



Company profile

GAZPACK 

We clean bio gas and oil gas

Dear Sir/Madam,

We are pleased to introduce our company to you by means of attached summary of information.

Gazpack was founded in 2006 as a research division under Airpack Nederland BV. Airpack's activities in the international oil and gas business led to the question of founder Mr. JP Warnar as to how gas flaring could be reduced or converted to a usable product. After extensive research spreading over several years together with various universities, a new desulfurization method was developed that converts the contaminated oil gas into multiple useful products. The patented method was tested in laboratories but still needed to show its full potential on a larger scale. A pilot version of the installation needed to be built and tested. Due to strict regulations in the oil and gas industry and the distant locations of the oil wells, Gazpack decided to look for an alternative test location closer to home.

Biogas turned out to be very similar in composition to oil gas, making it the perfect alternative to test the pilot installation of Gazpack. After successful testing, the patented system has now been fully developed to be implemented in both oil & gas and biogas industry. Both industries will benefit from a highly innovative and high-quality product that produces clean gas, usable sulphur gas and sulfuric acid without any waste.

The research continued and a new system, the SULAGO® system, was developed. This system is designed for smaller capacities (<1500 Nm³/h) and uses an iron hydroxide absorbent, called SULAFER®, to remove H₂S from the biogas.

Our core business is the design, engineering, and manufacturing of the following custom-made packages:

- Bio-/sour gas upgrading packages:
 - SULAGO®; capacities up to 1500 Nm³/h and smaller H₂S contents
 - SULAWAY®; capacities up to 1500 Nm³/h and high H₂S contents (>1.000 ppmV)
- SULAFER® packages with H₂S and or SO₂, Siloxanes (partial) removal.
- Methane purifying package.
- CO₂ liquefying packages.
- Utility packages.

Our packages are designed completely according to our clients' specifications and requirements. They are completely interconnected, cabled and programmed and ready upon arrival at site with minimal start-up time.

Our full range of in-house expertise allows us to engineer and manufacture our package with a unique level of customization to suit the clients' expectation.

We also support our products with a wide range of after sales services such as start-up and commissioning, troubleshooting, spare parts and overhauling services.

If you require any further information about our capabilities, experiences and facilities please do not hesitate to contact us.

Yours faithfully,
Gazpack B.V.

J.P. Warnar
President

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1 Bio/Sour gas upgrading packages

1.1 The SULAGO® system

The SULAGO® system is specifically engineered to efficiently manage capacities ranging from 20 to 1500 Nm³/h, especially for applications with low H₂S concentrations. To effectively eliminate H₂S and/or SO₂ from the system, we employ SULAFER®, a bonding material primarily composed of iron. This innovative material facilitates the transformation of H₂S into elemental iron, sulfur, and water, making it harmless compounds and ensuring minimal environmental impact. Furthermore, SULAFER® generates no unpleasant odors and can even be repurposed for enhancing walkways and as fertilizer, among other uses. Notably, its capacity surpasses that of active carbon by tenfold.

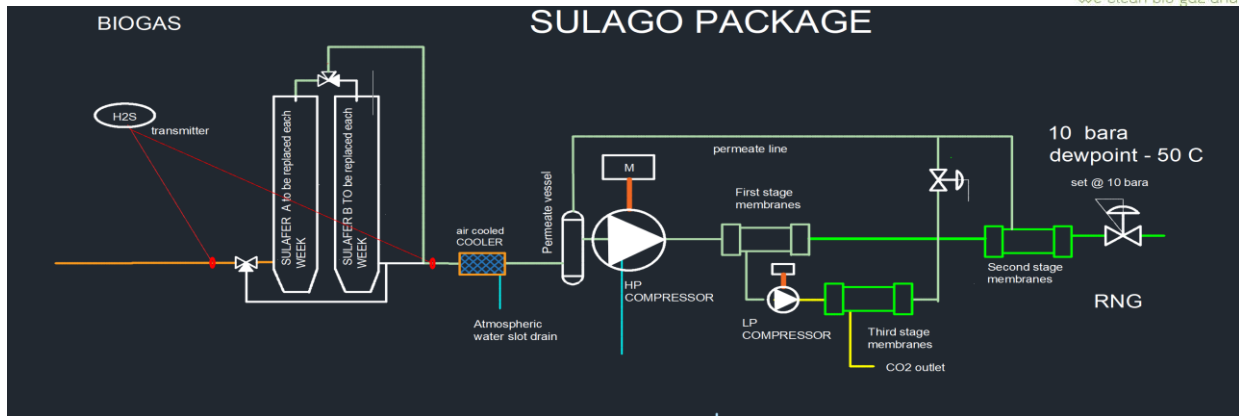
The system is skid mounted, a containerized solution can be offered upon request. The system is standard equipped with an oil lubricated screw compressor with oil filters to filter all the oil particles from the gas, different types of compressors can be offered upon request. To separate the CO₂ from the gas, the system uses membrane technology from well-known suppliers in the market. Gazpack is brand independent, that means that the most efficient and cost-efficient brand will be chosen. Upon request the system can be made fully redundant.

