

# TURBOEXPANDERS

Highly efficient and reliable turboexpanders  
for industrial scale air separation units



# Air Liquide Group

## A world leader in gases, technologies and services for Industry and Health

Air Liquide is present in 73 countries with approximately 67,100 employees and serves more than 3.9 million customers and patients. Oxygen, nitrogen and hydrogen are essential small molecules for life, matter and energy.

They embody Air Liquide's scientific territory and have been at the core of the company's activities since its creation in 1902. Air Liquide's ambition is to be a leader in its industry, deliver long term performance and contribute to sustainability – with a strong commitment to climate change and energy transition at the heart of its strategy.





# Air Liquide Engineering & Construction

## A technology partner of choice

Air Liquide Engineering & Construction builds the Group's production units (mainly air gas separation and renewable and low-carbon hydrogen production units) and provides external customers with efficient, sustainable, customized technology and process solutions.

Our core expertise in industrial gas, energy conversion and gas purification, enables customers to optimize the use of natural resources. We cover the entire project life cycle: license engineering services and proprietary equipment, high-end engineering and design capabilities, project management and execution services. In addition, our worldwide capability enables us to offer efficient customer services internationally.

As a technology partner, customers benefit from our research and development activities to achieve energy transition goals.

## Powered by our suite of Technologies

With extensive experience, the core technology of Air Liquide Engineering & Construction Turbo has been well proven for over 50 years.

During that time, with an installed base of well over a thousand turboexpanders, our technology has steadily grown and improved to become the leading technology in terms of both overall efficiency and reliability.

Our turboexpander range:

- Compressor TC Series:  
TC2000, TC3000, TC4000, TC6000, TC9000, TC12000
- Hydrobrake Cryogenic Compressor (THC) Series:  
THC-3000, THC-4000, THC-6000
- Turboexpander - Hydrobrake (TH) Series:  
TH-3000, TH-4000, TH-6000



3

Manufacturing centers

15

Engineering centers and front end offices

354

New patent applications filed in 2021



## It is time to **ACT** for a sustainable future

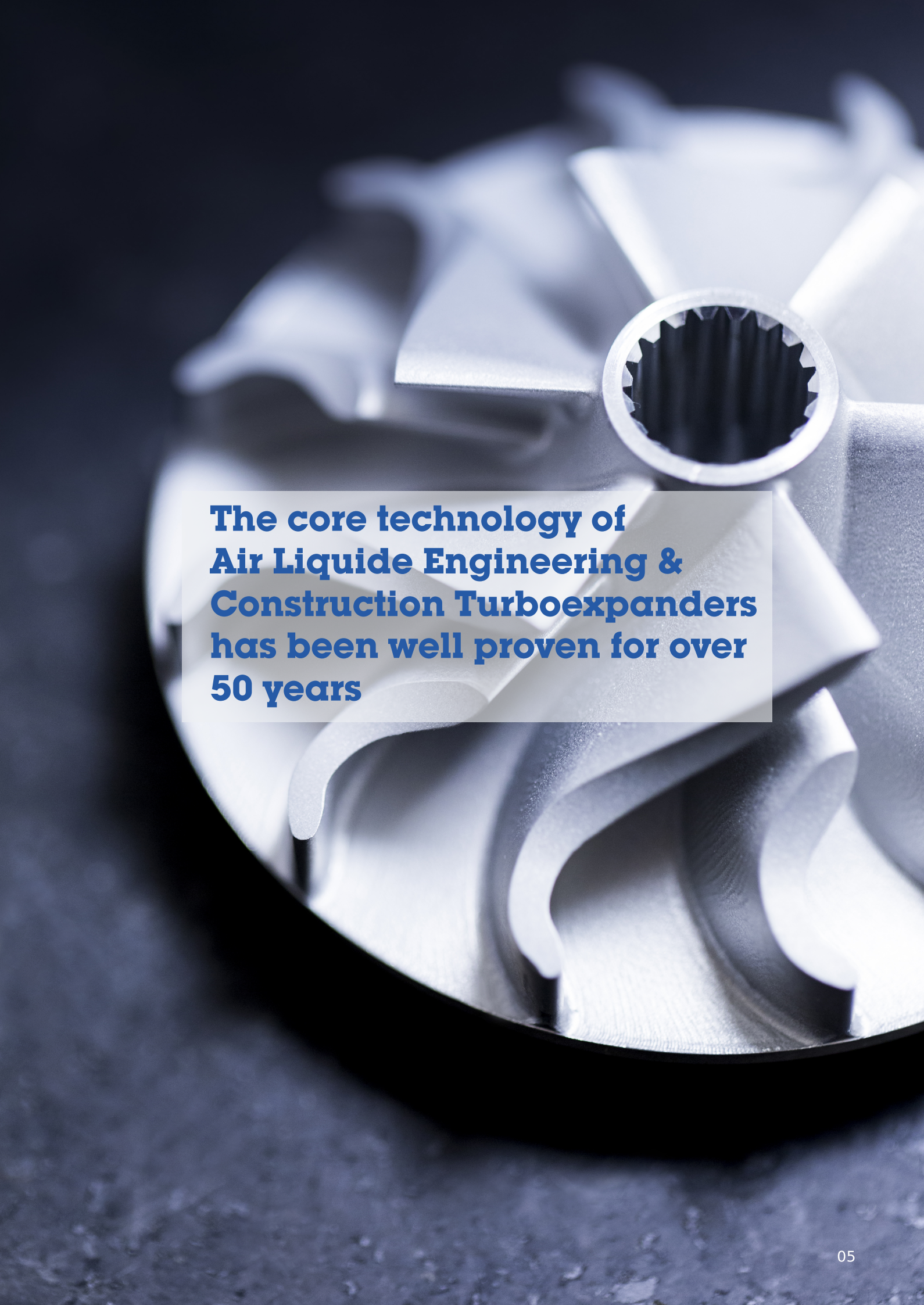
ADVANCE, Air Liquide's strategic plan for 2025, is a milestone in the company's history. It places sustainable development at the heart of the Group's strategy, firmly setting Air Liquide on a clear course to deliver targeted global performance, combining financial and extra-financial dimensions.

