

Chillventa Specialist Forums 2022
Chillventa Fachforen 2022

**CONNECTING
EXPERTS.**





THERMOPLASTIC TUBING AND HOSES

THERMOPLASTIC FLEXIBLE HOSES FOR R-744 APPLICATIONS

**CURRENT STANDARD LIMITATIONS AND FURTHER REQUIREMENTS TO
HANDLE R-744**

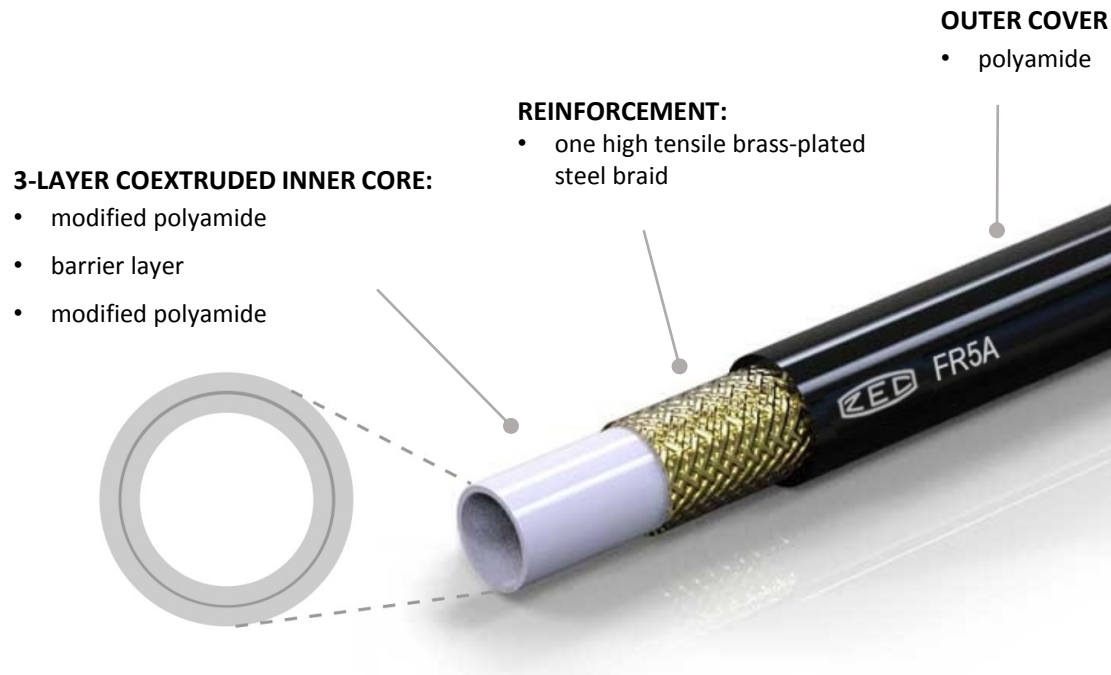
CHILLVENTA

12/10/2022

SUMMARY

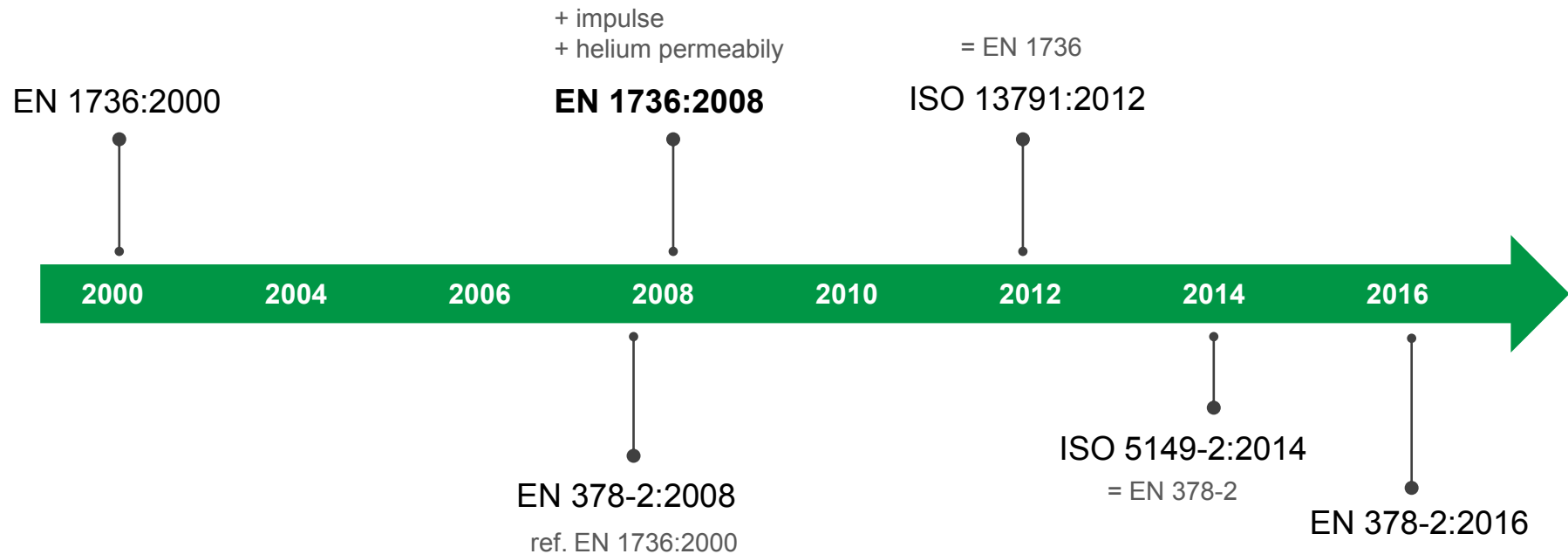
- **FLEXIBLE THERMOPLASTIC HOSE CONSTRUCTIONS**
- **CURRENT STANDARD ON FLEXIBLE HOSES**
 - HISTORICAL DEVELOPMENT
 - FLEXIBLE HOSE REQUIREMENTS
 - HELIUM TEST
- **OVERTAKE THE CURRENT REGULATIONS**
 - PERMEATION FOR NEW REFRIGERANTS
 - R-744 ENDURANCE TEST
- **ZEC SOLUTION FOR R-744**

