Driving Turboexpander Technology

Atlas Copco Gas and Process

GREAT IDEAS
TRANSFORM INDUSTRIES

At Atlas Copco Gas and Process, we help customers prepare for tomorrow by designing, building, and servicing turbocompressors, gas screw compressors, turboexpanders, and API 610 centrifugal pumps for the hydrocarbon processing, power generation (both conventional and renewable) and industrial gases industries. Our passionate people are dedicated to helping customers handle today's pressures while creating a sustainable future.

We are a division of the Compressor Technique business area, headquartered in Cologne, Germany, with additional production centers in the United States, India, China, Korea, and Canada.

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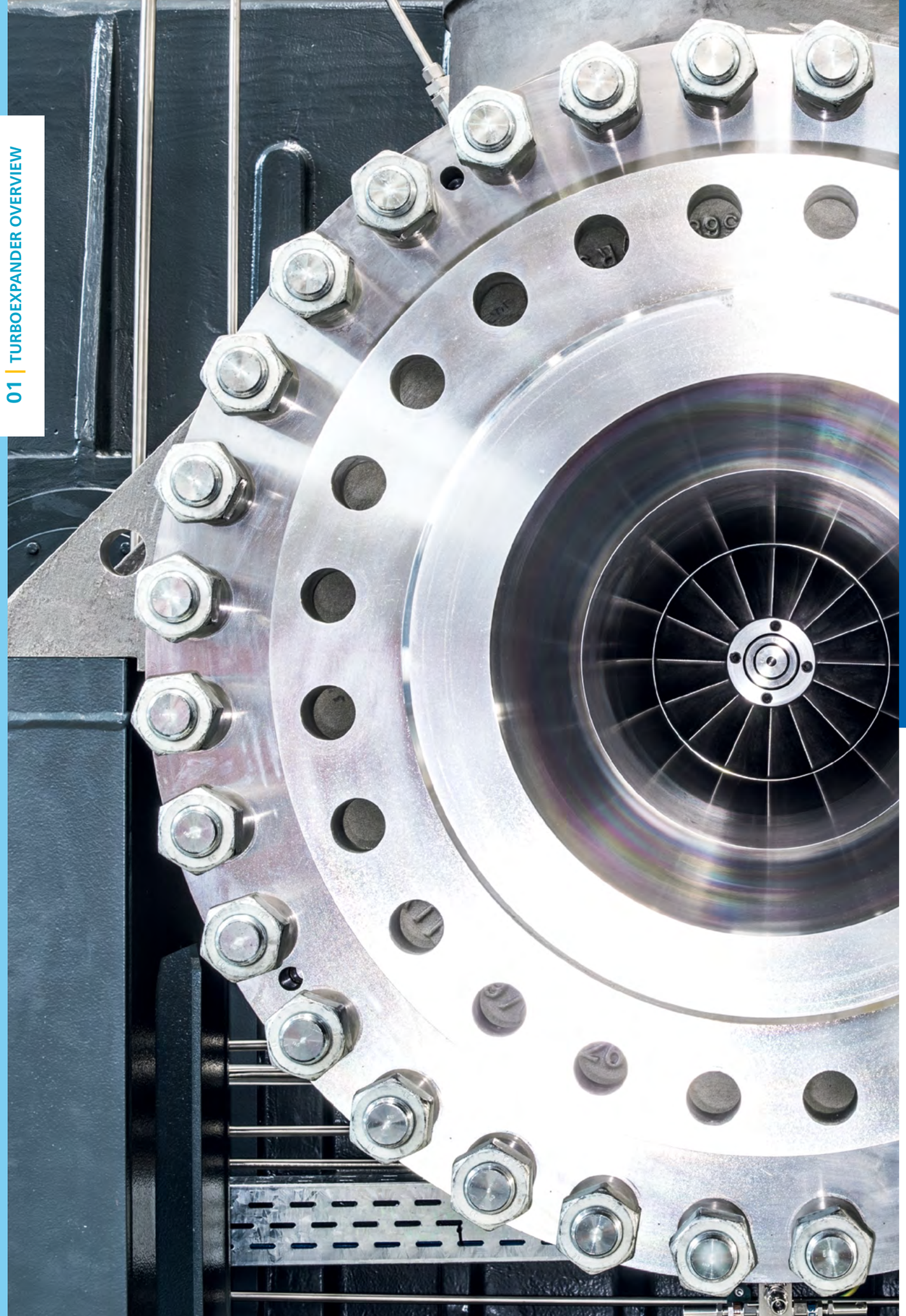


HARNESS THE POWER OF GAS EXPANSION

Atlas Copco Gas and Process has over eight decades of in-house experience in developing and designing reliable, highly-efficient turboexpanders. These expanders put the cold-producing qualities of gas expansion and its power potential to work in your process – in applications ranging from gas processing, LNG, and petrochemicals to hydrogen liquefaction and power generation.

80+ YEARS

of experience as a turboexpander specialist

MEET ALL STANDARDS

Industry standards (API and ANSI), International standards (ARH, CRN, GOST, China Vessel, etc.) and corporate standards

5,000+

references of installed turboexpanders worldwide

IN-HOUSE EXPERTISE

to handle the complete product lifecycle from design and manufacturing to testing, delivery and maintenance.

DRIVING TECHNOLOGY

Significant experience with expander solutions for gas expansion, sCO_2, liquid, or flashing liquids.

Extra cold, additional power

Converting high pressure gas into low pressure gas is simple: valves and orifices do it all the time. But converting the pressure drop into the maximum temperature drop and the maximum shaft power with high reliability is a challenge at which only a few can excel.

At Atlas Copco, our experience with expansion turbines began with our first patent application in 1936. It continues today through decades of turboexpander innovation, continually improving upon their efficiency and reliability.

Unlike the isenthalpic pressure drop of a conventional throttling or pressure reduction valve, where the potential power and temperature drop are not put to work, a turboexpander exploits the pressure change with efficiencies reaching 90%, drawing energy out of the pressure change and out of the gas.

The result is colder temperatures – vital to the process – but also additional available shaft power that can be re-used in the process chain.

Driving the technology further

Driving technology further, we have extensive experience with gas expansion, sCO2, liquid, or flashing liquid expander solutions.

Backed by decades of experience

Our unique role as a complete, “flange-to-flange” turboexpander manufacturer ensures that we know expansion technology inside and out.

DESIGNED FOR YOUR PROCESS:
OUR SOLUTIONS ACROSS KEY INDUSTRIES

Atlas Copco turboexpanders function as "power exchangers," recovering energy in a pressurized fluid while making it colder and releasing pressure. These dual capabilities – refrigeration and rotary power – have made turboexpansion technology essential for applications in several markets. See some of the processes that our turboexpanders can drive in your industry.

Applications relying on turboexpanders' cooling potential

Hydrogen applications include:

- Liquefaction
- Hydrogen purification
- Boil-Off Gas / reliquefaction

Gas processing applications include:

- Pipeline dew point control
- Gas preconditioning
- Natural Gas Liquids (NGL)
- Ethane recovery / rejection

LNG applications include:

- Nitrogen / methane reverse Brayton-cycle refrigeration for base load / peak-shaving
- FPSO / FLNG cryogenic liquefaction
- Small and mid-scale LNG
- On-ship reliquefaction
- Ethane recovery / rejection

Air separation applications

Petrochemical applications include:

- Ethylene / olefin production
- Ammonia purification (Fertilizer Industry)
- Propane / butane dehydrogenation (PDH / BDH)
- Carbon-monoxide reduction and processing

A turboexpander for cryogenic hydrocarbon separation.

Applications using turboexpanders' capability to recover power

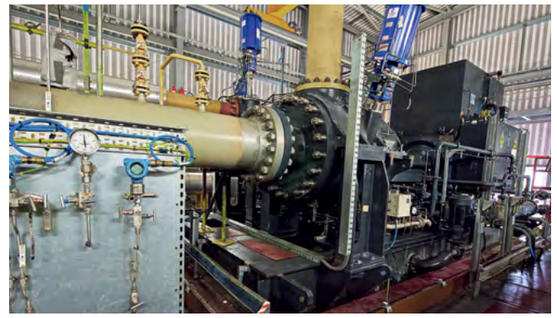
Energy Storage applications include

- Thermal energy storage (Solar, waste heat, etc)
- Compressed air energy storage (CAES)
- Liquid air energy storage (LAES)

Power generation applications include:

- Geothermal using Organic Rankine Cycle
- Pipeline natural gas pressure letdown
- Waste heat to power, cold to power using Organic Rankine Cycle
- sCO_2 power cycles

Generating electricity from geothermal heat.



A turboexpander for natural gas pressure letdown.

Plant energy efficiency improvement

For applications ranging from feed-stock chemicals to fertilizers, production often involves wasted energy in the form of higher gas temperatures and pressures that can be recovered and employed in the process to boost plant efficiency.

