Natural and associated petroleum gas treatment
Integrated solutions of Grasys
The Russian research and production company Grasys is the leading developer, producer and EPCM contractor in the field of air and gas separation in CIS and Eastern Europe.

The research and production company Grasys has implemented more than 700 projects for 350 companies. The equipment produced by Grasys is used by such companies as Gazprom, Rosneft, Lukoil, Surgutneftegaz, Slavneft, Tatneft, Gazprom neft, Transneft, NOVATEK, RITEC, Khimmash, Sibur, Eurochem, Irkutsk Oil Company, Samaranfta, Neftisa, Belorusneft, Naftogaz of Ukraine, Russneft, Oil Industry of Serbia, TurkmenGaz, KazMunaiGaz, Kazakhmys, Zarubezhneft, Exxon Mobil, Shell, Enel, Eni, ConocoPhillips, Petrofac etc.

The company is staffed with the industry leading specialists – graduates of the best national technical and economic higher education institutions, candidates and doctors of science. Building on their unique experience and knowledge, Grasys specialists develop new solutions and accomplish superior results ensuring the company sustainable development for more than 12 years.

The continuous scientific research conducted by the company in the field of membrane and adsorption air and gas separation technologies facilitates creation and implementation of new solutions fostering science and industry development.

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

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.

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**Grasys core business lines:**

- Natural and associated petroleum gas treatment, recovery of associated petroleum gas (APG)
- Development and production of air separation and gas separation equipment
- Engineering and design
- Implementation of integrated “turn-key” projects (EPC and EPCM contracts) with the main focus on air and gas separation, APG recovery and natural gas treatment
Science and research are the crucial and integral lines of the Grasys activity ensuring its development and industrial leadership. Development of unique solutions on the basis of its own technologies, as well as improvement and adaptation of the existing technologies allow successfully maintaining the high scientific and technical level of the equipment produced, resolving the challenges faced by industrial enterprises at the highest quality level and enhancing production efficiency.

The research and development activities are carried out on the research and testing benches of the company Engineering Center in close cooperation with the leading research centers Kurchatovskiy Institute and the Institute of Petrochemical Synthesis of the Russian Academy of Science. Industrial tests of new solutions are carried out in the fields of Gazprom, Rosneft and other companies together with the design institutions of oil and gas companies.
One of the most important results of the Grasys R&D program was the creation of the brand new globally unrivaled membrane technology for hydrocarbon gases separation based on the proprietary hollow-fiber membrane, and the development of new patented technological solutions in the field of natural and associated petroleum gas treatment.

Today, the Grasys scientific and technical department is involved in the performance of R&D projects commissioned by the leading oil and gas companies, and intensive research in various fields of gas separation and treatment, including: removal of hydrogen sulfide from hydrocarbon gases by plasma-chemical methods, ultraviolet removal of hydrogen sulfide from natural gas, perfection of the PSA and low-temperature separation processes, development of new propane refrigerator designs and new filtering systems, including coalescing filters, membrane gas mixture separation flow-charts and integrated technology systems.
Production of the Grasys membrane systems is arranged at the company in-house production site, where its equipment undergoes the assembly, testing, quality control and acceptance stages with the up-to-date methods of industrial projects management.

The level of the Grasys manufacturing system meets the highest requirements currently imposed by independent auditor companies involved in technical audit and expediting activities (control of manufacturing timelines and scope, assessment of order related risks) for our Clients.

Grasys production facilities are equipped with the modern testing benches for testing and upgrading of membrane cartridges and air separation systems based on various gas separation technologies. The testing benches of Grasys are unique developments standing out in the European market.
The technologies offered by Grasys complete the following tasks as part of natural and associated petroleum gas treatment:

- Meeting environmental challenges, fulfilling the terms of license agreements, reduction of flared gas volumes up to complete avoidance of flaring
- Gas treatment, purification, drying and recovery at production facilities
- Ensuring self-containment of power supply facilities, existing infrastructure facilities and transportation arrangements. Gas treatment as a fuel for gas-fired reciprocating plants and gas turbine power plants
- Gas treatment up to gas transmission network requirements
- Saving on capital expenditure and operating costs through streamlining of technological solutions
- Reduction in harmful emissions during operation of gas-fired reciprocating plants and gas turbine power plants

