While waiting for others to come in, here are some rules and reminders to keep in mind..

1

Please mute your microphone unless asked a question.

2

Turn off your cameras.

3

Questions sent via the chatroom will be answered after each presentation.

R290 heat pumps: a good solution?

Geert Gallet

The webinar will start at 3,30 PM..

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My professional life has always been linked to heat pumps

In 1990, I was searching for a heat pump for my private home. Since then, heat pumps have never let go of me and became the guiding thread throughout my entire professional career.

In 2002, I founded my own company, Climapac, to distribute, among others, RHOSS and Enerblue heat pumps and heat recovery systems.

Since November 2022, I have passed the torch to a younger generation and continue to work as a freelancer for Climapac.

Geert Gallet

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R290 heat pumps: a good solution?

YES !

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Heat pump ?

- Hot in winter, cool in summer
- Free energy source is used (Air, boreholes,)
- Low CO_2

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R290 heat pumps: a good solution?

YES !

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R290 ?

- GWP (Global Warming Potential) / **PRG** Potentiel de Réchauffement Global)
- F-gas Regulation
- Thermodynamics
- Temperature range

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R290 GWP

About the IPCC (https://www.ipcc.ch/)

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.
AR6 report 2023

Refrigerant	GWP previous	GWP new
R134a	1430	**1430**
R1234ze	7	**1,37**
R290	**3**	**0,02**
R32	675	**675**
R407C	1774	**1774**
R410A	2088	**2088**
R452B	698,3	**697,4**
R454B	466	**465**
R454C	148	**146**
R513A	631,4	**629,5**
R515B	293	**288**

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R290 ?

- GWP
- F-gas Regulation
- Thermodynamics
- Temperature range

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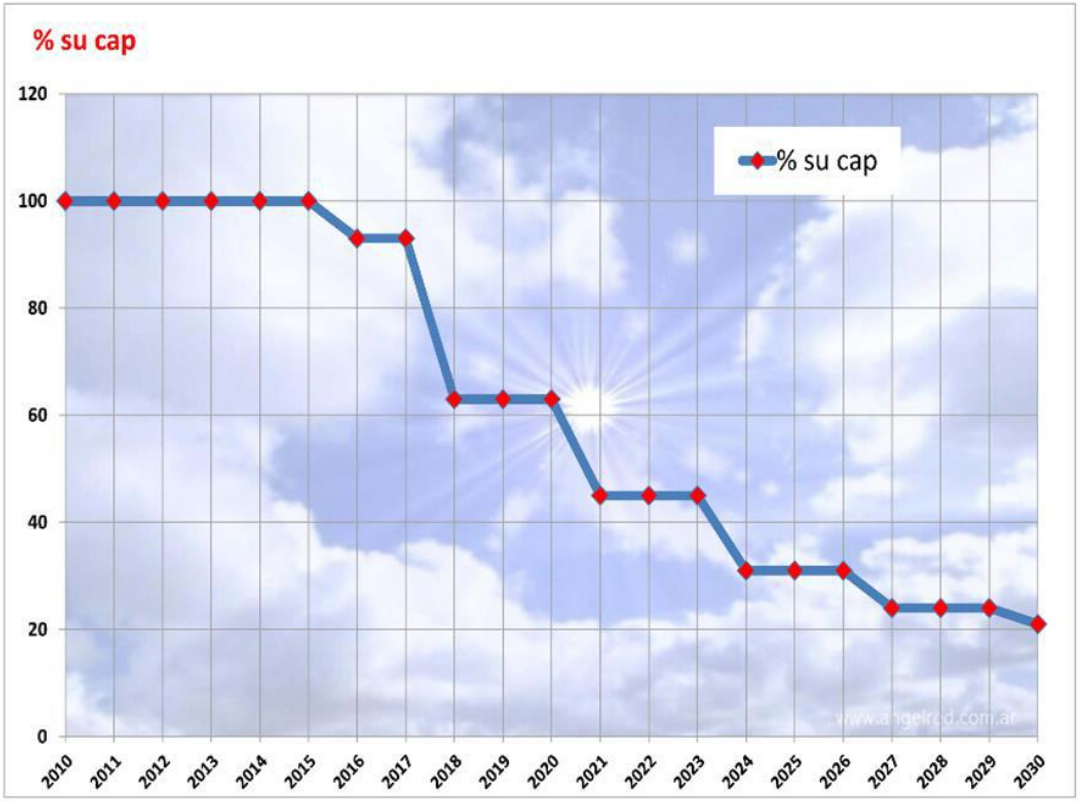
F-gas Regulation 517/2014

continuous phase-down of HFC refrigerants, “NOT PHASE OUT”



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F-gas Regulation 2024/573

- On 7th February 2024 European Commission revised Regulation (EU) No 517/2014 and approved The new F-gas Regulation (EU) 2024/573 in force from 11th March 2024.

- **Key Changes in the F-Gas Regulation**
  - ✓ Complete phase-out of hydrofluorocarbons (HFCs) consumption by 2050. HFCs, known for their high GWP, have been a major concern in efforts to combat climate change.
  - ✓ Regular reviews by the European Commission, with the first assessment scheduled no later than 1ST January 2030 to evaluate the availability of cost-effective, technically feasible, and environmentally friendly alternatives to HFC.

-> the shift towards refrigerant with low GWP and natural refrigerant

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New F-gas Regulation: bans and restrictions

MONOBLOCK Units	2027	2030	2032
Chiller < 12 kW	GWP 150		Natural gases
Chiller > 12 kW	GWP 750		
Heat Pumps < 12 kW	GWP 150		Natural gases
Heat Pumps < 50 kW	GWP 150		
Heat Pumps > 50 kW		GWP 150	

SPLIT	2027	2029	2033	2035
A/W < 12 kW	GWP 150			Natural refrigerants
A/A < 12 kW		GWP 150		Natural refrigerants
> 12 kW		GWP 750	GWP 150	

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R290 ?