Efficiency improvement applications include:

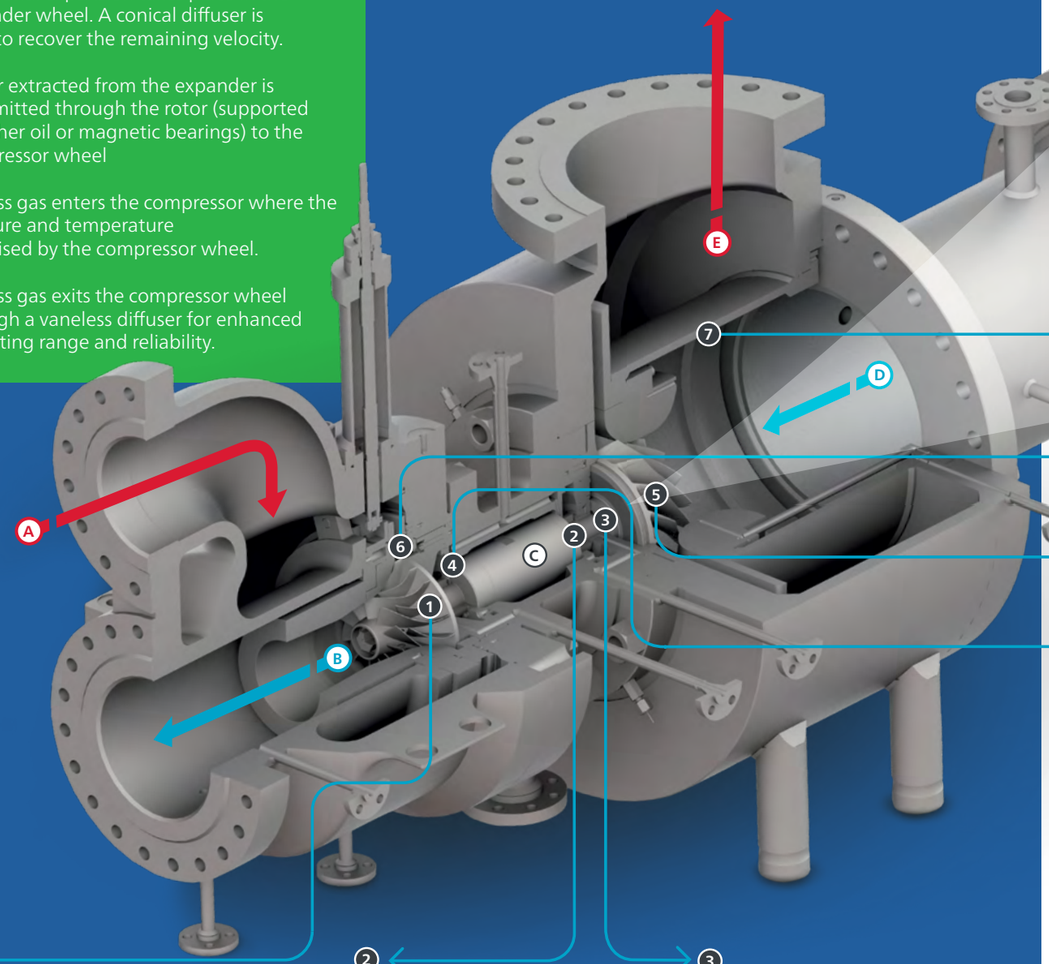
- Nitric acid plant hot gas expansion
- Various process tail gases (phenol, PTA, caprolactam)
- Feed gas pressure letdown
- Methanol (syngas)
- Hydrogen peroxide (autooxidation process)

EXPLORE OUR TURBOEXPANDER TECHNOLOGY

The technology behind our turboexpanders is designed for superior performance – to provide more cryogenic cooling and more recovered power for every application. In the case of our hydrocarbon turboexpander compressors, this means greater liquid recovery and extra compression power. Take a look inside to see the key design features.

HOW TURBOEXPANDERS WORK

- (A) Gas enters the expander through the inlet guide vanes creating an initial pressure drop and a high-velocity vortex
- (B) Additional expansion takes place in the expander wheel. A conical diffuser is used to recover the remaining velocity.
- (C) Power extracted from the expander is transmitted through the rotor (supported by either oil or magnetic bearings) to the compressor wheel
- (D) Process gas enters the compressor where the pressure and temperature are raised by the compressor wheel.
- (E) Process gas exits the compressor wheel through a vaneless diffuser for enhanced operating range and reliability.

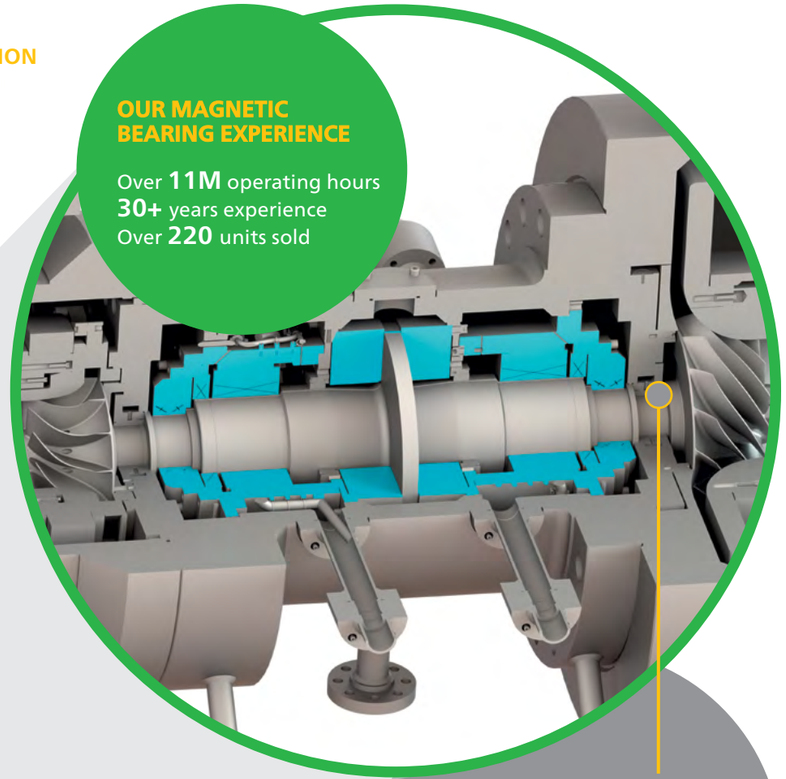


BENEFITS FOR REFRIGERATION AND CRYOGENIC COOLING

- Greater cooling than pressure reduction valves or other comparable technology
- Full flexibility to handle plant and process conditions
- High efficiency
- Exceptional reliability with availability above 99% in most applications
- Recover energy for re-use as compression power
- Energy recovery in the form of compression

OUR MAGNETIC BEARING EXPERIENCE

Over **11M** operating hours
30+ years experience
Over **220** units sold



AVAILABLE WITH ACTIVE MAGNETIC BEARINGS

Magnetic bearings are also available for Expander Compressor units of all sizes to provide an oil-free solution with reduced maintenance costs and a smaller plot plan.

1 Expander wheel (impeller)

Our expander wheels are machined from solid, heat-treated aluminum, titanium or stainless-steel billets, and manufactured using the latest five axis computer-aided manufacturing processes.

2 Shaft

Our one-piece shaft uses a proprietary wheel attachment method to ensure positive fit, balance, and torque transfer across the entire range of operating speeds, powers, pressures, and temperatures.

3 Shaft seals

Simple and robust, staggered labyrinth shaft seals provide the highest reliability of any seal design.

4 Journal and thrust bearings

Our oil-bearings provide stable operating with low vibration across the operating range. Optional oil-free magnetic bearings are also available.

5 Compressor wheel (impeller)

Offering a wide operating range and superb efficiency, our compressor wheels are manufactured from aluminum, titanium, or stainless steel. They are designed using Computational-Fluid Dynamics (CFD) and Finite-Element Analysis (FEA).

6 Variable inlet guide vanes (IGVs)

Our proprietary variable inlet guide vane design develops the optimum inlet swirl for highest expander stage efficiency. Erosion and galling resistant materials and coatings are used to achieve the highest reliability in the industry.

7 Removable diffuser bracket

Designed to allow re-rating of the machine for new process conditions without the need for a new housing or sacrificing performance; variable diffuser brackets give extra flexibility for further upgrades.