How the system works

The gas is introduced into a SULAFER® tower to effectively capture any remaining H₂S until it reaches a level below 1 ppmV. An automated H₂S transmitter constantly monitors the concentration of H₂S in the gas. Once the H₂S level rises to approximately 1 ppmV, an alarm is triggered to indicate the need for absorbent replacement. Additionally, the water generated during the above-described bonding process needs to undergo regeneration. To accomplish this, we provide two containers, one of which is actively operational while the other undergoes regeneration. The regeneration process involves passing counter air through the container to restore its functionality. It is important to note that the entire system operates in a fully automatic manner.

Firstly, the gas undergoes a cooling process using chilled water and then passes through a compressor. After this, it proceeds through three stages of membranes. The first membrane stage eliminates CO₂ and redirects the excess gas, via another compressor, to the third stage membrane. The gas that remains is then passed through the second stage membrane, which adjusts its composition to meet the desired requirements. Any surplus gas from the second stage and the outlet of the third stage membrane is rerouted back into the compressor's inlet to minimize methane slip, ensuring it stays below 0.5%.

Gazpack has the flexibility to provide a membrane system consisting of either two or three stages, tailored to meet the specific demands of each project. Typically, the two-stage membrane system is utilized for projects with smaller capacities.



Each package is controlled and monitored by a local control panel with PLC. This panel is placed in a safe area, unless otherwise specified. The PLC can be equipped with Modbus, so the system can be controlled by engineers from Gazpack's facilities to assist engineers on site. Thanks to the Modbus a historical back-up can be made to analyse performance of the system.

Along with the system itself, all types of filters in single or duplex configuration, control panels, PLCs, instruments, valves etc. can be applied in all materials, types and/or makes available in the market.

1.2 SULAWAY® system

The SULAWAY® system is initially developed to clean oil gas but can also be used in the biogas market. The system is developed to clean capacities of 1500 Nm³/h and/or high H₂S contents. This system is a more advanced technical system, which doesn't use any chemicals to remove H₂S. The system uses membrane technology to separate CO₂ from the gas to create biomethane.

The adsorption and converter process.

The gas enters the cooler and water separator to remove water up to a temperature of 6 °C. The wet gas enters a blower which increases the pressure to 1,5 bar(a), which reduces the vapor pressure (600 Pa) and increases the temperature (50°C) in order to decrease the humidity. A separator removes water particles to avoid water entering the permeate vessel. In this vessel the permeate gas from the membranes is mixed with the inlet gas to decrease acidity which reduces the maintenance.

Most compressors can handle H₂S as long as water droplets are not present. Water reacts with H₂S & CO₂, which forms acids (H₂SO₃ & H₂CO₃).

The gas enters an adsorbing system with two vessels, one vessel is adsorbing the H₂S with a molecular sieve, the other vessel is regenerating. At a pre-set H₂S level, the vessels switch from functionality.