- GWP
- F-gas Regulation
- Thermodynamics
- Temperature range

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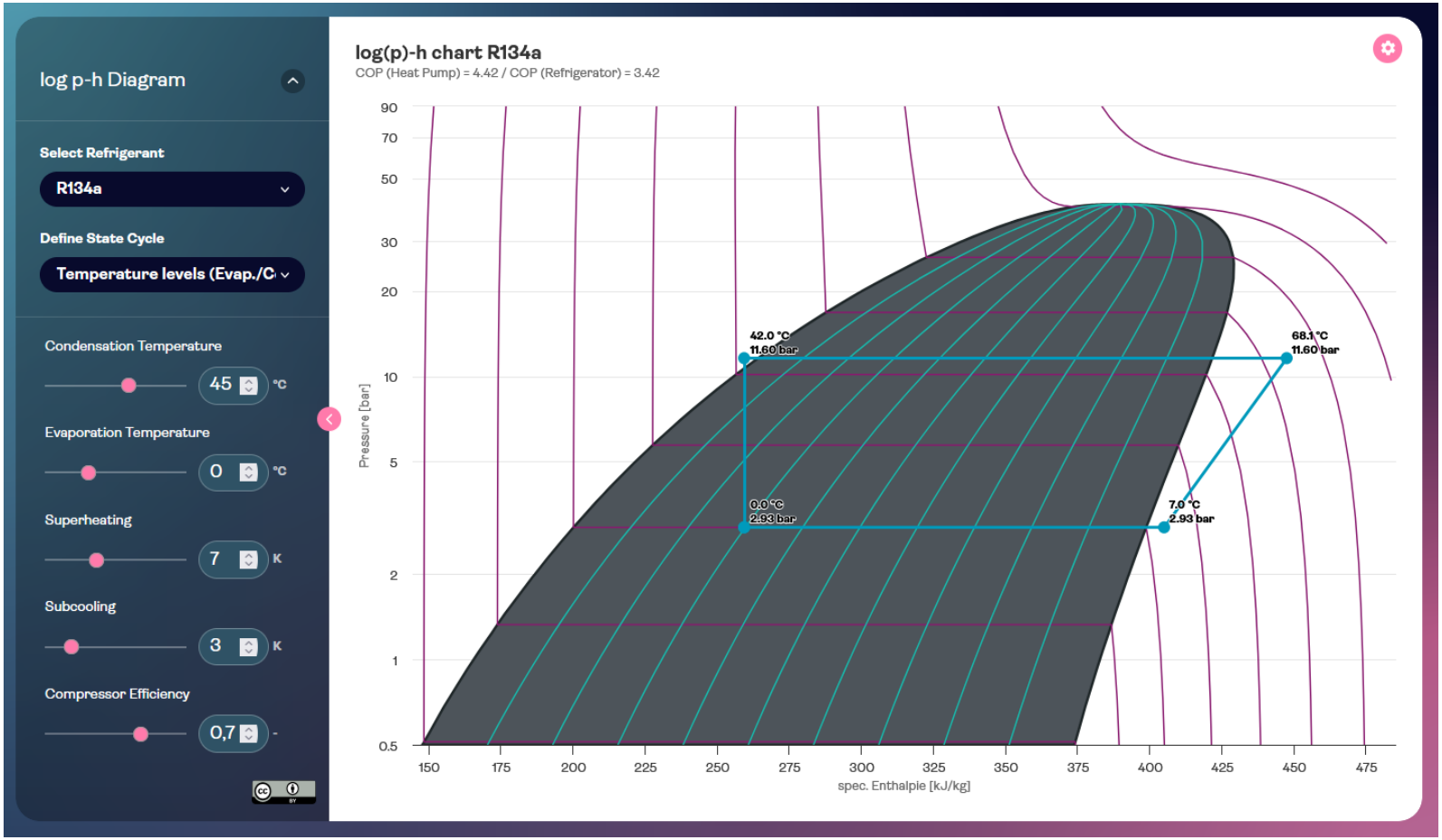
Thermodynamics



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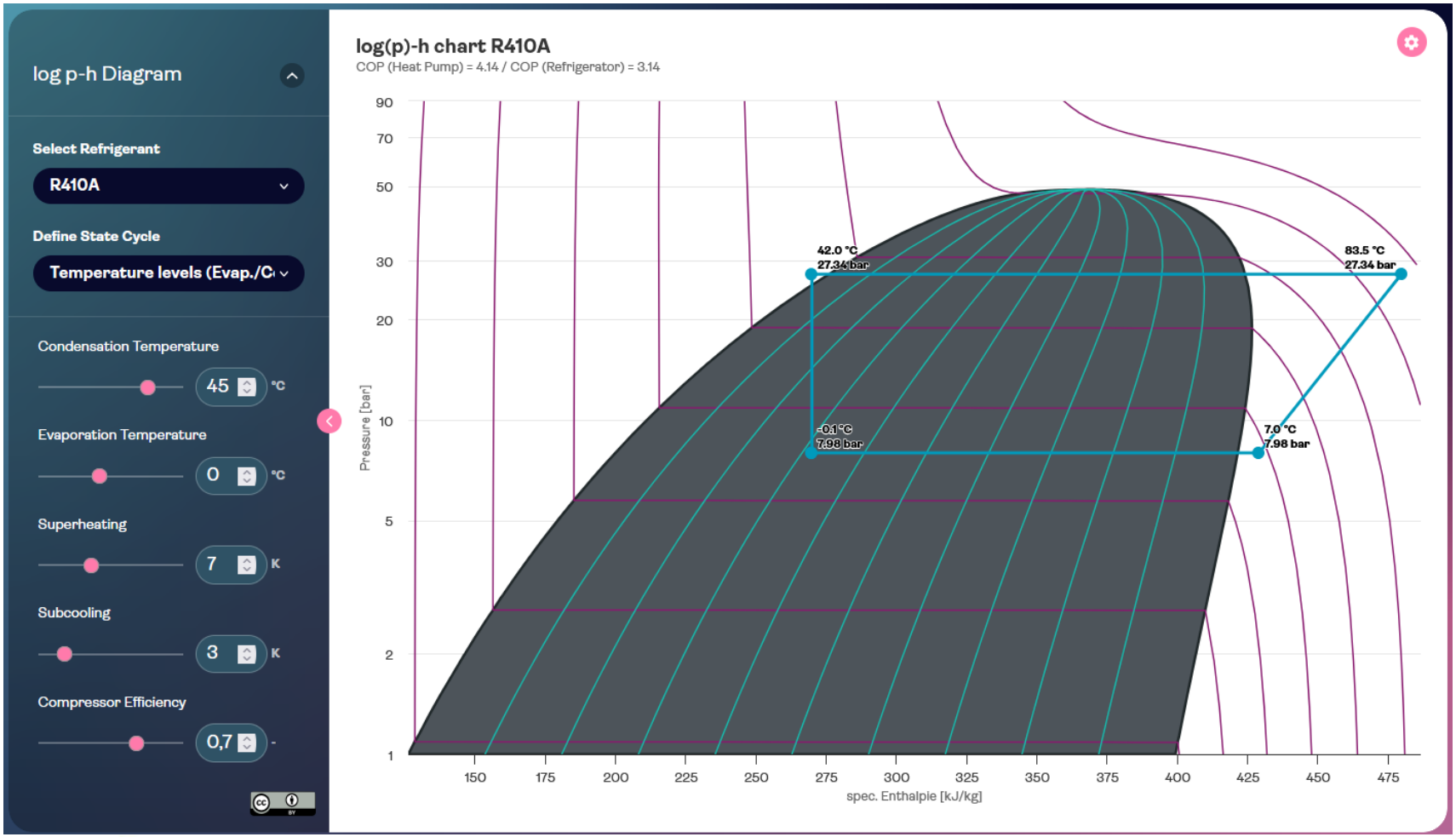
Thermodynamics



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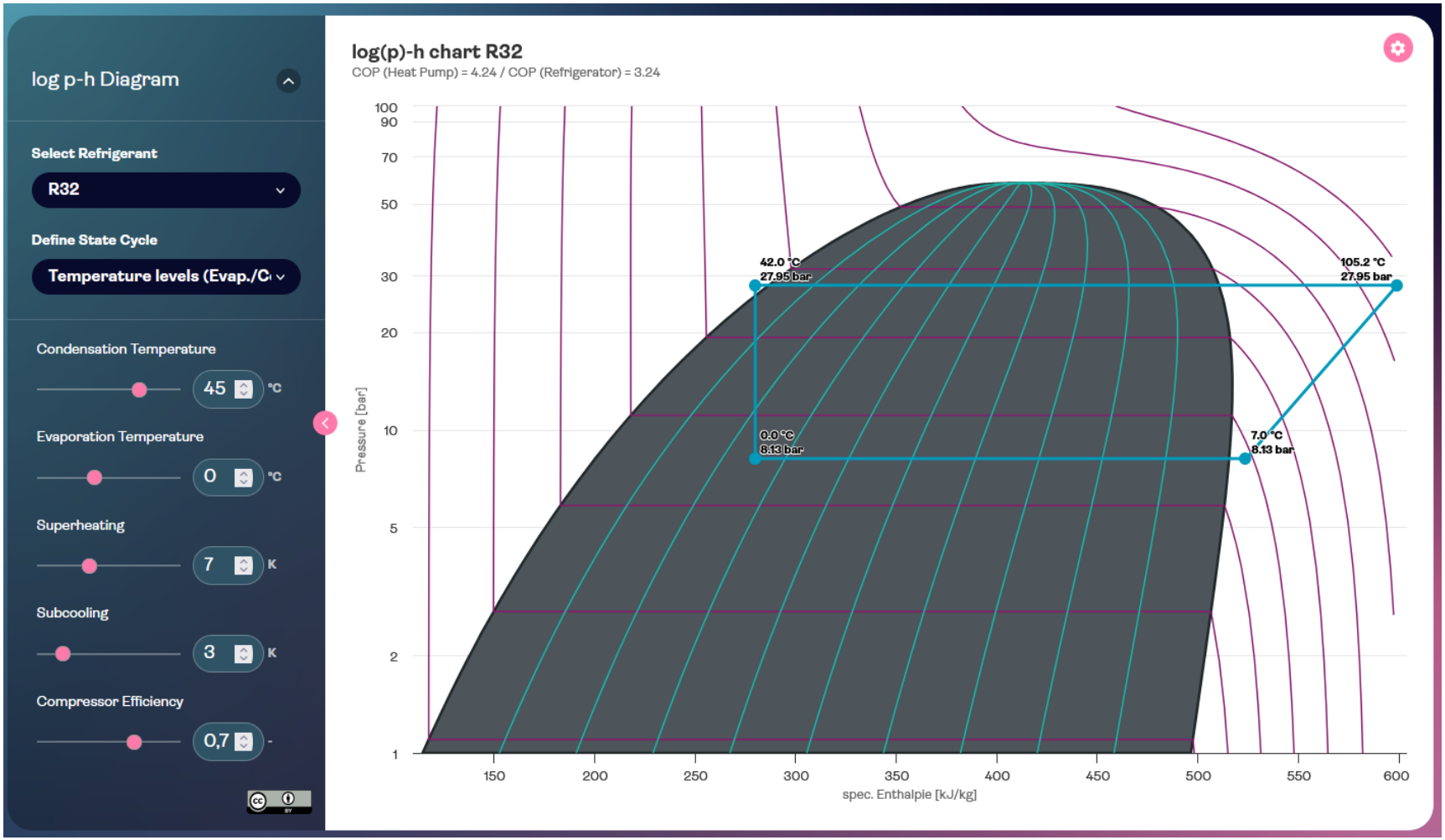
Thermodynamics



