AIR PRODUCTS

Shipboard Gas Generation Systems

PERMEA Maritime Protection

DNV

NORWEGIAN ACCREDITATION
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NS-EN ISO 9001/ISO 14001
CERTIFIED FIRM

Air Products AS offers a range of combustion inert gas systems and nitrogen generating systems designed for the demanding conditions of shipboard operations. These products are not only made for durability; they are also engineered to be light weight, compact, automatic, easily maintained and trouble-free
– all requirements in the marine environment.

PERMEA Maritime Protection

inert gas system

For safety against explosion accidents aboard crude oil carriers, OBO carriers, product carriers, barges etc.

Generator unit of a 15,000 Nm3/h Flexinert systen prior to delivery to a North Sea shuttle tanker

Deck water seal (semi-dry type) and pre-cooler unit

Permea Maritime Protection® inert gas systems produce and distribute inert gas based on combustion of hydrocarbon fuels. Combustion generated inert gas provides the lowest cost generators possible.

Permea Maritime Protection® inert gas systems have been among market leaders since 1970. All systems are built in accordance with the 1974 SOLAS Convention with latest amendments, and with its supplementary IMO guidelines. They also comply with the requirements of any major regulatory body.

Inert Gas Safety

The origin of today's statutory inert gas systems can be traced back to a series of tanker explosions in the late sixties and early seventies. The International Maritime Organization (IMO) defines inert gas as gas that contains insufficient oxygen to support the combustion of hydrocarbons. Inert condition means a condition in which the oxygen content throughout the atmosphere of a tank has been reduced from 21% (vol) to 8% or less by addition of inert gas. **Permea Maritime Protection®** inert gas systems are designed to efficiently meet this requirement.

Oil Spill Prevention

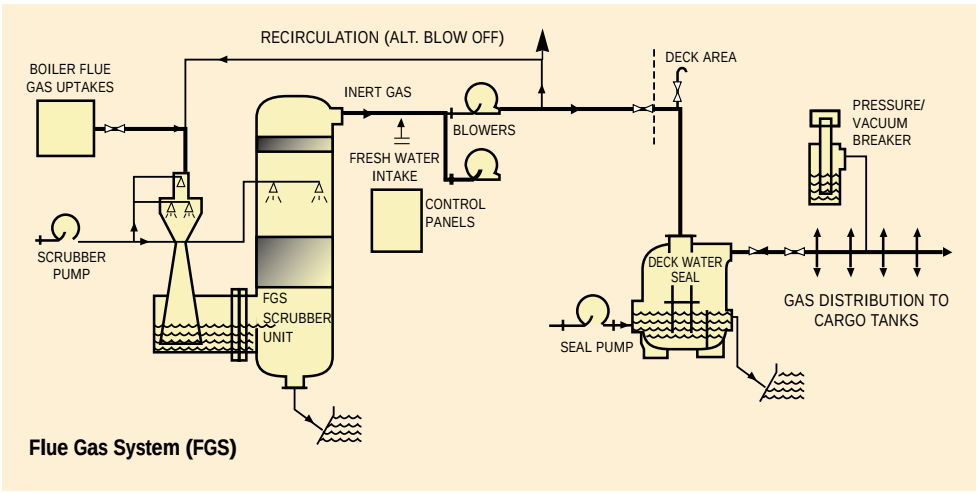
Environmental aspects play an increasingly important role in the design of most modern process plants, and **Permea Maritime Protection®** inert gas systems are no exception.

One result of this is that all gas generator units employed, except for the smallest model, have a horizontal, recessed combustion chamber. This construction retains fuel oil that, in the event of a misfire, otherwise would be discharged overboard.