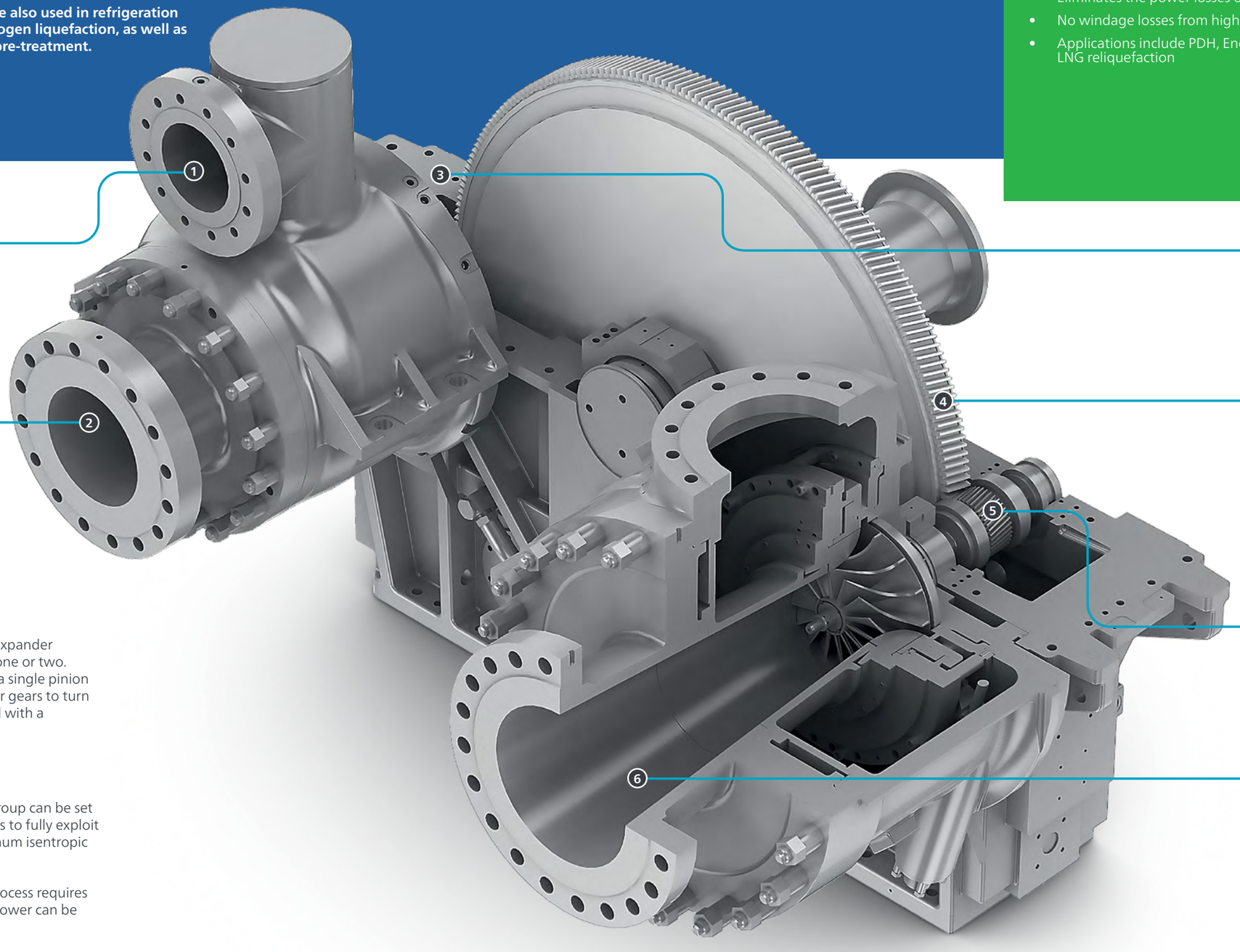
BENEFIT FROM THE MULTISTAGE INTEGRAL GEARING ADVANTAGE

As one of the industry's most efficient and compact designs, integral gear technology enables optimal aerodynamic speeds at each stage. Integrally-geared turboexpanders offer you a small footprint, and provide efficient energy recovery from waste-heat, geothermal and excess pressure (pressure letdown) sources.

Integrally-geared expanders are also used in refrigeration applications like PDH and hydrogen liquefaction, as well as NGL recovery and LNG export pre-treatment.

BENEFITS FOR ENERGY RECOVERY

- For each stage the best aerodynamic design from various impeller options is chosen
- Higher efficiency and greater power generation
- Eliminates the power losses of an external speed reduction gear
- No windage losses from high-speed couplings
- Applications include PDH, Energy Storage, and LNG reliquefaction



1 First-stage gas inlet
This two-stage expander reduces gas pressure in a series arrangement. Integrally geared expanders can also be set up in a parallel arrangement for higher flow and power capacities.

2 First-stage gas outlet
The fluid gas exits the first expansion stage and is routed to the second stage.

After gas pressure has been partially reduced, it enters a second stage for a further pressure drop and to generate additional electricity.

3 First stage pinion / pinion gear
A pinion powered by the first stage of expansion delivers rotational power to drive the bull gear.

4 Bull gear
Driven by both pinion gears through a meshed helical gear pattern, the bull gear's shaft is directly attached to an electrical generator.

Rotating parts are reduced to a minimum and contact surfaces are optimized for the lowest possible mechanical losses.

5 Second stage Pinion / Pinion gear
Expansion in the second stage provides an additional pressure drop for the gas and provides extra rotational power for the bull gear.

6 Second-stage gas outlet
Thanks to the additional stage, in series, larger pressure drops can be accommodated in a single unit

Multiple expansion stages (4 stages, per gearbox) are possible, depending on process and efficiency requirements.

Integral gearing at work for you

A multi-stage, integrally-geared turboexpander separates stages into groups of either one or two. Each of the stage groups is coupled to a single pinion (3 and 5). The pinions work as driver gears to turn the main bull gear (4) that is coupled with a electrical generator (not shown).

Stage efficiency for more energy

Using custom gear ratios, each stage group can be set to an optimal speed, allowing designers to fully exploit expansion aerodynamics for the maximum isentropic efficiency.

This is particularly important when a process requires a larger pressure drop, or when more power can be utilized for greater energy production.

IT'S ALL IN THE DETAILS:
TURBOEXPANDER DESIGN FEATURES

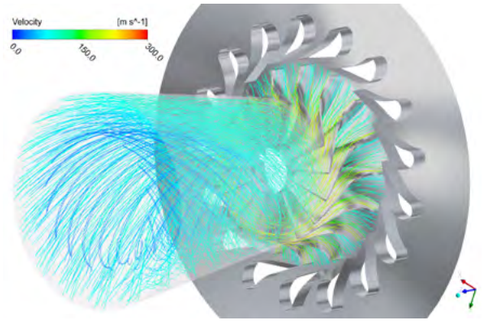
The efficient cooling and power produced by turboexpanders is the result of a seamless interplay of many components. Every part – from bearing systems and shaft seals to casings and controls – has an important role to play. We ensure no detail, no matter how small, is overlooked. The result: maximum efficiency, reliability and performance for your process.

Expander wheels (impellers)

Excellent efficiency begins with precisely designed expander wheels. After all, these are at the heart of the expansion process, accounting for around 50% of the total energy (enthalpy) drop of the gas.

Gas enters an expander wheel from the outside edge and moves inward. The speed of the gas at the outside is roughly the same as the wheel's rotational speed, but it loses speed as it moves to the smaller-radius at the center, reducing pressure.

As turboexpander specialists, we understand how careful design leads to optimal performance. We can choose from a variety of impeller designs already in our database, or develop new ones to meet new process specifications through Computational Fluid Dynamics (CFD) and Finite Element Analysis (FEA).

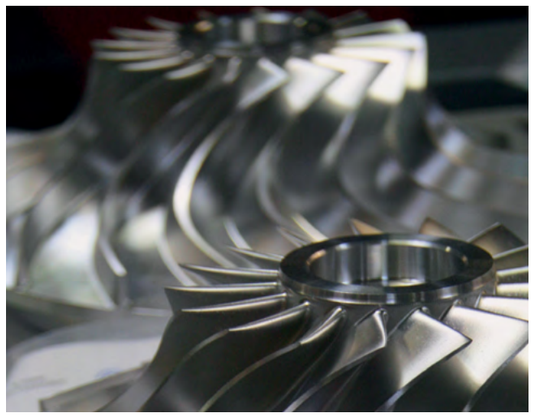


Expander computational fluid dynamics (CFD) results.

Variable inlet guide vanes (IGVs)

IGVs convert gas pressure to a velocity that matches the speed of the outer edge of the expander wheel. This ensures that the pressure drop is split between the IGVs and the expander wheel to maximize both the temperature drop and the recovered power.

Variable inlet guide vanes enable optimum performance across a full range of process conditions.



Aerodynamic performance is determined by shape of the blades and tip speed.

Photo: © John Crane Group Corporation

Dynamic dry-gas seals

Sealing options

Our expander compressors are hermetically-sealed and are equipped with labyrinth seals because they do not have shaft ends that extend through the pressure boundary.

For our integrally-geared expanders, a mechanical seal is often required to prevent process gas from entering into the gearbox, where it could otherwise contaminate the oil system.

For most applications, API-617-compliant single-port labyrinth seals are more than sufficient to prevent cross contamination. Our turboexpanders can also be equipped with carbon ring or dynamic dry-gas seals, increasing protection for even the most demanding conditions.

COMPLETE PRODUCTION EXPERTISE: DESIGN AND TESTING

Atlas Copco Gas and Process has over eight decades of experience in turboexpander design and manufacturing. We help drive the industry, extending the range of turboexpansion applications while handling the entire production chain. Through this broad experience, we deliver some of the most effiencient, reliable, and highest performing machines on the market.

Core experience that makes the difference

We know turboexpanders – inside and out. We develop them, build them, and maintain them.

Our in-house teams follow each machine from its initial order through every step of the design, testing, and commissioning process.

This not only allows us to maintain high quality and reliability, but also to offer the shorter delivery times important for today's dynamic markets.

We offer a full range of customization and optimization, covering packaging, controls, impellers, and more.

A global leader in turboexpanders

Our approach also means that we conduct all component, control system, and machinery testing in-house. This includes highly precise shaft and impeller balancing, hydrotesting of casings, full control system checks, as well as all major tests according to API 617, ASME or other standards.

Through the combined strength of our production facilities and application centers, Atlas Copco Gas and Process is the global leader in turboexpanders, with over 5,000 machines installed around the world.

A turboexpander is assembled for a hydrostatic test.

Specialists put the final touches on our expander-compressors before delivery.

Our aftermarket specialists cover the complete Atlas Copco turboexpander product line and use only genuine Atlas Copco parts.

We handle maintenance, optimization, and upgrades for a full range of all-brand turboexpanders.

PROTECT YOUR INVESTMENT WITH AFTERMARKET SERVICES

From erection and commissioning of your machinery, to knowledgeable preventive service with guaranteed genuine parts, our engineers are here at every step of the way. And whenever your process requirements change, we can help you make informed decisions about modification options, such as revamps.

24/7
Global customer support

DEDICATED
turboexpander
service technicians

LIFETIME AVAILABILITY
of OEM parts

200+
all-brand
turboexpanders
serviced

All-brand support

Your partner at every step of the way

When you purchase a turboexpander from Atlas Copco Gas and Process, you are investing in a lifetime of sustainable productivity.

At the same time, you are entering into an ongoing relationship with our team of dedicated specialists and technicians who know your process, know your machinery, and know your production goals – even as they evolve over time.