The Group develops solutions contributing to climate and the energy transition—particularly with hydrogen—and takes action to progress in areas of healthcare, digital and high technologies. Air Liquide also helps its industrial customers to reduce their carbon emissions, developing new technologies and skills to support their low-carbon transition.

In full support of the 2015 Paris agreement, Air Liquide commitments for sustainability address the urgency of climate change and energy transition, targeting carbon neutrality by 2050 with key intermediary milestones in 2025 and 2035:

- to start reducing its absolute CO<sub>2</sub> emissions by around 2025
- to achieve a 33% reduction in Scope 1 & 2 CO<sub>2</sub> emissions by 2035.





**The core technology of  
Air Liquide Engineering &  
Construction Turboexpanders  
has been well proven for over  
50 years**



## A value proposition for our customers

The breadth of our portfolio and experience enables us to provide the most innovative turboexpander solutions, focused only on what best meets the needs of each customer. We have extensive skills and experience in guiding customers through decision making processes.

- Air Liquide Engineering & Construction Turbo's license to operate relies on continuously achieving high levels of **safety, reliability and environmental** performance, and security. It is also a prerequisite for our success and that of our customers.
- The range of turboexpanders we offer enables us to address diverse needs across mainly industrial gas and LNG sectors, providing variations in scale, operating modes and process permutations. We can offer **flexible and simple integration into ASU cold box and customer utilities**.
- As we own and operate our own assets, we receive constant operating feedback and understand from hands-on experience the challenges related to process safety, reliability, and maintenance. We use this insight to design and build plants and equipment with an **operating mindset** and have a solid understanding of the challenges of on-site installation and complex projects
- We guarantee **quality, reliability, and efficiency** as standard. We can do this because our operational experience means we understand what our customers need and how to achieve it.



# Global Service Network of trained technicians for commissioning and service support

Our Aftermarket Services are more than just spare parts. Our factory-trained technicians are supported by the engineers and technicians that designed, built, and tested the equipment in the first place. Aftermarket Services manages upgrades, retrofits, repairs, training, field services, warranty, and commissioning.

**Turbo expander repair:** at our Santa Ana, California factory, our engineers and technicians evaluate each unit, ensuring that it is brought back to factory spec to ensure the lowest possible TCO cost. We use the same evaluation criteria, equipment, processes, technicians, and suppliers as new factory builds to ensure that a repair turbo meets the same expectation that it did when it was new. We utilize all the lessons learned from decades of experience to ensure that each day of operation is as reliable as the next.