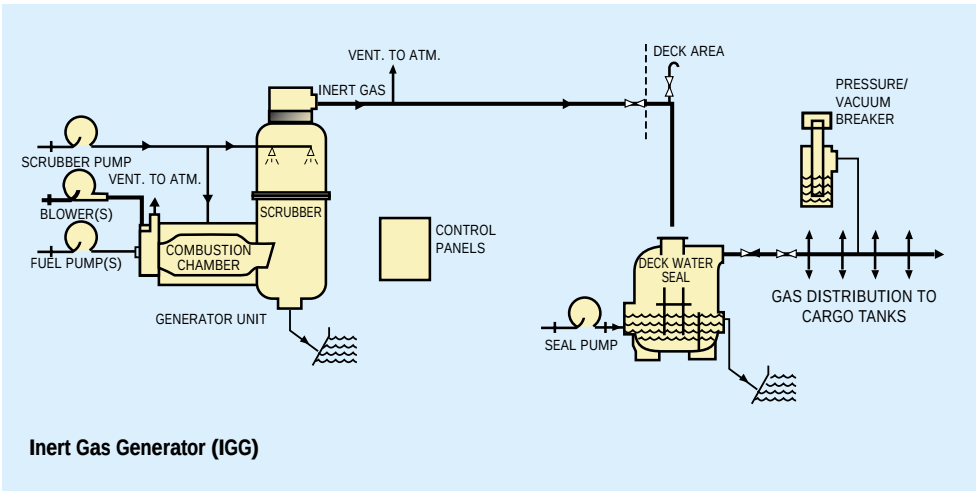
A Range of Choices

The customer is offered a series of standard variants of **Permea Maritime Protection®** inert gas systems, each designed to minimize capital and operating costs. In addition special designs are available upon request, both for newbuildings and for retrofit installation. The standard variants are the following:

PERMEA
Maritime Protection
inert gas system



Flue Gas System (FGS)



Inert Gas Generator (IGG)

- **Flue Gas System (FGS)**

These systems cool and clean flue gas available from the ship's boilers, and deliver it to deck, typically during cargo unloading and tank washing. The flue gas already contains less than 5% oxygen, which is the IMO limit for inert gas, and no further treatment is therefore necessary. The main components are scrubber unit, inert gas blowers, deck water seal, pressure/vacuum breaker, valves, instrumentation and control system.

- **Inert Gas Generator (IGG)**

The generator systems apply when no existing supplies of flue gas can be counted on. The scrubber unit of the flue gas system is here integrated into a generator unit consisting of a combined burner part and scrubber part, both seawater cooled.
Marine diesel or heavy fuel is burnt to produce flue gas with an oxygen content of typically 2% - 4%. The gas then enters the scrubber part, where it is cooled and cleaned by sprayed seawater before being piped to the deck area.
Generator capacities between 100 and 16,000 Nm3/h (normal cubic meters per hour) are available, and automatic turndown ratios 4:1.

- **Flue Gas System with Integrated Topping Up Generator (FGS+TUG)**

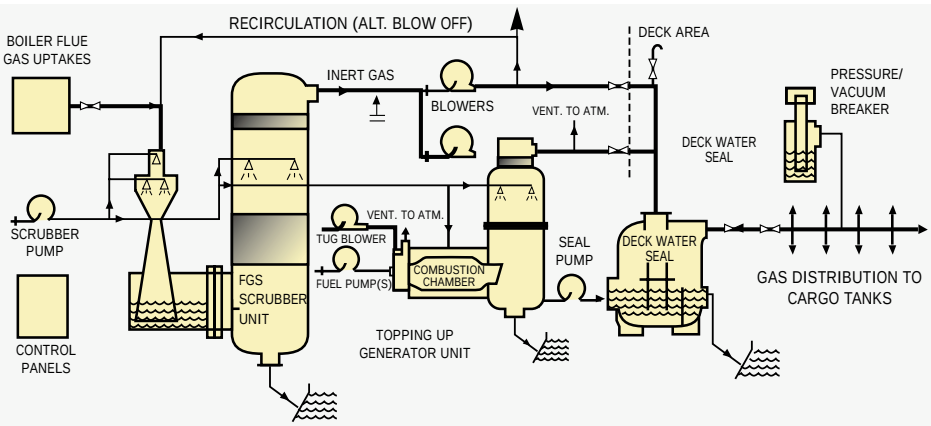
This alternative consists of a flue gas system supplemented by a separate small (500 Nm3/h) inert gas generator, and it is often preferred for OBOs and VLCCs.
The flue gas system covers the bulk of the inerting during cargo unloading etc., and the topping up generator tops up tank pressures during sea voyage.