Through regular inspections and preventive maintenance, we make sure that your machinery is running optimally.

That's why our global Aftermarket Services network offers a number of custom-tailored choices to ensure your sustainable productivity over the long haul.

Our Aftermarket Services cover the complete product lifespan:

- Regular service plans
- Preventive maintenance
- Ad-hoc repair
- Genuine parts and Turbo Oil Plus
- Erection and commissioning
- Redesign and upgrades
- Advanced services
- All-brand support

SPEED UP YOUR PLANT SETUP
THROUGH STANDARDIZED SOLUTIONS

ECOTS™, our pre-engineered line of expander-compressor packages, provide the right match for your natural gas processing applications in packages systems re-imagined for reduced carbon footprint. Thanks to this semi-standardized concept, ECOTS Plus™ and ECOTS-M™, provide fast delivery, while optimizing process performance and providing the excellent refrigeration level vital to your process.

More benefits through standardization

Our Expander-Compressor Off-The-Shelf, otherwise known as ECOTS™, is designed with top efficiency and fast delivery in mind.

Through standardization of key components, the expander is produced and delivered faster than a completely customized turboexpander – reducing delivery and set-up times by 25% to 35%.

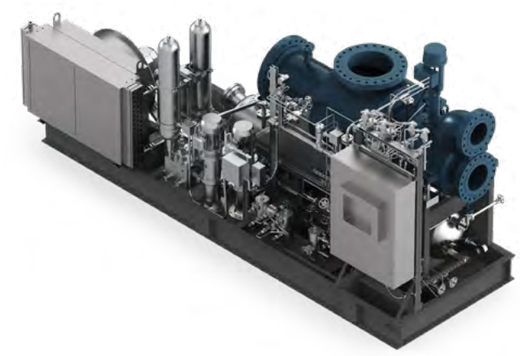
This means your processing plant can begin making commissioning plans sooner and see returns on investments as early as possible.

The basic engineering drawings are delivered shortly after order placement, enabling plant designers to work on integration ahead of time.

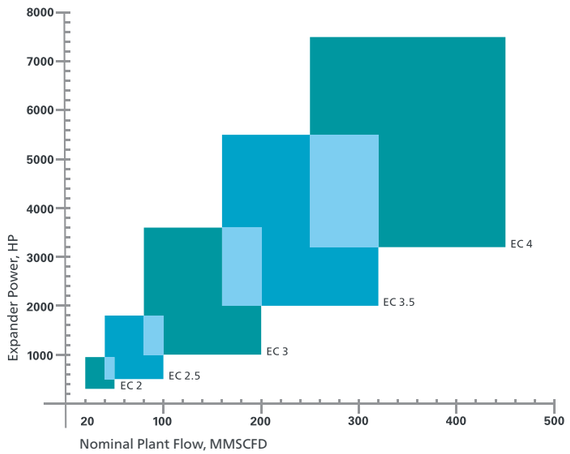
With a variety of package options

Our configure and built-to-order approach also offers the same excellent quality of fully customized machines while providing aerodynamic optimization to match process requirements.

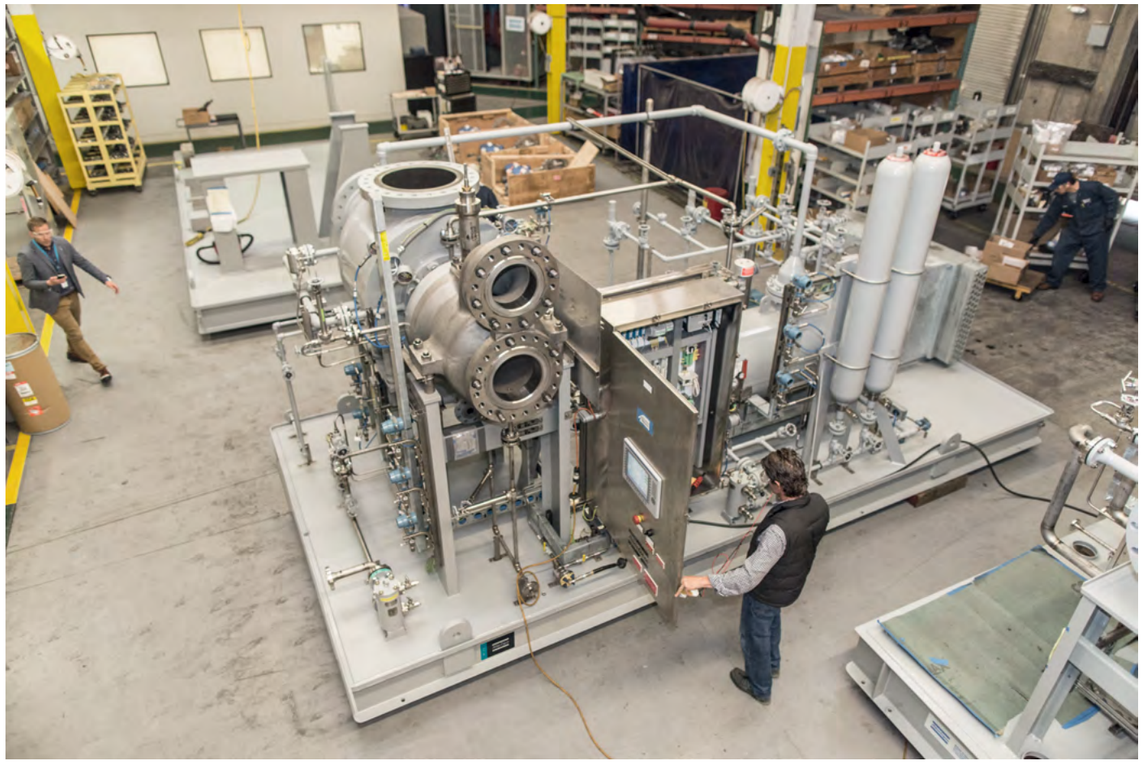
- Oil lubricated bearings (ECOTS Plus™) or Active Magnetic Bearings (ECOTS-M™)
- Winterization (up to -20°F/-29°C)
- Expander performance test
- Dual seal gas filter
- Spare parts
- Allen Bradley PLC upgrade
- 50Hz or 60Hz power supply
- IEC or NEC electrical design specification
- Air or water-cooled lube oil cooler
- Material upgrades (reservoir, LO manifold)
- Inlet trip valve and inlet screens
- Surge control valve
- Many other options



An ECOTS-Plus unit.



Nominal Gas Plant flow and expander power ranges by ECOTS frame size



TURBOEXPANDER TECHNICAL SPECIFICATIONS

	Expander-Compressor [1, 2]	Integrally-geared Expander Generator	ECOTS (TM) Expander-Compressor [3]
			
Maximum inlet pressure	200 bar(a) / 2,900 psia	200 bar(a) / 2,900 psia	82 bar(a) / 1,200 psia
Max. expansion ratio (per stage)	18 (depending on process fluid)	18 (depending on process fluid)	5
Inlet temperature	-253 °C to +200 °C / -423 °F to +400°F	-253 °C to +510 °C / -423 °F to +950 °F	Expander: -129 °C to +93 °C / -200 °F to +200 °F Compressor: -29 °C to +93 °C / -20 °F to +200 °F
Inlet flow range	1,000 to 1,000,000 Nm^3/h 6,000 to 600,000 SCFM	10,000 to 1,000,000 Nm^3/h 6,000 to 600,000 SCFM	Plant flow up to 470,800 Nm^3/h 400 MMSCFD
Maximum number of stages	1	1 to 4	1
Gases handled	All industrial gases and hydrocarbon gas mixtures	All industrial gases and hydrocarbon gas mixtures	Natural gas
Bearing type	Active Magnetic Bearing (AMB) Oil-lubricated	Oil-lubricated	Active Magnetic Bearing (AMB) and Oil-lubricated
Shaft			
Maximum impeller speed (RPM)	100,000	50,000	50,000
Maximum shaft power	22,500 kW 30,000 HP	50,000 kW 67,000 HP	5,200 kW 7,000 HP
Seals			
Labyrinth	•	•	•
Carbon ring		•	
Oil-lubricated		•	
Dynamic dry-gas		•	
Capacity control			
Variable inlet guide vanes (IGVs)	Expander only	•	Expander only
Applicable standards	Atlas Copco Gas and Process Standard; API 617, Customer specification	Atlas Copco Gas and Process Standard; API 617, Customer specification	Atlas Copco Gas and Process Standard
Axial thrust compensation	Bidirectional thrust bearings with Automatic Thrust Equalization (ATE) and monitoring system.	Bidirectional thrust bearings or thrust collars on pinions; bidirectional thrust bearings on gear shaft.	Bidirectional thrust bearings with Automatic Thrust Equalization (ATE) and monitoring system.
Oil system	Atlas Copco Gas and Process Standard; API 614, Customer specifications	Atlas Copco Gas and Process Standard; API 614, Customer specifications	Atlas Copco Gas and Process Standard
Test code	Atlas Copco Gas and Process Standard; API 617, ASME PTC-10 Type 2	Atlas Copco Gas and Process Standard; API 617, ASME PTC-10 Type 2	Atlas Copco Gas and Process Standard.

