

World novelty! The refrigerant WT69 – the future-proof substitute for R23



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#### Every Climatic Chamber Contains a Refrigerant

- Every climatic chamber uses a refrigerant
- All European manufacturers use synthetic refrigerants such as R404A, R23, R449A, R134A today
- Device components are often used at the edge of their performance level
- Climatic chambers exist in many sizes, but only in two basic performance categories:
  - With one cooling circuit for temperatures down to -40°C
  - With two cooling circuits (cascade) for temperatures down to -70°C
- For cascading cooling circuits almost always the refrigerant R23 is used today





## **F-gas Regulation**



#### The essence of this regulation is to

#### reduce the impact of refrigerants on global warming.

#### This is achieved by regulating the

- refrigerants used
- system designs (e.g. tightness, filling quantity)
- operating rules for refrigeration units (e.g. service)



Regulation (EU) No 517/2014 CO<sub>2</sub> equivalent

#### Calculation of the CO<sub>2</sub> equivalent

$$CO_2 \ equivalent \ [t] = rac{Filling \ quantity \ [kg] * GWP_{refrigerant}}{1000}$$

#### Example:

- ¬ R23 has a global warming potential of  $\approx$  14.800
- $\neg$  Filling quantity of the system = 2 kg
- ¬  $CO_2$  equivalent of the system ≈ 29.6 t



#### Legal Provisions / Bans

- Maximum GWP (global warming potential) of refrigerants in new devices from 2020 on: 2500<sup>1</sup>
- Additional leak tests required



- → Impact on procurement and operation of environmental simulation devices
- <sup>1</sup> Exception: Applications below -50°C and military use

#### **Quota Regulation**

- Extreme reduction of the total refrigerant amount in the EU until 2030
- Quota system at EU level

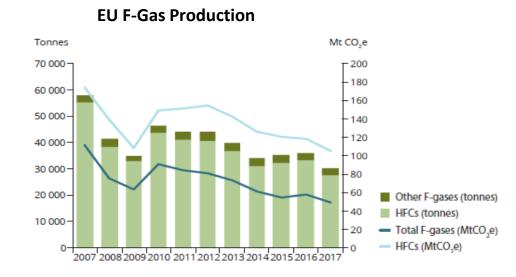


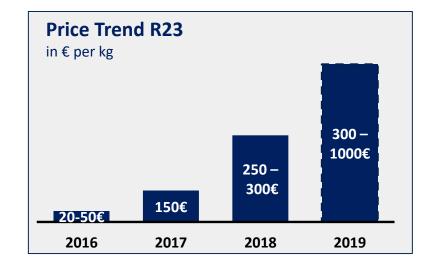
 $\rightarrow$  Impact on availability and price of refrigerants

#### Market situation refrigerants



- Yearly quota system for CO<sub>2</sub> equivalents for dealers and manufacturers in the EU
- EU-Quota works, procurement issues increasing
- Illegal import is an issue, especially unknown quality (e.g. propane instead of R23)
- ¬ The EU and the German Federal Office for Environment consider a future refrigerant price of €35 per ton of CO<sub>2</sub> -equivalents to be acceptable ("up to €50/t CO<sub>2</sub> is fine").
  - GWP R23: 14.800 → 14.8 \* 35€ = 518€ per kg R23
- R23 availability in the EU has decreased significantly







