

Instrumentation of cryogenic tanks



Functional measurement at low temperature using off the shelf or dedicated sensors

Instrumentation of cryogenic tanks requires special care due to specific measurement conditions and particular fluid behaviour at low temperature. Thanks to its proven expertise in the field of cryogenic tanks instrumentation, AIR LIQUIDE defines or supports the instrumentation of cryogenic tanks at various levels:

- system specification to optimise requirement and cost
- measurement system definition (sensors, wiring, supports, connectors, conditioning, acquisition, calibration,...)
- hardware design, qualification (space launch) and installation

As a result, AIR LIQUIDE is responsible for the propellant mass loading of all Ariane 5 cryogenic tanks.



Capacitance probe (Ariane 5)



Super conductive probe (Ariane 5)

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Level measurement

- *Capacitance probes* designed and manufactured by AIR LIQUIDE use the dielectric characteristics of the fluid to determine the immersed part of the sensor (or fluid physical properties).
- *Super conductive level probes* designed and manufactured by AIR LIQUIDE measure the electrical resistance change in a super conductive wire in very cold condition to determine the immersed part. (Mainly used for liquid Helium tanks)
- *Temperature sensors* can be used as punctual level indication.

Temperature measurement

The sensor type and characteristics are chosen according to the need : liquid or gaseous measurement, temperature range, reactivity, sensitivity, ...

- *Platinum sensors* are widely used except at liquid Helium temperature
- *Thermocouples* offer easy use, quick response, small size and wide temperature range
- *Silicon diode sensor* are accurate at liquid He temperature
- *Carbon sensors* are suitable in very cold conditions

Pressure measurement

The pressure sensor choice depends on the pressure levels to be measured, can be absolute or relative

Example of usual characteristics

Instrument	Use	Range	Accuracy
Capacitance probe	Level	10 cm – 1 m	± 1 mm
Super conductive level probe	Level	10 cm – 1 m	± 1 mm
Temperature sensor	Level	Punctual	± 1 mm
Platinum sensor	Temp.	20 K – 400 K	± 0.1 K
Thermocouple	Temp.	4.2 K – 1000 K	± 0.5 K
Carbon Sensor	Temp.	1 K – 100 K	± 0.05 K
Silicon diode sensor	Temp.	1 K – 450 K	± 0.05 K

AIR LIQUIDE role

The role played by AIR LIQUIDE in the Ariane cryogenic tanks instrumentation is the result of its extensive experience and deep understanding of:

- the use of measurement systems for launcher tanks and cryogenic test set-ups including accurate calibration at low temperature
- indirect measurement methods based on thermal analyses and wide knowledge of cryogenic fluids (e.g. for the Ariane 5 Helium sphere loaded mass : P,T method or capacitance measurement in supercritical conditions)
- the compatibility of sensors, wires, connectors with cryogenic temperatures, cryogenic fluids and launch conditions
- the specificity of measurements in cold conditions : thermalization of sensors and wires, sensor impact on the thermal budget, ...