Vaporisers & Gas Heaters

KRYTEM

At Your Service

Industrial gas applications demand tailor-made reliable supply designs regarding

- security of supply,
- productivity,
- accommodation of the customer's conditions and
- optimum utilisation of resources.

as the most important design criteria.

Both in the case of primary gas supplies and in relation to back-up systems which are based on the storage and transport of industrial liquefied gases, the selection of a suitable evaporator design takes a key position and contributes significantly to reducing the investment and operating costs.

When selecting the optimum plant solution, it is necessary above all to take into account all on-site specifications and facilities in good time. For this reason, we are pleased to make ourselves available for advice in the early design stages in order to work out a design for the plant which is geared to the specific application.

Krytem heat exchanger designs

Our product range includes gas preheaters and evaporators for all types of gases, including flammable, explosive and aggressive media. Apart from equipment which is warmed by space heaters, natural heat or industrial waste heat, we also supply heaters and evaporator systems incorporating integrated primary-energy heaters.

Modular systems made up of compact **CONVEX**, **SPIREX** and **PAREX** heat exchanger units, and **CENTREX**, **NDA** and **HDA** electrically heated systems make it possible to put together and manufacture tailor-made systems. Using high quality components guarantees the long-term availability of spare parts and controller components.

Krytem evaporator systems are characterised by

- a high level of reliability,
- optimum utilisation of energy resources and
- high investment security due to a long service life.

As is the case for all Krytem products, our evaporators and gas preheaters comply with all the valid technical EU directives.

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Krytem heat-exchangers and areas of application

PAREX WBH / E / D / G

pressureless water heated evaporators

PAREX evaporators consist of numerous medium cross-flow pipes installed in a tank filled with circulating water. The pipes are arranged in parallel and laid vertically between baffles. The heat-transfer medium therefore always flows around the pipes in the same direction. This flow arrangement results in the circulating water impinging on the whole surface of the pipework, which has the effect of preventing the uncontrolled formation of ice inside the evaporator and producing a uniform reduction in water temperature. The water may be circulated by means of, for example, an external low-pressure high-flow pump.

The variable external geometry of **PAREX** evaporators facilitates the manufacture of extremely compact and space-saving designs. The pressureless layout of the water tank offers a high degree of safety in case of leaks or pipe fracture under medium pressure.

PAREX evaporators are provided with level and temperature probes and can be mounted, with the cables and pipework connected, on a frame complete with the water circulation pump.

PAREX evaporators can be run at water temperatures from 15°C. Cooling water, river-water, seawater or waste water can be used as the heat-transfer medium, providing they are available in sufficient quantities and at minimal differential pressure. Heating by means of a district heating system is also an option. Alternatively, the evaporator energy can be supplied to a closed water circuit by, for example, direct or indirect steam injection or electrical heating.

If heating is carried out using steam, a maintenance-free steam injector can be used instead of the circulation pump. The injector not only heats the circulation water but also circulates it inside the evaporator. The steam condensate can either be fed out of the plant or left in the system. The amount of steam required to hold the temperature constant is controlled via a thermostate steam valve. If there is not sufficient industrial waste heat available, the circulation water can also be heated using an integrated oil- or gas-fired boiler.

Operating the **PAREX** evaporators with relatively cold water makes it possible to hold the gas-outlet temperature at the same temperature as the water almost constantly, even with a fluctuating gas throughput. The saving in energy which results is particularly important when primary

PAREX-evaporator for power station emergency supply:
18000 Nm^3/h O_2 + 5000 Nm^3/h CH_4;
heat transfer medium: cooling water 50°C

energy is used.

Technical Data

media	N_2, O_2, Ar, CO_2, He, CH_4, LNG	
heat transfer media	surface water, waste water, process water, cooling-circuit water	
inlet temperature	heat-transfer medium: medium:	+15 to +70°C -196°C to -70°C
outlet temperature	heat-transfer medium: medium:	2 to 5°C below inlet temperature of heat-transfer medium 0 to +25°C
max. operating pressure	heat-transfer medium: medium:	0.2 bar 40 bar (higher pressure on request)
pressure loss	heat-transfer medium: medium:	approx. 0.2 bar approx. 0.5 bar
throughput	heat-transfer medium: medium:	100 to 250 m³/h 1000 to 40000 Nm³/h
connections	flange according to DIN / ASA	
materials	1.4541, 1.4571, SF-Cu	

