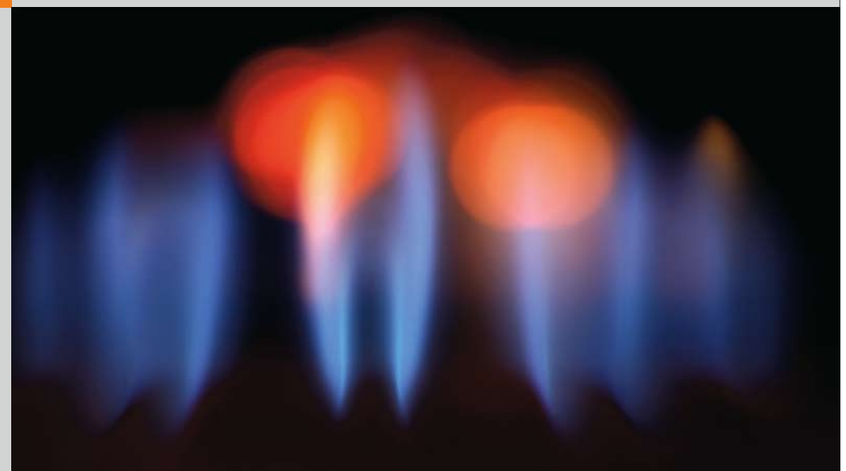
PGNiG

Polish Oil and Gas Company



COMPANY

Odolanow Branch

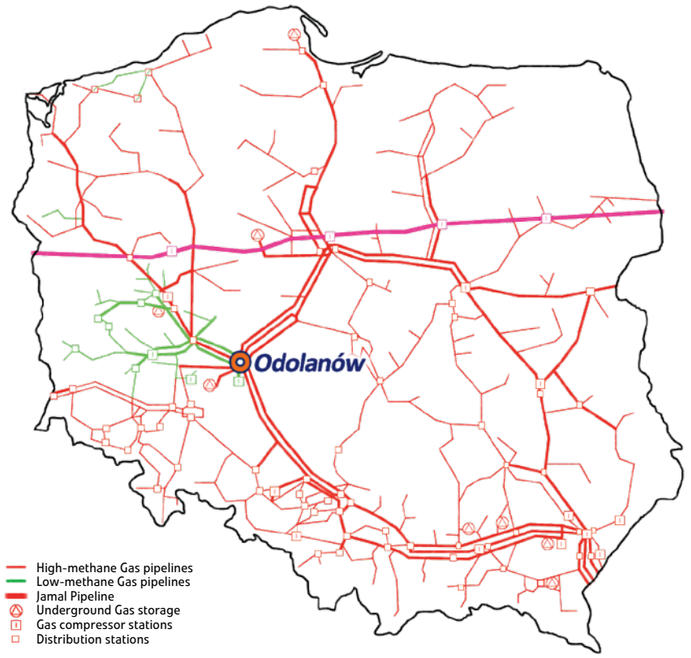
We are a branch of Polish Oil and Gas Company which with its Capital Group is a leader in the natural gas market in Poland.

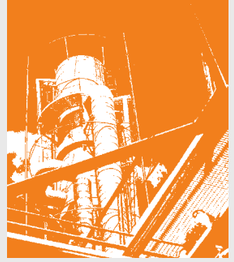
As a branch of Polish Oil and Gas Company we:

- cryogenically process nitrogen-rich natural gas to high-methane gas,
- purify and liquefy helium,
- compress methane gas,
- produce LNG.

Beginning of our history is connected with intensive exploration of oil and natural gas conducted at the beginning of the 60s of the twentieth century in the Polish Lowlands. Natural gas from discovered deposits, contained, in addition to methane, more than 40% of nitrogen, and a 0.3 ÷ 0.4% of helium. To eliminate unnecessary ballast gas, which is nitrogen, and - consequently - achieving high-methane gas fuel, in the 70s of the last century was built in Odolanow denitrification installation of natural gas with helium recovery and liquefaction.