FLEXIBLE HOSE CONSTRUCTION



STANDARDS

STANDARD HISTORY

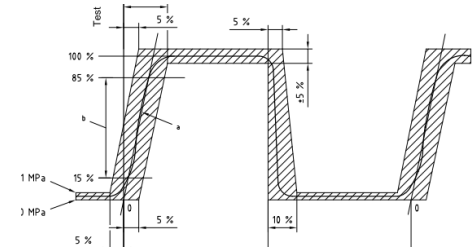
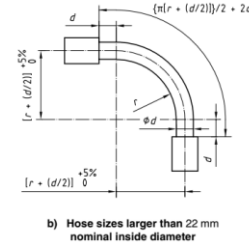
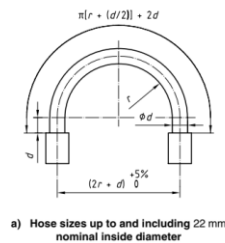


CURRENT REGULATIONS - EN 1736

FLEXIBLE HOSE REQUIREMENTS

- FATIGUE** (ISO 6605)

- 250.000 cycles
- 1.1 x SP
- 1 x WT



- BURST**

- 3 x SP (ISO 6605)

- VACUUM**

- RESISTANCE -0.99 bar

- PERMEABILITY**

- 32°C and saturated vapour pressure
- 100°C and max SP

Table 1 — Allowable permeabilities for non-metallic flexible tubes

LEAKAGE RATE CLASS	1) Permeability at 32 °C	2) Permeability at 100 °C
1	10 g/m ² per year	200 g/m ² per year
2	100 g/m ² per year	1 kg/m ² per year
3	1 kg/m ² per year	5 kg/m ² per year

CURRENT REGULATIONS - EN 1736 ISO 13791

HELIUM INTEGRAL TEST

TEST PROCEDURE

1. PUT HOSE INSIDE CHAMBER
2. CARRY TEMPERATURE TO 32°C OR 100°C
3. DISCONNECT HEAT SOURCE
4. VACUUM IN THE HOSE AND IN THE CHAMBER
5. PUT HELIUM INSIDE THE HOSE
6. CHECK THE LEAK RATE FOR 1 HOUR
7. CONVERT TO REFRIGERANT LEAK ACCORDING TO TABLE

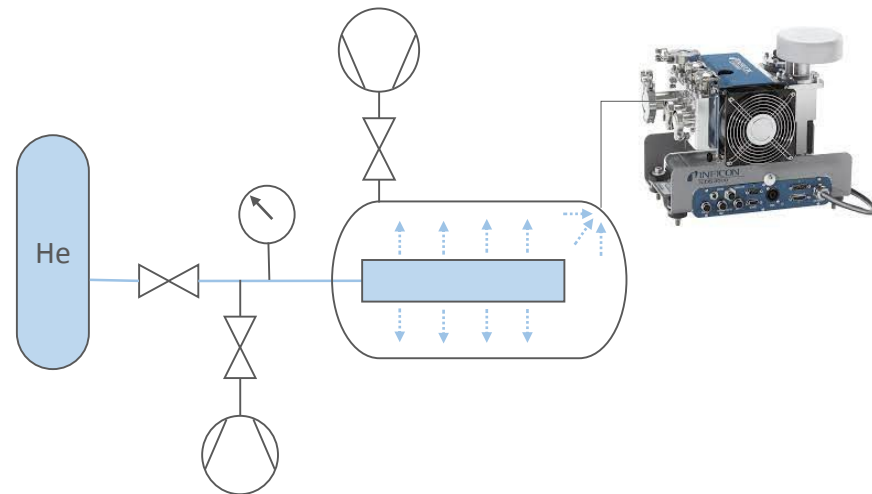


Table 2 — Conversion leak rate from helium into refrigerant through molecular flow