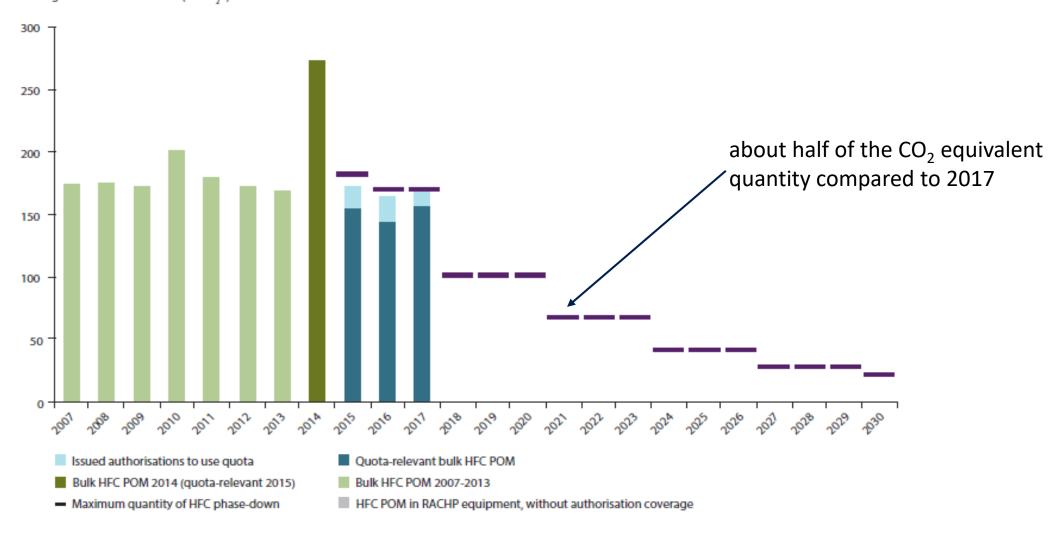
#### Relevant indicator: GWP value

Refrigerant	GWP	Possible minimum temperature [°C]	Allowed for use in new devices as of 2020	Cooling circuit
R134a	1430	- 10	Yes	single-stage
R449A	1397	- 45	Special regulation: Systems	s that can reach
R452A	2141	- 45	temperatures lower than -	
R404A	3920	- 48	exempted <sup>(1)</sup>	
R507	3990	- 45	No	single-stage
R23	14800	- 80	Yes	cascade



#### The amount of available refrigerant in the EU will continue to decrease

Placing on the market of HFCs (MtCO,e)

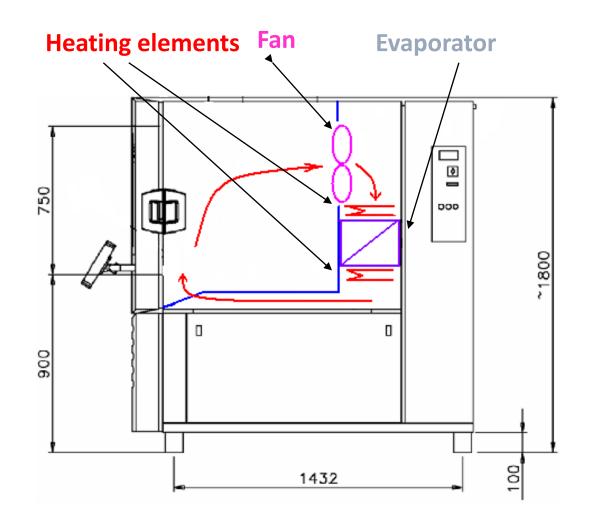




# Alternatives for R23 in Climatic Chambers







In almost all cases, parts of the refrigeration unit are located in the test space, in the direct vicinity of heating elements (ignition sources) that reach up to 500 °C.

#### Active test specimens





During a test, components are often operated electrically. This may also cause ignition sources.

## Flammable refrigerants cannot be used.



#### Refrigerants are divided into safety groups

#### Weiss Technik is using only "A1" refrigerants

- ¬ If the evaporator is located in the test space
- To prevent combustion and explosion in the test space
- ¬ No compromises on safety

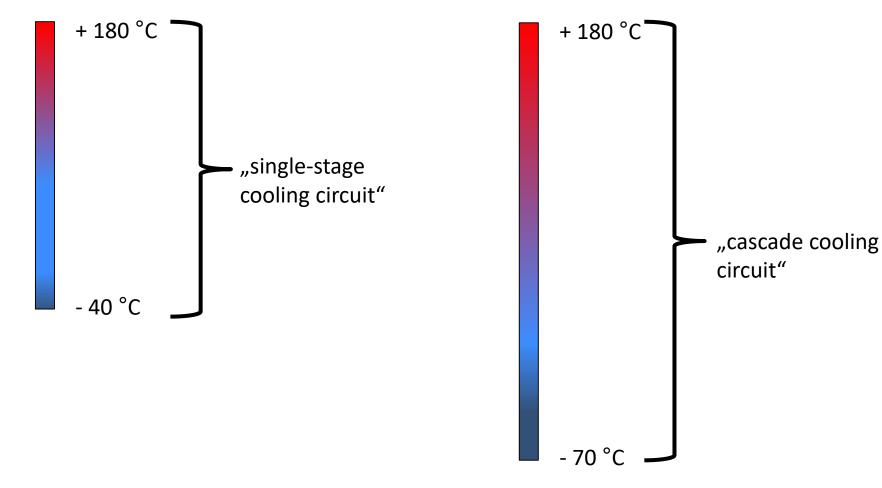
ASHRAE 34 Safety group						
	Lower toxicity	Higher toxicity				
Higher flammability	A3	В3				
Lower flammability	A2	B2				
Lower flammability with a maximum burning velocity of = 10 cm/s	A2L	B2L				
No flame propagation	( A1 )	B1				