Over the subsequent years of the plant's operation changed the gas production fields, which supplied it with feed gas in the beginning. In place of deposits being depleted and withdrawn from operation or rebuilt into an underground gas storage facility, newly discovered ones have started to supply the plant.





TECHNOLOGY

Nitrogen Removal Plant

Natural gas pretreatment

Runs in subsequent following stages:

- carbon dioxide (CO_2) removal - through absorption with the use of OASE (amine) solution to the final content of CO_2 below 5 ppm;
- moisture (H_2O) removal - through adsorption on molecular sieves 4Å to the final moisture level below 2 ppm (Dew point below -90°C);
- heavy hydrocarbons (C_{5+}) removal - through adsorption on activated carbon bed to the final content of C_{5+} below 5 ppm.

Low-temperature (cryogenic) distillation of natural gas

The pretreated natural gas, free of CO_2, H_2O and C_{5+}, is precooled within plate heat exchangers. Then it is subcooled as a result of expansion taking place in expansion turbines. As a result of different boiling points of natural gas components, the stream is separated within two distillation columns (high- and low-pressure) into: liquid methane (>96%), liquid nitrogen and crude helium gas. Liquid methane is then re-gasified in a block of low-temperature heat-exchangers (cold-box) and - as a gas stream - piped to the compressor station. A small part remains in the liquefied form and as LNG goes to consumers.

High-methane Gas Compression

Gas compressor station consists of five Cooper-Bessemer and three Waukesha-Ariel moto-compressors. The units compress high-methane gas downstream nitrogen removal plant, but also increase the gas pressure within national transmission grid (on order of the operator of gas transmission pipelines).

Helium Plant

Purification of helium

Crude helium gas (approx. 80%) is purified in the following stages:

- hydrogen and moisture removal - through adding air and hydrogen oxidizing in the presence of a platinum catalyst, followed by separation of water vapour and moisture adsorption on molecular sieves to the final combined content of moisture and hydrogen less than 2 ppm;
- nitrogen and oxygen removal - as a result of low-temperature condensation in the separator and adsorption on molecular sieves and activated carbon at a temperature down to -200°C;
- neon removal - through adsorption on activated carbon at a temperature below -250°C.

Helium liquefaction and storage

The stream of purified helium gas undergoes a continuous compression-expansion cycle with heat transfer in low-temperature heat exchangers which results in helium liquefaction. A deep vacuum of level up to 5 x 10^{-5} torr is required to maintain the liquefaction temperature in the system, which is close to absolute zero.

Liquid helium is stored in vacuum-insulated tanks with multi-layer super-insulation and liquid nitrogen shield.

low-methane gas pretreatment

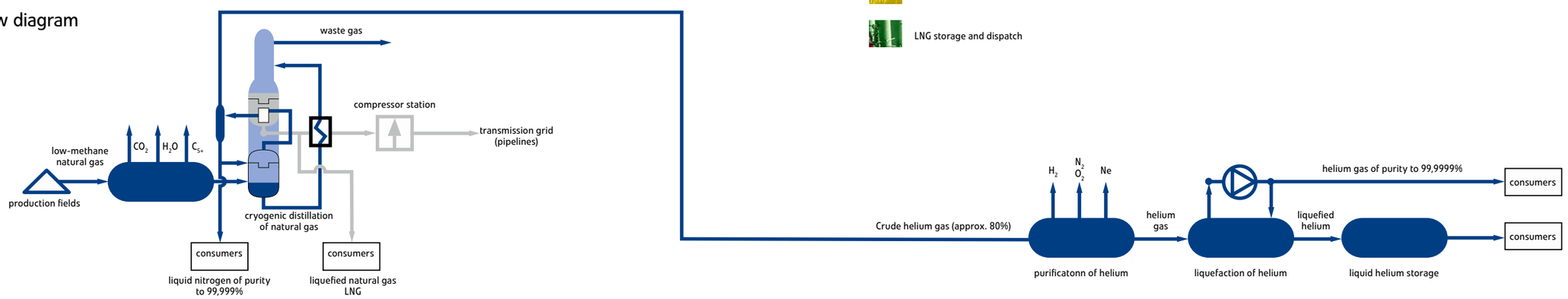
section of the low-temperature distillation of natural gas

high-methane gas compression

helium purification, liquefaction and storage

LNG storage and dispatch

Process flow diagram



INNOVATIONS

We implement innovative technical solutions that increase process flexibility and plant's operational reliability, but most of all - increase energy efficiency of our operations.