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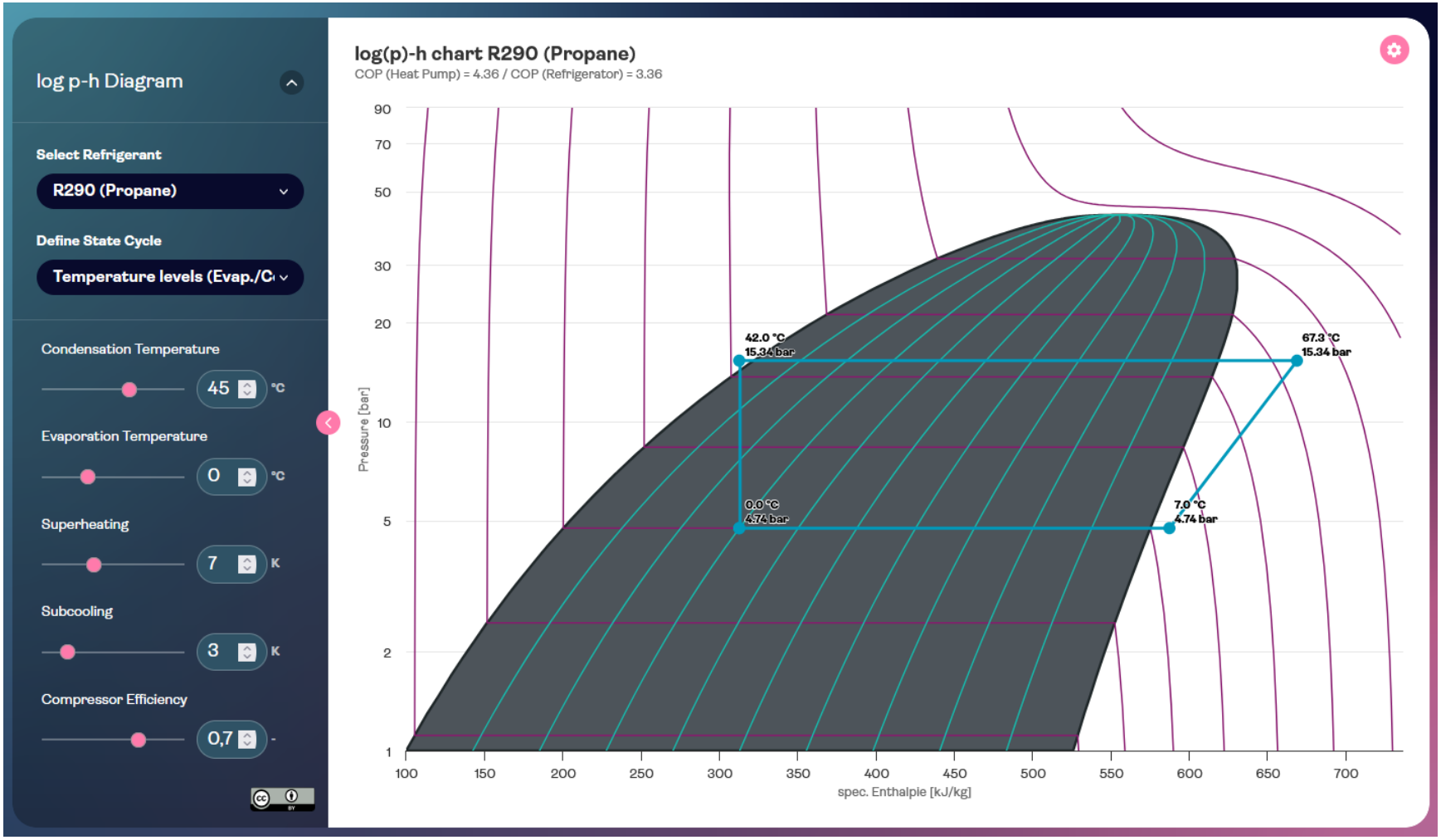
Thermodynamics



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R290 ?

- GWP
- F-gas Regulation
- Thermodynamics
- Temperature range

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Comparison table

Comparison table	GWP	Latent heat at boiling pt	LP (-25°C)	LP (0°C)	HP (45°C)	COP	Critical temperature
		kJ/kg	bar	bar	bar		°C
R290	0,02	425,6	2,03	4,74	15,34	4,36	96,7
R32	675	381	3,35	8,13	27,95	4,24	78,2
R134a	1430	217	1,06	2,93	11,6	4,42	101,1
R410A	2088	272,97	3,29	7,98	27,34	4,14	71,3

