

A Member of
The Linde Group

KRYOTECHNIK

Turbo Machinery.
Key Components of
Helium Liquefiers and Refrigerators.



Expansion turbines with dynamic gas bearings. Reliability that counts.

Linde Kryotechnik AG has more than 30 years of experience in the development, manufacturing and operation of expansion turbines with dynamic gas bearings for use in cryogenic gas processes. The turbines are used to generate refrigeration power with gases such as helium, hydrogen, nitrogen and neon. Worldwide, more than 1,000 expansion turbines of Linde Kryotechnik AG are successfully used in refrigeration units and liquifiers. The user community includes industrial plants, universities and research facilities like CERN, DESY, ORNL, JLab and Fermilab.

The expansion turbines in a refrigeration or liquefaction plant are actuated by the pressurized working gas, which consequently cools down. The expansion turbines convert pressure into mechanical performance and therefore function as refrigerating machines.

Energy extracted from the process gas is dissipated completely in the turbine's brake compression cycle. The heat generated in the brake compressors is released at ambient temperature to the cooling water system. The Linde expansion turbine is a single-stage radial-flow turbine. It is connected via the turbine shaft directly to a radial brake compressor. The rotational speed of the turbine is controlled by means of the brake compressor working point.

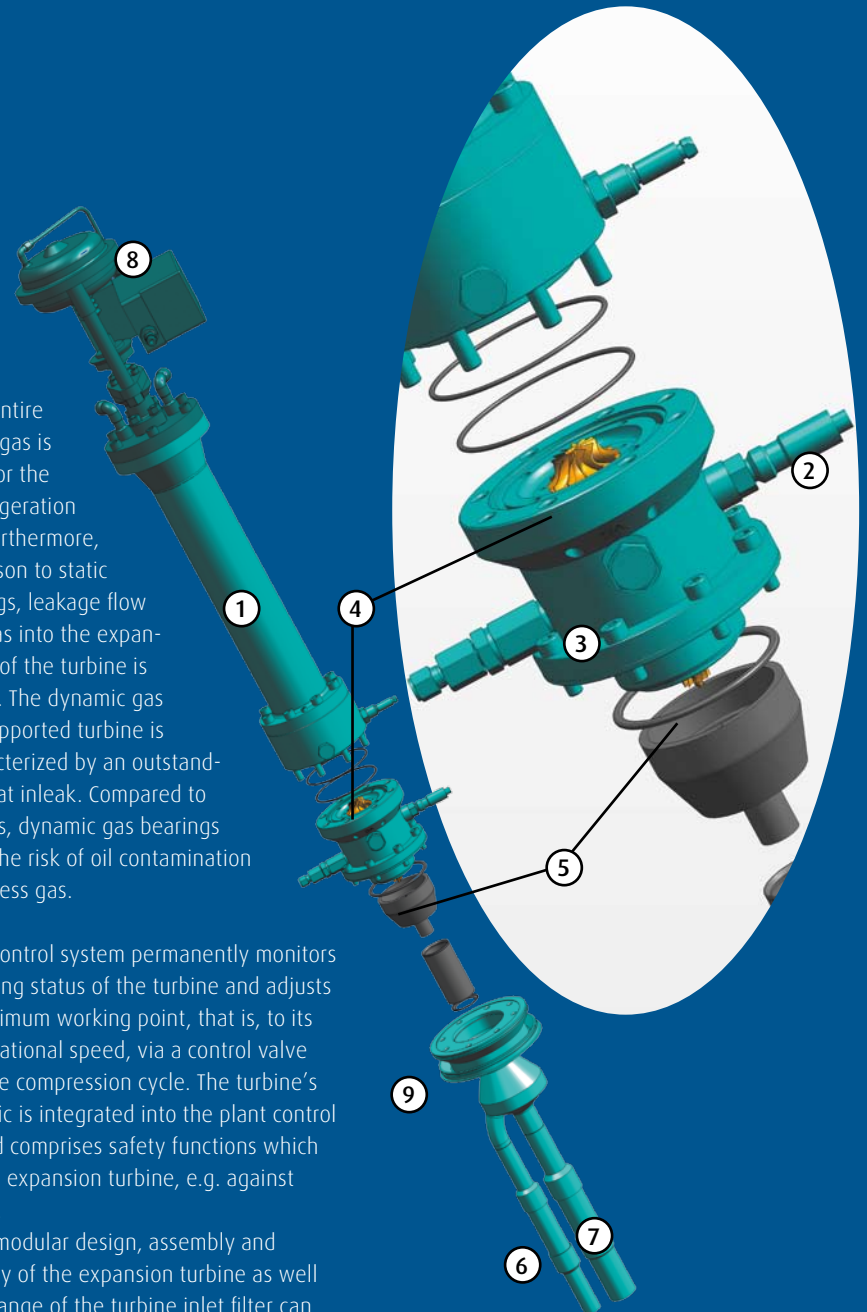
A special feature is the expansion turbine's innovative dynamic gas bearing system. In contrast to static gas bearings, dynamic gas bearings are self-supporting, that is, an external supply of bearing gas is unnecessary. The turbine thus works at a high efficiency

since the entire amount of gas is available for the actual refrigeration process. Furthermore, in comparison to static gas bearings, leakage flow of warm gas into the expansion stage of the turbine is eliminated. The dynamic gas bearing-supported turbine is thus characterized by an outstanding low heat leak. Compared to oil bearings, dynamic gas bearings eliminate the risk of oil contamination of the process gas.