Among the recently completed revamps worth mentioning are the following:

- installation of the new helium liquefier together with an additional liquid helium storage tank; results in 40% less power consumption;
- installation of a new hydrogen removal unit (on crude helium stream);
- application of the new absorbent solution (amine) in the CO_2 removal section; results in higher acceptable limit of CO_2 in the feed gas, considerably reduces energy amount necessary for regeneration of amine solution;
- replacement of Joule-Thomson valves with two-phase expansion turbines; increases the thermodynamic efficiency of the cryogenic distillation of natural gas;
- Installation of heat exchangers in the process points where energy recovery is feasible, such as: economizers on the exhaust stream of regenerative heaters;
- modernization of gas motocompressors, in particular: installation of a more efficient and less emissive engine or installation of fuel valves with turbulences of injected gas;
- replacement of old type regenerative heaters in the moisture removal section with new generation heaters of vortex burners;
- replacement of two cooling water pumps with state-of-art units using hydrokinetic couplings;
- modernization of SCADA process control system both with local controllers; results among others in optimum sequence of adsorbers' switching.

PEOPLE IN THE COMPANY

Competent

Long-term use of advanced technology has resulted in collection of unique know-how in our team. The operational experience we combine with high level of academic education of branch employees, of whom more than half have graduated of one or more university courses.

Involved

Commitment is the most valued attribute of each employee. We see it as active and fully aware participation and involvement in defined activities, but also as an inquisitiveness and enthusiasm during implementation of new projects.

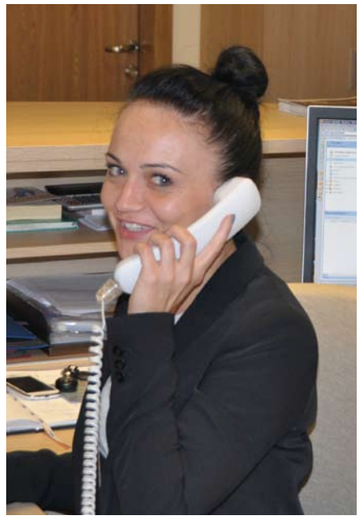
Innovative

We are constantly updating our knowledge of the latest available technical and organizational solutions. We analyze the possibility of their implementation in our systems, firstly assessing the expected economic and environmental effects.

We strive to create the most favourable working environment, which shall ensure the harmonious development of the company and employees.

We focus on:

- ensuring safe working conditions,
- supporting open and honest communication,
- ethical behaviour,
- acquiring competent professionals and retaining committed employees.



SAFETY - ENVIRONMENT - QUALITY

We focus on:

- continuous improvement of health and safety conditions at work, as well as fire protection,
- minimizing the negative impact on the environment,
- effective protection of our fixed assets both with information,
- quality improvement of our both core products as well as the customers service.

Environment protection

The impact of our manufacturing processes on the environment is identified in the form of environmental aspects while the impact's range is assessed for normal operational conditions, abnormal states (e.g. start-up or shut-down) and emergency conditions.

We monitor the intake of fresh water from wells, which has been minimized through implementation of closed cooling water circuits.

We periodically measure noise levels being emitted (much reduced after installing the silencers and guards), and exhaust gases emissions to the atmosphere (limited after replacing the old-type heaters and motor-compressor's engine). We efficiently control the storage and operations with dangerous substances, which are harmful to humans and environment, but indispensable in our manufacturing processes. We have implemented procedures for environmental emergencies.