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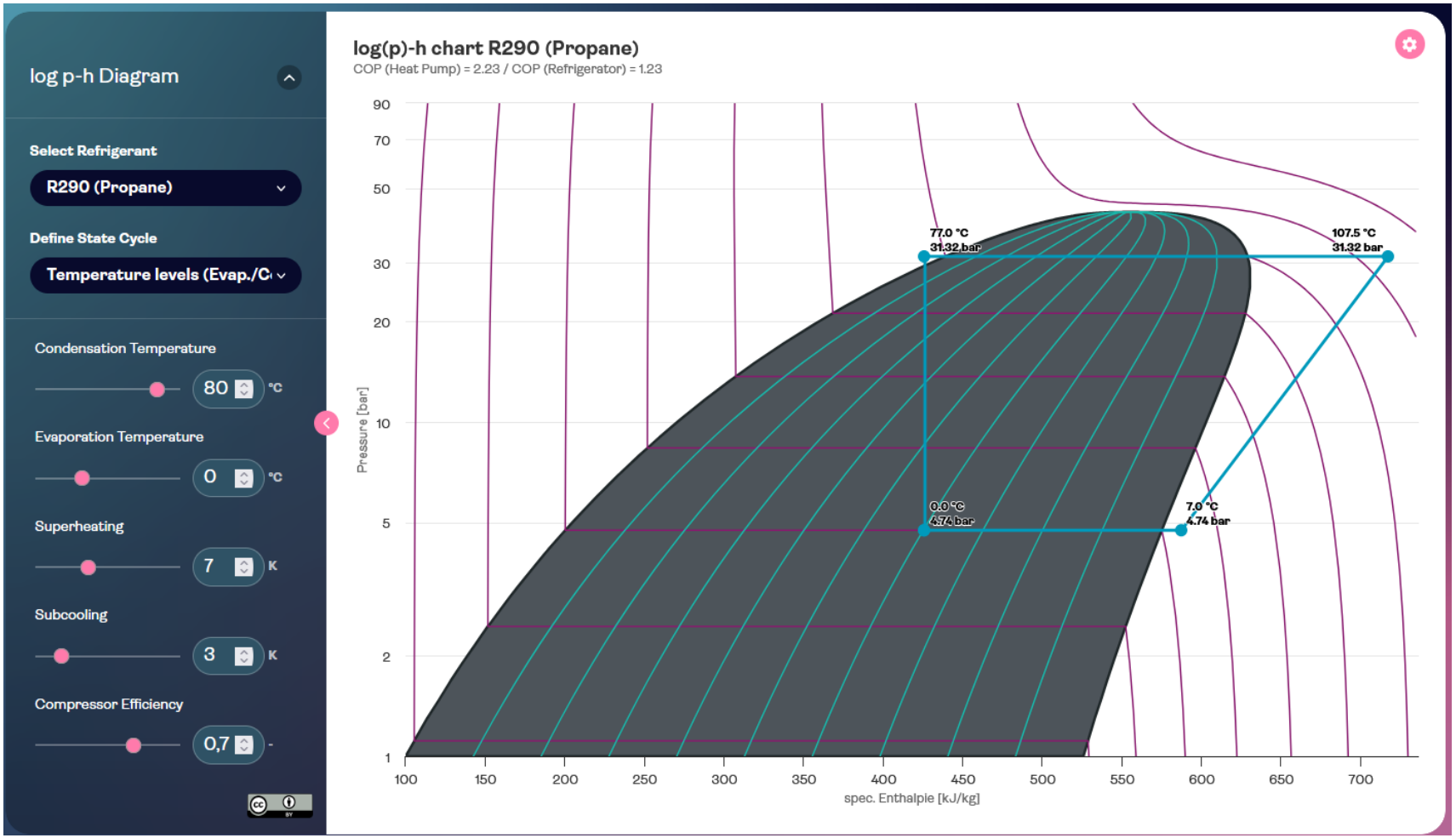
Thermodynamics



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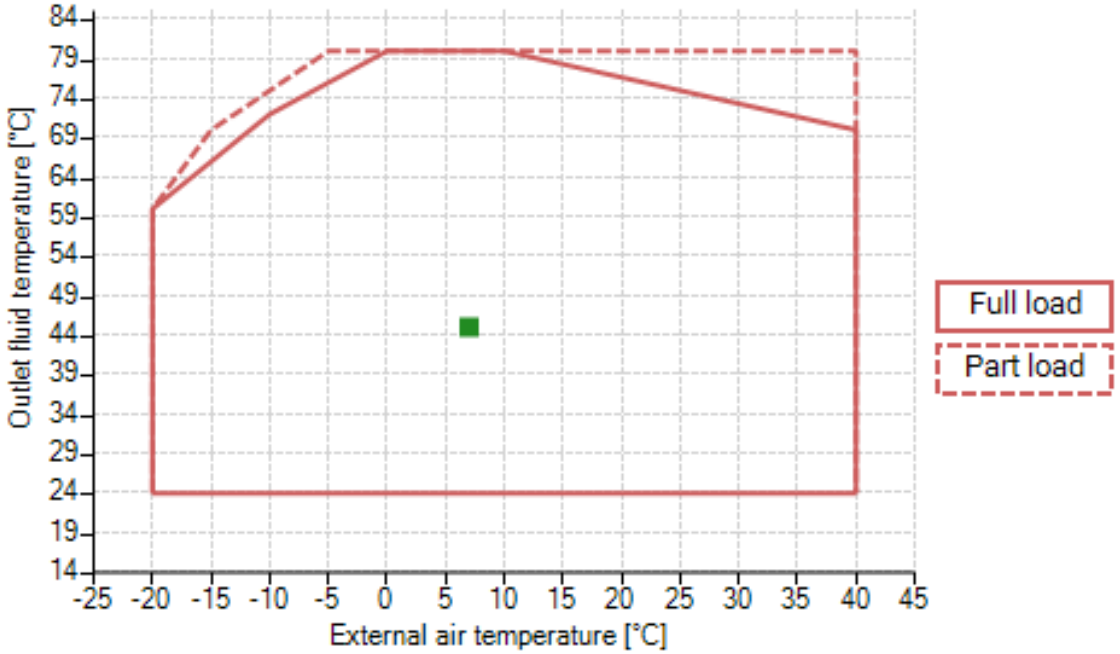
Operating limits R290 A/W

Heating



Example : RHOSS POKER PI THAITI 150

R290 ?

- GWP 👍
- F-gas Regulation 👍
- Thermodynamics 👍
- Temperature range 👍
- Classification

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Propane is used for…

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NBN EN 378

*The **standard** specifies the requirements for the **safety of people and property**, provides guidance for **environmental protection** and establishes **procedures for** the **operation**, **maintenance** and **repair** of refrigeration systems and the **recovery** of refrigerants.*

DIN EN 378-1:2021-06

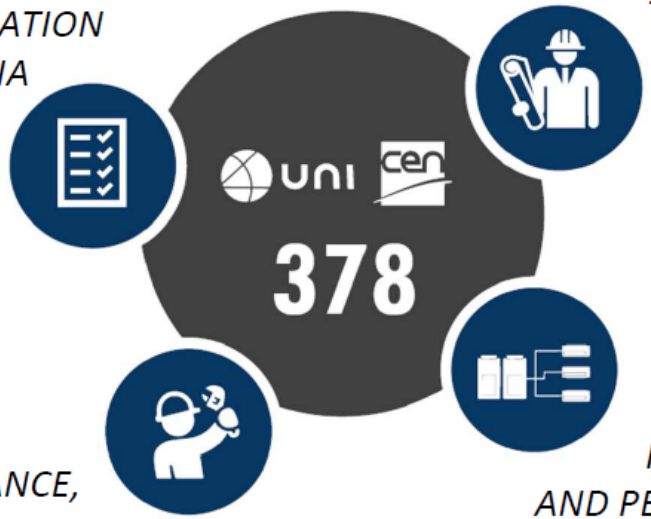
BASIC REQUIREMENTS, DEFINITIONS, CLASSIFICATION AND SELECTION CRITERIA

Design and installation context of the refrigeration system

DIN EN 378-2:2018-04

DESIGN, COSTRUCTION, TESTING,MARKING AND DOCUMENTATION

Construction of the refrigerator system



DIN EN 378-4:2017-03

OPERATION, MAINTENANCE, REPAIR AND RECOVERY

System installation, maintenance, repair and disposal

DIN EN 378-3:2020-12

INSTALLATION SITE AND PERSONAL PROTECTION

Preparation of the machine room where the refrigeration system is installed

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Class Code

Toxicity

- **A = lower toxicity** (safe in normal use, not expected to cause chronic health effects).
- **B = higher toxicity** (can cause harmful effects even at low concentrations).
  → R290 is **A** → low toxicity.

Flammability (number 1, 2L, 2, 3)

- **1 = no flame propagation** (e.g. R134a).
- **2L = lower flammability, slow flame speed** (e.g. R32,R454B).
- **2 = flammable, but higher ignition energy needed**.
- **3 = highly flammable, low ignition energy** (e.g. propane R290, isobutane R600a).

