy efficiency
- Moderate weight and footprint
- Low cost of nitrogen produced
- Low operating costs
- Long service life
Grasys mobile nitrogen units are designed for nitrogen production at up to 3,000 m³/h with a maximum purity of 99.9%. Nitrogen systems include the compressor with a diesel or electric drive, air pretreatment unit, gas separation unit and control system.

The use of the compressor equipment of the leading European and USA manufacturers, modern intelligent control system, the ideally designed membrane gas separation units ensures exceptional reliability of the nitrogen station, guaranteed attainment of the specified technical characteristics and convenient operation.

The nitrogen generation packages produced by Grasys are a real technological breakthrough in the field of production of high-capacity, user-friendly and reliable mobile systems for nitrogen production from air.

The main process and auxiliary equipment of the nitrogen stations is installed in shelters designed for operation in various climatic zones. The shelters are completed with automatic balanced ventilation systems, heating, fire-fighting, security and fire alarm systems, external and internal lighting. The stations may be provided in the stationary, trailer or truck mounted version.

The shelters for Grasys mobile nitrogen packages are made of sea type 40 or 20-feet containers and may be provided in modules with the required size and configuration. The container is thermally insulated inside
with 50-100 mm wide prefabricated three-layer sandwich panels with a fire rating depending on the operating conditions.

The "Intelligent Control-7" system ensures full control of the package operation in manual, automatic and remote modes, monitoring and archiving of process parameters. The control system may be optionally completed with the remote monitoring system for record and regular transfer to the Grasys service center of the process deviations register to be remote diagnosed by the company specialists.

Grasys containerized mobile nitrogen systems are adapted for severe conditions of Siberia and Far North and designed in consideration of the recommendations of Gazprom, Rosneft etc. operating divisions.

The utility systems of Grasys nitrogen systems comply with the requirements for stand-alone (unattended) facilities.
Nitrogen parameters at station output

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purity, %</td>
<td>up to 99.9</td>
</tr>
<tr>
<td>Capacity, m³/h *</td>
<td>up to 3,000</td>
</tr>
<tr>
<td>Pressure, atm</td>
<td>up to 350</td>
</tr>
<tr>
<td>Dew point, °C</td>
<td>up to -60</td>
</tr>
<tr>
<td>Ambient temperature during operation, °C</td>
<td>-60 to +50</td>
</tr>
<tr>
<td>Warm-up time, min</td>
<td>up to 10</td>
</tr>
</tbody>
</table>

*The capacity is referenced to the normal conditions (t=20 °C, P=1 atm)
**TURN-KEY CONSTRUCTION OF NITROGEN GENERATION PLANTS**

Grasys has a profound experience in the performance of turn-key projects (EPCM contracts) in the field of air and gas separation, APG utilization, NG and APG treatment and oilfield development. Among the company projects are the major CIS and Eastern Europe plants for nitrogen production based on membrane and adsorption technology, globally unrivaled APG treatment plants and other facilities.

The company business process optimization department uses the most advanced management technologies to organize the efficient operation of all company divisions involved in the project implementation: design and engineering, manufacturing, procurement, and logistics. It continuously improves and upgrades the existing processes in view of new challenges and technologies. Efficient project management and monitoring helps accomplish the target results within the scheduled timelines.

**Engineering**

Grasys renders engineering services, including selection of efficient technologies, delivery and assembly of required equipment and accessories, provision of design and permitting documentation, equipment installation.

Grasys offers the up-to-date efficient integrated technological solutions using equipment of the world leading manufacturers.

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**GRASYS – YOUR EPCM CONTRACTOR**

EPCM (engineering, procurement, construction management) implies conclusion of a general contract for design and delivery of equipment, turn-key construction and commissioning of the completed facility.

As an EPCM contractor Grasys performs the following works:

- Project management
- Technical auditing and consulting
- Engineering survey
- Design
- Procurement, production and supply
- Logistics
- Construction and installation, erection of main process equipment
- Startup and commissioning
- Related services, personnel training
**Design**
The key process solutions developed by Grasys are streamlined in line with the Customer individual requirements and current regulations. The company high-proficiency design staff includes more than 30 specialists.

**Activities:**
- Design of key process solutions
- 3D engineering
- Development of design and detail documentation
- Undergoing industrial safety and state expert appraisal
- Development of process procedures, manuals and instructions

**Related services**
High-quality maintenance services forming the basis for long-term operation between Grasys and Customer are rendered by a staff of more than 30 service engineers. Grasys offers its clients a full package of related repair and maintenance support for both proprietary and third party equipment:
- Startup and commissioning
- Pilot operation
- Scheduled equipment maintenance
- Equipment repair and overhaul
- Equipment upgrading
- Personnel training