**Field Services and Commissioning** is ensuring that your equipment is installed and operating smoothly. When commissioning a new plant, our technicians provide remote support and pre-commissioning checklists to minimize issues during the start-up and on-site support and training for the commissioning activities.

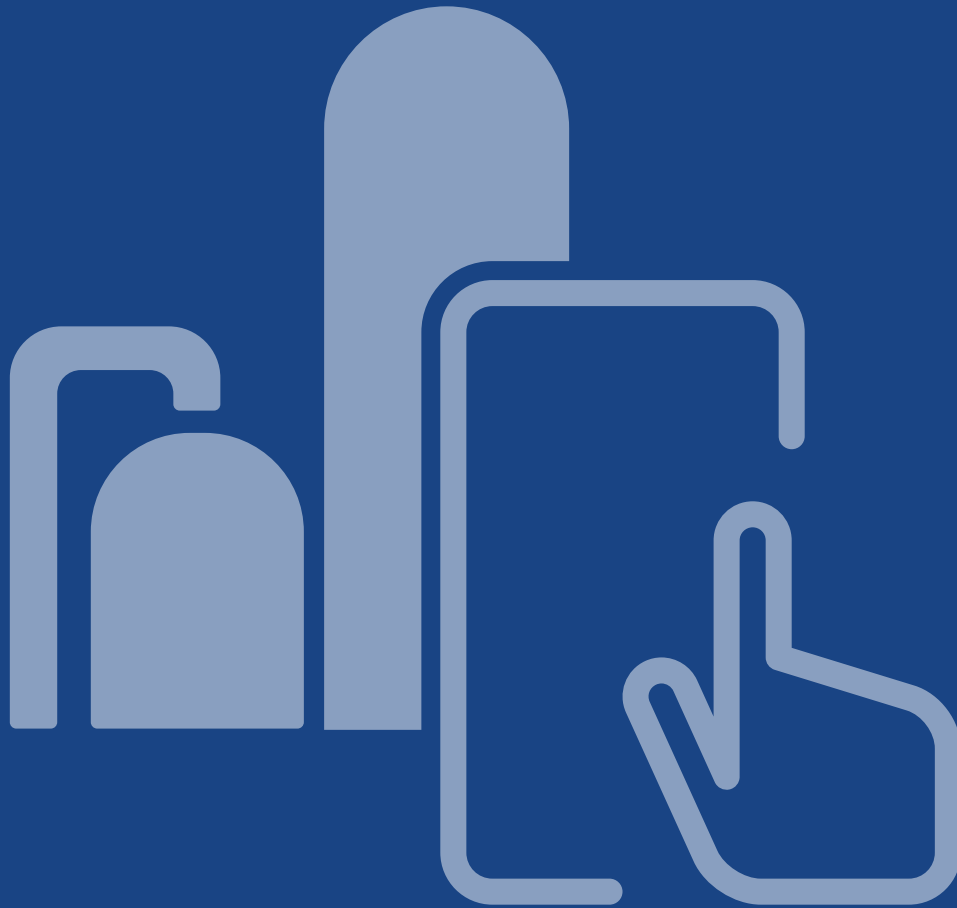
**Upgrades and Retrofits** are an integral part of our service offerings. We utilize our engineering resources to determine aero, process flows, and hardware adjustments needed when moving a plant or changing its operational characteristics.



- Headquarters
- Authorized service centers

# Our Turboexpanders

A range of innovative turboexpanders that address the different needs and individual requirements of our customers.







# Compressor TC Series: TC2000, TC3000, TC4000, TC6000, TC9000, TC12000

## Description:

### “Zero Leakage” Inlet Guide Vanes

- Adjustable inlet guide vanes provide optimum flow patterns as well as precise and continuous control across the machine’s full operational spectrum
- Self-energizing back plate maintains zero sidewall clearance for maximum expander efficiency
- Zero backlash variable guide vane configuration provides smooth turn-up capability to 125% of design flow

### Rugged Rotor Design

- Stiff rotor shaft and high capacity tilt pad bearings assure maximum stability at all operating loads and speeds
- High capacity tilt pad thrust bearings provide the extra margin necessary to handle transients
- Numerous bearing designs available to accommodate specific process applications, including hydrodynamic (journal and tilt pad) bearings, ball bearings, ceramic bearings, and air/foil bearings
- Sealing design offers robust construction and reliable performance

### Dual Independent Labyrinth Shaft Seal

- Reliable teeth-on-shaft design is precision machined to ultra close clearances, minimizing seal gas consumption
- Dual port, atmospheric center vent prevents process stream contamination