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Class 2:

LFL ≥ 0.10 kg/m³
&
minimum ignition energy (MIE) ≥ 0,1 mJ (MilliJoule)
&
burning velocity > 0,1 m/s

Class 2L:

LFL ≥ 0.10 kg/m³
&
minimum ignition energy (MIE) ≥ 0,1 mJ
&
burning velocity < 0,1 m/s

Class 3:

LFL ≤ 0.10 kg/m³
OR
minimum ignition energy (MIE) < 0,1 mJ

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If R290 is that good, why not used before?

Comparative table	GWP	Latent heat at boiling pt	LP (-25°C)	LP (0°C)	HP (45°C)	HP (85°C)	Critical temperature	CLASS
		kJ/kg	bar	bar	bar	bar	°C	
R290	0,02	425,6	2,03	4,74	15,34	34,36	96,7	A3
R32	675	381	3,35	8,13	27,95	---	78,2	A2L
R134a	1430	217	1,06	2,93	11,6	29,26	101,1	A1
R410A	2088	272,97	3,29	7,98	27,34	---	71,3	A1

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NBN EN 378-1:2016+A1:2020

R 290

Class A3

Toxicity **A : Low**

Flammability **3 : highly flammable, low ignition energy**

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R290 = Propane

R290 is not odorized because it is a high-purity propane (C3H8) that, in its natural form, is odorless. Odorants are added to natural gas for safety to detect leaks, but these impurities can interfere with the refrigerant's thermodynamic properties and are not needed for the R290 refrigerant itself to be safe or effective. However, the lack of odor makes it difficult to detect R290 leaks by smell, requiring the use of specialized leak detection equipment.

Implications of Being Odorless

Leak Detection Challenges:
Because there is no smell to indicate a leak, it can be difficult to detect R290 leaks without specialized electronic detectors.

Importance of Safety Measures:
Despite being odorless, R290 is highly flammable, so it is crucial to follow proper handling procedures, maintain good ventilation, and be aware of the increased risk of leaks to prevent ignition.

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5.1 ACCESS Category

a: unrestricted access:Hospitals, courts or prisons, theatres, supermarkets, schools, lecture halls, public transport termini, hotels, dwellings, restaurant

b: **supervised personnel**: Business or professional offices, laboratories, places for general manufacturing and where people work

c: authorized personnel only: Manufacturing facilities, e.g. for chemicals, food, beverage, ice, icecream, refineries, cold stores, dairies,abattoirs, non-public areas in supermarkets

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5.3 Location classification of refrigerating systems

IV : All refrigerant-containing parts are located in a ventilated enclosure.

III : All refrigerant containing parts are located in a machinery room or open air.

II : All compressors and pressure vessels are either located in a machinery room or in the open air. Coils and pipework including valves may be located in an occupied space.

I : The refrigerating system or refrigerant-containing parts are located in the occupied space.

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Charge Limits

- ATEL : Acute Toxicity Exposure Limit
- ODL : Oxygen Deprivation Limit
- LFL : Lower Flammability Limit

R290

ATEL/ODL : 0,09 kg/m³

LFL : 0,038 kg/m³ (2,1 vol% in air)

Molecular Mass : 44,0 g/mol (Air = 29 g/mol)

DANGEROUS CONCENTRATION is between 2,1 and 9,5 vol% in air

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NBN EN 378-1:2016+A1:2020

Toxicity class	Access category		Location classification			
			I	II	III	IV
A	a		Toxicity limit × Room volume or see C.3	No charge restriction [a]	No charge restriction [a]	The charge requirements based on toxicity shall be assessed according to location I, II or III, depending on the location of the ventilated enclosure
	b	Upper floors without emergency exits or Below ground floor level	Toxicity limit × Room volume or see C.3			
		Other	No charge restriction [a]			
	c	Upper floors without emergency exits or Below ground floor level	Toxicity limit × Room volume or see C.3			
		Other	No charge restriction [a]			

Example of charge limit requirements for refrigerating systems based on toxicity (From Table C.1)

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NBN EN 378-1:2016+A1:2020

Flammability class	Access category			Location classification			
				I	II	III	IV
3	a	Human comfort		According to C.2 and not more than the greater of m_2 or 1,5 kg		Not more than 5 kg [c]	Refrigerant charge not more than m_3 4,94 kg
		Other applications	Below ground	Only sealed systems: 20 % × LFL × Room volume and not more than 1 kg			
			Above ground	Only sealed systems: 20 % × LFL × Room volume and not more than 1,5 kg			
	b	Human comfort		According to C.2. and not more than the greater of m_2 or 1,5 kg		Not more than 10 kg [c]	
		Other applications	Below ground	20 % × LFL × Room volume and not more than 1 kg [a]			
			Above ground	20 % × LFL × Room volume and not more than 2,5 kg			
	c	Human comfort		According to C.2. and not more than the greater of m_2 or 1,5 kg.		No charge restriction [c]	
		Other applications	Below ground	20 % × LFL × Room volume and not more than 1 kg [c]			
			Above ground	20 % × LFL × Room volume and not more than 10 kg [c]	20 % × LFL × Room volume and not more than 25 kg [c]		

[a] m_2 = 26 m^3 × LFL. [b] m_3 = 130 m^3 × LFL.
[c] For open air, EN 378–3:2016, 4.2 applies and, for machinery rooms, EN 378–3:2016, 4.3 applies.

Example of charge limit requirements for refrigerating systems based on flammability (From Table C.2)

R290 LFL = 0,038 => a: 26m³*0,038 = 0,99 kg

b: 130m³*0,038 = 4,94 kg

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NBN EN 378-1:2016+A1:2020

Flammability class	Access category			Location classification			
				I	II	III	IV
3	a	Human comfort		According to C.2 and not more than the greater of m_2 or 1,5 kg		Not more	
	a		Below	Only sealed systems:			
	b	Other applications	Below ground	20 % × LFL × Room volume and not more than 1 kg [a]		more than 10 kg [c]	m_3 4,94 kg
	b	Other applications	Above ground	20 % × LFL × Room volume and not more than 2,5 kg			
	c	Human comfort		According to C.2. and not more than the greater of m_2 or 1,5 kg.		No charge restriction [c]	
	c	Other applications	Below ground	20 % × LFL × Room volume and not more than 1 kg [c]			
	c	Other applications	Above ground	20 % × LFL × Room volume and not more than 10 kg [c]	20 % × LFL × Room volume and not more than 25 kg [c]		

[a] $m_2 = 26\ m^3 \times LFL$. [b] $m_3 = 130\ m^3 \times LFL$.
[c] For open air, EN 378–3:2016, 4.2 applies and, for machinery rooms, EN 378–3:2016, 4.3 applies.

Example of charge limit requirements for refrigerating systems based on flammability (From Table C.2)

According C2.

For unit filled with 300g R290 at a floorheight 60cm, you need a minimum surface area of 142 m².

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DEFINITION OF ATEX

What's the meaning of ATEX and how is the definition of ATEX Zone?