- **Flexinert**

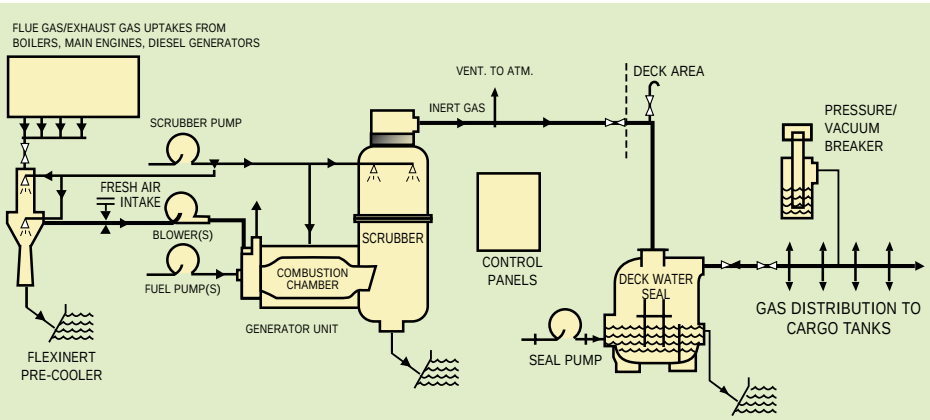
Flexinert is a fuel-saving combination of a flue gas system and an inert gas generator.
As long as sufficient boiler flue gas is available, Flexinert works as a flue gas system. When no basis gas is available it works as an inert gas generator, and when high-oxygen exhaust gas from main engines or diesel generators is available, it afterburns this gas to produce inert gas of acceptable oxygen content. Afterburning saves fuel since the combustion "air" already has reduced oxygen content.

Service and Spare Parts

Service and spare parts are supplied and co-ordinated world wide from our office and workshop in Kristiansand.



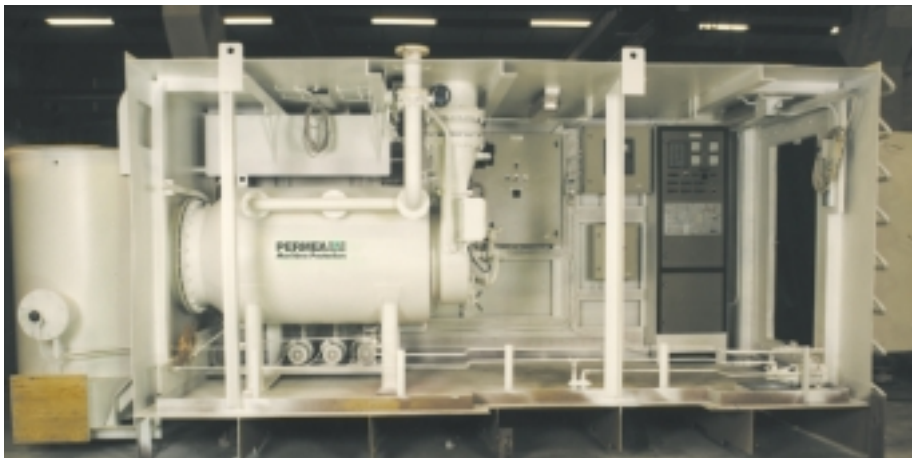
Flue Gas System with Integrated Topping Up Generator (FGS+TUG)



Flexinert

PERMEA Maritime Protection

inert gas system



Inert gas generator with burner house prior to retrofit installation on an American crude carrier. The scrubber part of the generator (here without top section) is shown to the left, and the burner section (marked with logo) inside. Capacity: 4250 Nm³/h.

Front view of typical topping up generator. Capacity: 500 m³/hr.

PRISM® membrane nitrogen systems

For safety and convenience aboard chemical tankers, LNG carriers, etc.

A highly popular model of PRISM® nitrogen systems for chemical tanker. The Capacity of this unit is 1000 Nm^3/h of 95% N_2

Air Products specializes in gas separations by membranes and offers a series of PRISM® nitrogen systems specially designed for use aboard chemical and methanol tankers, LNG carriers, LPG carriers etc. These systems generate low-cost nitrogen gas on demand as suits the user, and frees him from the nuisance and cost of having nitrogen cylinder racks supplied from ashore.

State of the Art Cargo Protection

The nitrogen produced by PRISM® nitrogen systems is very dry, with dewpoints down to -70 ˚C, depending on purity. When used for inert purging and blanketing of chemicals and other cargoes, it not only minimizes the risk of fires and explosions, but it also prevents degradation of cargoes sensitive to oxygen, moisture or combustion by-products.

Furthermore, with ample supply available, the nitrogen can be used more extensively and properly, without an eye to what is left in the bottles. One example of such extended use may be the purging of cargo lines between pumping of different cargoes, which, often at the expense of safety, still frequently is done with air.