We meet all environmental standards for emissions into the atmosphere; while our emissions of dusts, sulphur and nitrogen oxides, are significantly below established limits.

We are active participants in the trading scheme for rights to CO_2 emissions.

Health and safety

In a uniform and structured way we identify hazards associated with the work; we also determine the level of acceptable risk and take actions to improve safety.

The technology in use imposes on us a special obligation to care for the safety. Our plant is ranked as one of "high-risk" companies as for serious industrial accidents due to the large quantity of hazardous substances being stored within our installations. That makes us liable for implementation special EU Directive obligations.

An important part of minimizing the risk of failure and limiting its possible consequences is the safety system, which consists of automatic shut-offs and gas blow-downs, explosimeter system both with fire detection and alarm system. In the safety area we look for the best available technical solutions, such as recently installed state-of-art foam system to slow down the evaporation of spilled LNG.

Cyclic trainings (often connected with inner competitions), including the ones in which participate professional fire brigades, environment protection services or police, shape the consciousness of both, our employees and the local community, and help to learn appropriate responses in emergency situations.

Preventive actions, practiced every day, results in many years of accident-free functioning of our Branch, as well as the reduction of occupational diseases.

Protection of assets

We have implemented systems to protect people, property and information.

Property protection is supported by system tools such as electronic access control system, system of microwave barriers, video monitoring system.

In view of the widespread use of electronic data we pay special attention to the proper management of this type of information. Information systems, both administrative and technical, are secured, among others, by advanced network traffic analyzers and login collectors.

Relations with the local community

The actions we undertake are in line with the objectives defined by Strategy for Sustainable Development and Responsible Business of PGNiG SA Capital Group, which distinguishes four essential areas: market/customers, employees, environment, and local community.

We support the associations and other institutions in their activities for talented youth, people with disabilities or persons in need. We are committed to local initiatives developing sailing passions of young people or their interest in science knowledge.

Cooperation with science

For many years we sponsor the research summer school called „Summer with helium" organized by the Institute of Molecular Physics, Polish Academy of Sciences for university and high school students. Lasting two weeks classes include both lectures by recognized scientists as well as self-experimentation. The guiding idea of the summer school changes in the subsequent years, but the subject remains in close relation with the physics of low temperatures.

Supporting the research made by the Institute of Molecular Physics, Polish Academy of Sciences in Poznan with the usage of liquid nitrogen and liquid helium, we supply the researchers with the cryogenic liquids.

Together with the Institute of Molecular Physics of Polish Academy of Sciences and the Technical University of Wroclaw we conduct a research project aiming for extraction of 3He isotope from liquid 4He. The project is co-financed by the National Research and Development Centre

Every year we host students of technical universities, to whom we clarify the technologies in use, while showing operating industrial systems on site.

LHe
LN_2 LNG
GHe

PRODUCTS

Liquefied natural gas LNG

Production

Natural gas, in normal conditions occuring in a gaseous form, is liquefied due to it's essential feature - 600 times lower volume in the liquid form comparing to the gaseous one. Therefore storage and transportation of liquefied natural gas is far more economical.

LNG is produced out of the natural gas which is not feasible for pipeline transportation to end-users, neither technically or economically. World transport of LNG is carried mostly by sea with the use of specially insulated LNG carriers of capacity up to 266 000 m^3. The LNG carriers are loaded and unloaded within terminals comprising liquefaction or regasification installations and storage tanks.

Applications

LNG available form Odolanow Branch is transported to end-users by road in vacuum insulated semitrailers; it is mainly used for:

- supplying with natural gas the end-users with no access to pipeline gas,
- supplying with natural gas the end-users that are temporarily cut off piped gas due to the grid's maintenance works or failure.

Perspectival applications for LNG are:

- Peak-shaving concept - to meet irregular demand for natural gas with the use of low-temperature storages from which gas is withdrawn after regasification
- Fuel for vehicles - such as trucks, buses, locomotives, helicopters or even supersonic aircrafts.