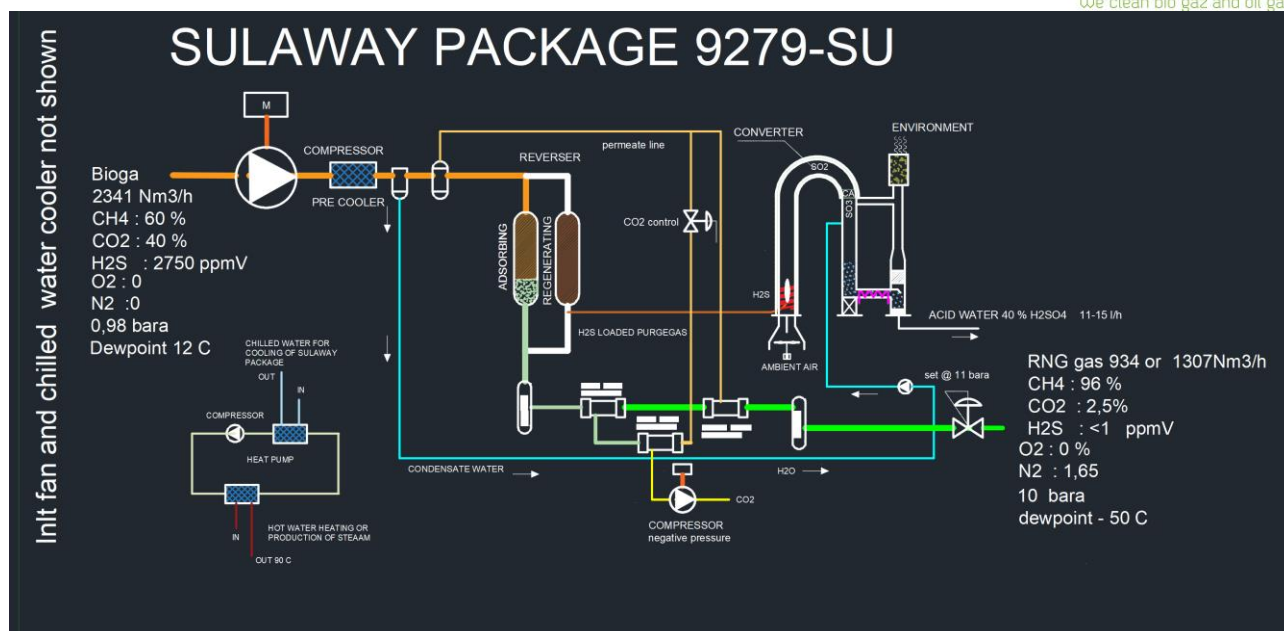
Regeneration circuit

The adsorber is depressurized and the remaining gas at 1 bara absolute is circulated by a blower through a heater to increase the gas temperature to 150°C. The hot gas enters the bottom of the adsorber to increase the temperature of the bed to 100°C. The outlet gas at the top of the absorber vessel, passes a heat exchanger to recover heat energy and a chilled water cooler to cool the gas to approximately 10°C, so a water separator can remove the excess water.

When the adsorber vessel has reached 100°C, steam is formed, which condensates in the separator after the cooler. Above 120°C the H₂S leaves the molecular sieve pores and starts to float freely through the system. At 135°C the heater is shut off and H₂S gas is directed to a H₂S gas receiver.

Reformer unit

The H₂S gas is taken from the H₂S gas receiver and directed into the bottom leg of the U-tube. This leg is filled with heat accumulating mass, which at start-up, heats ambient air up to a temperature of 1000°C. Once this temperature is reached, the H₂S gas is added and ignites itself, after which the external heater can be shut down. During oxidation H₂S is transformed into iSO₂ which continues to flow through the top of the U-tube where ambient air enters the system to cool the gas down to 450°C. A catalyst reforms the SO₂ into SO₃. At the bottom part of the U-tube, the previous water is added to cool the gas further down and to transform it into acid water. There is a water circulating circuit (not shown) consisting of a water pump, acid vessel and cooler, circulating the acid water until the required acid percentage of 40% has been reached. Most SULAWAY® systems generate enough condensate water, which means that no extra water is required.



Precooler

The water content is removed by a water cooler and used in the converter to make battery water. Normally, due to the high water content no additional water is required for the converter to supply battery water.

Molecular Sieve

The adsorption towers contain a molecular sieve with a guaranteed lifetime of 16.000 hours (about 2 years). If the pre-filters are replaced according to the maintenance schedule, the lifetime can be increased considerably.

Membranes

The lifetime of the membranes is at least five years if the filters are replaced according to the maintenance schedule.

Third stage compressor

To guarantee a methane slip lower than 0,5 % we can offer an extra stage of membranes. In case a higher loss can be considered, this is not required and means reduction in price.

Guard

The guards contain SULAFER® and SILOXgo.

SULAFER® is an absorbent that catches the remaining H₂S particles that may be present in the gas.

SILOXgo is used to remove Siloxanes.

Catalyst

This is a catalyst that changes SO₂ into SO₃ and has a guaranteed lifetime of 16.000 hours (about 2 years).

Emergency shutdown filter

This filter is designed to remove excess sulfur particles when the system is shut down. The filter consists of an iron hydroxide absorbent, named SULAFER®.

Capacity control

The pressure and flow need to be as constant as possible to guarantee a smooth operation of both compressor as well as membranes. If the pressure and flow vary too much, both the compressor and membrane can be damaged. This is prevented in our system using a bypass.



