Advanced Satellite Thermal Control
Pumped Cooling Systems




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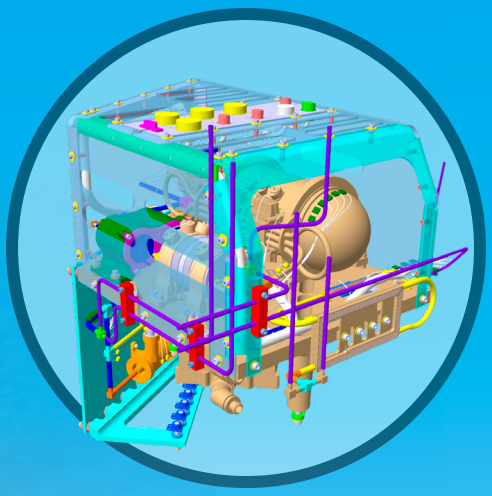
"WHERE HEAT PIPES GIVE UP PUMPS TAKE OVER"

Advanced payloads or large S/C demand for higher thermal fluxes, higher temperature stability and integration ground testing flexibility. Pumped cooling technology is capable of providing these features. The NLR Pumped thermal control solutions range from lightweight mini-pumped loops for dedicated instruments to 10 kW systems for complete S/C thermal control.



NLR developed the Tracker Thermal Control System (TTCS), which is a mechanically pumped two-phase carbon dioxide cooling loop. Pumped two-phase cooling systems can also be used as cooling system for high-power communication satellites and scientific spacecraft requiring tight temperature control. NLR's capabilities are on system design, loop component specifications and critical component designs, safety (launcher and ISS), system integration, environmental, pre-flight and in-orbit testing.

"IN-FLIGHT EXPERIENCE CRUCIAL FOR ACCUMULATOR DEVELOPMENT"

What you need

- Cooling of advanced payloads
- Cooling of entire S/C
- High thermal fluxes
- High temperature stability
- Integration ground testing flexibility

What we deliver

- Design, modelling, prototyping, development testing and qualification of satellite and aerospace pumped cooling systems
- Design, modelling, prototyping, development testing and qualification of loop components (e.g. two-phase accumulators)
- Cost-effective development of dedicated thermal control systems (10 W-10 kW)
- High thermal stability thermal control systems (mK-level)
- Lightweight and mini thermal control systems
- Mini-pumped loops
- Design and delivery of filling systems for cooling systems, heat pipes, and spacecraft storage tanks

Our track record

The TTCS was developed for the Alpha Magnetic Spectrometer (AMS02) experiment residing on an ISS truss since May 2011. This TTCS provides accurate (± 0,2 K) temperature control and removes 140 W heat of the AMS02 Tracker front-end electronics to dedicated radiators. TTCS-like systems are also integrated in three particle detectors at CERN. NLR's in flight experience with the TTCS was crucial for the development of the Heat Controlled Accumulator (HCA) for the 2Φ-Mechanically Pumped Loop (MPL) of Thales Alenia Space. The accumulator copes with volume variations in the loop during the different satellite functioning modes and provides the 2Φ-set-point control. The HCA with its capillary internal structure is, apart from the pump, the most critical MPL component.
The TTCS and HCA system design experience makes NLR the perfect partner for two-phase loop component design. NLR can oversee the component design impact on system design, system integration and system operation.
Major customers are: ESA, AMS02 (CERN), ASML, Thales Alenia Space, Moog Bradford and Dutch Space.

Components

- accumulators
- heat exchangers
- loop heaters
- high stability evaporators
- space pump electronics

Mini-pumped loops

NLR developed a new small pumped loops concept, the multi-parallel micro-pump. This reduced mass pump allows for the introduction of small pumped loops in space. The concept also solves the pump reliability problem by using a large set (15-50) of parallel micro-pumps built in one unit, in which a single pump failure is no problem and even multiple pump failures will cause only graceful degradation. The pump is made of Titanium through Laser Additive Manufacturing and based on micro-pumps developed for the medical sector.

Pump specifications for a 5 pump unit:

- Flow rate 15 ml/min
- Pressure head 50 mbar
- Mass 100 gr (excl. electronics)
- Average Power 600 mW

The mini pumped loops are developed to cool P/L's with high heat fluxes >16 W/cm2 and to replace Loop Heat Pipes with start-up problems.

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