PAREX methane gas evaporator 5000 Nm³/h, heating by waste heat via secondary circuit

PAREX evaporator for N_2 / O_2: 2000 / 4000 Nm³/h; district heating via secondary circuit

CONVEX

Ambient Air Heated Vaporisers

CONVEX-Vaporisers and gas heaters consist of vertical stainless steel tube registers, which are embedded in large surface aluminium fin profiles. Mounted in a rigid corrosion-resistant dip-galvanised mild steel frame the pipe registers either form a wall or they are arranged in the shape of an open chest consisting of four vertical walls.

Along the vertical aluminium fin tubes the ambient air cools and flows down rapidly, producing a high convectional heat transfer. The chest-like geometry causes a reverse chimney effect due to which all internal fins are exposed to a high flow of ambient air so that a superior heater capacity is maintained almost independent of external weather conditions.

The enforced convection produces and enhanced thermal efficiency of the CONVEX design in comparison with the conventional single fin tube design of ambient heat exchangers. The chest arrangement also prevents chilling of the vaporiser outlet area which often is observed on conventional ambient vaporisers if they are exposed to unfavourable wind, blowing from the inlet to the outlet direction. Moreover the wall / chest arrangement allows for easy de-frosting if this should become necessary during permanent frost periods.

Application:

- industrial gas cylinder filling
- high pressure and medium pressure process supplies,
- high purity gases supplies.

Design features:

- low space requirements
- capacity almost independent of wind conditions

Accessories / Special Equipment:

- Closing Plates to reduce inner chest convection in summer operation
- two-way or multiple way design for reduced pressure drop
- manual or automatic shut-off devices at vaporiser outlet for online capacity reduction
- foot extensions for erection in gravel beds
- ex-vaporiser control block for gas temperature / pressure supervision
- monel piping (2.4360) for oxidising media
- CENTREX electric trim heaters for continuous operation

Capacity Calculation

Due to condensation of ambient air humidity the vaporiser fin tubes cover with an increasing and insulating ice armour, which reduces the vaporiser capacity and causes a drop of the gas outlet temperature. Amount and velocity of the capacity reduction depend on the weather conditions.

The specified nominal capacity of CONVEX vaporisers is valid for eight hours continuous operation under Central European climate conditions at an average system pressure of 200 bar. Under these conditions the gas outlet temperature will not drop further than 30 °C below the ambient temperature. Usually a temperature compensation for winter operation is not required if the vaporiser is operated intermittently - such as in a typical cylinder filling installation. However, during permanent frost periods in which the icing does not melt down during operational breaks it may become necessary to defrost the vaporiser from time to time by means of warm gas internally or warm air / steam externally. Furthermore an electric trim heater may become necessary in order to prevent cold-embrittlement of subsequent facility components reliably.