Grasys performs integrated projects for APG recovery and natural gas treatment on the basis of its proprietary unique membrane technology with employment of other existing technologies:

- Gas drying
  Grasys membrane technology
  Glycol drying

- Gasoline extraction
  Grasys membrane technology
  Low-temperature separation (LTS)
  Low-temperature condensation (LTC)
  Combined technologies

- Removal of H₂S and CO₂
  Grasys membrane technology
  Adsorption technology
  Absorption technology
  Alkali treatment

- Gas compression
- Gas conditioning before liquefaction
ASSOCIATED PETROLEUM GAS RECOVERY METHODS
The membrane principle of gas mixture separation is based on different rates of polymer membrane permeation by various components due to partial gas pressure difference on the membrane sides.

The membrane gas separation technology is widely used throughout the world for nitrogen recovery from air, hydrogen extraction from hydrogen-bearing gas mixtures, removal of carbon dioxide and water from natural gas. The broad array of applications is based on the well-studied ‘conventional’ membrane, which allows successfully completing the above tasks, but cannot be used for separation of gases with heavy hydrocarbons due to their destroying or plasticizing effects. Besides, the gas treated in such membrane systems requires further compression since ‘conventional’ membrane separation is associated with considerable pressure loss in the product flow.

Distinctive features of the new membrane are the hollow-fiber configuration, totally new distribution of gas components permeation rates (figure at p. 12), enhanced chemical stability against nearly all components of hydrocarbon mixtures and high selective ability. During treatment of associated petroleum gas and natural gas all impurities are concentrated in the low-pressure flow, while the treated gas comes out with almost zero pressure loss.

Using its extensive experience in production of membrane plants intended for various applications and in-depth understanding of the membrane technology advantages, Grasys held a complex of scientific and practical research resulting in the development of a specialized membrane for separation of hydrocarbon gases saturated in heavy hydrocarbons, water and sulfur-bearing compounds.
Advantages of Grasys membrane technology

- Grasys membrane allows removal of a number of impurities from natural and associated petroleum gas during a single process cycle, which is impossible with any other hydrocarbon gas conditioning technology.

- Grasys plants on the membrane basis are characterized by excellent weight and footprint characteristics.

- Treated gas is delivered almost without pressure loss, thus eliminating the need for additional gas compression for consumption and transportation purposes.

- Grasys membranes allow simultaneously deriving several product flows with different characteristics at the same plant.

- Membrane operation is arranged within a wide range of pressures – 3 to 100 atmospheres and therefore independent of the pressure limitations of the Customer pipeline system.

- Grasys membrane technology is environmentally friendly using no chemical agents.

- Grasys membrane technology ensures up to 100% APG recovery (all membrane systems are designed to achieve 95-100% product gas utilization).

Advantages of gas treatment plants based on Grasys membrane technology

- The plant capacity can be varied from 5% to 100% of the nominal capacity by switching on or off gas separation modules. This is especially useful for seasonally fluctuating fields and/or declining feed flowrates.

- Grasys plants may be operated for a long time at capacities markedly higher than the rated load with insignificant deterioration of gas treatment quality.

- Grasys plants are delivered to Customers in transportable shelters and completed with a firmware package, including APCS, fire and gas alarm systems, which substantially reduces the duration and costs of construction and installation works.

- The plant running time is 365 days a year without shutdown.

- Plants are easy to operate with and do not require highly qualified operating personnel.

- The plants are easy to operate and do not require constant manned attendance during operation.

- Costs involved in plant operation are low.

