Thermal Conditioning Unit for Space Simulation

Telstar TCU

For 25 years, Telstar has been supplying Thermal Vacuum Chambers (TVACs) for Space Industry. Along this time Telstar has delivered top-class TVACs, ranging from large turn-key projects for complete satellite testing to small compact ones for system or subsystem level testing and validation campaigns.

During any satellite development phase, many operational factors can only be experimentally determined by testing under the most extreme environmental conditions that will be encountered in its life. Testing the system at the required different temperatures, thermal loads and vacuum conditions allows analyzing the suitability of new materials, components and even the complete assembly for these extreme conditions. Tests must mimic the most similar conditions to the real ones that will be encountered in the outer space.

Thermal Conditioning Units (TCUs) are the most fundamental part in a space simulation chamber; they must cover the required temperature range, the needed heating and cooling speed while maintaining the necessary temperature uniformity across the thermal panels.

Main Features

- Fluid recirculation for optimum performance:
  - Silicone Fluid, with a temperature range from -90ºC to +150ºC
  - Dense GN2, with a temperature Range from -180ºC to + 180ºC
- PLC control and user friendly 10″ color touchscreen
- Standard design, adaptable to user shroud or baseplate to optimize performance

Silicone Oil units:

- Mechanical refrigeration or LN2 cooling
- Circulation pumps with magnetic coupling avoiding leak-tightness problems

GN2 units:

- Constant Pressure Operation to achieve optimal LN2 consumption
- High Efficiency LN2 Injection System
- High speed, cryogenic, hermetically canned blower

Silicone Oil circulation TCUs

A certain range of satellite subsystems require thermal cycling within a limited temperature range (-90ºC to +150ºC). In this case, silicone oil circulation TCUs are a very good choice, because they provide excellent temperature uniformity and heating / cooling speeds, while keeping both the investment and the operational costs at moderate levels. Telstar has successfully adapted this technology, after more than 50 years using this application in freeze-drying plants for the Pharmaceutical Industry with several thousands of these silicone oil circulation systems in total in the market. These fluid circulation systems can be either cooled by mechanical refrigeration (low temperature limit down to -70ºC) or by specially engineered LN2 heat exchangers, with a low temperature limit down to -90ºC.

Dense GN2 circulation TCUs

When testing the complete spacecraft or certain subsystems like antennas, a wider temperature range is required, typically from -180ºC to +150ºC. In these cases, the use of GN2 / LN2 is mandatory.

Telstar has developed a new TCU concept based on GN2 recirculation that brings significant operational cost savings when compared to the traditional dense GN2 TCUs and also when compared to the low cost systems based on LN2 flooding of the thermal shrouds.

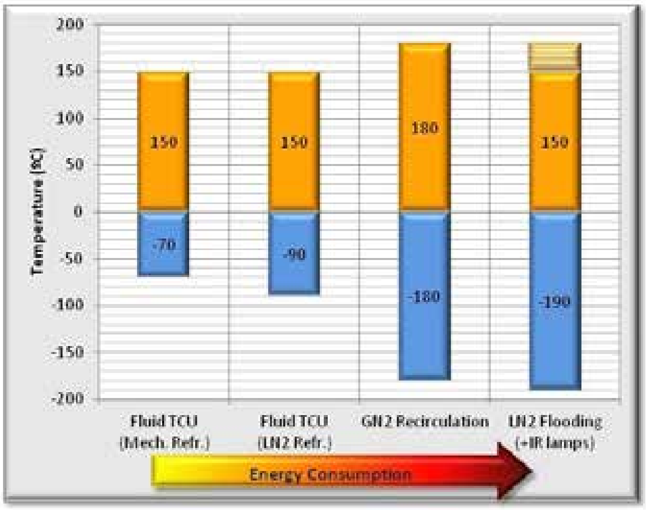
Additionally, Telstar TCUs provide excellent controllability allowing a complete control of the test facility performance like cooling/heating rates and, more important, temperature uniformity, which are all critical parameters for test management minimizing LN2 consumption.

One of the innovative TCU concepts is based on a GN2 constant pressure loop. This approach ensures that compression losses are minimized and thus an optimum LN2 consumption regime is achieved. The only limitation is the lower temperature limit, this approach works well down to -150ºC. For lower temperatures, the system automatically reduces the loop pressure to avoid the risk of generating LN2 in the GN2 loop. Nominal design operating pressure is 8 bar(g) (116 psig), this requires LN2 supply pressure of about 10 bar(g) (145 psig). Units can be engineered to any available LN2 supply pressure.