Transport and storage safety

Hazard identification number 223 (acc.to ADR)
Material identification number (UN) 1972 (acc. to ADR)

Hazard identification: extremely flammable substance; creates explosive mixture with air; lighter than air; accumulates in the upper parts of rooms.

Personal protection: persons working in close contact should wear gas-tight protective clothing with breathing apparatus.

LNG conversion to other fuels

1 tonne of LNG	+/-	1 350 m^3 of gas
1 million m^3 of LNG	+/-	600 million m^3 of gas
1 million tonnes of LNG	+/-	1.23 million tonnes of crude oil
1 million tonnes of LNG	+/-	1.86 million tonnes of coal

Liquid nitrogen LIN

Production

Liquid nitrogen is mostly produced at cryogenic air separation plants where is one of the final products together with liquid oxygen and argon. In the few cases, such as Odolanow Branch, liquid nitrogen is produced out of low-methane natural gas as a result of the low temperature nitrogen rejection process.

Applications

The use of liquid nitrogen is mainly related to it's low temperature ensuring good cooling properties. In non-cryogenic applications it's liquid form allows for more economical storage and transportation of nitrogen.

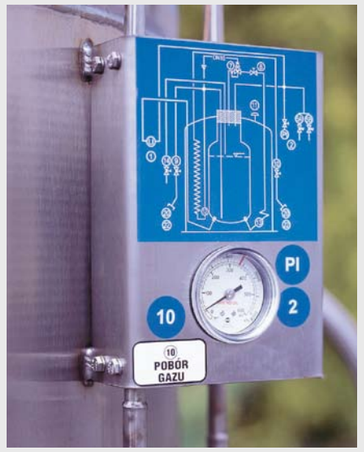
Traditionally it is used in the food industry for quick freezing of products but also for making anaerobic atmosphere in storage of perishable goods. In addition, as an inert medium it is used in the electronic industry and also for danger neutralization in explosion risk environment. Liquid nitrogen is utilized within medicine as well, for rheumatological or dermatological cryotherapies.

Transport and storage safety

Hazard identification number 22 (acc.to ADR)
Material identification number (UN) 1977 (acc. to ADR)

Hazard identification: deeply cooled liquid; contact with product can cause frostbite; in high concentration may cause asphyxiation.

Personal protection: persons working in direct contact with product should use accident-prevention measures, such as glasses or insulated gloves to protect eyes, face and skin.



Liquid HELIUM LHe

Applications

- cooling of superconducting magnets - used in magnetic resonance imaging MRI (medical diagnosis) or nuclear magnetic resonance NMR (research),
- superconductivity (superconductive cables, Josephson junction devices, etc.)
- space programs - to make rocket fuel, to cool space telescopes,
- military programs - to cool infrared sensors used for target location and guidance (anti-satellite rockets),
- research - like particle accelerators, magnetohydrodynamic water propulsion system MHD, superconducting magnetic energy storage SMES.

Transport and storage safety

Hazard identification number 22 (acc.to ADR)
Material identification number (UN) 1963 (acc.to ADR)

Hazard identification: deeply cooled liquid; contact with product can cause frostbite; in high concentration may cause asphyxiation.

Personal protection: persons working in direct contact with product should use accident-prevention measures, such as glasses or insulated gloves to protect eyes, face and skin.

Containers for transportation (dewars)

Dewar's capacity (litre)	100	250	500
Weight - empty (kg)	96	155	256
Weight - full (kg)	108	186	318
Height (cm)	150	178	186
Depth (cm)	115	135	140
Maximum transfer line O. D. (mm)	12,7	19,0	19,00
Minimum transfer line O. D. (mm)	9,5	9,5	9,5
Caster size (cm)	70 x 70	86 x 80	111 x 106

Note: The given dimensions may vary depending on dewar's manufacturer.