ATEX classification

Hazardous Areas are classified into 3 Zones based upon frequency of the occurrence and duration of an explosive gas atmosphere, as follows:

- ZONE 0

- Area in which an explosive gas atmosphere is present continuously or for long periods or frequently

- ZONE 1

- Area in which an explosive gas atmosphere is likely to occur in normal operation occasionally

- ZONE 2

- Area in which an explosive gas atmosphere is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

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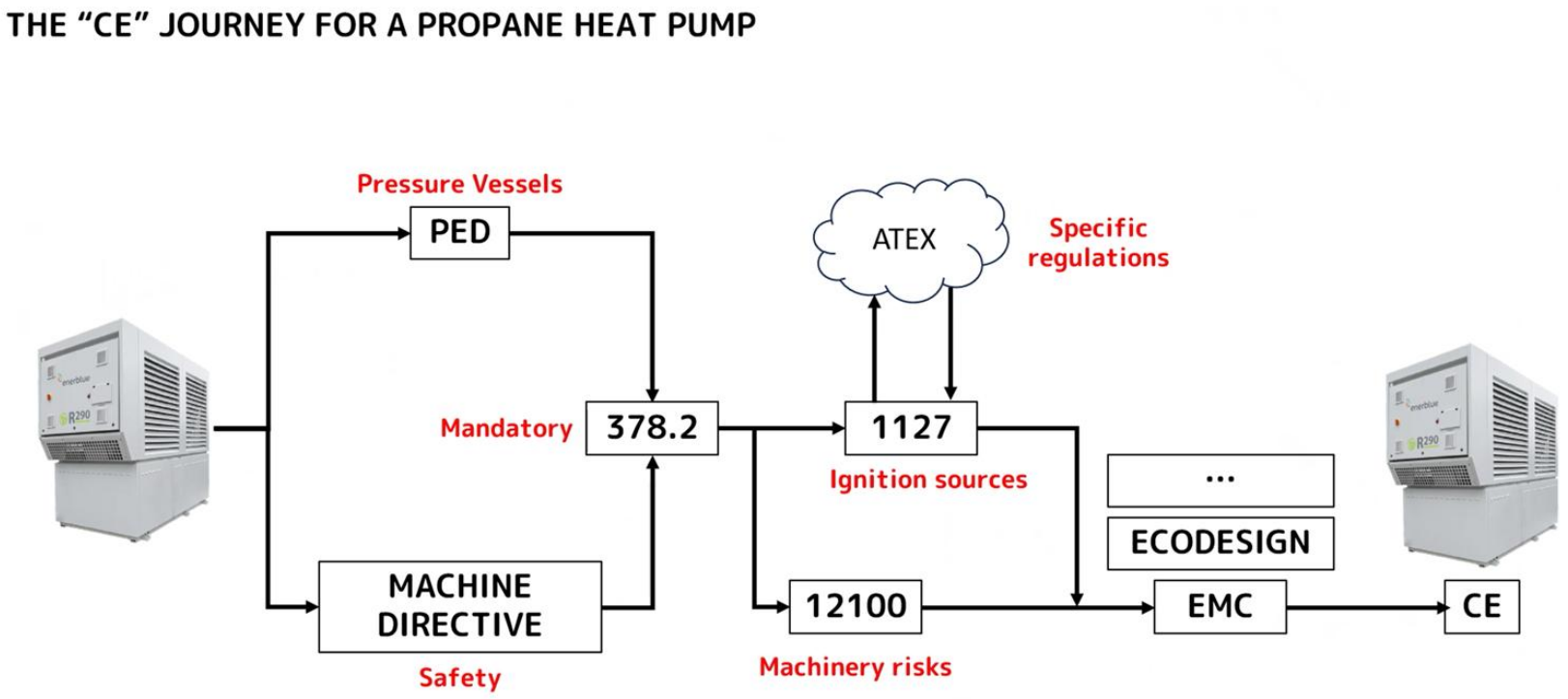
Manufacturer



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Manufacturer

BASED ON INTERNAL RISK ANALYSE BASED ON EN ISO 12100

Manufacturer will suggest minimum distances to avoid any kind of risk in case of a controlled or uncontrolled leakage.

Controlled leakage

- If the gas leakage is inside the compressor casing which has an active gas sensor and Atex fan.

Uncontrolled leakage

- If the leakage is outside the compressor casing (example coils).

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Mini Tube Coils

- 5mm diameter
- Very low refrigerant charge!

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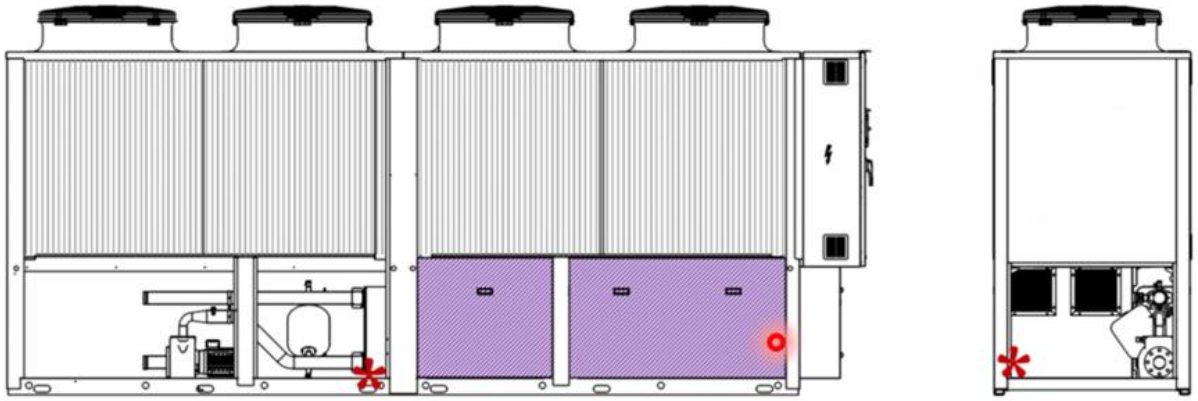
Compessor box



COMPRESSOR BOX

Location of PRV vent

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Compessor box

COMPRESSOR BOX

1

GAS LEAK DETECTOR

In case of refrigerant leak inside the compressor box:

- the power supply is disconnected
- the extraction fan (ATEX certified) is switched on to clean the compressor box.

2

ATEX

The ATEX certified extraction fan runs at nominal speed to clean the compressor box.

3

ATEX

All the components inside the compressor box are ATEX certified: compressors, solenoid valves, EEV. The box is always insulated as standard.

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Forced ventilation systems

ATEX EXTRACTION FAN

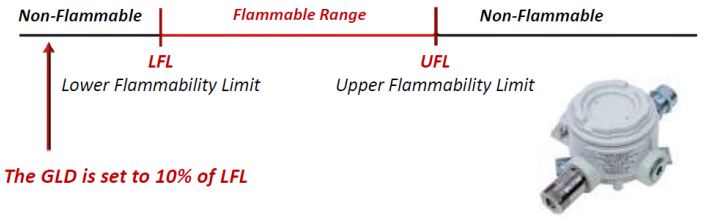
- Compressors are closed in a box equipped with ATEX certified extraction fan;

- Fan running at low speed during normal function;
- Maximum fan speed in case of leakage signalization

Air Pressure switch checking the ventilation status for the compresor box if unit is properly ventilated. It triggers alarms and stops the unit or prevent start up if there is no air flow for the compressor box. Fan broken, or box not closed.

LEAKAGE DETECTOR

- Gas presence sensor composed by an electronic detector combined with catalytic sensor able to reveal a Propane gas presence in the air with a sensibility of 10% necessary explosion quantity (LFL).
- In case of leakage and due to an internal safety connection, the power supply of the complete unit will be switched off apart of the sensor and the extraction fan.



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R290 Spaces of safety, respect and positioning

- TO DO : RISC ANALYSIS !!

  A risk analysis must be drawn up for each installation.
  Local regulations must be followed.