Refrigerant leak	R12	R134A	R404A	R407C	R410A	R600A
g/yr	Helium leak rate equivalent mbar l/s					
1	$3,5 \cdot 10^{-5}$	$3,8 \cdot 10^{-5}$	$3,9 \cdot 10^{-5}$	$4,2 \cdot 10^{-5}$	$4,5 \cdot 10^{-5}$	$5,1 \cdot 10^{-5}$

CURRENT REGULATIONS - EN 1736 ISO 13791

HELIUM INTEGRAL TEST

ZEC helium test bench specifications:

- **Max Pressure:** 120 bar
- **Max Temperature:** 120 °C
- **Sensibility:** 1e-7 mbar*I/s
- **Temperature control:** nr. 4 IR lamps (irradiation) for temperature control during the test



OVERTAKE THE CURRENT REGULATIONS

What about New Refrigerants ?

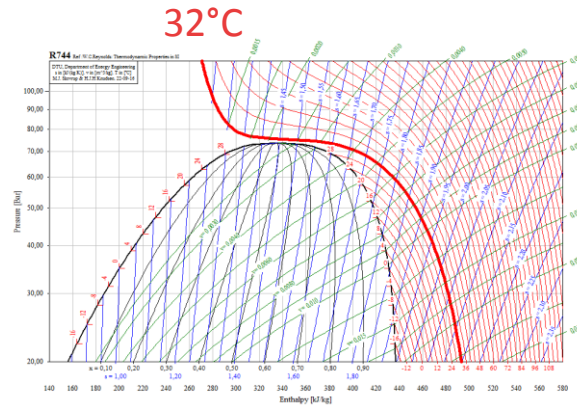
- EN 1736 do not provide conversion table from He to new refrigerants

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What about R-744?

- No saturated pressure at 32°C



OVERTAKE THE CURRENT REGULATIONS

PERMEABILITY FOR NEW REFRIGERANTS

Permeability approximated as a **Molecular flow**

Graham's law

$$q_A = q_B \cdot \frac{\sqrt{M_B}}{\sqrt{M_A}} \Rightarrow \text{smaller is } M_A \text{ greater is } q_A$$

Permeability in g per unit time

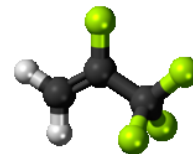
$$q(g/yr) = q(mbar \text{ l/s}) \frac{31557600 \cdot M}{R \cdot T \cdot 10}$$

$$q_A^g = q_B^g \cdot \frac{\sqrt{M_A}}{\sqrt{M_B}} \Rightarrow \text{greater is } M_A \text{ greater is } q_A$$

- T: temperature (°K)
- M_A : molar mass gas A
- R: ideal gas constant
- q_A : flow of gas A (expressed in mol)
- q_A^g : flow of gas A (expressed in grams)



R744
M = 44 g/mol



R1234yf
M = 114 g/mol

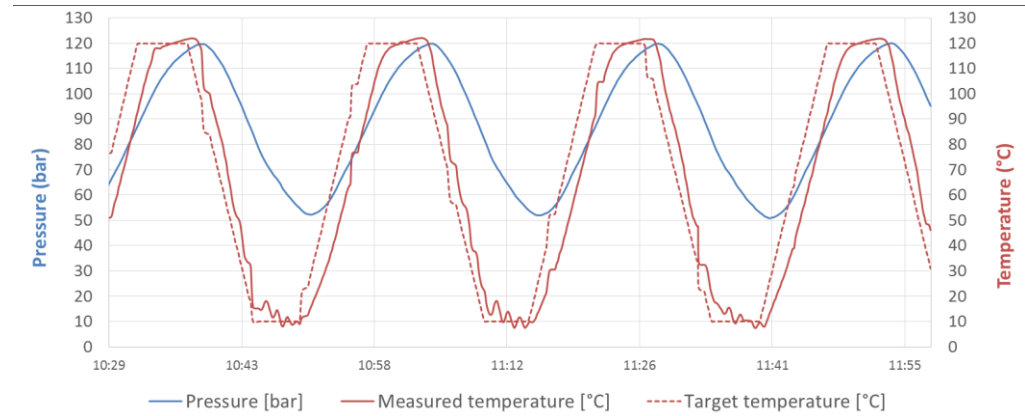
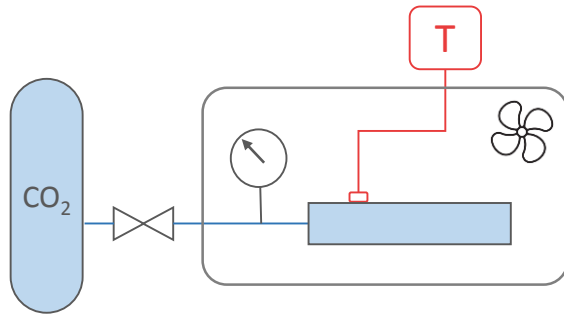
OVERTAKE THE CURRENT REGULATIONS