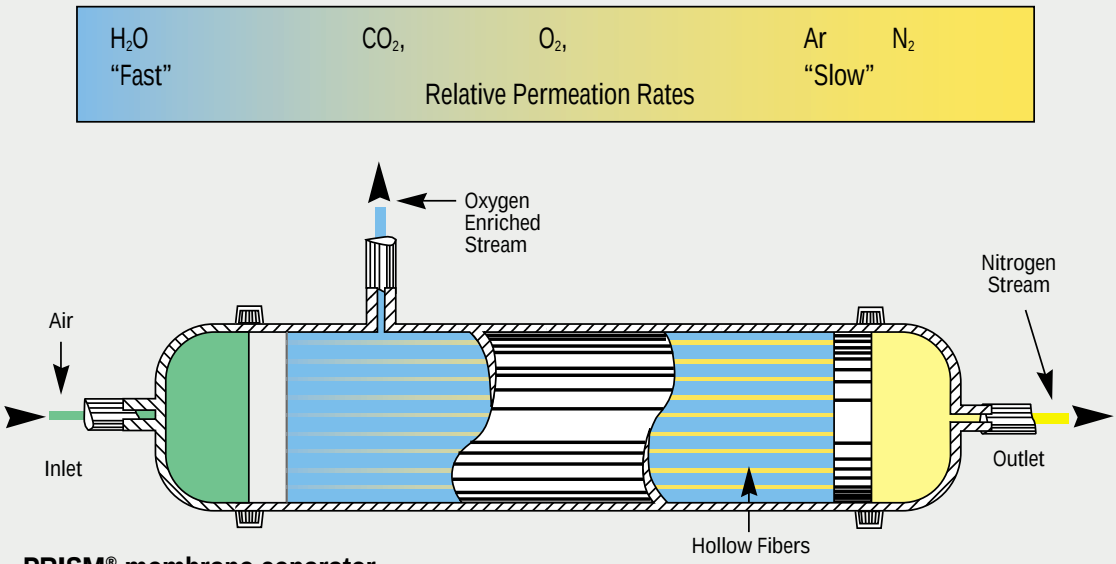
Super-dry nitrogen is also ideal as non-freezing, non-corrosive instrument gas, and for drying of void spaces like cofferdams etc.

A Sound Investment

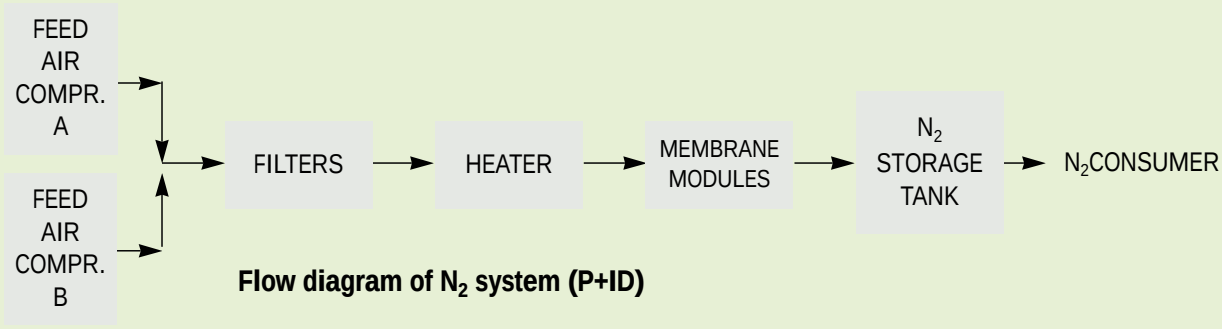
PRISM® nitrogen systems typically generate nitrogen at a cost between one-tenth and one-half the price of merchant nitrogen. They also save you from paying ultra-high purities you never need. With your own PRISM® system you pre-set the required purity, and, since nitrogen purity and flowrate are inverse parameters, you turn the reduced purity into high flowrate.

Nitrogen from Air

PRISM® systems produce nitrogen gas from air by means of PRISM® membrane separators. Each separator consists of a bundle of hollow fibers in a cylindrical shell. As compressed air is fed into the separator, oxygen, carbon



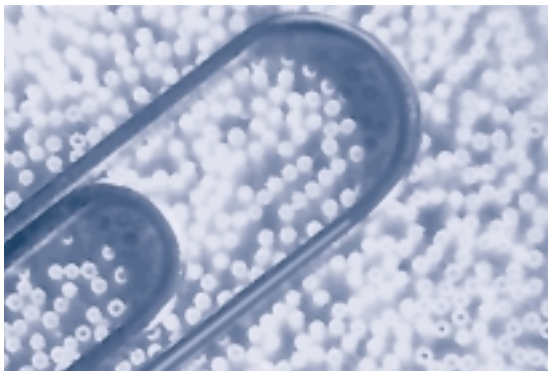
PRISM® membrane separator



Flow diagram of N_2 system (P+ID)

dioxide and water vapor permeate through the walls of the fibers faster than the nitrogen, leaving behind a product stream of super-dry nitrogen. The nitrogen leaves the separator at essentially the same pressure as the incoming feed air.The secondary oxygen-rich stream is by-passed to atmosphere at nearly atmospheric pressure.
A standard skid mounted system consists of a number of separators, feed air filters, feed air heater, piping, instrumentation and controls for automatic unattended operation.