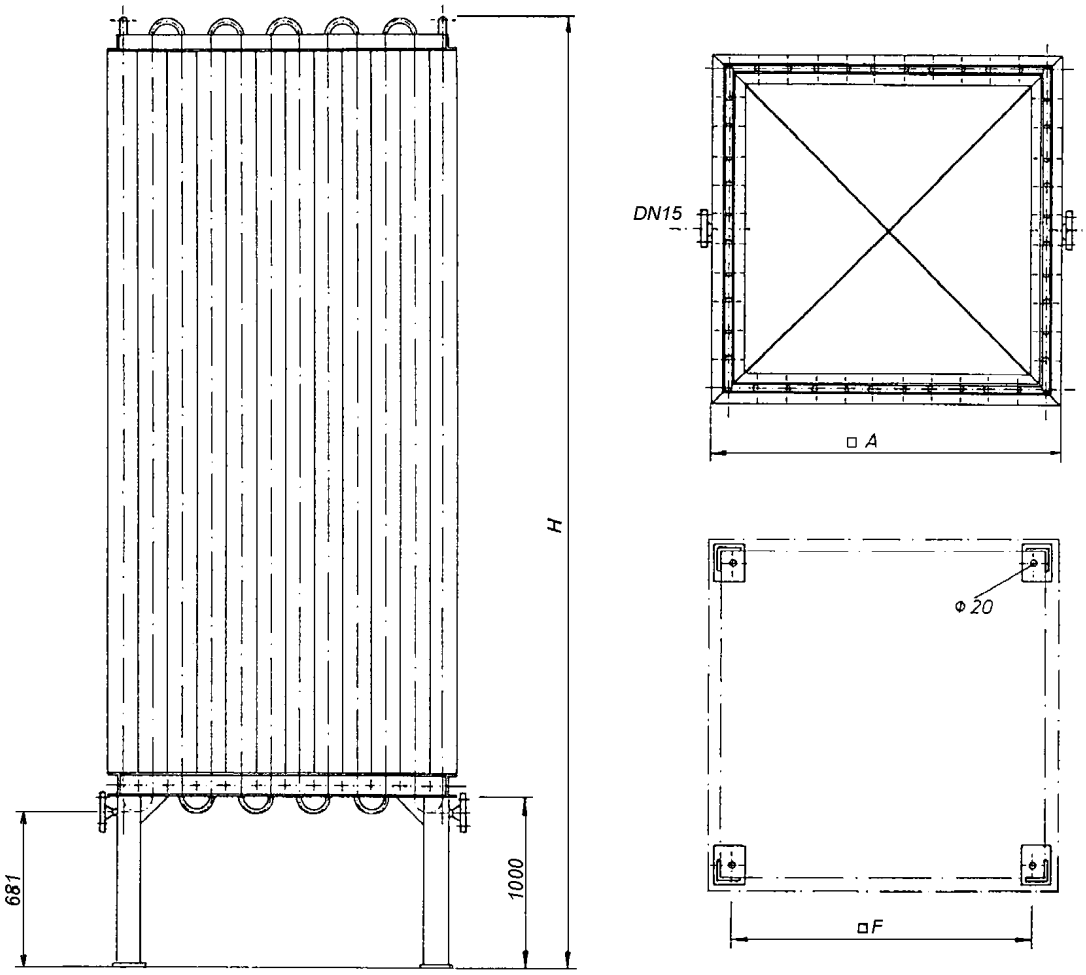
If the particular operating conditions are known, the required CONVEX size can be determined roughly by means of the attached dimensioning templates.

For the use of ambient air vaporisers generally keep in mind:

- High ambient vaporiser capacity leads to a massive chilling of ambient air and a consequential formation of dense fog around the vaporiser location. This may be hazardous for adjacent transport infrastructure such as roads railways etc. Therefore other vaporiser designs (electric, steam, gas-heated etc.) should be considered for vaporising capacities in excess of 300 kW.
- For regions with long periods of permanent frost primary energy heated vaporiser designs should be preferred in order to prevent frequent interruptions of service for the defrosting of vaporisers.

CONVEX HD Vaporiser

Data Sheet



Technical Data

media	all low-boiling industrial gases (N_2, O_2, Ar, CO_2, CH_4, H_2, He etc.)
energy supply	ambient air
inlet temperature	-196°C ... -20°C
outlet temperature	0 to 30°C below ambient temperature, nom. flow up to 8 h continuous operation under Central European climate conditions
design pressure	300 / 450 bar
capacity	standard sizes up to 1300 Nm^3/h N_2
connections	metal sealed three-piece threaded connections / welding ends
materials	1.4541, 1.4571, AlMgSi0,5, special version 2.4360 (monel)

dimensions	*nom. flow [kg/h N_2]*	*A [mm]*	*F [mm]*	*H [mm]*	*Register*	*weight [kg]*
CONVEX HD-16.28/300	713	1200	980	6730	28	940
CONVEX HD-16.44/450	1121	1800	1580	6730	44	1505

(frequently used standard sizes, exemplary)