Gaseous HELIUM GHe

Applications:

- welding - as a shielding gas,
- purging and pressurizing - for cryogenic systems or in the electronic industry,
- gas chromatography - as a carrier gas,
- leak detection - in high-vacuum or high-pressure equipment,
- breathing mixtures for deep sea diving and medical therapies,
- balloon and airship inflation,
- production of semiconductors.

Transport and storage safety

Hazard identification number 20 (acc.to ADR)
Material identification number (UN) 1046 (acc.to ADR)

Hazard identification: compressed gas; in high concentration may cause asphyxiation; exposure to fire may cause explosion of vessels.

Personal protection: ensure adequate air ventilation.

Tanks for transportation

Gas cylinders and bundles both with tube trailers and battery trailers of nominal pressure up to 30,0 MPa

He

Helium unique properties such as: the lowest boiling temperature, low density, high thermal conductivity and ionization potential, both with chemical inertness and stability, make for wide helium applications.

Helium conversion data

	weight		gas		liquid	
	pounds (lb)	kilograms (kg)	cubic feet (scf)	cubic meter (Nm^3)	gallons (gal)	litres (l)
1 pound	1,0	0,4536	96,69	2,542	0,9593	3,630
1 kilogram	2,205	1,0	213,17	5,603	2,115	8,003
1 scf, gas	0,01034	0,00469	1,0	0,02629	0,009918	0,03754
1 Nm^3, Gas	0,3935	0,1785	38,04	1,0	0,3773	1,4282
1 gallon, liquid	1,043	0,4730	100,82	2,650	1,0	3,785
1 litre, liquid	0,2755	0,12496	26,64	0,7002	0,2642	1,0

HELIUM

He

What is HELIUM

Helium is a noble gas, extremely rare on Earth, but in the universe, after hydrogen, the most abundant element.

What makes HELIUM so unique

Helium is the most stable of all the elements; it means it will not burn or react with other elements. Helium has the lowest melting and boiling points. It exists as a gas except under extreme conditions; it becomes liquid at temperatures close to absolute zero.

Where does HELIUM come from

Helium is a non-renewable resource resulting from the radioactive decay of heavy isotopes of uranium and thorium in the earth's crust. It is obtained from only few natural gas deposits in the world.

What is HELIUM used for, and why is it a strategic natural resource

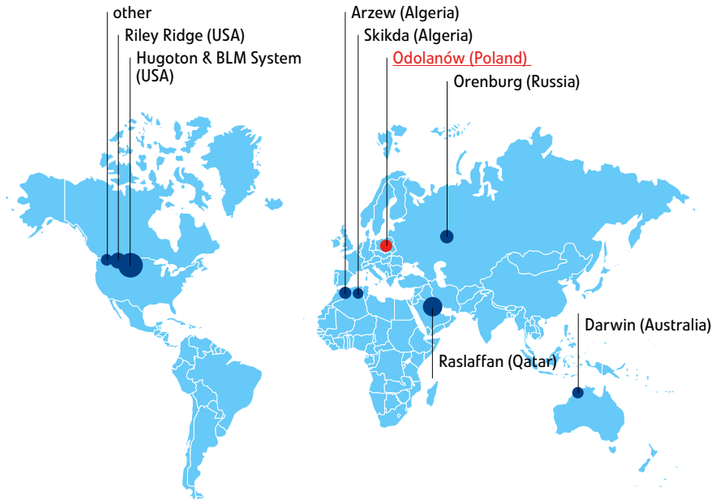
Perhaps the most familiar use of helium is as a safe, non-flammable gas to fill party and parade baloons. However, helium is a critical component in many fields, including scientific research, medical technology, high-tech manufacturing, space exploration, and national defense.

