

membrane
and adsorption
hydrogen plants

economically
viable solution



Tapping new opportunities

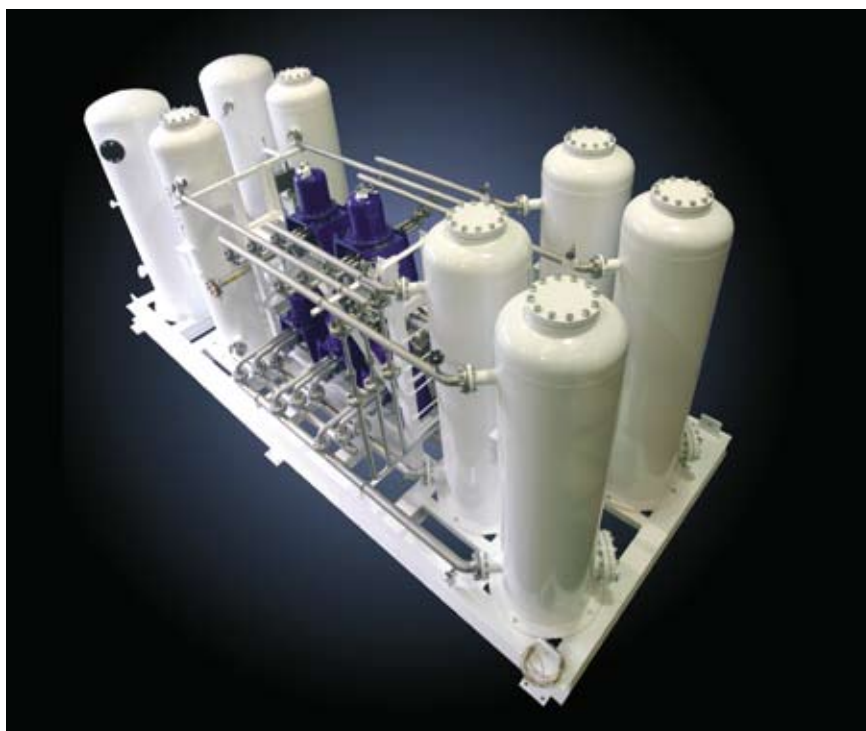
GRASYS is the leading Russia and CIS engineering company in exploring the area of manufacture of modern equipment for industrial gas separation and development of advanced gas separation technologies. GRASYS is one of the world leaders engaged in the development and manufacture of non-cryogenic gas separation equipment.

GRASYS manufactures its equipment with the use of all three technologies currently available for gas separation purposes: membrane, adsorption, and cryogenic. The experience accumulated in the implementation of many complex and unique projects enables GRASYS to offer its customers the optimal solutions to respond to their specific challenges.

Competence

Over the years of its operation, GRASYS has won an immaculate reputation and broad recognition due to the application of state-of-the-art technologies, implementing multi-stage quality control, process flexibility, and customer-focused approach.

GRASYS equipment is being successfully operated in more than 250 large and reputable enterprises. GRASYS systems are used by such companies as Gazprom, Rosneft, NOVATEK, TNK-BP, Lukoil, Surgutneftegaz, Shell, Solvalub, RITEC, Salym Petroleum Development N.V., Tatneft, Slavneft, TWEL, Empils, Kotovsky Paint-and-Varnish Plant, Russian Paints, and others.



Hydrogen plants

GRASYS hydrogen plants based on the membrane and adsorption technologies provide new opportunities for the improvement of chemical and petrochemical facilities cost-effectiveness. The new-generation hydrogen plants produced by GRASYS made it possible to improve the efficiency of hydrogen concentration from gas streams and its recycling for technological or other purposes.

The plants profitably combine a high degree of automation with the outstanding technical characteristics, together with an added advantage of light weight and compactness as compared with outdated analogs.

Besides, GRASYS new-generation plants are considerably superior to outdated models in terms of reliability and fail-safety.