- Membrane plants may be provided in a skid-mounted version for operation at open-air sites, or as combined units.
The high efficiency of petroleum gas treatment with Grasys membrane systems for removal of water, higher hydrocarbons, CO₂, and H₂S is confirmed by comprehensive testing at industrial sites of the leading oil and gas companies. Over the past few years, Grasys commercial membrane hydrocarbon modules were tested at the sites of Kogalym compressor station (CS) of Kogalymneftegaz LLP, Slavyanskaya NGDP-4000 and Klyuchevaya GPU of RN-Krasnodarneftegaz LLC.
The first membrane gas separation plant was brought on stream in 2010 at the Novoukrainskaya CS of RN-Krasnodarneftegaz LLC. The plant is designed for treatment of wet sulfur-bearing petroleum gas for supply to the Gazprom gas transport network (GTN). Based on the results of its operation, a series of plants has been produced and commissioned for some oil and gas majors of Russia.

Grasys continues improving its membrane technology for hydrocarbon gas treatment. In 2012, the company scientific and technical department developed new customized membranes, for example, membranes for treatment of H₂S-rich gases, membranes with improved gas separation properties, as well as new designs of cartridge housing. Testing of new technological solutions and membrane module designs is under way, and new applications for Grasys membrane technology are explored for efficient solution of the tasks faced by the oil and gas industry companies.
INTEGRATED SOLUTIONS FOR NATURAL AND ASSOCIATED PETROLEUM GAS TREATMENT

Grasys performs integrated projects offering its Customers the most efficient solutions. The process baseline is the proprietary membrane gas treatment technology used to complete the tasks of gas conditioning, drying and treatment.

Nevertheless Grasys shall meet any Customer requirements using other existing process technologies.

MAIN AREAS OF PROJECT PERFORMANCE:

- Treatment of natural and associated petroleum gas for transportation
- Treatment of associated petroleum gas up to fuel gas specifications
- Treatment of H₂S-bearing gas up to fuel gas specifications
- Treatment of mine gases up to fuel gas specifications
- Treatment of CO₂-bearing gas for use as a fuel / for transportation
- Recovery of associated petroleum gas for downhole injection
- Recovery of valuable monomers (propylene, butadiene, vinyl chloride etc.) from petrochemical effluents
- Gas treatment before liquefaction
Removal of sulfur-bearing compounds and CO₂

Grasys membrane technology is the only process allowing for simultaneous removal of sulfur-bearing compounds and gas drying in terms of hydrocarbons and/or water. Grasys membrane plants condition sulfur-bearing gas up to the fuel specifications for gas engine (gas turbine) power plants, oil heaters and boiler houses. With the hydrogen sulfide content within 0.1-0.2% mole, gas is suitable for treatment up to the requirements for supply gas transmission system.

Depending on the feed gas parameters, treatment depth requirements, volume and composition of sulfur-bearing impurities and Customer preferences, membrane technology may be used together with other conventional methods for gas sweetening.

The content of hydrogen sulfide and mercaptan is reduced by 10-100 times.

Grasys membrane plants ensure the required degree of gas drying for liquefaction and considerable reduction in CO₂ content. Where it is inexpedient to use the membrane method alone for CO₂ removal up to the required parameters, the combined membrane and sorption conditioning process is recommended. Thereby, the use of a membrane plant allows multiple reduction of load on the sorption treatment unit and achievement of the required indicators regardless of CO₂ ratio fluctuations in the feed gas.

Adsorption technology. The use of this technology is rational for deep gas treatment for removal of sulfur compounds and CO₂. In some cases, adsorption technology may be combined with preliminary absorption or membrane treatment for removal of sulfur-bearing impurities. The adsorbents used may be both regeneratable and non-regeneratable type.

Absorption technology (amine treatment). This technology is used within a wide range of sulfur and CO₂ concentrations. The range of associated goals is fulfilled with the use of MEA, DEA, TEA, MDEA solutions. In some cases, other absorbents can be used. For reduction of operating costs, this technology may be combined with membrane and adsorption treatment.

Alkali treatment. This method is basically used in addition to the main technology, especially if the treated gas is mercaptan saturated.
Grasys offers the comprehensive approach to drying hydrocarbon gases with both low and high C₃+ content. The main drying process used by Grasys is membrane technology used to dry any hydrocarbon gases without limitation of the ratio of heavy hydrocarbons and sulfur-bearing gases.