ENDURANCE TEST

Cyclic variations of temperature and pressure to simulate real market conditions:

- **Pressure:** from 50 to 120 bar
- **Temperature:** from 10°C to 120°C

➡ **> 2.000 cycles**

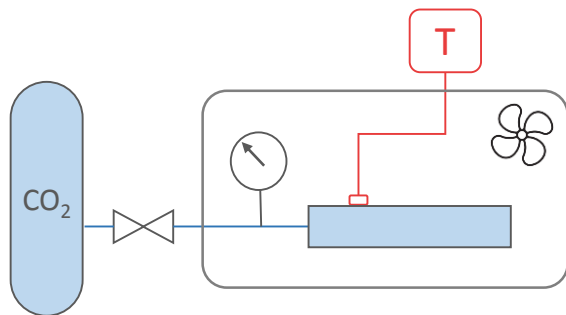


OVERTAKE THE CURRENT REGULATIONS

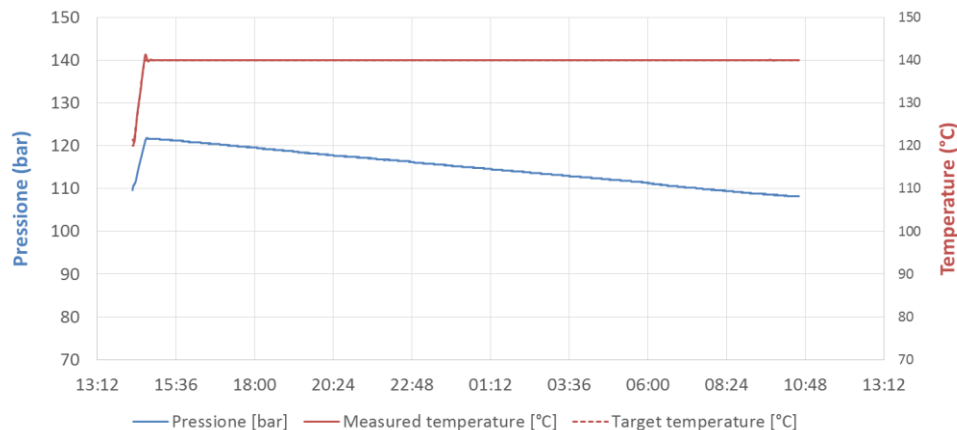
OVERHEATING TEST

After cycles test same sample exposed to:

- **Pressure:** 120 bar
- **Temperature:** 140°C



**No destructive failure
after 20 hours**



OVERTAKE THE CURRENT REGULATIONS

How to guarantee reliability in real applications?

EN 1736 requirements	ZEC R-744 requirements
<ul style="list-style-type: none"> • Impulse test 	<ul style="list-style-type: none"> • Impulse test + nitrogen test at 2 x SP
<ul style="list-style-type: none"> • Burst pressure 3 x SP 	<ul style="list-style-type: none"> • Burst pressure 5 x SP
<ul style="list-style-type: none"> • Permeability: <ul style="list-style-type: none"> ○ 32°C saturation pressure 	<ul style="list-style-type: none"> • Permeability: <ul style="list-style-type: none"> ○ 32°C 120 bar
<ul style="list-style-type: none"> ○ 100°C SP 	<ul style="list-style-type: none"> ○ 100°C 120 bar
<ul style="list-style-type: none"> • No temperature control during helium test 	<ul style="list-style-type: none"> • Temperature control during all the test
	<ul style="list-style-type: none"> • Endurance 2000 cycles + Overheating





THERMOPLASTIC TUBING AND HOSES

CHILLVENTA

International Exhibition
Refrigeration | AC & Ventilation | Heat Pumps



Nuremberg 11-13.10.2022

You will find us at
Hall 7 / Booth Number 7-149

Find us at
Hall 7 / Booth Number 149



THERMOPLASTIC TUBING AND HOSES

Thermoplastic flexible hoses for R-744 applications

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