- Outside: EN 378-2 + Guidelines manufactorer

- Inside: EN 378-2

  Machinery Room

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Spaces of safety, respect and positioning

ATEX ZONE 2 - SAFETY DISTANCES

It must be ensured that in the category 2 zone:

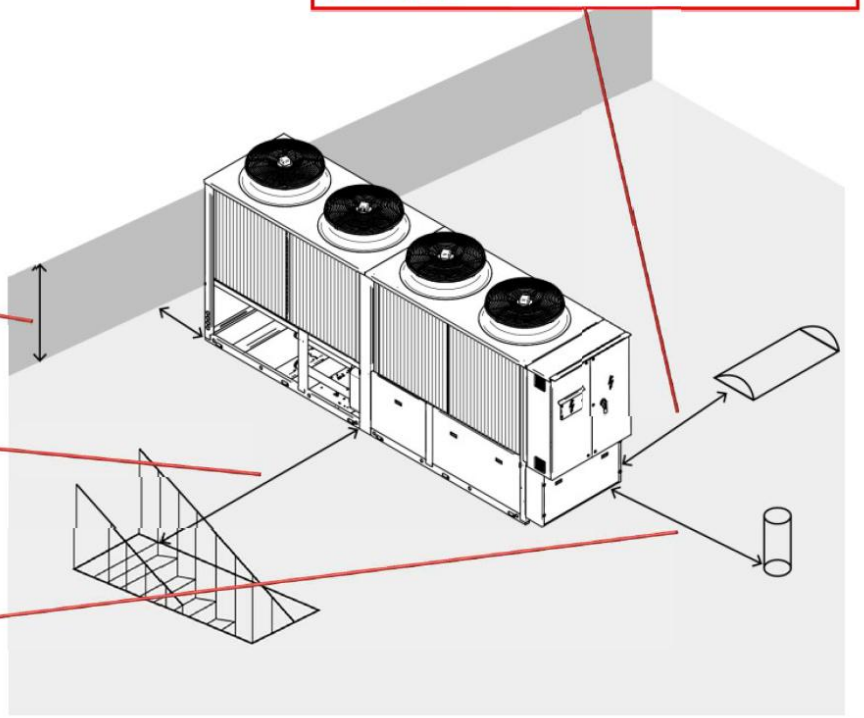
- *There are no sparks or sources of ignition;*
- *No drains, floor drainage etc.*
- *No pedestrian zone;*
- *No access for persons without appropriate authorization/qualification*

Distance to any window (just possible if window continuously closed) ***min 2,5 m***

Walls ***min 1m*** *height*

Distance to stairs (→ Downstairs) ***min 2,5 m***

Distance to air discharge pipe or any kind of drain ***min 2,5 m***



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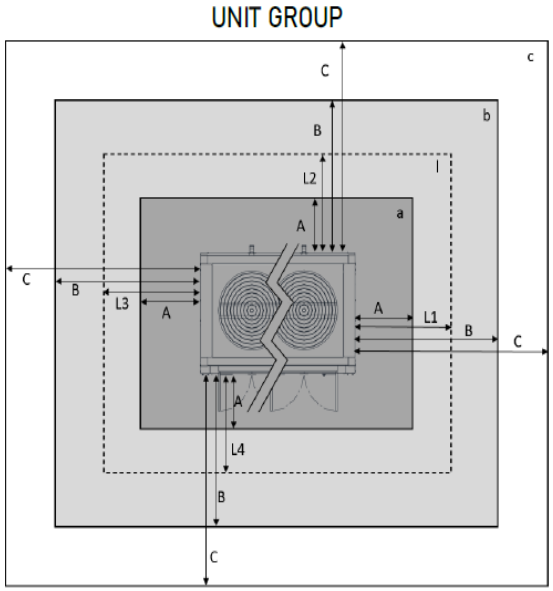
enerblue INSPIRED BY NATURE

Spaces of safety, respect and positioning



A	mm	500
B	mm	2500, 5000 for public places
C	mm	15000
L1	mm	1000
L2 (*)	mm	1000
L3 (*)	mm	1000
L4 (**)	mm	1000, 1400 if group

Distance A equal to 0.5m (compliant w ith safety area **"a"** as per paragraph "Safety spaces, respect and positioning") from any ignition source.

In order that any gas leaks cannot accumulate in enclosed or local spaces, a minimum horizontal safety **distance B** of 2.5m must be provided (compliant with safety area **"b"** as per paragraph "Safety, compliance and positioning spaces") (or in accordance w ith any local regulations in
force if more restrictive) from openings w here dispersed gas could stagnate. This minimum safety distance shall be increased to 5,0 m for premises intended for public establishments, collectives, places of assembly, entertainment or the public.

Minimum safety **distance C** equal to 15.0m (compliant w ith safety area **"c"** as per paragraph "Safety spaces, respect and positioning“) in plan projection from railway, tramway and high-voltage pow er lines.

The unit is designed for outdoor installation

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RHOSS

W/W units: installation

1) In case of propane leakage, the area where the gas is evacuated is a potentially dangerous area (zone 2 by ATEX).
2) It could happen that safety valve evacuates propane: the installer must provide suitable piping to allow the gas to be discharged outside. Even in this case there will be an area that could be risky (zone 2 by ATEX).

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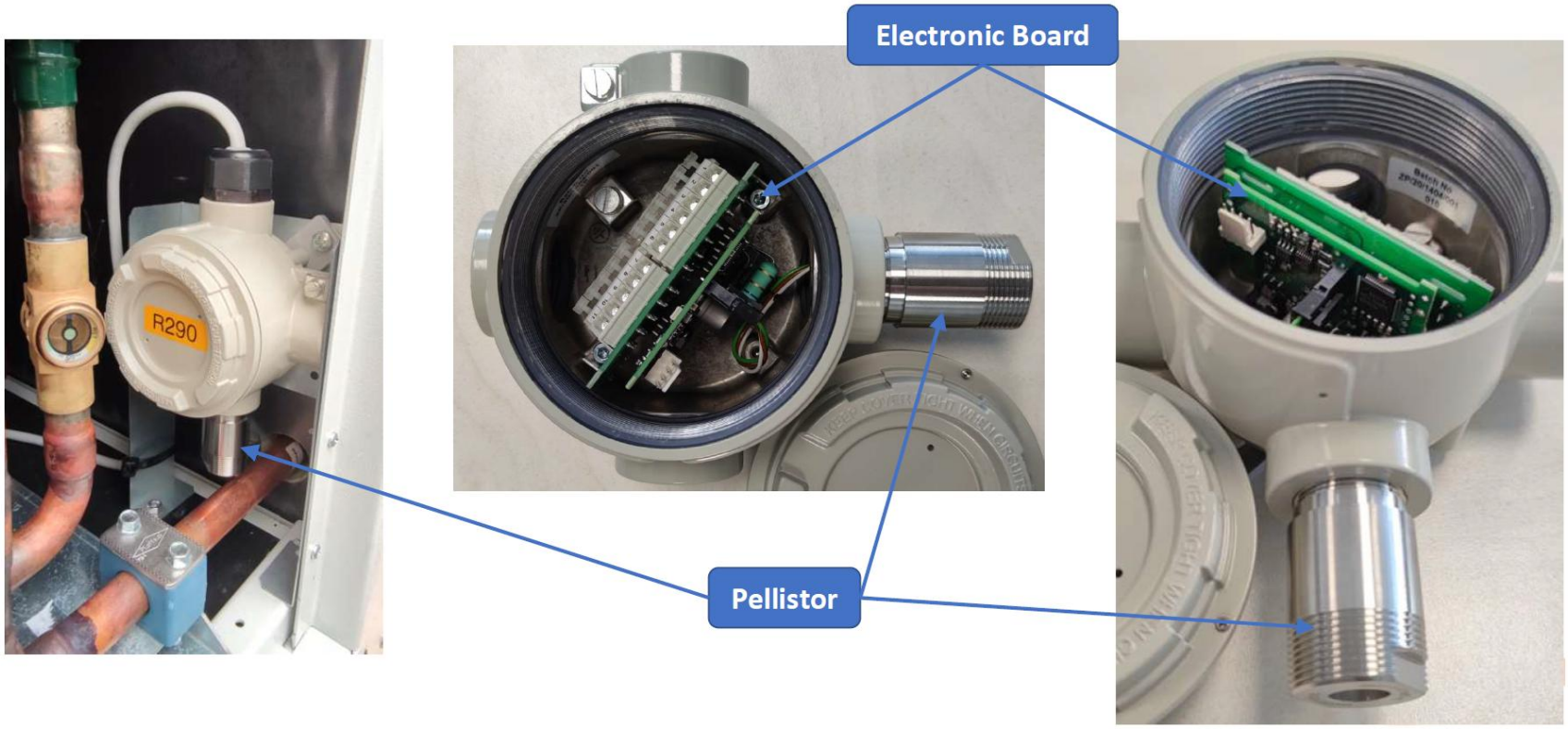
Gas Leakage Detector



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Extraction Fan

Differential pressure switch

Hole for air extraction duct connection

Extraction fan

In case the pressure difference between inside and outside of the unit is **below than 20 Pa**, the unit cannot be powered.