2 Removing contaminated gases

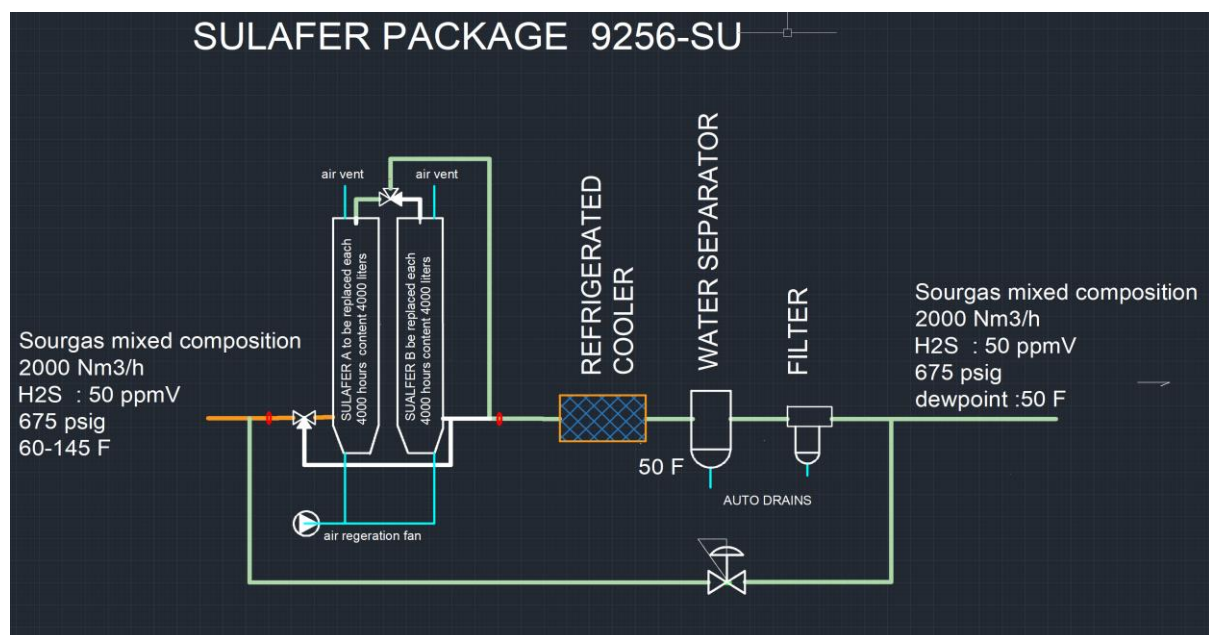
2.1 H₂S removal with SULAFER®

The SULAFER® package is a part of the SULAGO® package and is developed to remove H₂S and siloxanes from (bio)gas. The package works with an iron-based absorbent. The absorbent, called SULAFER®, is basically a catalyser that transfer the H₂S into elementary sulphur, iron, and water. That means that the absorbent stays a non-hazardous waste once it is saturated. SULAFER® is able to remove the H₂S to 1 ppmV and siloxanes up to 200 ppmV

How the system works

The gas is introduced into a SULAFER® tower to effectively capture any remaining H₂S until it reaches a level below 1 ppmV. An automated H₂S transmitter constantly monitors the concentration of H₂S in the gas. Once the H₂S level exceeds 1 ppmV, an alarm is triggered to indicate the need for absorbent replacement. Additionally, the water generated during the above-described bonding process needs to undergo regeneration. To accomplish this, we provide two containers, one of which is actively operational while the other regenerates the absorbent. The regeneration process involves passing counter air through the container to restore its functionality. It is important to note that the entire system operates in a fully automatic manner.

Note: besides H₂S, the absorbent also absorbs SO₂ and siloxanes up to 200 ppmV.



2.2 Siloxane removal

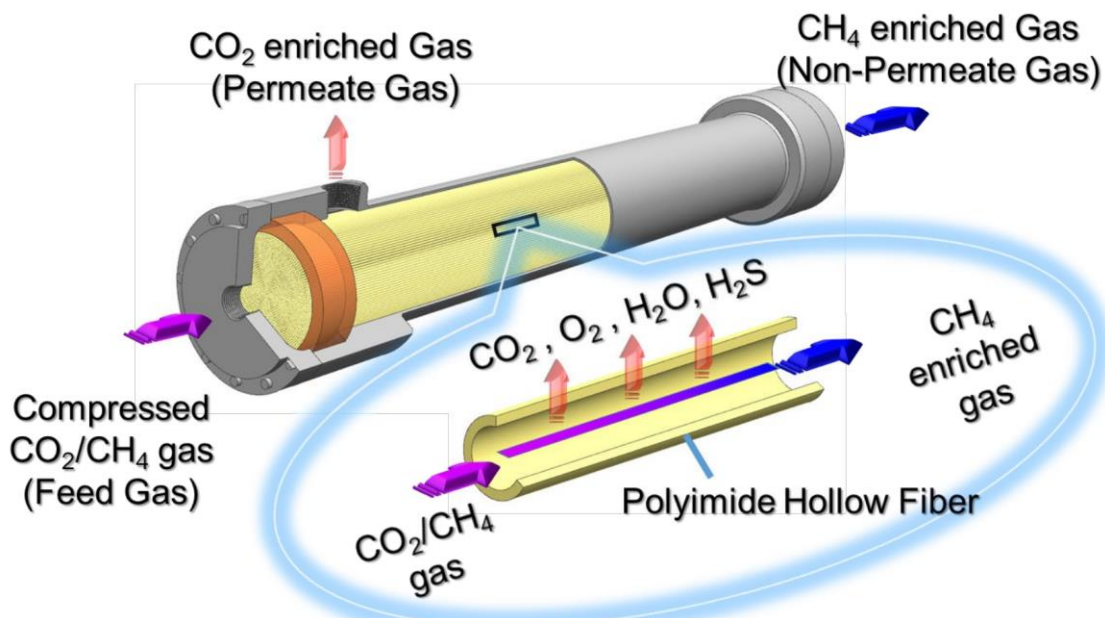
Most biogas suppliers generally prefer a maximum siloxanes level of 5 ppmV. To achieve this, one effective method is to install a pressure vessel containing SILOXgo downstream of the membranes in both the SULAGO® and SULAWAY® packages. While we can provide the SILOXgo as a separate package, it is essential to ensure the elimination of water before introducing it.