[1] Expander-Compressor available with oil bearings or active magnetic bearings
[2] Available with fluid brake for small power ranges
[3] Pre-engineered single-shaft expander-compressor for NGL recovery processes

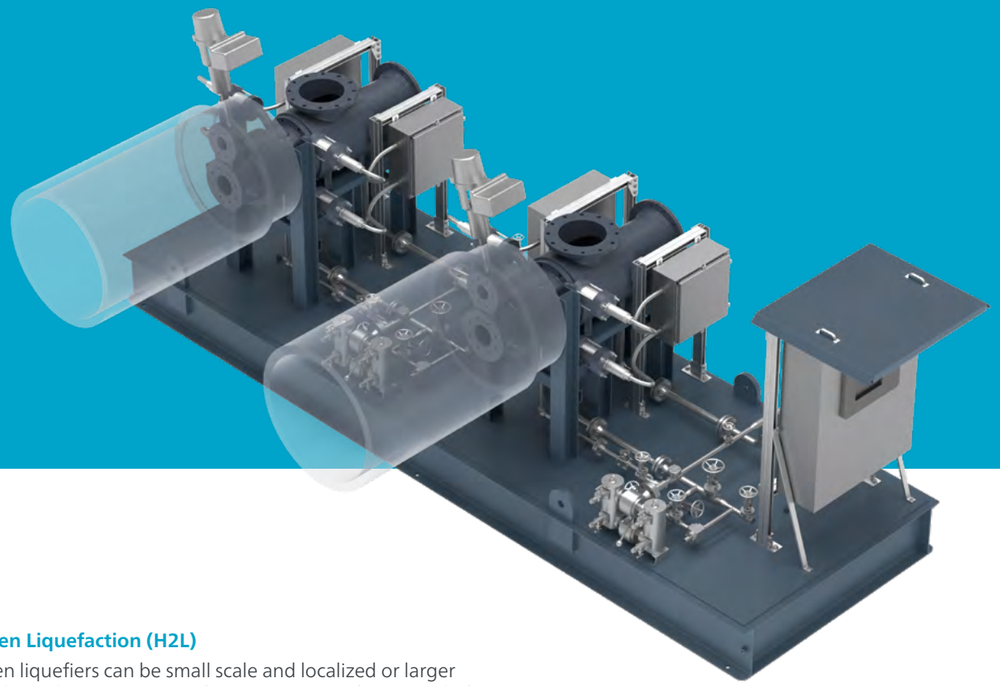
PRODUCT APPLICATION MATRIX

Market / Application	Expander-Compressor [1, 2]	Integrally-geared Expander Generator / Compander (TM) [3]	ECOTS (TM) Expander-Compressor [4]
Hydrogen			
Liquefaction	•	•	
Hydrogen purification	•	•	
BOG / reliquefaction	•	•	
LNG			
FPSO / FLNG	•	•	
LNG reliquefaction	•	•	
LNG liquefaction	•		
LNG peak shaving	•	•	
Gas processing			
Pipeline dew point control	•		•
Cryogenic NGL recovery	•	•	•
Ethane recovery	•		•
Gas preconditioning	•		•
Refineries			
LPG production	•	•	
Aromatics	•	•	
Olefins	•	•	
Gas to Liquid (GTL)	•	•	
Chemicals/Petrochemicals			
Hydrogen purification / recovery	•		
Ethylene and propylene	•		
Propane/Butane dehydrogenation	•	•	
Phenol	•	•	
Olefins	•		
Purified Terephthalic Acid (PTA)	•		
Nitric acid		•	
Ammonia	•	•	
Air Separation	•	•	•
Renewables and Low-Carbon Energy			
Pipeline (pressure letdown)	•	•	
Geothermal (conventional ORC or sCO_2)		•	
Waste heat to power (conventional ORC or sCO_2)		•	
Energy storage (CAES, LAES)		•	
Carbon Capture			
Low Temperature Carbon Capture	•	•	

[1] Expander-Compressor available with oil bearings or active magnetic bearings
[2] Available with fluid brake for small power ranges
[3] Combination of expander and compressor stages on one gearbox
[4] Pre-engineered single-shaft expander-compressor for NGL recovery processes

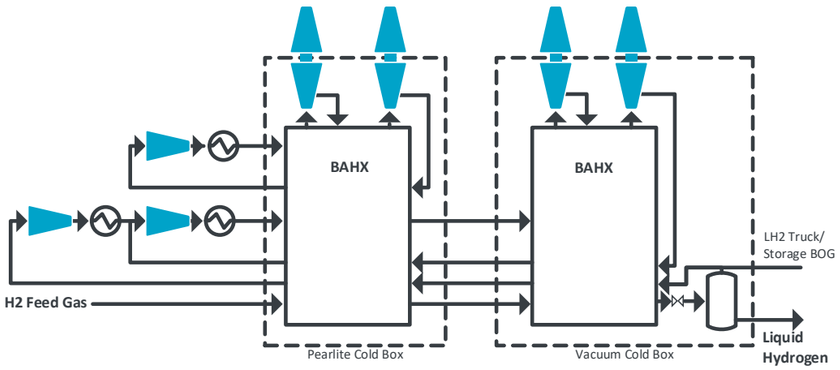
EFFICIENT REFRIGERATION FOR HYDROGEN, AIR, HYDROCARBONS, AND PETROCHEMICALS

An overview of some of the most common applications



Hydrogen Liquefaction (H2L)

Hydrogen liquefiers can be small scale and localized or larger scale with productions ranging from 10-500 TPD (tons per day). Refrigeration for all liquefiers is provided by turboexpanders, which expand high-pressure hydrogen (or other refrigerant mixtures) in a near-isentropic process.

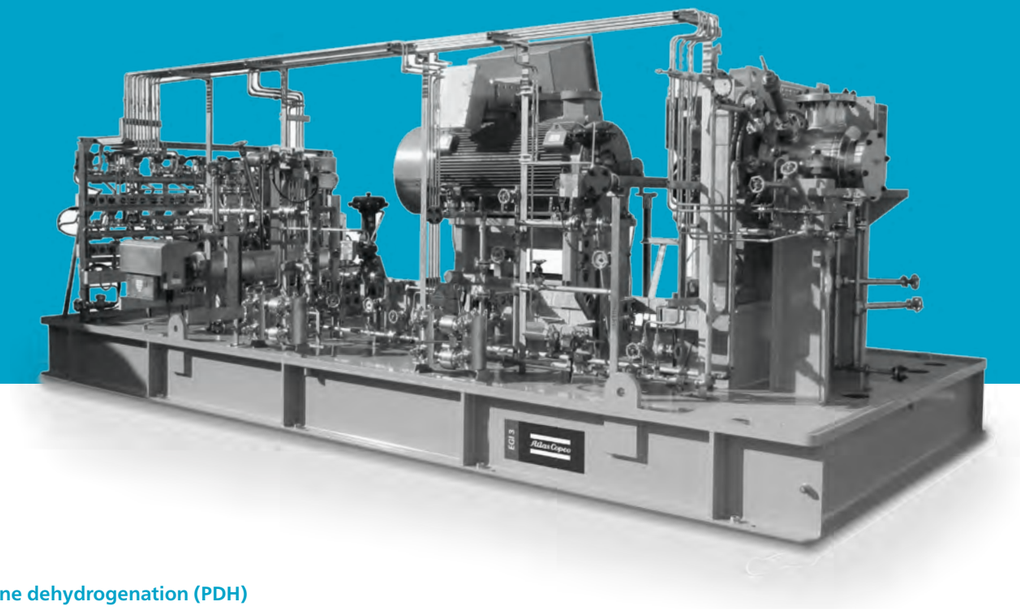


Plant capacity:
10 to 500 TPD

Operating temperature:
-253°C / -423°F

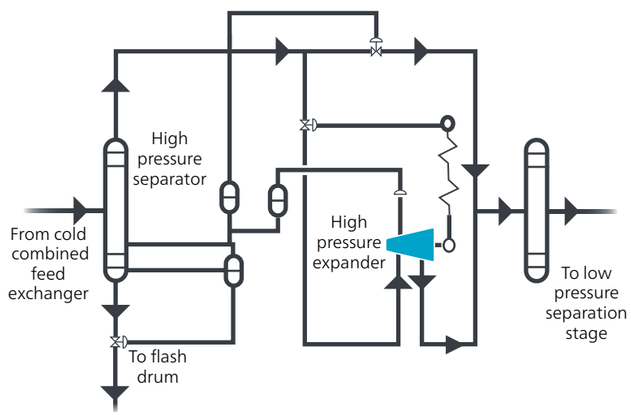
No. of stages:
up to 4 on a single gearbox

Vacuum insulated expander housing for direct integration with the coldbox



Propane dehydrogenation (PDH)

Turboexpanders provide an efficient means to deliver the cryogenic temperatures necessary for converting propane into propylene and hydrogen. It is one way to produce propylene which doesn't require a steam cracker or fluid catalytic cracking unit, and gives an independence from oil-derived ethylene.