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NBN EN 378-1:2016+A1:2020

Flammability class	Access category			Location classification			
				I	II	III	IV
3	a	Human comfort		According to C.2 and not more than the greater of m_2 or 1,5 kg		Not more than 5 kg [c]	Refrigerant charge not more than m_3 4,94 kg
		Other applications	Below ground	Only sealed systems: 20 % × LFL × Room volume and not more than 1 kg			
			Above ground	Only sealed systems: 20 % × LFL × Room volume and not more than 1,5 kg			
	b	Human comfort		According to C.2. and not more than the greater of m_2 or 1,5 kg		Not more than 10 kg [c]	
		Other applications	Below ground	20 % × LFL × Room volume and not more than 1 kg [a]			
			Above ground	20 % × LFL × Room volume and not more than 2,5 kg			
	c	Human comfort		According to C.2. and not more than the greater of m_2 or 1,5 kg.		No charge restriction [c]	
		Other applications	Below ground	20 % × LFL × Room volume and not more than 1 kg [c]			
			Above ground	20 % × LFL × Room volume and not more than 10 kg [c]	20 % × LFL × Room volume and not more than 25 kg [c]		

[a] m_2 = 26 m^3 × LFL. [b] m_3 = 130 m^3 × LFL.
[c] For open air, EN 378–3:2016, 4.2 applies and, for machinery rooms, EN 378–3:2016, 4.3 applies.

Example of charge limit requirements for refrigerating systems based on flammability (From Table C.2)

R290 LFL = 0,038 => a: 26m³*0,038 = 0,99 kg

b: 130m³*0,038 = 4,94 kg

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W/W units with scroll compressors

Flamability risk analysis

All component or junctions of the unit are classified as hermetic (EN ISO 14903)

The unit and its components **are not Atex classified.**
But to ensure the compliance with standards (EN 378,...) the unit is classified as a

VENTILATED ENCLOSURE

It means that the units can be installed within an occupied space.

- It is necessary to install a fan (ATEX certified) with a min flow rate, always active;
- The airflow shall be monitored continuously, and the refrigerating system is switched into a safe mode within 10 s in the event that the airflow is reduced below Qmin;
- The negative pressure measurement in the interior of the enclosure **shall be 20 Pa or more**;
- Fan could be installed inside the unit or better outside, close to the discharge;
- It isn't mandatory, but possible as an option, install a leak detector ATEX certified;
- All the flammability safety component must be electrically supplied independently by the unit.

The safety valves are not installed, only safety pressure switch, in compliance to the standard EN378-2.
Provide for a free distance of no less than 5 m from the exhaust outlets of the fans.

Machinery Rooms

- Minimum requirements for A2, A2L, A3

Always: Normal ventilation: ≥ 4 ACH

Always: Gas detection & trip levels (setpoint 20% LFL)

Always: Emergency ventilation: ≥ 30 ACH

Always: Alarming + Security Button
on in & outside machinery room.

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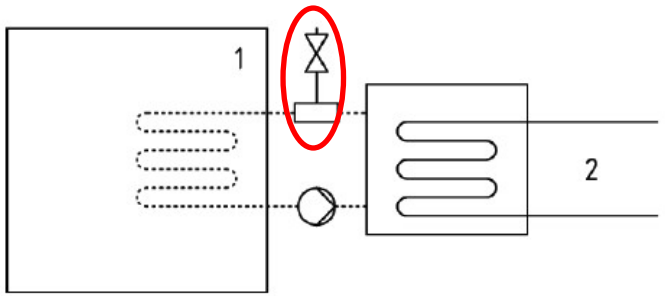
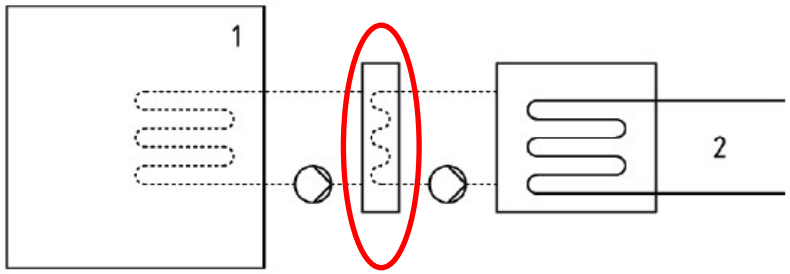
ACH (Air Changes / Hour)

WATER SIDE CONNECTION

- To avoid any kind of refrigerant entering into the water circuit in case of a leakage , the solutions which can be applied are various:





ATTENTION:
Water safety valve !
Air purge !

1. occupied space.
2. refrigerant-containing parts

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Service rules for R290

work environment

- Only in a **well-ventilated** or open area.
- **No ignition sources**: no smoking, no hot lamps, no sparking tools.
- Keep **fire extinguisher** nearby (powder or CO_2 type).
- **Explosion-proof ventilation fan**: to sweep potential gas cloud out of work area.

tools & equipment

- Use ATEX-rated or intrinsically safe tools where a leak cloud is possible.
- Recovery machine, vacuum pump, and refrigerant scale must be approved for hydrocarbons.
- **Electronic leak detector**: ATEX-rated, calibrated for propane

competence

- Only trained, certified persons should work on R290

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Managing safety: Suggestions and tips.

- Carefully avoid all sources of ignition of fire or explosion.
- Use devices (gas recuperator, vacuum pump, etc.) specifically designed for explosive gases. Adopt all precaution to avoid any small gas losses during interventions on site.
- As a precaution, always use an Atex fan when you are carrying out operations that could prove dangerous.
- Use anti-static clothing (ISO 1149) to avoid being a potential ignition source.
- Use a wearable propane gas detector

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Managing safety: Intervention in the refrigerant circuit.

Remove and weight the refrigerant present inside the circuit; be careful removing the refrigerant from all the branches of the whole refrigerant circuit. Use devices (gas recuperator, vacuum pump, etc.) specifically designed for explosive gases.

ATTENTION: propane must be removed from both circuits!!

Before working on the refrigerant circuit, be 100% sure that there is no trace of propane gas.
How this result can be reached?
After recovering the gas:

- a. “Clean” the circuit by pressing with nitrogen (3-4 bar).
- b. Evacuate the circuit.
- c. Make vacuum at 50 mbar.
- d. “Clean” the circuit by pressing with nitrogen (3-4 bar).
- e. Evacuate the circuit.
- i. Check with gas leak detector the presence of propane.

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Maintenance

Leakdetection

Calibrate sensors according to manufacturer specifications; check for interfering chemicals.

competence

- Only trained, certified persons should work on R290.
- Regular refresh on ATEX and EN 378 service procedures.

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Classification

R290 is indeed flammable

That danger is real, and we must never downplay it.

But because we know this risk inside out, we can deal with it in a professional, controlled way. With today's technology

- Smart leak detection with high precision
- ATEX-safe tools
- Designs that keep the refrigerant charge to a minimum

we can turn that risk into a managed factor, not a show-stopper. That makes R290 not only safe to apply, but also the logical and future-proof choice.

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R290 ?

- GWP 👍
- F-gas Regulation 👍
- Thermodynamics 👍
- Temperature range 👍
- Classification 👍

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Bedankt voor het volgen van het webinar!

Geef ons aub uw feed-back door het evaluatieformulier in te vullen dat we u hebben doorgemaild of door te klikken op de link hiernaast in de chat!

Morgen krijgt u de presentaties per mail alsook de video

Merci d'avoir suivi notre webinaire!

Donnez-nous votre avis en remplissant le formulaire d'évaluation que nous vous avons envoyé par e-mail ou en cliquant sur le lien à côté dans le chat !

Demain, vous recevrez les ppt ainsi que la vidéo par mail

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