### Self-Aligning Wheel Attachment

- Tapered bore and stretch rod design automatically compensates for thermal and mechanical changes to maintain alignment under all operating conditions
- Precision machined tapered bore/shaft attachment allows independent balancing of turbine wheel and shaft to facilitate

### Main features:

- Common lube oil system and controls support two expanders/compressors
- “Zero leakage” inlet guide vanes
- Components individually balanced for ease of field replacement
- Tapered shaft wheel attachment for field interchangeability
- Labyrinth shaft seal design minimizes seal gas consumption and prevents process stream contamination
- Shaft-driven boost compressor reduces power consumption, increasing plant efficiency
- Easily upgraded for future plant changes e.g. improved aero for higher efficiency/capacity

## Application

Industrial Gas Production -  
Air Separation & Liquefaction

## Feedstock - Fluids Handled

Air, Nitrogen, Waste Gas (high oxygen content),  
Carbon dioxide and carbon monoxide



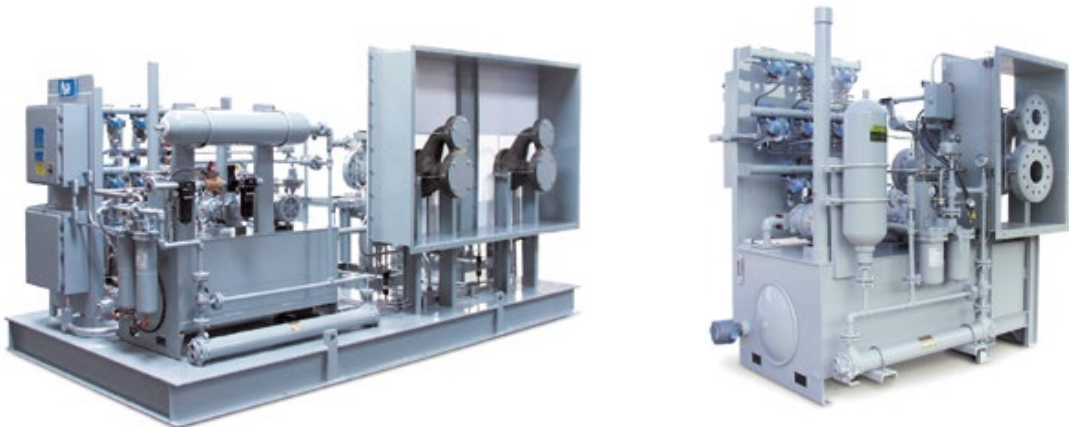
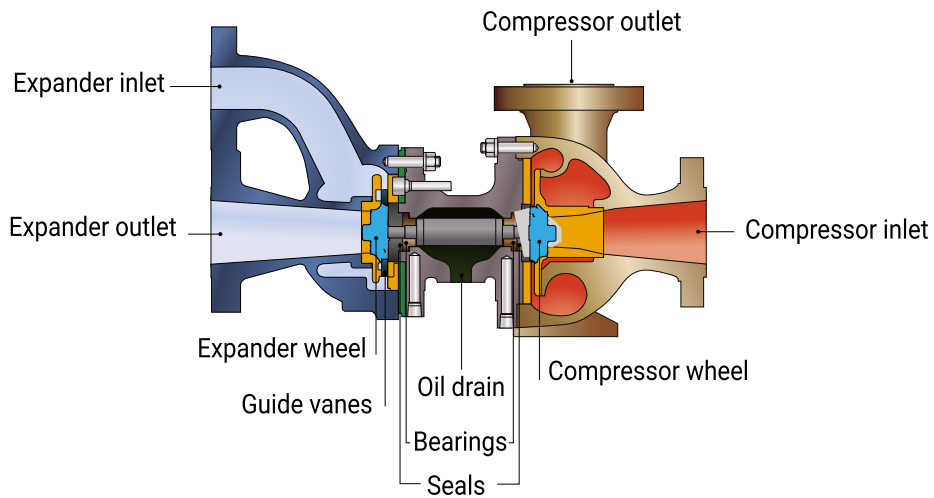
# Available options

- Inlet screens
- Inlet trip valves
- Surge control system
- Low hysteresis high cycle inlet guide vanes
- Cable trays or conduit
- Safe area or hazardous area location
- International code compliance (HPGSL, PED, GOST, etc.)
- Cryogenic performance testing
- Spare cartridge with nozzle assembly