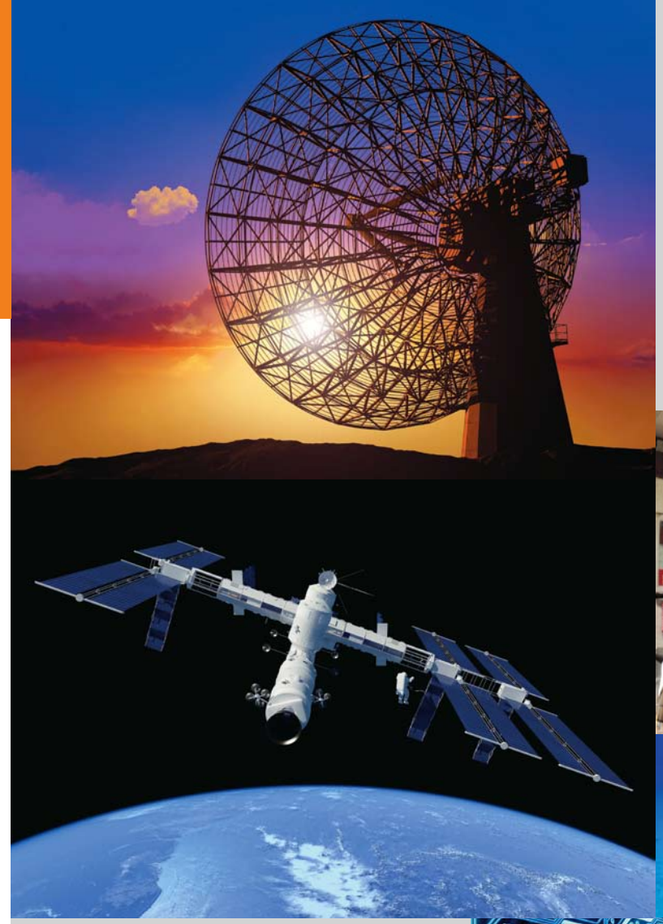
Here are a few examples:

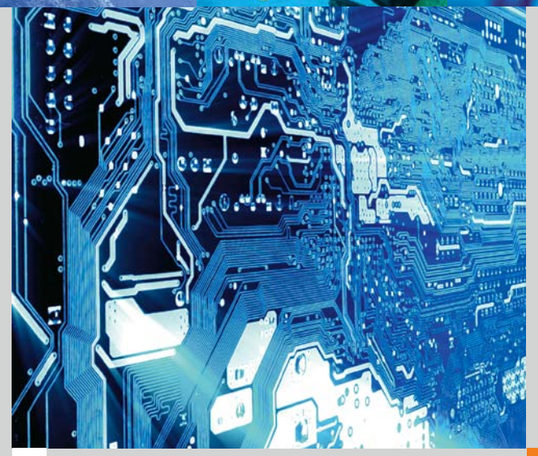
- the medical field uses helium in essential diagnostic equipment such as MRI's (Magnetic Resonance Imaging scanners), while helium-neon lasers are used in precision surgery;
- military applications include rocket engine testing, scientific balloons, surveillance craft, air-to-air missile guidance systems;
- helium is used to cool thermographic cameras and equipment utilized by search and rescue teams and medical personnel to detect and monitor physiological processes;
- various industries use helium to detect gas leaks in their products; helium is a safe tracer gas because it is inert. Manufacturers of aerosol products, tires, refrigerators, fire extinguishers, air conditioners and other devices use helium to test seals before their products come to market;
- cutting edge space science and research requires helium, which is used to keep hot gases and ultra-cold liquid fuel separated during lift off of rockets;
- arc welding uses helium to create an inert gas shield;
- divers, but also others working under pressure use mixtures of helium and oxygen to create a safe atmosphere for breathing;
- helium is a protective gas in titanium and zirconium production and in growing silicon and germanium crystals.
- helium, being not reactive, is used as a cooling medium in nuclear reactors;

Cryogenics, superconductivity, laser technology, supersonic tunnels, pumps for cardio-pulmonary resuscitation, monitoring blimps used by border patrols or liquid propellant rockets - all of these areas require helium, whether in in either their manufacture or use.

Helium production in the world







Helium

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