3 Membrane purification package

Membrane technology

Membrane technology is a rapidly advancing field that has revolutionized various industries and applications. This cutting-edge technology employs permeable barriers called membranes to separate components within a mixture or fluid. Membranes, depending on their composition, can allow specific substances to pass through while blocking others.

That means that membrane technology allows methane (CH_4), nitrogen (N_2) and other gases to go through the membranes, while it blocks and separates carbon dioxide (CO_2) and oxygen (O_2). Below here you can find an image that shows which gases are blocked and which are let through.



The membranes consist of a bundle of fibres. Each fibre has a diameter of 1 micron or smaller. The CO_2 molecules can be separated fairly easy by the fibres. The O_2 , H_2O and H_2S molecules are more difficult to separate. Luckily are most of the H_2O and H_2S molecules already removed before the biogas enters the membranes.

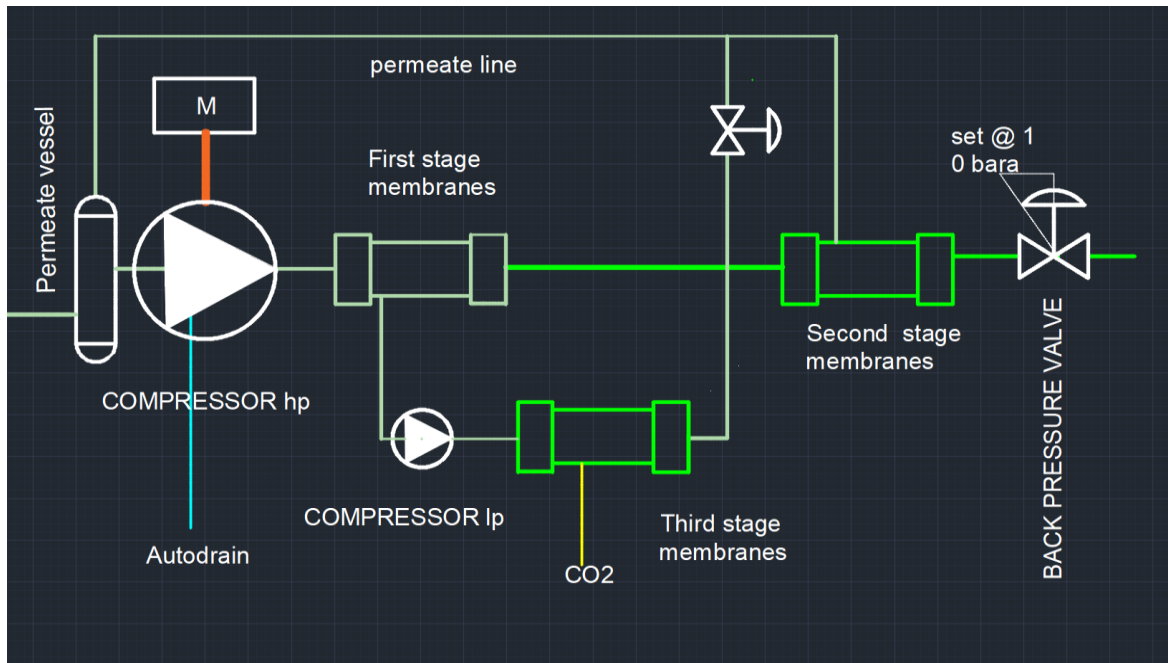
The second part of both the SULAGO® and SULAWAY® process is the purification part. Gazpack can offer both systems separately if required. The purification system purifies the biogas by separating the CO_2 , and other impurities, from the CH_4 to create biomethane. The CO_2 is removed up to 200 ppmV.

