



Sustainable testing. **CO₂ refrigeration technology from Weiss Technik.**

Sustainability and energy efficiency are becoming increasingly important in laboratory environments. The goal is to meet regulatory requirements and achieve overarching sustainability objectives. Operating costs and potential savings are also decisive criteria for potential investments.

Our new CO₂ test chambers significantly contribute to these goals by saving up to 30% of electricity compared to previous models. Their low energy consumption actively supports laboratory managers in implementing sustainable operating strategies.

Of the natural refrigerants, only flammable refrigerants and CO₂ (R744) have a global warming potential (GWP) of less than 150, which is required by the current F-Gas Regulation. However, for safety reasons, flammable refrigerants are not suitable for use in temperature and climate test chambers, especially when testing flammable substances or batteries.

Weiss Technik has been using CO₂ as a refrigerant in large-scale systems for many years. Thanks to technical advances, it is now possible to use CO₂ technology in smaller test chambers in a cost-effective and safe manner.

Data and measurements from customers' practical testing confirm the savings achieved when different test devices are compared directly

Key arguments at a glance:

- CO₂ can also be used economically as a refrigerant in smaller test chambers
- Up to €400 less in electricity costs per month
- Reduction of secondary energy costs in the cooling water infrastructure
- Significantly reduced noise level thanks to much quieter compressors
- Full test performance and compliance with standards (e.g. IEC 60068-2-38)

CO₂ as the new standard for many temperature and climate tests down to -40 °C

Equipment and systems for environmental simulation testing traditionally operate with single-stage refrigeration systems down to -40 °C or with refrigeration cascade systems down to -70 °C. Since 1 January, 2025, Weiss Technik has replaced the previous single-stage systems with the refrigerant R449A with CO₂-based refrigeration systems. This ensures compliance with current legal requirements.

Although R449A achieves a minimum temperature of -40 °C, the effective cooling capacity drops significantly below approximately -25 °C. For many applications, this is not sufficient, and users have resorted to cascade systems with a final temperature of -70 °C.

The solution from Weiss Technik: CO₂ refrigeration technology down to -50 °C

The new CO₂ refrigeration systems from Weiss Technik offer powerful cooling down to -50 °C – with increased heat compensation compared to systems with -40 °C. This positions them between classic single-stage systems and cascades.

CO₂ refrigeration technology is bringing about a paradigm shift: cascade systems with F-gases will only be used where they are technically essential in the future. One example is the aerospace industry, where temperatures below -50 °C are required. For all other applications, Weiss Technik CO₂ test chambers offer a powerful, efficient, sustainable, and future-proof solution.

Practical comparison: energy efficiency and other advantages

A 1000-litre climate test chamber with a change rate of 10 K/min (in accordance with IEC 60068-3-5) was equipped with Weiss Technik CO₂ technology in the laboratory of a reference customer. A standard test cycle in accordance with IEC 60068-2-14 Nb was selected for a benchmark test run. The test temperatures in the empty test chamber were $T_A = -40$ °C (lower test temperature) and $T_B +150$ °C (upper test temperature). The rate of temperature change was set at 5 K/min. Various climate chambers with conventional refrigeration technology (R449A/R23 cascade) with 5 K/min to 15 K/min were used for comparison. All climate

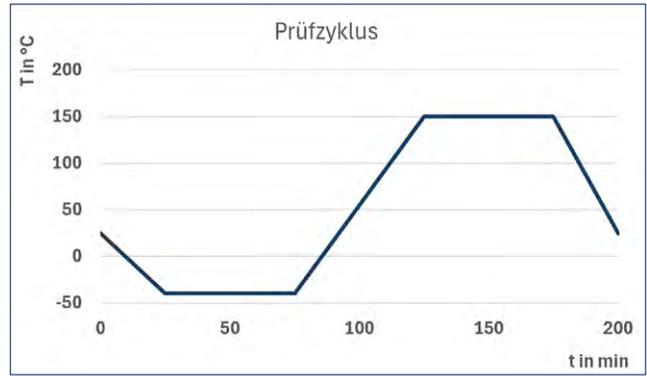


Figure 1 The test drive according to IEC 60068-2-14 Nb was used for energy measurement

chambers tested were connected to the same cooling water network to ensure comparable conditions.