Optional feed air compressors and nitrogen storage tanks are often supplied with the systems.



The paper clip illustrates the relative size of the hollow fibers inside a PRISM® separator

Purity and Flow to Meet your Needs

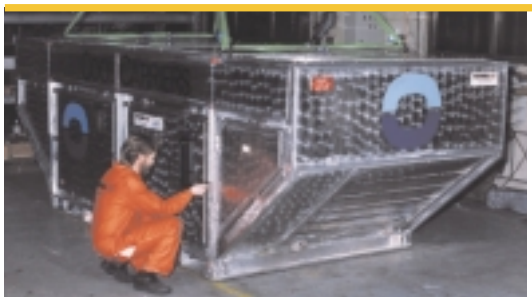
Typical capacity of shipboard systems as outlined is 15- 6250 Nm^3/hr. (normal cubic meters per hour), with 95-97% N_2 purity. Purities in excess of 99% N_2 are however available from the same systems, but at the cost of nitrogen flowrate.

Feed air pressures down to 5.5 barg are acceptable, but as system efficiency rises with rising pressure, it is generally economical to maximize the feed pressure.

Besides the feed air the nitrogen system also requires supply of electric power, mainly for its feed air heater. System efficiency varies with the temperature, and stable optimal feed temperature contributes to stable optimal system output. PRISM® systems are very simple to install, operate and maintain.

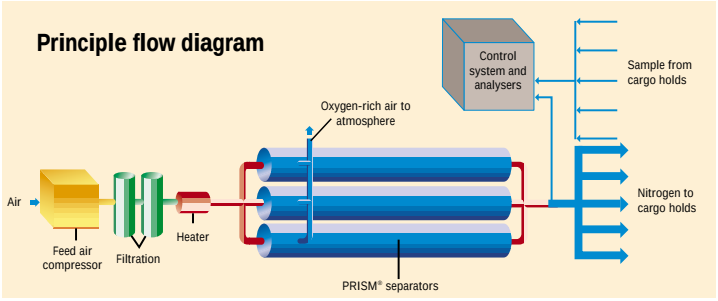
PRISM® CA systems

transform conventional reefer vessels into controlled atmosphere stores



Typical PRISM® CA system in air transportable container

Typical PRISM® CA system in 40 ft standard containers



Air Products AS, the world leader in gas separations by membranes, offers the reefer vessel industry controlled atmosphere (CA) nitrogen systems based on PRISM® membrane separators.

Extended Storage Life

Compared to refrigeration alone, the supplement of a PRISM® system significantly extends the storage life of perishable cargo. It efficiently transforms a conventional reefer into a controlled atmosphere store, and thereby allows shipboard transportation of perishables to form part of an unbroken CA chain from the origin to the consumer. The system does this by purging the ship's cargo holds with nitrogen (also referred to as inert gas) of specific purity, typically 95 and 98% N_2 . The result is optimal oxygen and carbon dioxide levels, ideal for storage of the perishable produce.

Operational Flexibility

The CA systems are designed either for fixed installation onboard reefer vessels, or as containerized, transportable units. The latter type will be installed on the weather deck of the reefer, and can later, whenever desired, be transferred to another ship or to a landbased store.

If a special air cargo container is chosen, the system can be returned for the next voyage in a passenger/cargo airplane.

A Complete Package

A typical PRISM® system for CA use consists of a feed air compressor, air filters, air heater, membrane air separators, piping, instrumentation and controls for automatic unattended operation. It has nitrogen hoses leading to each cargo hold, and sample gas hoses returning atmosphere samples from the same holds. Electric power is the only utility required.

Stay ahead of competition. Contact us today for more information about how your reefers can be fitted with state-of-the-art CA systems. We will be pleased to work with you to provide the best technical and economical solution for your application.

For more information about any system described in this brochure, call or write the nearest Air Products office.

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