# Performance

- Expander Ns Range: 40 – 140
- Expander Efficiency: up to the low 90%<sup>s</sup>
- Expander Pressure Ratio: up to 24:1
- Tip Speed: up to 1,500 ft/sec (457 m/s)
- Rotor Speed: up to 115,000 RPM
- Refrigeration Production: up to 10,000 HP (7,457 kW)

Cross Section: Tc-4000



Compressor Loaded Expanders – Dual Machines



Rugged Rotor Design



Self-Aligning Wheel Attachment

# Hydrobrake Cryogenic Compressor (THC) Series: THC-3000, THC-4000, THC-6000

## Description:

### "Zero Leakage" Inlet Guide Vanes

- Adjustable inlet guide vanes provide optimum flow patterns as well as precise and continuous control across the machine's full operational spectrum
- Self-energizing back plate maintains zero sidewall clearance for maximum expander efficiency
- Zero backlash variable guide vane configuration provides smooth turn-up capability to 125% of design flow

### Rugged Rotor Design

- Stiff rotor shaft and high capacity tilt pad bearings assure maximum stability at all operating loads and speeds
- High capacity tilt pad thrust bearings provide the extra margin necessary to handle transients
- Numerous bearing designs available to accommodate specific process applications, including hydrodynamic (journal and tilt pad) bearings, ball bearings, ceramic bearings, and air/foil bearings
- Sealing design offers robust construction and reliable performance

### Dual Independent Labyrinth Shaft Seal

- Reliable teeth-on-shaft design is precision machined to ultra close clearances, minimizing seal gas consumption
- Dual port, atmospheric center vent prevents process stream contamination
- Self-Aligning Wheel Attachment
- Tapered bore and stretch rod design automatically compensates for thermal and mechanical changes to maintain alignment under all operating conditions
- Precision machined tapered bore/shaft attachment allows independent balancing of turbine wheel and shaft to facilitate field repair

### Main features:

- Compact footprint
- "Zero leakage" inlet guide vanes
- Rugged rotor design
- Components individually balanced for ease of field replacement
- Tapered shaft wheel attachment for field interchangeability
- Dual vibration probes
- Coalescing mist eliminator
- Labyrinth shaft seal design minimizes seal gas consumption and prevents process stream contamination
- Easily upgraded for future plant changes e.g. improved aero for higher efficiency/capacity

## Application

Industrial Gas Production -  
Air Separation & Liquefaction

## Feedstock - Fluids Handled

Air, Nitrogen, Waste Gas (high oxygen content),  
Carbon dioxide and carbon monoxide



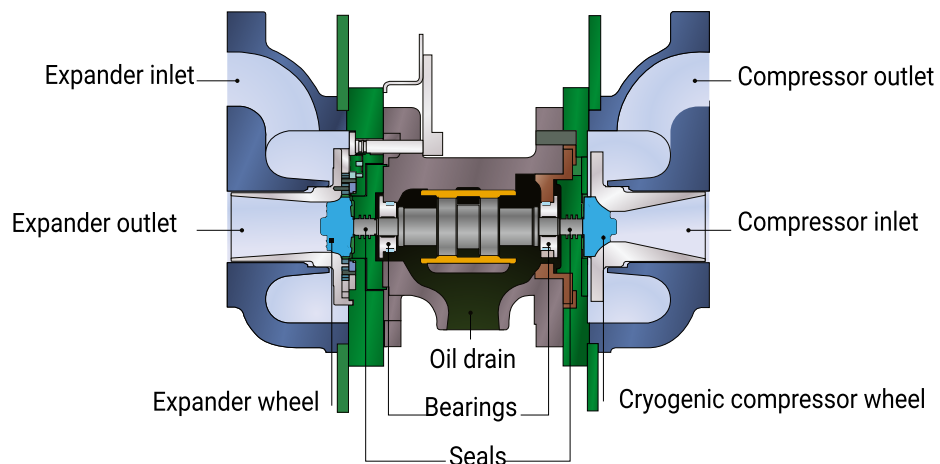
## Available options

- Inlet screens
- Inlet trip valves
- Surge control system
- Low hysteresis high cycle inlet guide vanes
- Cable trays or conduit
- Safe area or hazardous area location
- International code compliance (HPGSL, PED, GOST, etc.)
- Cryogenic performance testing
- Spare cartridge with nozzle assembly