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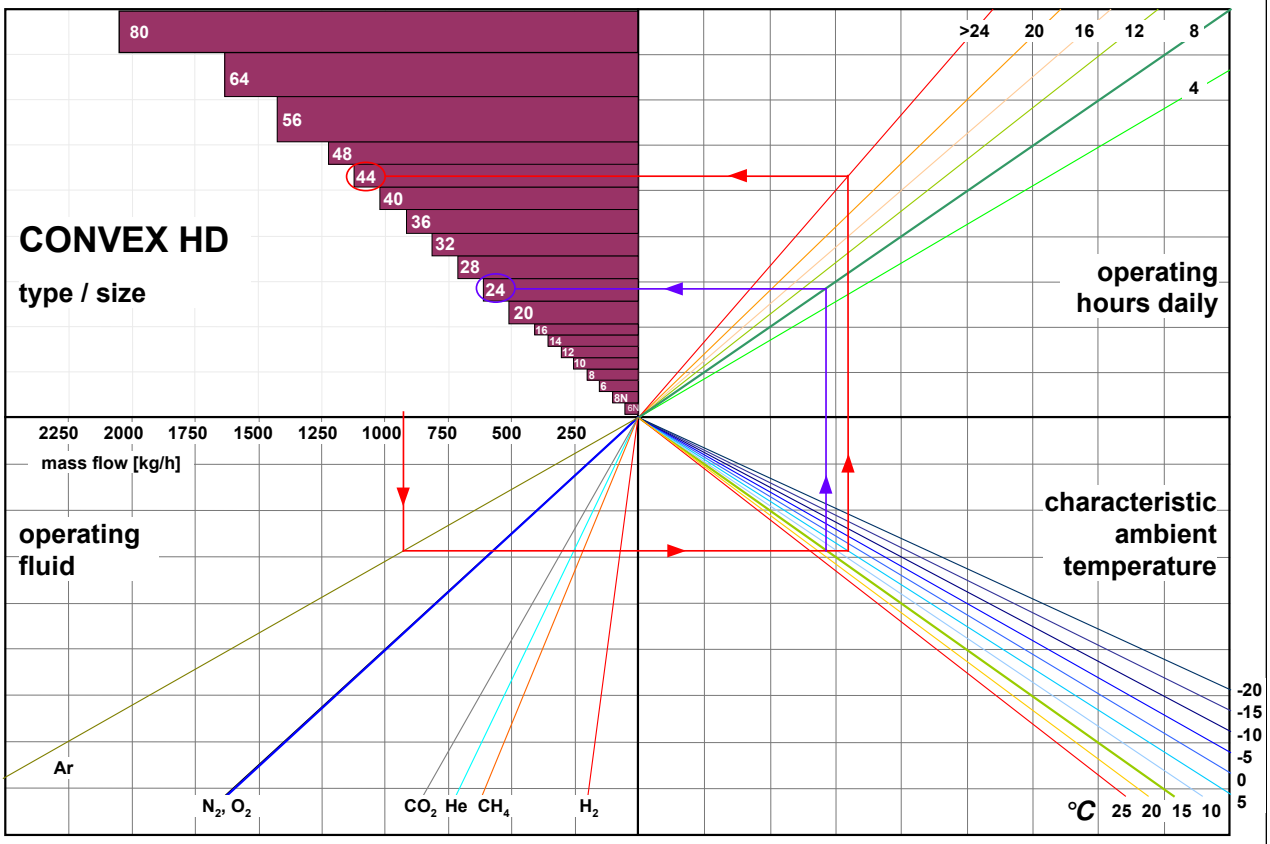
CONVEX HD Vaporiser

Standard Types

CONVEX HD Recommended Capacities

(special sizes and geometry available per request)

CONVEX	N_2	O_2	Ar	CH_4	CO_2	H	B
HD-16.	*kg/h (ref. to max. 8 hrs @ 15°C characteristic ambient temp.)*					*mm*	
10 W	255	253	408	106	136		
12 W	306	304	489	127	163		
14 DW	357	355	571	149	190		
16	408	405	652	170	218	900	600
20	510	507	815	212	272	900	900
24	612	608	979	255	326	1200	900
28	713	710	1142	297	380	1200	1200
32	815	811	1305	343	435	1500	1200
36	917	912	1468	389	489	1500	1500
40	1019	1014	1631	425	544	1800	1500
44	1121	1115	1794	467	598	1800	1800
56 / 56-4	1427	1419	2283	541	760	2100	2100
64 / 64-4	1631	1622	2610	618	870	1800	1800
80 / 80-4 / 80-8	2038	2028	3262	850	1088	2100	2100



Conversion of operating conditions:

Example 1 (red): *Argon, 930 kg/h - continuous operation (>24 h), mean ambient temp.: 5°C (central European conditions, winter operation) → **CONVEX HD-16.44***

Example 2 (red / blue): *Argon, 930 kg/h - intermittent operation one shift, 8 h daily (e.g. cylinder filling), mean ambient temp.: 15°C (central European conditions, only daytime operation) → **CONVEX HD-16.24***

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CENTREX WBH / AL
electrical heater

Electrically heated Krytem **CENTREX WBH** and **AL** series gas preheaters are characterised by their capability to damp temperature fluctuations which arise during unstable operating conditions. A heat accumulator with gas flowing through it has the effect of smoothing the gas outlet temperature when there are short-term fluctuations in throughput. The heating elements are not in direct contact with the medium and can be easily changed without having to open the medium pressure chamber. Contaminating the medium is therefore avoided, leaks will not occur at the heating element connection and erosion of the heating element by the medium is also excluded.