The result in numbers

In this laboratory, monthly energy consumption was reduced by up to 1,200 kWh compared to the reference system. This corresponds to annual savings of up to €400 in electricity costs per climate chamber. Furthermore, the integrated electronic cooling water control system minimises pressure loss by up to 1 bar, thereby alleviating the strain on critical infrastructure.



Figure 2 Comparison of power consumption of various devices

System	Test space volume	Final temperature	Nominal change speed	Consumption	Electricity costs for 30 days/difference
C2/1000/50/10 (CO ₂)	1,000 l	-50 °C	10 K/min	3,870 kWh	€1,083
VTS 7100-5	1,000 l	-70 °C	5 K/min	5,130 kWh	+ €353
VCS 7048-15	480 l	-70 °C	15 K/min	5,940 kWh	+ € 580
VCS3 7048-15	480 l	-70 °C	15 K/min	6,600 kWh	+ € 765
VCS 7080-15	800 l	-70 °C	15 K/min	14,640 kWh	+ € 3017

Figure 3 Measured values for power consumption

Further examples

The efficiency and energy savings achieved by CO₂ refrigeration technology are not unique. Comparative measurements taken in test chambers with volumes ranging from 180 and 340 to 3600 litres also demonstrated significantly lower power consumption. For example, a temperature ramp profile between -40 °C and +120 °C with change rates of up to 2 K/min showed energy savings of over 30 percent compared to performance-equivalent units with conventional refrigeration cascades using R449A and R469A.

These results confirm the high energy efficiency of CO₂ refrigeration systems and highlight their potential as a sustainable alternative to conventional systems, regardless of the size of the unit.



Figure 4 ClimeEvent XXL temperature test cabinet, 3600 l, 2 K/min

Benefits:

- Significantly lower energy consumption - 30% less compared to reference chambers with equivalent performance
- No changes to the installation site for ambient temperature and cooling water
- Further energy savings in the cooling water infrastructure
- Noise level reduced by up to 9 dB(A)