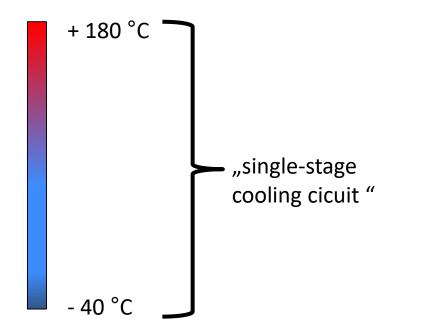
Temperature ranges

#### Common temperature ranges (examples):





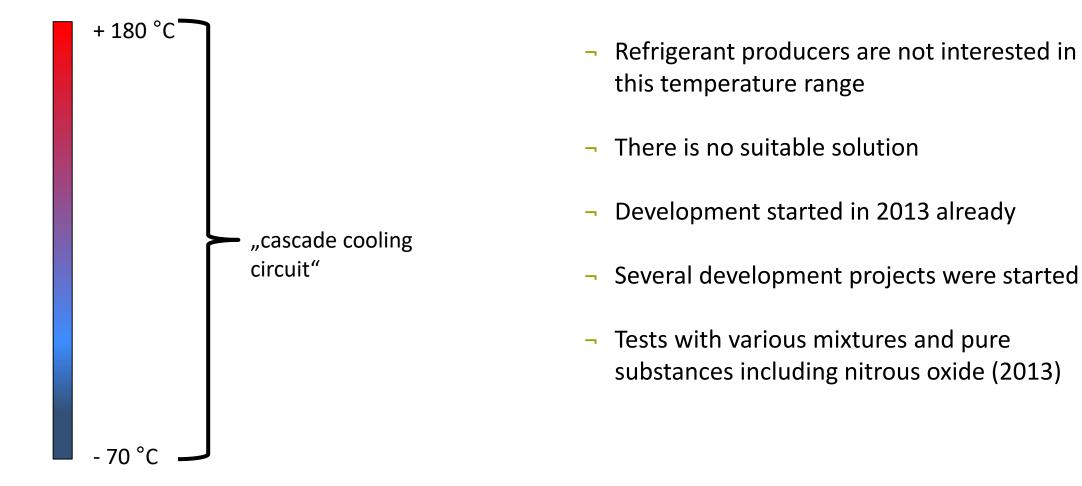
### Common temperature ranges (examples):



- Refrigerant producers developed alternative refrigerants
- Development started in 2012 already
- ¬ First tests with R407F → failure
- Solution found in R449A
- ClimeEvent with R449A released to market in 2016 already
- Entire standard portfolio converted in 2018