For **CENTREX** heaters, evaporation or heating is achieved during stable operation with a constant temperature difference between the wall of the plant and the medium in an annular-gap stream. During brief fluctuations in throughput, the fluid adopts the temperature of the heat accumulator which only changes slowly. In the standard model, there is a two-step controller which limits the gas-outlet temperature fluctuations to ± 15°C. The thyristor controlled model (P, PI or PID characteristics) achieves temperature fluctuations of no more than ± 1°C.

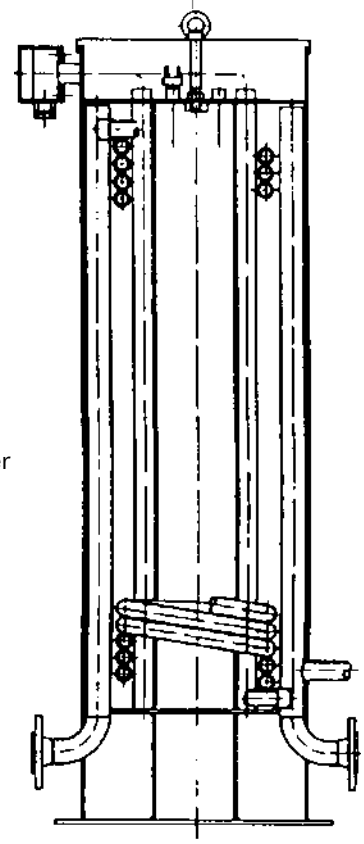
The N model is available for nominal pressures 25 and 40; The H model is used for operating pressures up to 100 bar. The modular construction of the SR series facilitates designs for almost any magnitude of heating power.

In the case of **CENTREX AL** evaporators, the medium is fed through a pipe-coil which surrounds an electrically heated metal core of high mass. The high pressure version is especially intended for gas post heating after ambient vaporisers in high-pressure bottling plants. Monel tubing is available for oxygen applications

CENTREX gas heater with thyristor control:
O_2 post heating approx. 1000 Nm^3/h;
$\Delta\vartheta \approx 50°C$; outlet temperature +25±1°C

Application:

- evaporation of small to medium-sized quantities of gas at moderate to low pressures
- post-heating after atmospheric evaporators
- evaporation / preheating where it not possible to connect to hot water or fuel supplies



Design features:

- compact design
- minimum erosion, as there is no direct contact between the medium and the heating elements
- heating element easily replaceable, thus upgrading to higher heating power possible in most cases
- standard design with dual-step control
- integrated overheat protection

optional:

- power control via thyristor controller
- for CENTREX AL series: horizontal design for additional-pressure evaporators for storage tanks
- monel tubing for oxygen duty

Technical Data

media	N_2, O_2, Ar, CO_2, He, CH_4, CNG
inlet temperature	-196°C to -20°C
outlet temperature	0 to +60°C ±15°C (±1°C with thyristor control)
operating pressure	max. 450 bar (higher pressure on request)
throughput	1 to 2000 Nm^3/h
heating power	0,5 to 60 kW
control	temperature recording via a resistance probe in the outlet; dual-step controller or microprocessor controlled P, PI or PID control using thyristor technology
overheat protection	via an electronic temperature switch mounted externally on the medium pipework
heating element	ceramic immersion heater
power supply	230 / 400 V- 50 Hz (standard)
connections	flanges in accordance with DIN / ASA
materials	1.4541, 1.4571, 2.4360 (CENTREX AL)