How the system works

Firstly, the gas undergoes a cooling process using chilled water and then passes through a compressor. After this, it proceeds through three stages of membranes. The first membrane stage eliminates CO_2 and redirects the excess gas, via another compressor, to the third stage membrane. The remaining gas is then passed through the second stage membrane, which adjusts its composition to meet the desired requirements. Any surplus

gas from the second stage and the outlet of the third stage membrane is rerouted into the compressor's inlet to minimize methane slip, ensuring it stays below 0.5%.

Gazpack has the flexibility to provide a membrane system consisting of either two or three stages, tailored to meet the specific demands of each project. Typically, the two-stage membrane system is utilized for projects with smaller capacities.



4 CO₂ liquefying packages

A package to liquify CO₂ is often supplied together with a biogas plant to make the plant completely sustainable to meet the current decarbonization targets.

In order to safeguard our downstream equipment, we employ two SULAFER® containers to remove aggressive sulfur as a standalone supply without a biogas plant. This proactive measure ensures the smooth operation and longevity of our equipment.

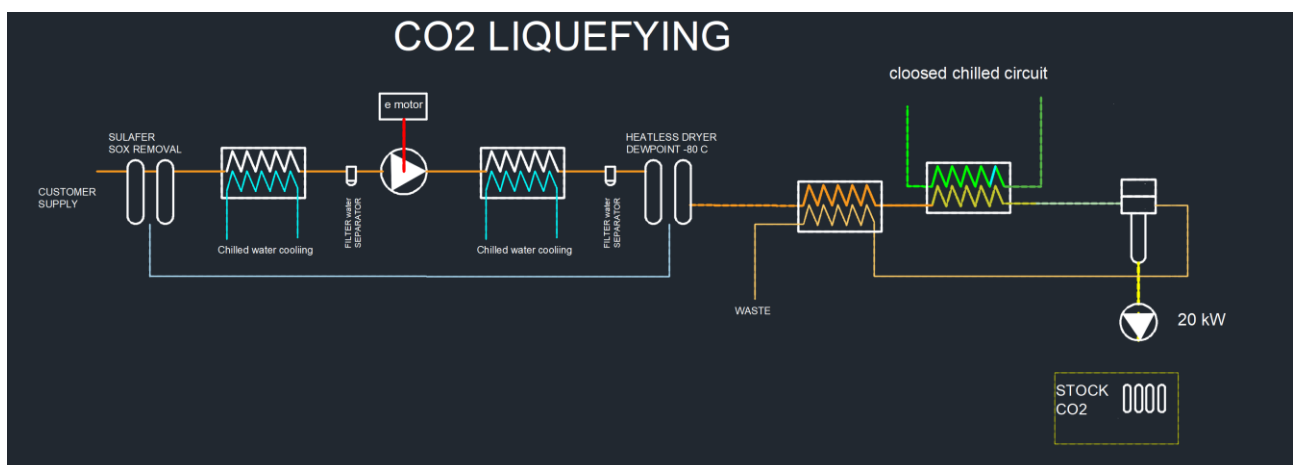
To eliminate any moisture content, we utilize a chilled water cooler with a separator, also known as a knockdown drum. This efficient system allows us to extract any water present in the gas, ensuring dry gas supply downstream.

As part of our meticulous process, the gas is compressed and cooled above its liquefying temperature. This technique aids in the removal of impurities and prepares the gas for further purification.

To achieve the liquefaction of CO₂, the gas is subjected to a drying and freezing process. By lowering the temperature and removing any remaining moisture, we can attain the desired outcome of CO₂ liquefaction. Through the implementation of a bubble separator, we effectively separate other gases such as nitrogen and methane from the CO₂. This crucial step ensures the purity and quality of our final product.

The resulting CO₂ liquid holds vast potential for various applications. It can be used for bottling purposes or supplied to industries requiring CO₂ as an essential component. Additionally, it can be injected into old empty gas sources for sustainable utilization. When considering the application of liquid CO₂ in the soft drink industry, it is imperative to adhere to bacteria-free regulations. This strict adherence ensures the safety and quality of the final soft drink product, meeting industry standards.

With our comprehensive and efficient processes in place, we demonstrate our commitment to providing high-quality, purified CO₂ in various industries. Our proactive sulfur removal, water elimination, and thorough gas purification techniques allow us to offer a reliable and valuable product to our customers.