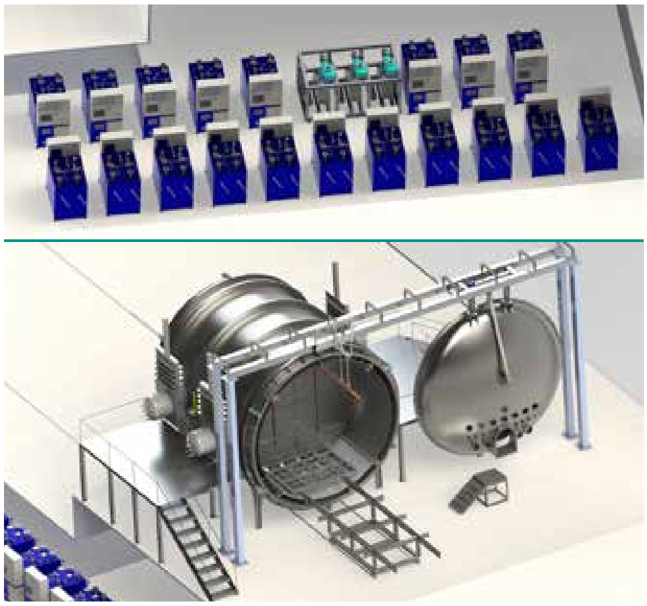
Energy consumption strongly depends on many parameters like chamber size, testing profile, shroud temperature uniformity, and Device Under Test (DUT) load. For analogous conditions, typical savings in LN2 consumption between Telstar TCUs and an open loop configuration can be in the range of 20% to 50%.

An additional advantage is that using a TCU one may eliminate the need of using local heating devices like IR lamps, which increase the inefficiency of the test, and are a source of non-uniformities in the DUT, creating unnecessary thermal risks in complicated shaped DUTs.

Another significant improvement with respect to traditional dense GN2 TCUs is related to the control system algorithms, always having in mind the ease of use, flexibility in assigning control temperature probes, and most important, saving LN2 consumption. The control is based in a local mounted PLC with a color touchscreen and a user friendly interface. The control system can work stand alone, but it is also prepared to be connected to a higher level control layer, like the TVAC PLC and/or a Supervisory Control And Data Acquisition (SCADA) system. A quick re-tuning of the TCU is possible, extending its adaptability to very different demands that can be encountered in different test campaigns and even connecting it to different testing chambers.



Standard ranges of applicability of the different thermal control technologies



Large TVAC with independent thermal zones

Small compact TVAC concept

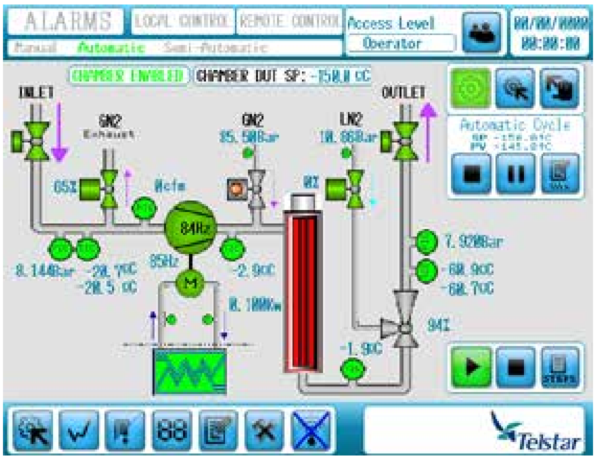
Technical Data

Dense GN2 TCUs

TCU Model	Nomical Gas Flow	Effective Heating/ Cooling Capacity(*)	Total Electrical Power	Size (LxWxH)	Weight
	m3/h(cfm)	kW	kW	mm3	kg
GT-18	170 (100)	13	25	1750x900x1800	1000
GT-38	700 (412)	47	70	2110x1270x1940	1800
GT-HG	3000 (1766)	190	260	2200x1400x1940	2500

Silicone Oil TCUs

	Cooling Method	Effective Refrigeration Capacity		Effective Heating Power	Fluid Flow	Total Electrical Power
		(@ +20ºC)	(@ -50ºC)		(@ 2bar)	
		kW	kW	kW	m³/h	kW
FT-10	Mech. Refr.	2.1	1.0	3	1.3	9
FT-10.2	Mech. Refr.	4.2	2.0	6	2.2	16
FT-35	Mech. Refr.	9.4	3.2	12	3.4	21
FT-60	Mech. Refr.	14.7	5.7	15	8.4	28
FT-120	Mech. Refr.	27.4	11.3	33	13	57
FT-170	Mech. Refr.	38.8	16.8	42	20	69
FTL-60	LN2	6.8	5.9	9	3.4	12
FTL-200	LN2	17.8	17.0	21	13	26
FTL-500	LN2	47.0	45.0	54	36	61



Scada screenshot

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Telstar reserves the right to improvements and specification changes without notice.

Telstar
Vacuum solutions

SPAIN
Headquarters
Av. Font i Sagué, 55
08227 Terrassa (Spain)
T +34 937 361 600
F +34 937 861 380

Santibáñez de Béjar, 3
08042 Madrid
T +34 913 717 790
F +34 913 717 791

NORTH AMERICA
1504 Grundy's Lane
Bristol PA 19007
T +1 (215) 826 0770
F +1 (215) 826 0222

JAPAN
Azbil Corporation
Tokyo Building,
2-7-3 Marunouchi, Chiyoda-ku,
Tokyo 100-6419,
T +81 3 6810 1000
F +81 3 5220 7270

CHINA
No. 30 Jin Wen Road,
Zu Qiao Airport Industrial Park,
Pudong District
201323 Shangai
T +86 21 58 093 731
F +86 21 58 092 857

www.telstar.com
telstar@telstar.com