Manufacture

GRASYS places the principle emphasis on the quality and reliability of the plants manufactured. All stages of the process cycle are subjected to a multi-stage quality control applicable to component parts and assemblies. This allows guaranteeing a long-term trouble-free operation of GRASYS plants in the harshest environs. All new equipment is furnished with the "Permit for Application" issued by the Federal environmental, technological, and nuclear supervision agency (Rostekhnadzor).

Technologies

GRASYS is conducting on a continuous basis scientific research and engineering developments aimed at the perfection of its equipment. This activity is carried out in close collaboration with the leading foreign companies engaged in the field of innovative gas separation technologies.



Application efficiency

GRASYS plants designed for hydrogen recovery from a variety of gas streams are a ready choice in a broad range of processes at chemical, petrochemical, and refining enterprises. Hydrogen is a valuable chemical, and its recovery and concentration from fuel, residual, and waste gases allow a significant improvement of the production process cost-effectiveness. Hydrogen generated by GRASYS plants may be reverted to the process flow or diverted for liquefaction.



Oil and gas refining processes

The task of hydrogen recovery and concentration in the process flows of oil and gas refineries is effectively resolved with the help of membrane and adsorption hydrogen plants. The primary hydrogen sources are fuel gases, catalytic cracking purge gases, etc.

Chemical and petrochemical industry processes

Hydrogen recovery from waste, purge, and fuel gases is becoming an increasingly relevant challenge in the technological processes of the chemical and petrochemical industries. Hydrogen plants make it possible to concentrate a highly valuable gas of hydrogen with its subsequent reuse in the process cycle.

Hydrocracking and hydrotreating

Hydrogen plants are efficiently applied for hydrogen recovery from hydrotreating and hydrocracking purge gases and hydrogen recycling in the technological process.

Ammonia production

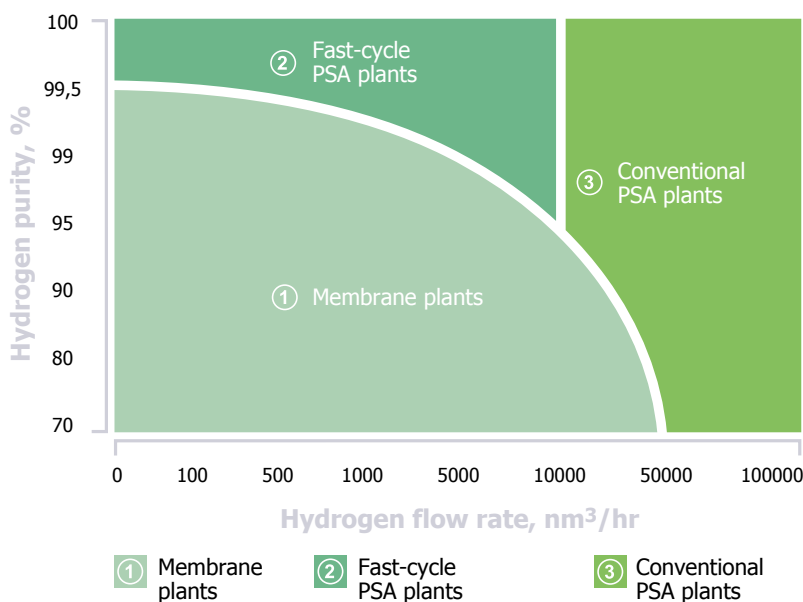
Hydrogen separation from nitrogen, methane and argon in ammonia synthesis gas streams is one of the most common applications of hydrogen plants. Hydrogen-enriched gas obtained at the output of a hydrogen plant is reverted to the

SNG compressor and is returned to the reactor.

Synthesis gas production

Hydrogen plants find broad application in adjusting H₂/CO ratio in oxo synthesis process flows.