Integrated Supply Plants

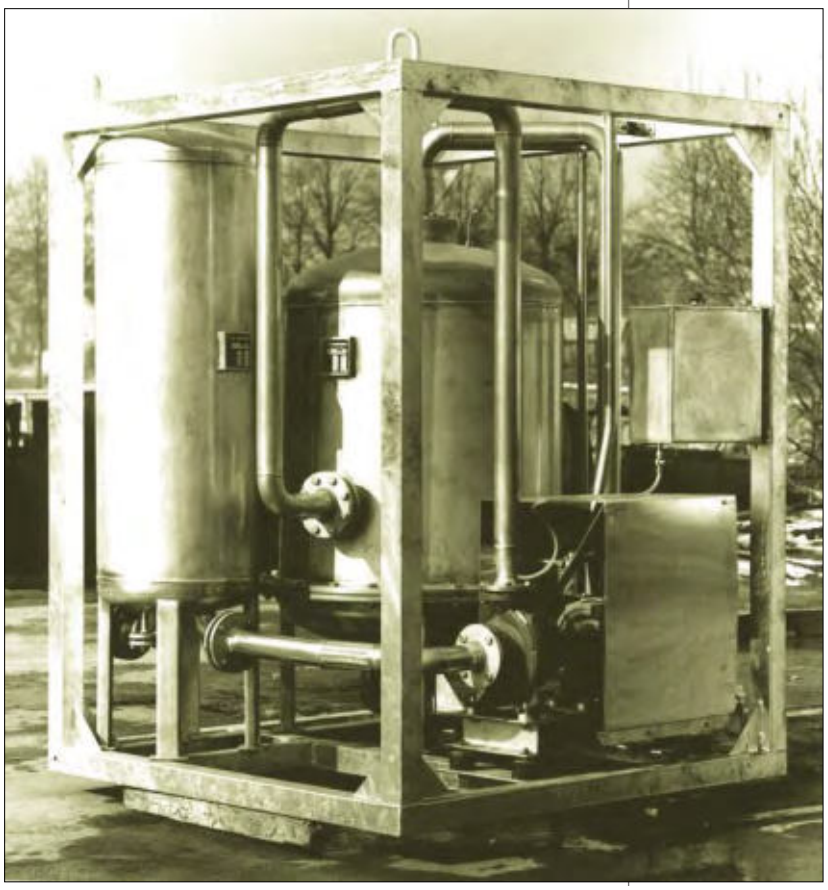
The field of application for KRYTEM integrated supply plants extends from the mobile methane or LNG evaporation plants for municipal energy supplies to stationary steel-works' emergency oxygen supplies and complete **TRANSINERT** mobile nitrogen inerting plants.

KRYTEM supply units are characterised by their high level of reliability and simplicity of operation. As a rule, they include the following main components:

- a water-heated Krytem evaporator
- hot-water circulation via a circulation pump or injector
- a diesel unit for generating electrical power and driving the circulation pumps
- a gas- or oil-fired boiler
- an automatic controller/regulator