Inlet pressure (typical values):
13 bar(a) / 189 psia

Outlet pressure:
8 bar(a) / 116 psia

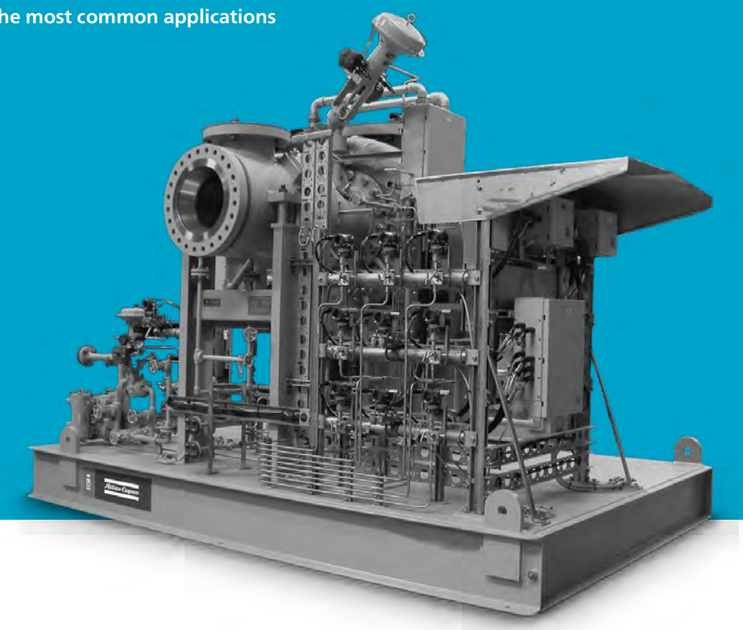
Inlet temperature:
-99 °C / -146 °F

Flow:
200 000 Nm^3/h / 120,000 SCFM

Power:
up to 1.3 MW / 1,800 HP

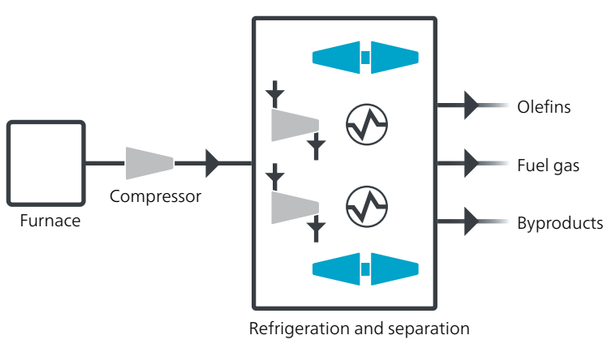
EFFICIENT REFRIGERATION FOR HYDROGEN, AIR, HYDROCARBONS, AND PETROCHEMICALS

An overview of some of the most common applications



Ethylene production

Tuboexpanders produce cryogenic temperatures in ethylene plants, to facilitate high levels of ethylene recovery from refinery gas. Turboexpanders handle condensing streams and provide a high expansion ratio in a single stage. Multiple stages of expansion are not uncommon in this high enthalpy process.

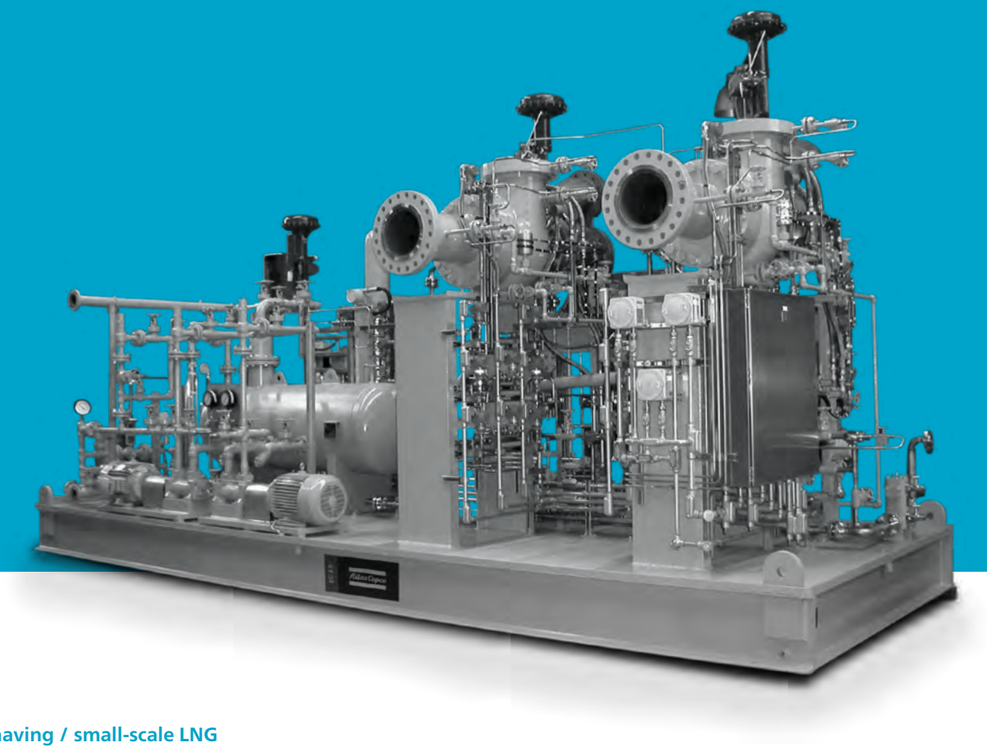


Inlet pressure (typical values):
30 bar(a) / 435 psia

Outlet pressure:
6 bar(a) / 90 psia

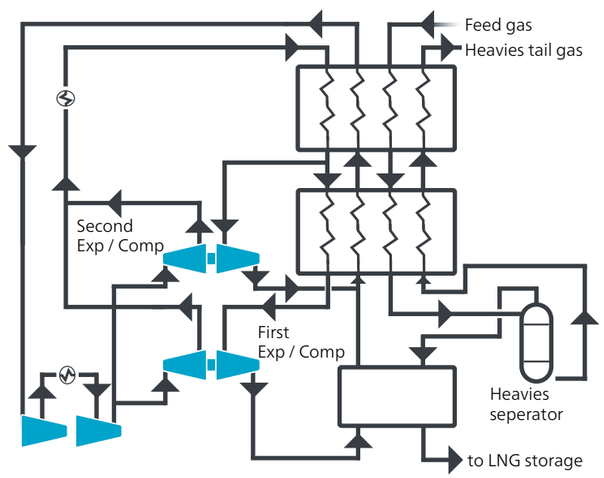
Inlet temperature:
-100 °C / -150 °F

Outlet temperature:
-160 °C / -260 °F



LNG peak shaving / small-scale LNG

Used since the mid-1970s at LNG peak shaving facilities, the reverse-Brayton cycle – with methane, nitrogen or a combination of the two – is now adding increased flexibility for small-scale LNG production. The cycle is also employed on LNG transport vessels and FLNG installations for BOG reliquefaction.



Inlet pressure (typical values):
48 bar(a) / 700 psia

Outlet pressure:
3 bar(a) / 44 psia

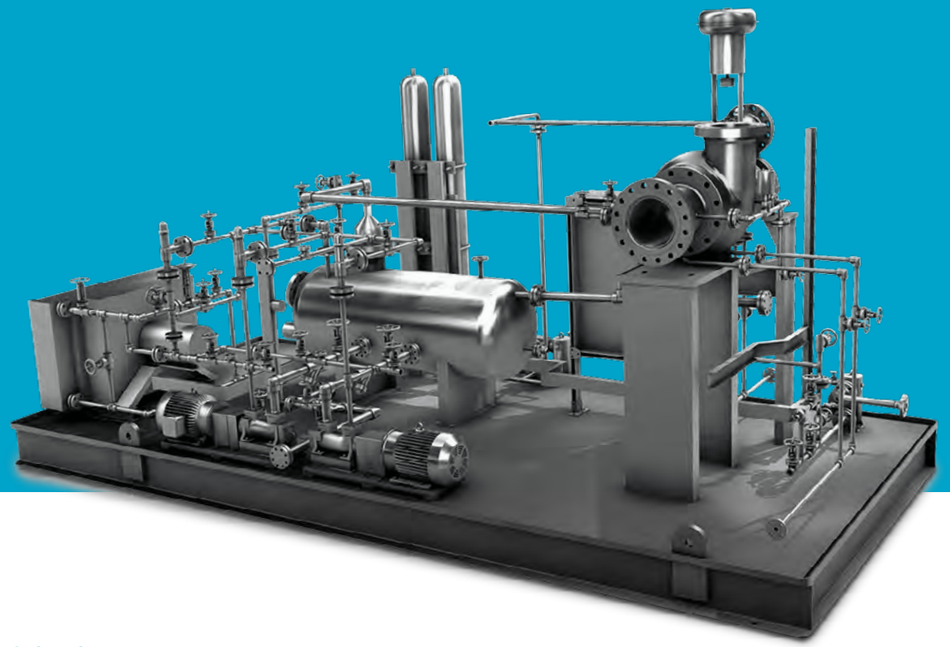
Inlet temperature:
-23 °C / -10 °F

Outlet temperature:
-109 °C / -164 °F

Flow:
50,000 kg / hr / 110,000 lb / hr

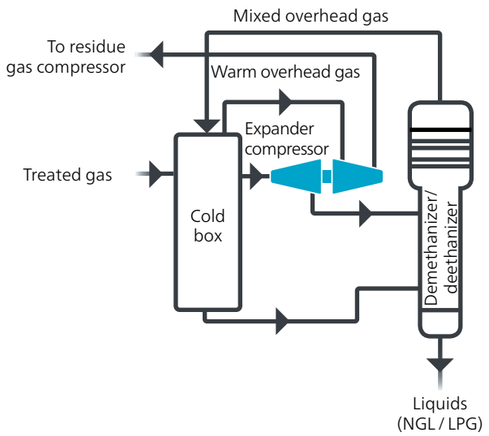
EFFICIENT REFRIGERATION FOR HYDROGEN, AIR, HYDROCARBONS, AND PETROCHEMICALS

An overview of some of the most common applications



Natural Gas Liquids (NGL) recovery

An expander compressor in a processing plant implements a hermetically sealed design for zero emissions and elimination of vented seal gases. Plants can operate in either full ethane recovery or rejection mode giving added flexibility for current market conditions.