### Common temperature ranges (examples):





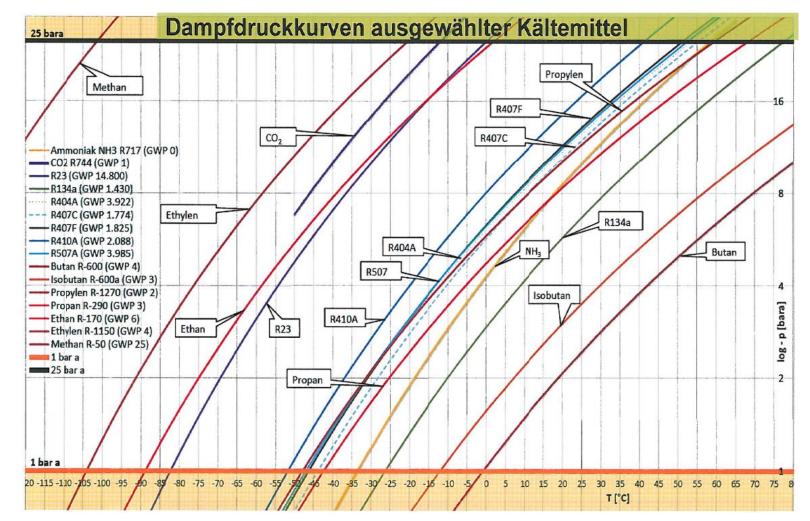
#### Ultra-low temperatures without R23

## Without R23, the limit is currently - 45°C

- ¬ CO₂ solidifies
- Ethane is flammable
- Liquid nitrogen expands too much

## Heat compensation (cooling capacity)

 All alternatives to R23 have a very low heat compensation already below - 40°C





#### • 4 examples for natural refrigerants

Name	Molecular formula	ASHRAE Numer	GWP	ODP	T <sub>o</sub> at 1.013mbar	ASHRAE Safety Group	Remark
Carbon dioxide	CO <sub>2</sub>	R744	1	0	-56,56°C (5,18bar)	A1	tripel point, high pressure
Ammonia	NH <sub>3</sub>	R717	0	0	- 33,5°C	B2L	toxic, flammable
Ethane	$C_2H_6$	R170	6	0	-88,6°C	A3	flammable, explosive
Nitrous oxide	N <sub>2</sub> O	R744a	298	0,1	-88,5°C	A1?	corrosive, chemically unstable

- Renaissance in various refrigeration applications.
- They are for some cases an interesting alternative to
  - Chlorinated hydrofluorocarbons (CFCs) as well as
  - Fluorinated hydrocarbons (FCs)
  - (harmful to the climate (GWP) and ozone layer (ODP))



- A new "mono substance" refrigerant for low temperatures is unlikely
- "Hitting the boundaries of chemistry"
- Best technological approach: refrigerant blends
- Make use of the inerting effect of R744
- Technical substitutes require a high degree of knowledge
- Substitutes are much more environmentally friendly than R23 solutions

### - Environmentally friendly substitutes for R23 are possible!



#### Development project started in 2013

¬ 150 mixtures analyzed

#### Alternatives found and tested:

- ¬ Project team of 75 people
- Coordination with legal advisors for European and German law about classification, manufacturing and distribution of refrigerants
- ¬ Validation with external partners (e.g. developer of R134a)
- 20 chamber configurations tested for more than 3 years
- Until now: More than 100,000 hours of testing
- External flammability reports and disaster evaluations using international refrigerant standards

### **Mixtures of HFCs and CO<sub>2</sub> work**





Q

X

#### Refrigerant WT69 meets all requirements:

- ✓ Controllable pressure in the system:
- ✓ Not flammable:
- 🔇 🗹 Not toxic:
- 💐 🗹 No ODP:
- 🖌 🗹 Not corrosive:
- Components and lubricants available:
   Chemically stable:
- Minimum temperature:
  Legal & future-proof:

🗞 🗸 Affordable:

Pressure levels similar to today's devices A1/A1 certified by ASHRAE Safety data sheet officially released Composition without ozone-depleting substances 100,000 hours of testing without corrosion Verified analysis of compressors ASHRAE & BAM tests successful

-70°C achievable. Down to -60°C almost linear cooling Mixture of commercial gases

Distribution via refrigerant wholesaler



#### WT69: Independently Certified and Produced

#### Refrigerant WT69 works down to -70°C

 $\rightarrow$  All test profiles can still be used and test results remain comparable

#### WT69 was independently certified

 $\rightarrow$  Not flammable, safety and documentation ensured, GWP 1357

#### WT69 is a normal synthetic refrigerant

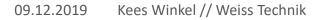
→ Standard cooling components sufficient, no safety assessments, no separate cooling, no increase in refrigerant quantity in the system

#### WT69 is produced independently

 $\rightarrow$  Availability guaranteed

#### **Objective:**

- Establish WT 69 as the standard refrigerant for ultra-low temperature ranges
- Allow selected other manufacturers to use WT 69







#### Summary: Refrigerant WT69 - R469A



### Same performance.

### Cheaper.

Greener.





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