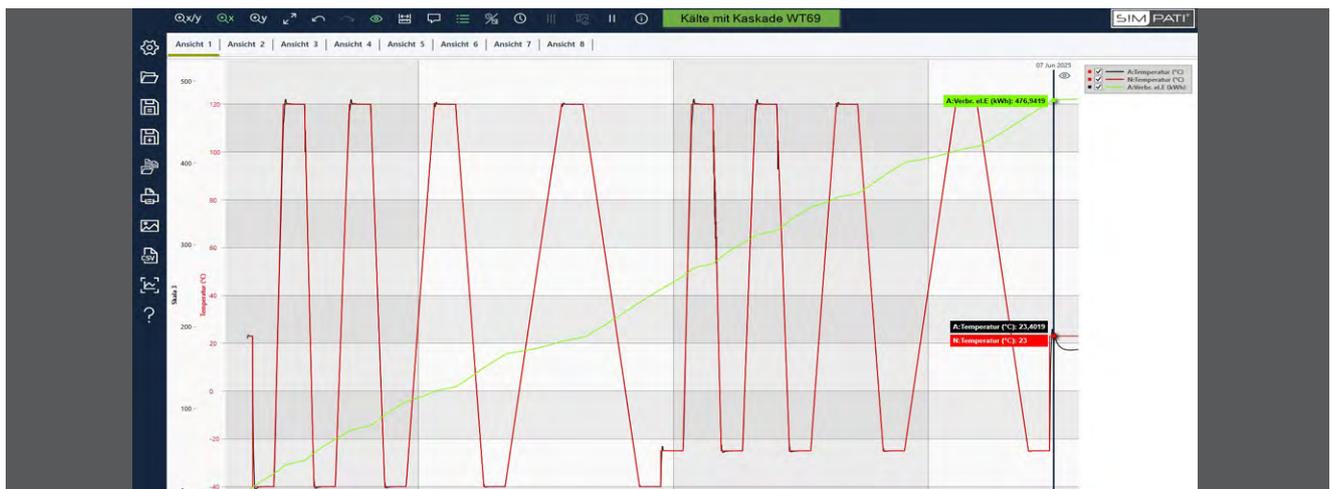


Figure 5 Ramp test run between 120 °C and -40 °C with 0.5-2 K/min

System	Test space volume	Final temperature	Nominal change speed	Consumption in 75 hours	Consumption per year (90%, 365 days of use)	Annual electricity costs (28 cents/kWh)
C2/180/50/3	180 l	-50 °C	3 K/min	90 kWh	9,446 kWh	€ 2,645
C2/180/70/3	180 l	-70 °C	3 K/min	136 kWh	14,274 kWh	€ 3,997
C2/340/50/3	340 l	-50 °C	3 K/min	92 kWh	9,656 kWh	€ 2,704
C2/340/70/3	340 l	-70 °C	3 K/min	133 kWh	13,959 kWh	€ 3,909
C/3600/50/4/W	3600 l	-50 °C	4 K/min	317 kWh	33,272 kWh	€ 9,316
C/3600/70/4/W	3600 l	-70 °C	4 K/min	477 kWh	50,066 kWh	€ 14,018

Figure 6 Measured values for power consumption

Typ Type		Baujahr Year of Constr.				
Geräte-Nr. Serial No.		Gewicht Weight				
Kältemittel Refrigerant	Menge Quantity	GWP 100 GWP 100	CO ₂ -Äquiv. CO ₂ -Equiv.	ND max. LP max.	HD max. HP max.	Standdruck Const. pressure
R404A	10,00 kg	3.920	39,20 t	1		
R23	4,50 kg	14.800	66,60 t	2		
R404A	2,00 kg	3.920	7,94 t	3		
Nennstrom Nom. Current		Nennleistung Nom. Output		Spannung Voltage		
Zusatzinformation Additional info						Made in Germany
Enthält fluoridierte Treibhausgase. Contains fluorinated greenhouse gases.						CE

Labelling requirements

Since January 2015, the type and quantity of refrigerants used must be indicated on the rating plate. The designation, GWP and quantity must be specified for each refrigeration circuit. If the refrigerant does not comply with the F-Gas Regulation, the reason why it is permitted to be used must be explained.

The relevant implementing regulation has been amended and will take effect on 1 January 2025 in the form of EU Directive 2024/2174.



Leak test / leak detection

Since the F-Gas Regulation of 2015, regular leak checks must be carried out and documented by certified personnel. The frequency depends on the quantity and GWP of the refrigerant. An inspection at least once a year is mandatory for F-gases exceeding 5 tonnes of CO₂ equivalent (e.g. 3.6 kg R449A) per refrigeration circuit. A new requirement introduced in March 2024 states that, following a repair, you must wait at least 24 hours before conducting a leak check and finalising the repair. Devices that use natural refrigerants, such as CO₂, are not covered by the F-Gas Regulation. A leak test is still required in accordance with EN 378-4. The amount of refrigerant is crucial. An inspection must be carried out annually for total system contents of 3 kg or more.



Exemption

In October 2024, the EU adopted Implementing Regulation 2024/2729. Among other things, it applies to environmental simulation systems with a temperature range below -50°C.

For these extremely low temperatures, no safe natural refrigerants are expected to be available in the foreseeable future. Due to these safety requirements, the EU has explicitly permitted the use of refrigerants with a GWP >150 in these devices.

The exemption applies to the placing on the market of equipment by all manufacturers and distributors in the EU until 31 December 2028.