Economic viability of various types of hydrogen production



MEMBRANE AND ADSORPTION HYDROGEN PLANTS

Advanced hydrogen separation technologies

Basic technical specifications

Hydrogen parameters
at the plant output

purity, %	70 – 99.9995
capacity, nm ³ /hr *	50 – 50,000
pressure, barg	3 – 110

Ambient temperature

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

Plant useful life,

thousands of hours	120 – 180
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* capacity is referenced to normal
operating conditions
(t=20 °C, P=1.013 bar)



Advantages of GRASYS hydrogen plants

- ⚠ High purity of hydrogen obtained
- ⚠ Low drop between inlet and outlet pressures for adsorption plants
- ⚠ Ability to operate at high feed gas pressure for membrane plants
- ⚠ Comparatively small investment volume
- ⚠ Compactness and low weight
- ⚠ Minimum operating costs
- ⚠ Simplicity of installation and maintenance
- ⚠ Enhanced reliability and fail-safety
- ⚠ Extended useful life period

Advanced solutions for modern industry

GRASYS membrane hydrogen plants represent advanced facilities for hydrogen separation from gas streams. The plants deliver a variety of benefits, being cost-effective, reliable, compact, and fully automated.

Membrane hydrogen plants

GRASYS hydrogen plants based on the membrane separation principle allow hydrogen separation from waste, residual, fuel, and other gases up to 99.9% purity with the product flow rate of up to 50,000 nm³/hr.

Up-to-date membrane hydrogen plants appear a worthy alternative to

cryogenic and adsorption systems. In many cases, membrane plants designed for hydrogen concentration find application in the areas where the use of other technologies based equipment are impossible or ineffective.

A significant advantage secured by membrane hydrogen plants is their ability to operate at various pressure levels of separated gas – 10 to 110 barg. Besides, membrane plants, unlike adsorption and cryogenic systems, allow easy adjusting purity of product hydrogen. This makes it possible to decide on the optimum equipment operation mode depending on the tasks set.

Another important advantage is the complete absence of moving parts in the plants structure. This enabled the production of exceptionally reliable and serviceable equip-

ment while preserving complete automation and providing excellent performance characteristics together with compact dimensions.

Hydrogen plants based on the membrane separation method contain no wearing assemblies, and for this reason, require practically no maintenance.

GRASYS membrane hydrogen plants may be operated by personnel without specific training: maintenance and control of all working parameters are effected with electronic means.

The operating life of GRASYS hydrogen plants ranges between 120 and 180 thousands of hours of continuous operation.





New-generation adsorption technology

The core of operation of hydrogen plants utilizing adsorbents is the most recent super-short cycle pressure swing adsorption technology. Plants based on this technology are characterized by the superior performance: there are more reliable, fully automated, simple in operation, thereby many-fold more compact and lighter than traditional PSA plants.

Fast-cycle hydrogen adsorption plants

GRASYS offered adsorption plants with a fast working cycle are designed for the production of high-purity hydrogen from gas streams. GRASYS fast cycle ad-

sorption plants allow generating hydrogen with the purity of as high as 99.9995% and the minimum pressure drop during the separation process.

The fast-cycle adsorption technology is the most prominent achievement in the field of gas separation over the past years. With the invention of this technology, it became possible to resolve a variety of problems typical for hydrogen PSA plants.

The fast-cycle adsorption plants integrate two technological novelties: rotary system with the use of only two valves and a structured new-generation adsorbent resistant to fluidization. This resulted in an option of 100-time increase in the cycle speed – up to 50 cycles per minute as compared with conventional PSA plants and consequently a manifold

reduction in the required adsorbent volume. That is why the dimensions and weight of the fast-cycle adsorption plants offered by GRASYS are an order of magnitude less than those of PSA plants.

Unlike modern fast-cycle adsorption plants all conventional PSA systems has applied so far only granular adsorbent. Considering the opportunity of carry-over of such adsorbent, cycle speed cannot be significantly increased, remaining at some 0.05 to 0.5 cycles per minute. Due to this, 4 to 16 high-capacity adsorbers with a complex valve and pipelines system are used in PSA plants in order to ensure the required productivity.

GRASYS fast-cycle plants are completely free from such shortcomings and getting increasingly popular on a global basis.

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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