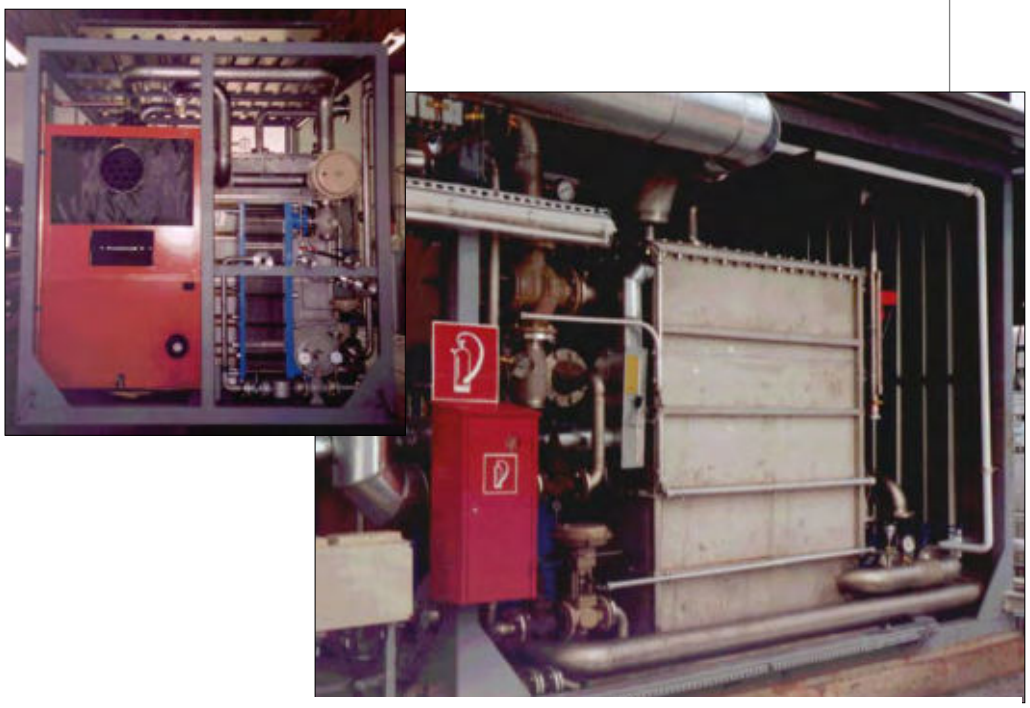
and optionally

- a storage tank for the operating medium
- a fuel storage tank



Inerting plant for tanker ships with SPIREX evaporator 2000 Nm^3/h N_2, heated with sea water 15 to 22°C, 3 bar, 150 m^3/h (1987)

Combined O_2 /N_2 supply with PAREX evaporator 1500 Nm^3/h, steam heated, water circulation 100 m^3/h, (1997)



O_2 supply for glass works with PAREX evaporator 9000 Nm^3/h at 6 bar, district heating and oil heating, water circulation: 200 m^3/h (1996)

TRANSINERT

The inerting of industrial sectors at risk from fire or explosion requires transient supplies of large quantities of inert gas (usually in the form of nitrogen) at environmental temperatures. Many industrial plants, however, do not have their own stationary inerting plants.

The **TRANSINERT** mobile evaporator station was designed for this type of application. When supplied together with the container tank, the **TRANSINERT** represents the complete supply unit which can be operated self-sufficiently due to an integrated energy supply and closed heating circuit.

TRANSINERT consists of independently operating heat and evaporator units connected by a common water circuit. The medium is evaporated in a water-circulation evaporator. A diesel-powered circulation pump circulates the water which is heated in an oil-fired boiler.

Areas of application:

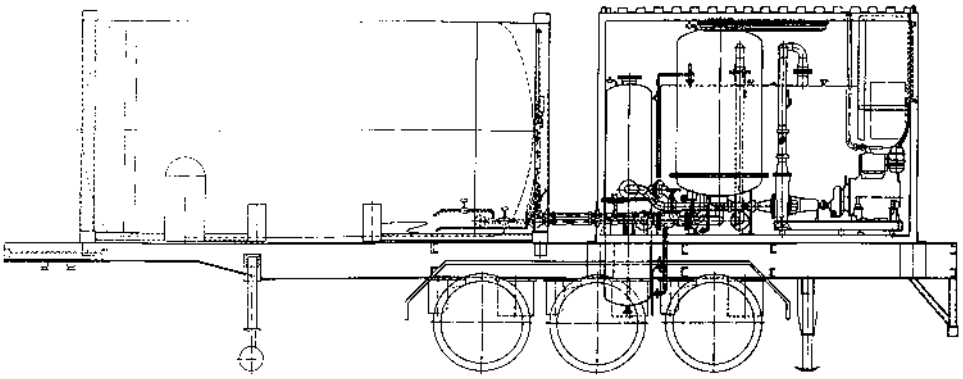
- inerting industrial plants such as chemical plants, reactors, tanker ships, offshore installations, pipelines, coal mines and silos etc.
- as an emergency supply when there is a plant or pipeline failure
- for short-term gas supply
- for immediate on-site installation

Design features:

- compact, self-contained unit in container construction
- simple operation and maintenance
- high level of operational reliability
- automatic power controller

TRANSINERT plant: 4000 / 6000 Nm^3/h N_2 (1988 / 1989)