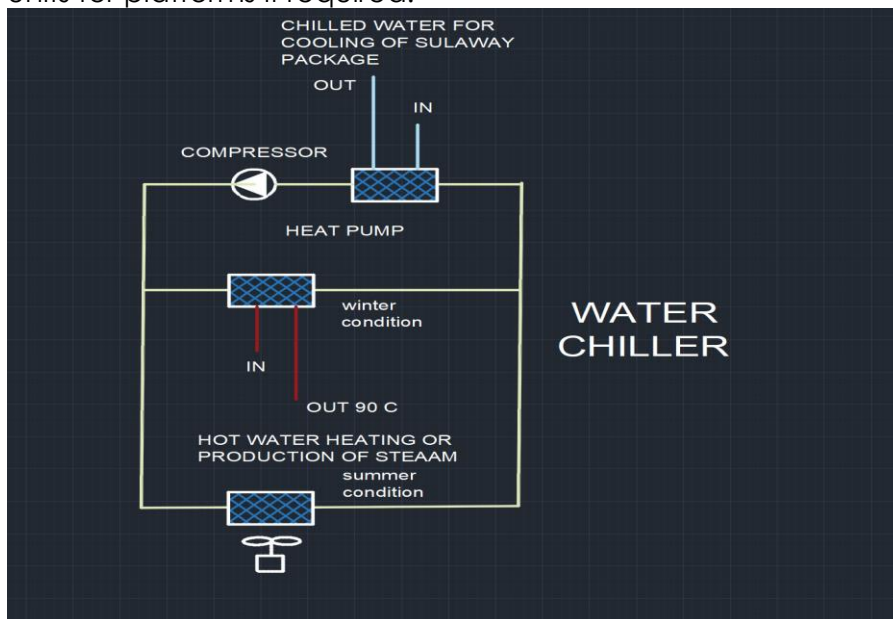


5 Utility packages

When it comes to biogas packages, the energy recovery aspect is highly regarded by the market. This can be achieved effectively by employing compressors and coolers that are cooled by chilled water, which is supplied by a water chiller. While there are already chillers available in the market for this purpose, we are pleased to provide specialized options to meet specific requirements.

For instance, we can offer a water chiller with a dual compensator that operates as an air-cooled system in the summer and a water-cooled system in the winter, which provides hot water. In the biogas environment, our preference is to position the unit in a safe area. However, for platforms where explosion certification is required, we are able to accommodate such needs.

In summary, our goal is to meet the market's demand for energy recovery in biogas packages through the utilization of chilled water-cooled compressors and coolers. We offer a range of chillers, and we are also capable of providing customized solutions tailored to specific requirements. Safety is a priority, and we can supply explosion certified units for platforms if required.



6 Certificates and applicable standards

Airpack can design according to different international high standards as for instance:

- CE-certificate
- A.S.M.E. section VIII
- ANSI
- TEMA
- IEC
- AD Merkblatter
- Airpack Welding Specification
- British Standard
- Bureau Veritas Classification Rules
- Det Norske Veritas
- Lloyds Register of Shipping
- Service de Mines
- T.U.V.

Airpack also works according to various API standards, such as:

- API 526: Flanged Steel Pressure Relief Valves
- API 582: Welding Guidelines for the Chemical, Oil, and Gas Industries
- API 613: Special Purpose Gear Units for Petroleum, Chemical and Gas Industry Services
- API 614: Lubrication, Shaft-sealing and Oil-control Systems and Auxiliaries
- API 618: Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services
- API 619: Rotary-Type Positive Displacement Compressors for Petroleum, Petrochemical and Natural Gas Industries
- API 661: Air cooled heat exchangers for General Refinery Service
- API 670: Machinery Protection Systems
- API 671: Special Purpose Couplings for Petroleum, Chemical and Gas Industry Services
- API 672: Packaged, Integrally Geared Centrifugal Air Compressors for Petroleum, Chemical, and Gas Industry Services
- API 677: General-purpose Gear Units for Petroleum, Chemical and Gas Industry Services
- API 680: Packaged Reciprocating Plant and Instrument Air Compressors for General Refinery Services
- API 686: Recommended Practice for Machinery Installation and Installation Design

Airpack is also familiar with the special specifications of Oil Company Materials Associations (OCMA), National Fire Protection Association (NFPA) and many other specifications of particular clients:

- | | |
|-------------------------------|----------------------|
| - ADGAS | UAE |
| - ADNOC | United Arab Emirates |
| - Agiba | Egypt |
| - BP | Great Britain |
| - Exxon Mobil | U.S.A. |
| - ENI | Egypt |
| - Fluor Daniel | Haarlem (NL) |
| - Foster Wheeler | Great Britain |
| - GASCO | UAE |
| - JGC Corporation | Japan |
| - Jordan Petroleum Co. | Jordan |
| - Korea Fine Chemical Co. | Korea South |
| - Kuwait Oil Company | Kuwait |
| - Mannesmann | Germany |
| - Mitsui Eng. & Shipbuilding | Japan |
| - Mobil | Denmark |
| - N.N.P.C. | Nigeria |
| - NPC | Iran |
| - Occidental | Qatar / U.S.A. |
| - ONGC | India |
| - Pakistan State Oil Company | Pakistan |
| - Qatar General Petroleum Co. | Qatar |
| - Saudi Aramco | Saudi Arabia |
| - Shell | Worldwide |
| - Sonatrach | Algeria |
| - Sucreries | Egypt |
| - Technip | France |
| - Total | Worldwide |
| - Umm Al Jawaby | Libya |
| - ZADCO | UAE |