As compared with conventional technologies, this is the only process allowing water and hydrocarbons dewpoint temperature reduction within one process unit gas transmission network requirements with gas treatment up to for cold-climate regions with dried gas pressure of 4.0-10.0 MPa. The use of membrane plants for gas drying helps minimize the related capital and operating costs.

**Depending on the process flowchart, gas may be dried by 15–60°C.**

According to needs and requirements of Customer, triethylene glycol dehydration plants may be used. Glycol drying is recommended for conditioning (without hydrocarbon composition correction) of significant gas volumes meeting all rated indicators apart from water content.

**Membrane technology capabilities:**

- APG drying up to the specifications allowing its delivery to gas processing plants (GPP) for further processing
- Natural gas drying after storage facilities before delivery to consumers
- Adoption of membrane systems for hydrocarbon gas drying in place of (or in addition to) adsorption gas drying plants at GPP
- Gas drying on wellhead in fields with declining formation pressure instead of low-temperature separation
Gasoline extraction

Membrane technology of Grasys ensures gasoline extraction up to the rated dewpoint temperature together with gas conditioning in terms of other regulated parameters: water dewpoint temperature, concentration of sulfur-bearing impurities (hydrogen sulfide, mercaptan) and carbon dioxide. This makes it unique as compared with conventional gasoline extraction methods, especially in case of weight and footprint limitations and operation at remote locations with underdeveloped infrastructure.

Grasys also can offer traditional gasoline extraction solutions (low-temperature separation (LTS) and low-temperature condensation (LTC)), as well as combined options of low-temperature processes with membrane technology, which are effective in cutting down capital and operating costs.

**Reduction in C$_4$ content by 2.5-8 times**

**Reduction in C$_5$ content by 6-12 times**

Gas compression

As part of development of technological solutions for natural gas and associated petroleum gas treatment and utilization, Grasys undertakes selection and supply of all necessary compressor equipment. It offers screw, reciprocating, centrifugal compressor units with electric or gas drive. The optimal solution is selected on the basis of the compressed gas composition, inlet and outlet parameters.

Modular compressor stations produced by Grasys may also be used for other APG applications – fuel gas conditioning for gas turbine power plants or boiler plants. The modular design of gas compression stations allows its installation on any even coated surface (site) meeting the specific load requirements, as well as on platforms, skids, chassis of specialized machinery, trailers and semi-trailers with an adequate bearing capacity.

The equipment package includes all necessary systems providing and ensuring the optimal station operation conditions (space heating; ventilation; lighting; oil and gas heating (where applicable) etc.).

Depending on the gas utilization technology and required parameters, modular compressor stations may be completed with various type compressors of the world leading producers. The equipment is selected on the basis of Customer requirements and according to delivery dates.
The EPCM contract includes:
- Project management
- Technical audit and consulting
- Engineering survey
- Design
- Procurement, manufacture and supply of equipment
- Logistics
- Construction and installation works, installation of the main process equipment
- Facility delivery and commissioning
- Services, personnel training

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

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

Due to the use of the most advanced management technologies, the company project coordination department organizes the efficient operation of all company divisions involved in the project: design and engineering, production, procurement, and logistics. The business processes optimization department 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 the 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 with the use of equipment of the world leading producers.
Design
The main technological solutions developed by the Grasys Design Department are streamlined and customized to meet the Customer individual requirements and comply with the current regulations. In the performance of projects, plants are ultimately integrated in the Customer facility infrastructure with due account for its specifics.

Works performed:
- Development of key technological solutions
- 3D design
- Preparation of design and detailed documentation
- Industrial safety expert appraisal, state expert appraisal
- Development of process procedures, manuals and instructions

Services
Provision of high-quality associated services is the main factor driving the longterm cooperation between Grasys and the Customer. Grasys offers its customers the full package of repair and technical support services of its own and third party equipment:
- Plant commissioning
- Pilot operation
- Regular equipment maintenance
- Equipment overhaul and repair
- Upgrading
- Personnel training