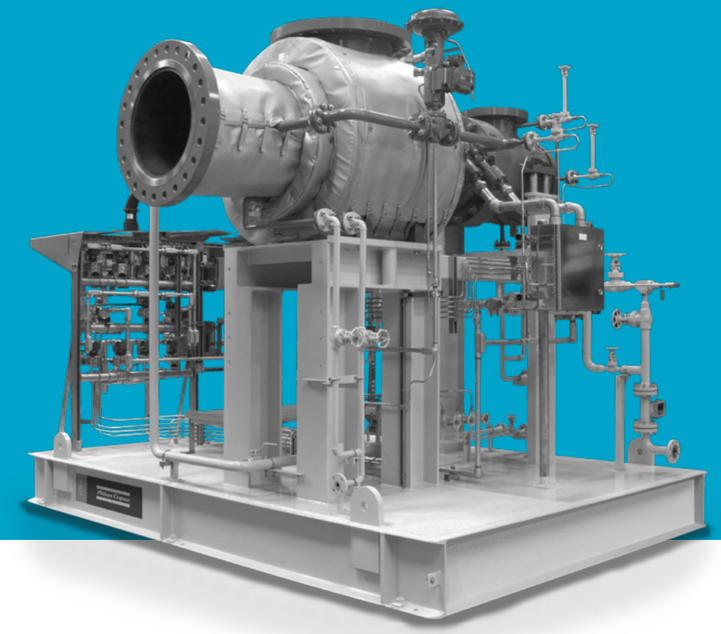


Inlet pressure (typical values):
up to 125 bar(a) / 1,800 psia

Outlet temperature:
down to -165 °C / -265 °F

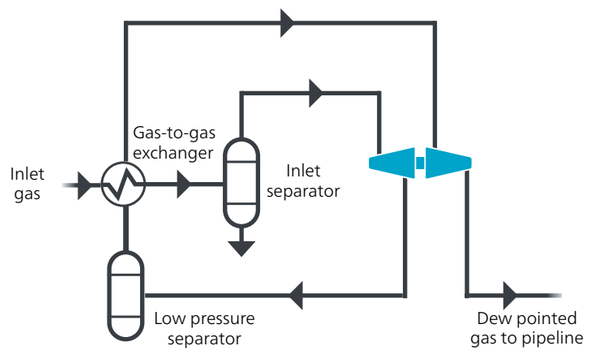
Shaft power:
up to 18,000 kW / 24,000 HP

Single train capacity:
up to 27 million Nm^3/day
up to 1,000 MMSCFD



Pipeline dew point control

Hydrocarbon dew point control is achieved by cooling gas through expansion and separating the water content. The process is not only the simplest for gas treatment, it is one of the least expensive. As an added benefit, it enables expansion power to be recovered as compression.



Inlet pressure (typical values):
100 bar(a) / 1,450 psia

Inlet temperature:
-12 °C / 10 °F

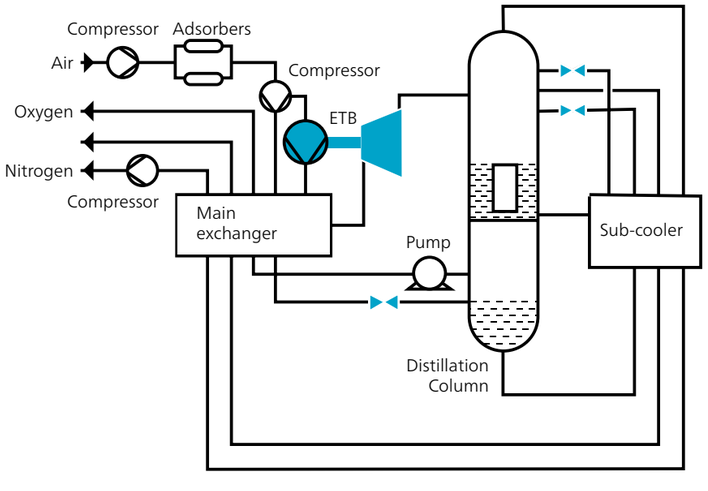
Outlet pressure:
48 bar(a) / 700 psia

Outlet temperature:
-40 °C / -40 °F

INDUSTRIAL GASES

The Expansion-Turbine-Booster (ETB), is the heart of the Air Separation Unit: it is used as a refrigeration source to achieve the required low distillation temperatures for the separation of atmospheric air into its primary components. High-pressure gases are expanded through the turboexpander and the produced work drives the booster compressor for improved efficiency.

Air Separation



Inlet pressure:
up to 64 bar(a)

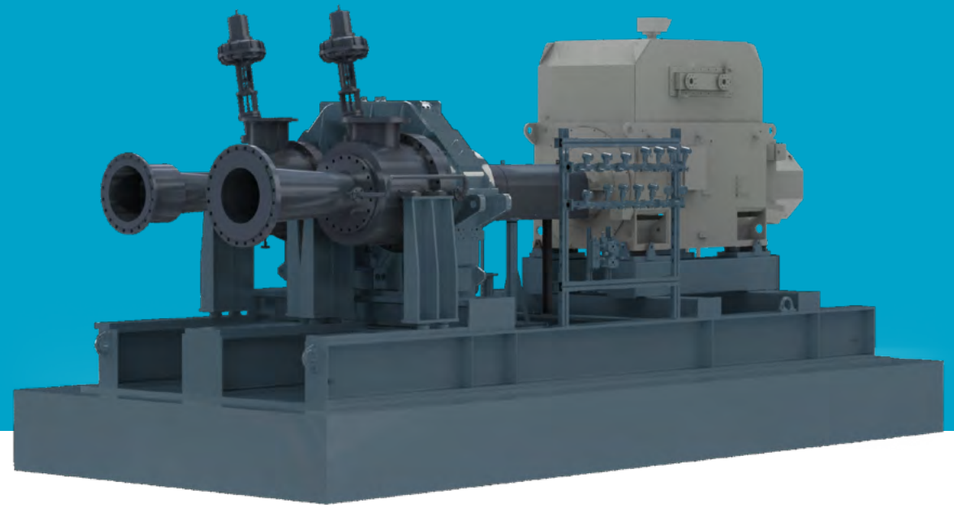
Outlet temperature:
down to -190 °C

Expansion ratio (typical values):
12 to 14

Actual inlet flow:
100 m^3/h - 3,500 m^3/h

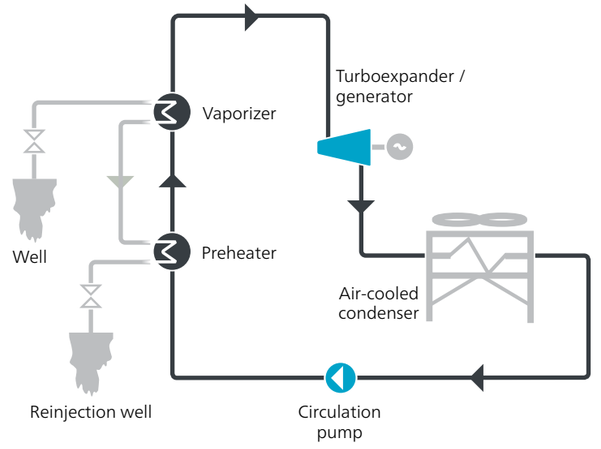
ENERGY RECOVERY TURNS PRESSURE OR HEAT INTO VALUABLE POWER

An overview of some of the most common applications



Geothermal power

The temperatures in geothermal reservoirs are turned into sustainable electricity by employing the Organic Rankine Cycle with a turboexpander generator running at the heart of the process. Our turboexpanders can generate up to 50 MW gross per power train.



Inlet pressure:
up to 200 bar(a) / 2,900 psia

Heat source temperature:
up to 220 °C / 450 °F

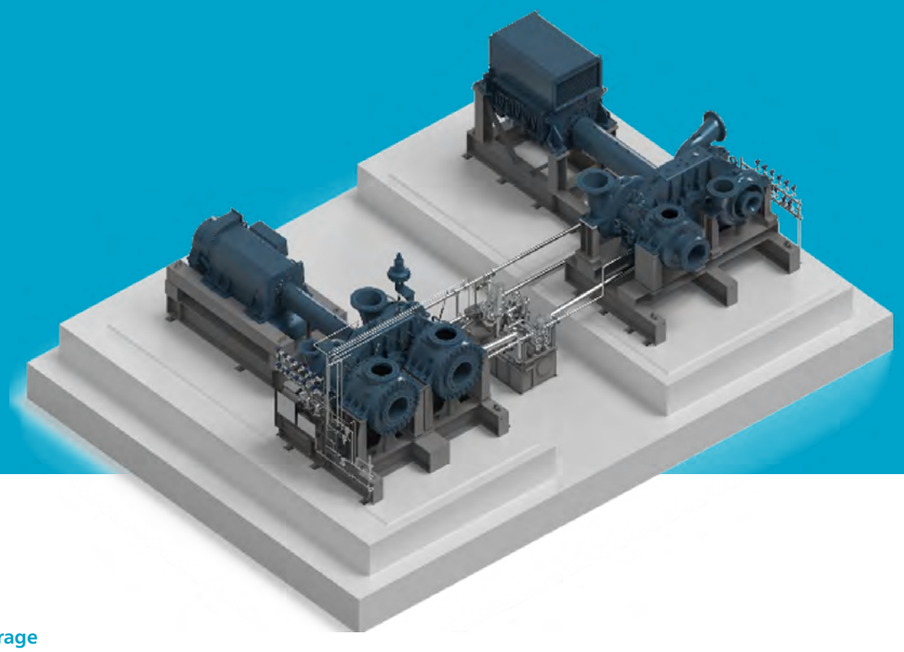
Enthalpy:
500 – 1,000 kJ/kg (215 – 430 Btu/lb)

Max gross power:
50 MW per train / 67,000 HP per train

Inlet guide vane flow range:
40 – 150%

ENERGY RECOVERY TURNS PRESSURE OR HEAT INTO VALUABLE POWER

An overview of some of the most common applications

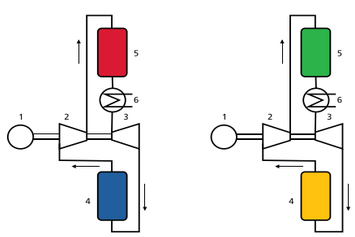


Energy Storage

Turboexpanders are key components in a variety of energy storage processes. Excess energy is stored in the form of heat (or cold) and / or pressure and discharged across the expander when needed. The variable inlet guide vanes enable optimized long duration discharge, even as the storage pressure drops. Our expanders have greater than 25 year design life, far outperforming a typical chemical battery lifespan.