7 Subcontractors

Because of our sophisticated network in the Netherlands with our sub suppliers (all ISO 9001 screened) we are able to handle relatively large orders. Sufficient construction area is available in our factory in Zierikzee to handle large and heavy frames. Our engineering department works with sophisticated 3D engineering software to design complicated and large packages.

In case any activities should be sub-contracted, the following companies are preferred.
Construction:

- Beijer
- ITM
- Meeuwsen
- TMS
- VDS
- Tekoma

Shotblasting, painting:

- C.A. Geuze
- Kamps
- ABS Zierikzee

8 Quality and assurance

For details we refer to our quality control and quality assurance books I, II, III and IV.

N.D.T. equipment:

- | | |
|----------------------------|-------------------------------|
| - X-ray unit | by subcontractor (RTD or SGS) |
| - Gamma ray unit | by subcontractor (RTD or SGS) |
| - Dye penetrant | available |
| - Magnetic particle | by subcontractor (RTD or SGS) |
| - Leak detection-available | available |
| - Ultra-sonic equipment | by subcontractor (RTD or SGS) |

Equipment for:

- | | |
|----------------------|-------------------------------|
| - Particle test | available |
| - Hydrostatic test | available |
| - Dye penetrant test | available |
| - Ultra-sonic | by subcontractor (RTD or SGS) |

Equipment for:

- | | |
|----------------|----------------------------|
| - Tensile test | by subcontractor (Element) |
| - Impact test | by subcontractor (Element) |
| - Micro test | by subcontractor (Element) |

Equipment for:

- | | |
|---------------------|-------------------------------|
| - X-ray | by subcontractor (RTD or SGS) |
| - Gamma ray | by subcontractor (RTD or SGS) |
| - Magnetic particle | by subcontractor (RTD or SGS) |

9 Site situation and transport facilities

Gazpack is located in the South-West of The Netherlands in Zierikzee. Its location is ideal, at a short distance from the sea harbours of Antwerp, Flushing and Rotterdam. The site has direct access to all kinds of transportation.

Office:

Since 2005 the total office surface is 2000 m².

Workshops:

Since 2005 the total workshop surface is 3700 m².

W23: 792 m²

W24: 960 m²

W25: 660 m²

W19: 1.365 m²

Transportation:

Road near to the international high-way system

Water barge point Zierikzee 500 m.

Distance to seaports (ocean lines)

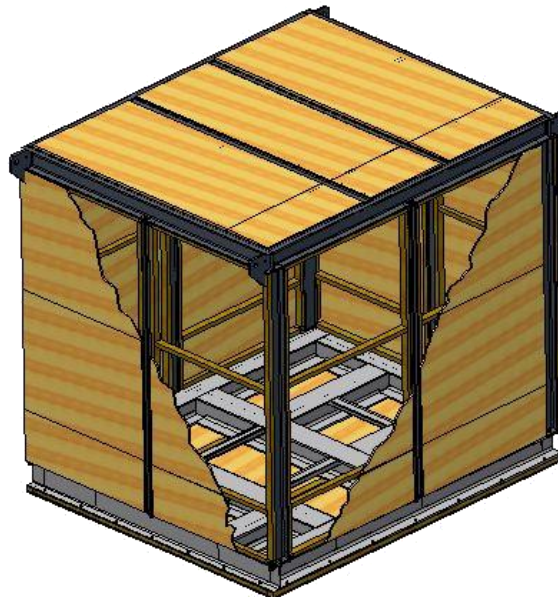
- Antwerp 70 km
- Flushing 35 km
- Rotterdam 70 km

For transportation by vessel our packages can be provided with a seaworthy packing as described on the next page.

10 Seaworthy packing

Seaworthy packing generally complies with our drawing TDMW - 103 as per below. It consists of a removable packing frame of steel covered with underlayment and wooden support of 2 x 3 inch beams.

Each critical item will be protected by a separate plastic cover. Switchbox will be filled with desiccant to avoid oxidation. The closed system will be filled with glycol for anti-oxidation and freezing during transport.



11 Organisation chart of Gazpack B.V.

