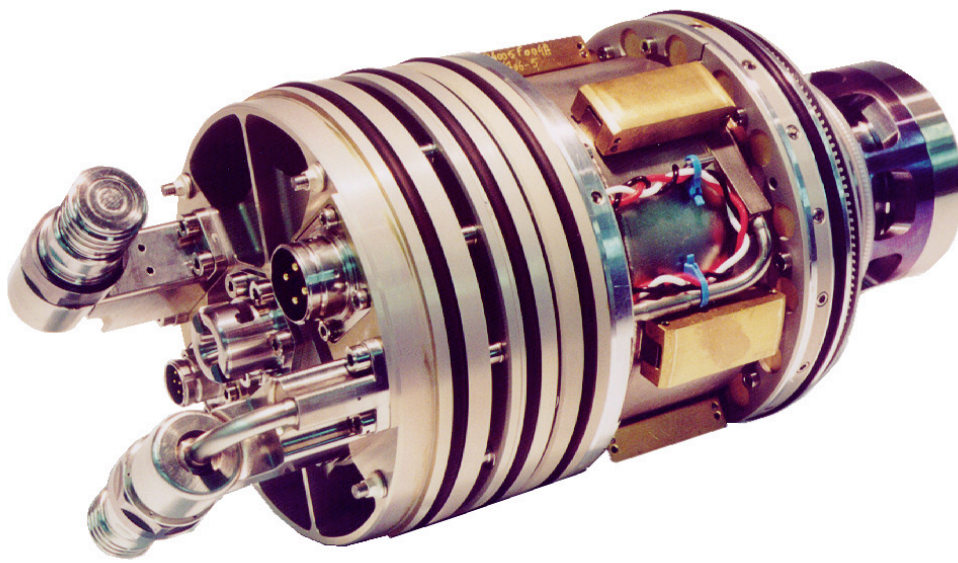


Turbo-Brayton Coolers for Space Applications



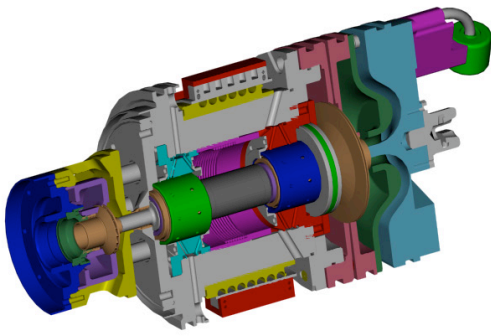
Wide
temperature
range

Low power
consumption

Low induced
vibrations

AIR LIQUIDE has developed, qualified and delivered a reversed **Turbo-Brayton Cooler** for the MELFI freezer. This payload is the first freezer delivered by the European Space Agency to NASA as Laboratory Support Equipment for the International Space Station.

This technology is further developed at AIR LIQUIDE for future missions on-board scientific satellites.



Brayton Machine Architecture

MELFI : a – 80 °C freezer for the International Space Station

In the frame of the MELFI Programme, AIR LIQUIDE has developed and qualified a turbo machinery based on the reverse Brayton thermo-dynamical cycle, using a high-speed rotating shaft supported by gas bearings, and carrying the compressor and the turbine wheels.

This Brayton Machine, designed as an Orbital Replaceable Unit, offers :

- Compactness
- Contact free rotating parts
- Very low induced vibrations
- Reduced electrical power consumption
- Wide cooling power range

Some characteristics :

- Electrical power input : 840 W to produce 60 W at 178 K
 1000 W to produce 90 W at 178 K
- Mass : 8,5 kg

Turbo Brayton Cryocooler for 2-5 K Space Applications

For some future scientific satellites, detectors will require cooling power in the temperature range 2 – 5 K. For this purpose, a multi-stage Brayton cycle cooler operating at high rotation speed to minimize low frequency vibrations is presently under development at AIR LIQUIDE. The development is performed in the frame of the ESA Technological Research Programme and includes the complete system design studies and the development of the most critical technologies.

Some characteristics :

- Cold source temperature : 5 K
- Cooling power : 110 mW
- Operation frequencies : > 1000 Hz
- Cooler cycle : Brayton cycle (He) with 3 turbines
- Electrical power supply : < 200 W

Dynamic gas bearings

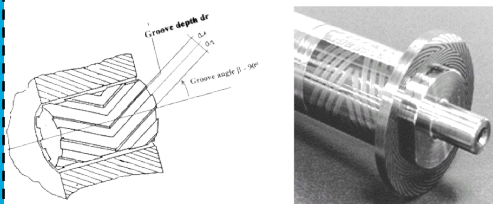
In order to run the shaft at the required speed (typically 100 krpm for the MELFI and 155 krpm for the 2 – 5 K Brayton), AIR LIQUIDE has developed and qualified dynamic journal and thrust bearings.

Some characteristics :

- Material : Tungsten Carbide
- Extended lifetime (no wear-out during operation)
- Qualified on MELFI for 2400 start/stop cycles
- Machining accuracy better than 1 µm



Compressor wheel



Grooved dynamic bearings

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