A turbine control system permanently monitors the operating status of the turbine and adjusts it to its optimum working point, that is, to its optimal rotational speed, via a control valve in the brake compression cycle. The turbine's control logic is integrated into the plant control system and comprises safety functions which protect the expansion turbine, e.g. against overspeed.

Due to its modular design, assembly and disassembly of the expansion turbine as well as an exchange of the turbine inlet filter can be carried out without breaking the insulating vacuum of the Coldbox.

Linde expansion turbines with dynamic gas bearings are characterized by a simple and robust design, a high efficiency, high operational safety and reliability, as well as a very long service life. Because of their wear-free operation, periodic inspections are unnecessary.



1. Brake circuit cooler
2. Speed sensor
3. Turbine cartridge
4. Brake wheel
5. Turbine wheel
6. Gas inlet
7. Gas outlet
8. Control valve
9. Low temperature casing



Cold compressors

Maximum performance.

Today, cold compressors from Linde Kryotechnik AG are used in a wide array of cryogenic systems.

Cold compressors compress gas at cryogenic temperatures. Depending on the required final pressure several cold compressors can be connected in series. Moreover, with cold compressors it is possible to create subatmospheric process conditions, e.g. for generating near-absolute zero superfluid helium (< 4.2 K).

The use of cold compressors in medium-sized refrigeration units is very cost-efficient, in large-sized units indispensable. Due to the compression of subatmospheric process gas, the essential advantage here lies in a drastic reduction in the sizes of downstream equipment such as vacuum pumps, compressors, and heat exchangers.

The cold compressors consist of a radial flow compression stage, a cryogenic housing and an electrical drive unit with integrated bearing assembly. For optimized operation of the radial flow compression stage, the electrical drive is speed-controlled. The overall system is characterized by a modular design. Assembly and disassembly of the cold compressor can be carried out without breaking the insulating vacuum of the Coldbox.

The machines developed by Linde Kryotechnik AG are designed for the individual process conditions of the respective system.

The cold compressors of Linde Kryotechnik AG are characterized by the following:

- high thermodynamic (polytropic) efficiency
- high compression ratio
- broad operational range
- minimum heat inleak, optionally with a helium or nitrogen shield
- operational safety due to the advanced control concept
- precise speed control of the high-performance drive for working at different operation points
- standardized components for easy replacement
- extremely low-maintenance



Cold circulators

Efficient distribution of cold.

Cold circulators are used to cool system components which are spatially separate from the refrigeration unit.

Cold circulators transport cryogenic helium from the refrigeration unit to the point of use. Typically, cold circulators are used to supply large cooling mass flows to the consumer.

One particular application of cold circulators is also the requirement of strictly separating primary and secondary cooling circuits in nuclear equipment systems as for example in a cold neutron source (CNS, UCN). Cold circulators consist of a pumping stage, a cryogenic housing and an electrical drive unit with integrated bearing assembly.

The pump wheel is driven via a speed-controlled electric motor. The overall system is characterized by its modular design. Assembly and disassembly of the cold circulator are possible without breaking the insulating vacuum of the Coldbox.

The machines developed by Linde Kryotechnik AG are designed for the individual process conditions of the respective system.

The cold circulators of Linde Kryotechnik AG are characterized by the following:

- high thermodynamic (polytropic) efficiency
- broad operational range
- minimum heat leak, optionally with a nitrogen or helium shield
- compact design, a high degree of stability, and long operating periods
- precise speed control of the high-performance drive for working at different operation points
- standardized components for easy replacement
- extremely low-maintenance operation



Technical Performance.

Turbine Expander Type

Turbine Expander Type	TED16	TED22	TED32	TED45
Max. Process Power	5 kW	10 kW	25 kW	50 kW

Cold compressors and cold circulators

	Cold compressors	Cold circulators
Min. Flow Rate	10 g/s	100 g/s
Max. Flow Rate	on request	on request
Suction Pressure	15 mbar	> 3 bar
Max. Pressure Difference	—	2.5 bar
Compression Ratio per Stage	up to 4	—
Polytropic Shaft Efficiency	70% – 85% *	70% – 85% *
Shield Cooling / Thermal Intercept	optional	optional
Codes and Standards	ASME, AD 2000 and others	ASME, AD 2000 and others

* as a function of the design point

Linde Kryotechnik reserves the right to make changes without prior notice, in particular when design and engineering changes are made to improve functionality and when errors have occurred in descriptions and images.

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