1. Motor
2. Compressor
3. Turbine
4. Cold storage tank
5. Hot storage tank
6. Cooler

550˚C	600˚C
330˚C	385˚C
80˚C	75˚C
-40˚C	-30˚C



Charge

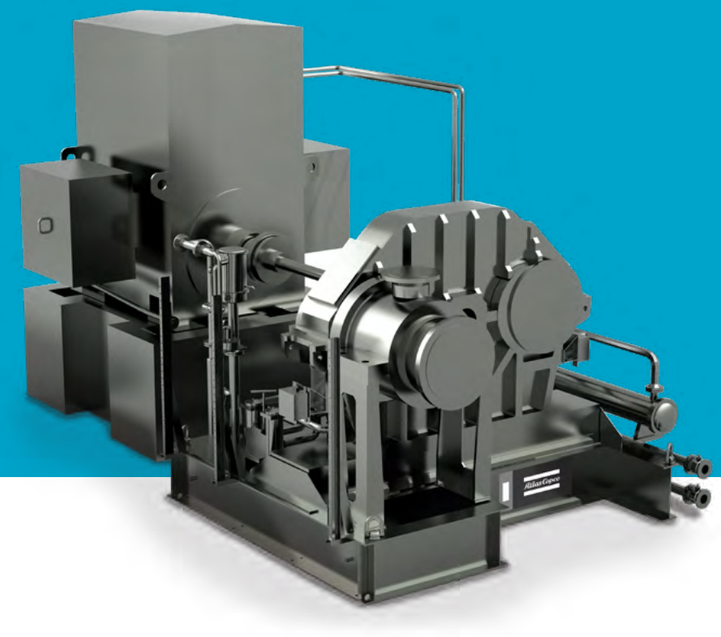
Discharge

Inlet pressure:
up to 200 bar (a)

Inlet temperature ©:
-253 to +510 °C

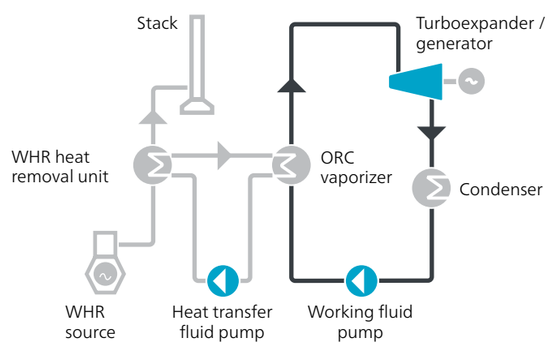
Number of stages:
up to 6

Power:
up to 30 MW



Waste heat to power

Turboexpanders transform excess heat created from industrial processes into valuable electric energy for sale to the grid or use in a plant. Waste heat power generation using an ORC system is an excellent investment at industrial sites with a capacity factor of about 60%. It has little or no impact on main industrial processes. The expander will be custom-designed to optimize power generation for any number of working fluids including sCO_2, hydrocarbons, and traditional refrigerants.



Inlet pressure:
up to 200 bar(a) / 2,900 psia

Heat source temperature:
up to 650 °C / 1,200 °F

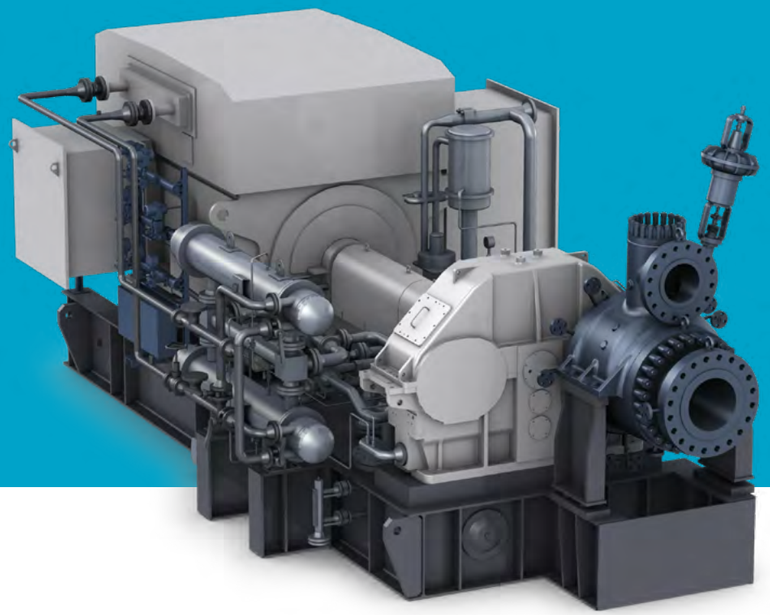
Enthalpy:
300 – 700 kJ/kg (130 – 300 Btu/lb)

Max gross power:
40 MW per train / 53,600 HP per train

Inlet guide vane flow range:
40 – 150%

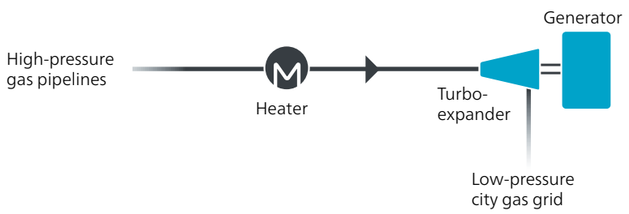
ENERGY RECOVERY TURNS PRESSURE OR HEAT INTO VALUABLE POWER

An overview of some of the most common applications



Pressure letdown

Turboexpanders replace pressure letdown valves at natural gas pressure reduction stations. They generate sustainable electricity from a pressure drop already necessary for gas distribution to end-users. The result is an extra revenue stream to power plants, gas processing plants, and gas grid operators.

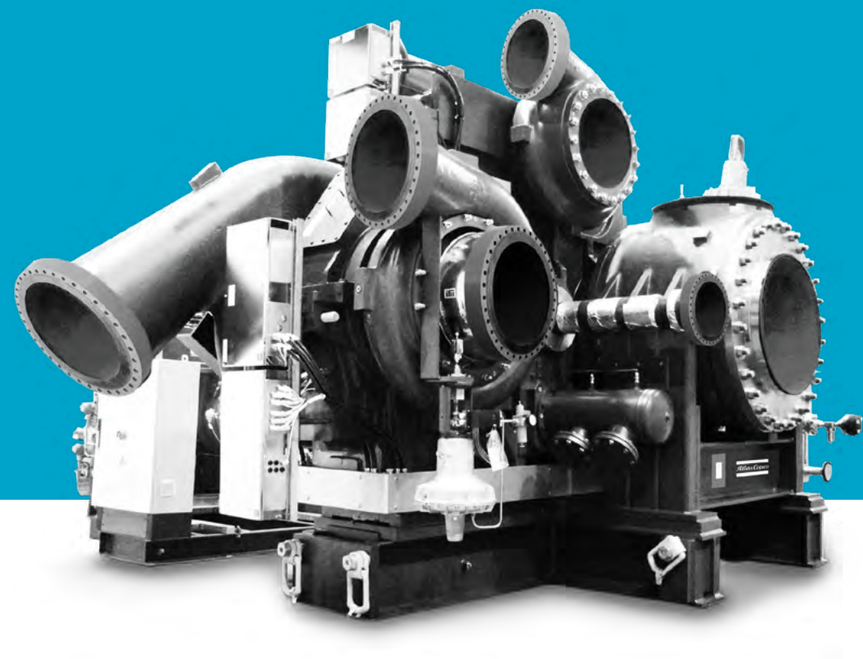


Inlet pressure:
up to 200 bar(a) / 2,900 psia

Inlet temperature:
up to 510 °C / 950 °F

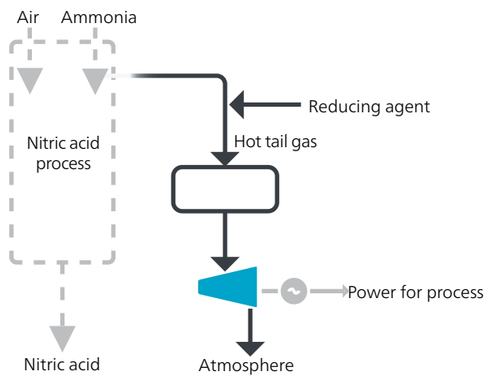
Typical flow levels:
up to 500,000 Nm³/h
up to 294,288 SCFM

Power:
up to 50 MW / 67,000 HP



Process tail gas (nitric acid, caprolactam)

Turboexpanders are employed at the end of the nitric acid production process in order to recover the high temperatures from the catalytic reactor's hot tail gases. They allow this energy to be reused, most commonly as power for air compression at the beginning of the process.



Inlet pressure:
up to 50 bar(a) / 725 psia

Outlet pressure:
atmospheric

Inlet temperature:
up to 510 °C / 950 °F

Flow:
50 000 – 1 million Nm³/h
29,000 – 600,000 SCFM

Power:
up to 50 MW / 67,000 kW

Notes

Notes

Atlas Copco Gas and Process

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