## Performance

- Expander Ns Range: 40 – 140
- Expander Efficiency: up to 88%
- Expander Pressure Ratio: up to 24:1
- Tip Speed: up to 1,200 ft/sec (366 m/s)
- Rotor Speed: up to 55,000 RPM
- Refrigeration Production: up to 200 HP (150 kW)

Cross Section: Thc-3000



Hydrobrake Cryogenic  
Compressor  
Loaded Expanders



Self Aligning Wheel Attachment



# Turboexpander - Hydrobrake (TH) Series: TH-3000, TH-4000, TH-6000

## Description:

### "Zero Leakage" Inlet Guide Vanes

- Adjustable inlet guide vanes provide optimum flow patterns as well as precise and continuous control across the machine's full operational spectrum
- Self-energizing back plate maintains zero sidewall clearance for maximum expander efficiency
- Zero backlash variable guide vane configuration provides smooth turn-up capability to 125% of design flow

### Rugged Rotor Design

- Stiff rotor shaft and high capacity tilt pad bearings assure maximum stability at all operating loads and speeds
- Sealing design offers robust construction and reliable performance
- Uniformly loaded drive tangs provide the high torque capacity necessary to handle upset conditions

### Self-Aligning Wheel Attachment

- Tapered bore and stretch rod design automatically compensates for thermal and mechanical changes to maintain alignment under all operating conditions
- Precision machined tapered bore/shaft attachment allows independent balancing of turbine wheel and shaft to facilitate field repair

### Main features:

- Compact footprint
- "Zero leakage" inlet guide vanes
- Rugged rotor design
- Tapered shaft wheel attachment for field interchangeability
- Components individually balanced for ease of field replacement
- Externally adjustable power absorption control
- Labyrinth shaft seals with oil-free design
- Manual or automatic oil brake flow control valve for adjustment
- Easily upgraded for future plant changes e.g. improved aero for higher efficiency/capacity

## Application

Industrial Gas Production -  
Air Separation & Liquefaction

## Feedstock - Fluids Handled

Air, Nitrogen, Waste Gas (high oxygen content),  
Carbon dioxide and carbon monoxide

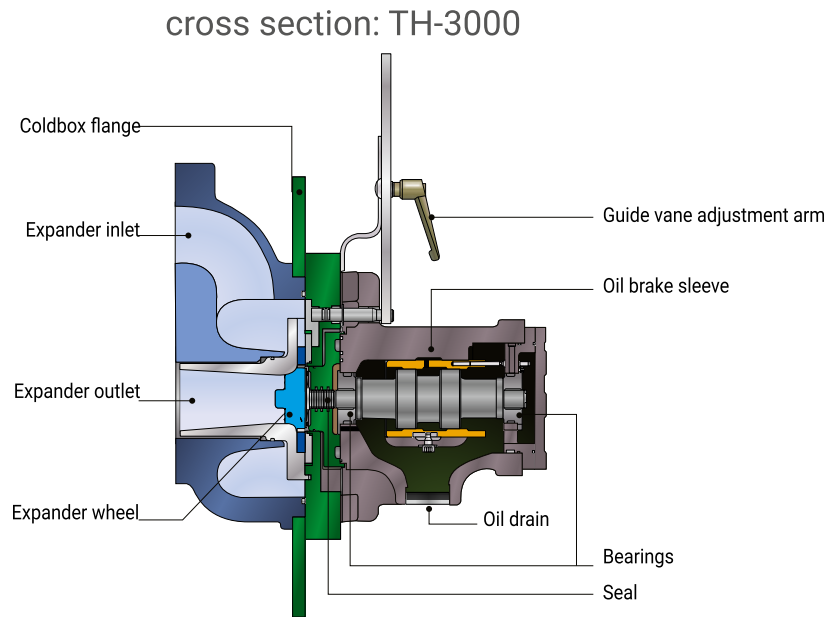


## Available options

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- Inlet trip valves
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- Low hysteresis high cycle inlet guide vanes
- Cable trays or conduit
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Oil Brake Loaded Expanders



Rugged Rotor Design



Self Aligning Wheel Attachment



## A global presence



A fundamental goal at Air Liquide Engineering & Construction is to provide our customers with competitive solutions that are safe and reliable. Our aim is to make sure that our customers can secure the best possible performance from their operations and make the most efficient use of natural resources that support the transition to a low-carbon society.



**Contact us**

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