Technical Data



medium	nitrogen	
heat-transfer medium	water	
energy supply	oil or gas-fired heating with integrated boiler 0,25 to 1,4 MW; oil storage tank if necessary; hot-water circuit with circulation pump	
evaporator inlet temperature	heat transfer medium:	+15 to +70°C
	medium:	-196°C to -170°C
evaporator outlet temperature	heat transfer medium:	2 to 5°C below inlet temperature
	medium:	0 to +25°C
max. operating pressure	heat transfer medium:	2 bar
	medium:	25 bar
throughput	heat transfer medium:	100 / 200 m^3/h
	medium:	2000 to 10000 Nm^3/h
dimensions	width: height length 2802 / 1780 / 1273 mm (ISO container sizes 1D / 1E / 1F)	2300 mm 2197 mm
weight	3 to 5 metric tons according to size and equipment	
connections	flanges in accordance with DIN / ASA	
materials	1.4541, 1.4571, SF-Cu	

References: water heated evaporators

device type	*capacity [Nm³/h]*	*media*	*heat transfer medium / energy supply*	*customer*
PAREX	150	N_2	cooling water	Linde
PAREX	400	N_2	warm water	Linde
PAREX	400	N_2	warm water	Westfalen AG
PAREX	1000	N_2	warm water	Westfalen AG
PAREX	1200	N_2	steam	SKW
PAREX	1200	N_2	steam	SKW
PAREX	1500	N_2	steam	SECM
PAREX	1500	O_2	steam	SECM
PAREX	2000	N_2	steam	Linde
PAREX	2000	O_2	district heating	AGA
PAREX	2000	O_2	district heating	AGA
PAREX	2000	O_2	cooling water	Messer Griesheim
PAREX	2700	N_2	steam	SECM
PAREX	4000	N_2	waste water	Linde
PAREX	4000	N_2	district heating	AGA
PAREX	4000	N_2	district heating	AGA
PAREX	4500	CH_4	district heating	Messer Griesheim
PAREX	5000	O_2	steam	Air Liquide
PAREX	6000	O_2	steam	AGA
PAREX	6000	O_2	steam	AGA
PAREX	9000	O_2	district heating/ oil heating	Messer Griesheim
PAREX	17000	O_2	oil heating	Messer Griesheim
SPIREX	150	He	warm water	Messer Griesheim
SPIREX	250	O_2	warm water	Air Liquide
SPIREX	300	O_2	warm water	AGA
SPIREX	400	N_2	warm water	Linde
SPIREX	400	O_2	warm water	Messer Griesheim
SPIREX	400	CH_4	warm water	Ruhrgas AG
SPIREX	400	CH_4	warm water	Ruhrgas AG
SPIREX	500	O_2	warm water	Air Liquide
SPIREX	1200	N_2	warm water	Messer Griesheim
SPIREX	6000	N_2	oil heating	Messer Griesheim
SPIREX	6000	O_2	cooling water	Westfalen AG
TRANSINERT	2500	N_2	oil heating	SECM
TRANSINERT	2500	O_2	cooling water	SECM
TRANSINERT	5000	N_2, O_2	steam + oil heating	Westfalen AG
TRANSINERT	5000	N_2	oil heating	Linde
TRANSINERT	5000	N_2	oil heating	Messer Griesheim
TRANSINERT	5000	N_2	oil heating	Messer Griesheim

Evaporator / heater data sheet

Design questionnaire

Quotation no.

Customer

(address, phone / fax)

resp. technician

project-no. customer

project-description
incl. local and
ambient conditions

Medium ☐ high purity

tank pressure ____ bar(g)

admissible pressure loss ____ bar

medium inlet temperature ____ °C ± ____ °C ☐ liquid ☐ gaseous

medium outlet temperature ____ °C ± ____ °C ☐ liquid ☐ gaseous

flow characteristics ☐ continuous ☐ discontinuous [1]

min. ____ kg/h max. ____ kg/h average ____ kg/h

Energy supply

☐ electrical: voltage ____ V - ____ Hz

☐ firing: fuel ____ calorific value H_u ____ MJ/kg

☐ by heat transfer medium (specification as below)

☐ others: ____

Heat transfer medium ☐ water ☐ steam ☐ ambient air

☐ others: ____

impurities, contamination [2]

inlet temperature min. ____ °C max. ____ °C

outlet temperature min. ____ °C max. ____ °C

available flow min. ____ kg/h max. ____ kg/h

operation pressure ____ bar(g)

admissible pressure loss ____ bar

☐ with condensate recirculation

☐ with condensate drain - drain pump: ☐ required ☐ existing

[1] include time consumption diagram: cycles, peaks, average
[2] acids, chlorine, other chemicals, sand etc.

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