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European Heat Pump Association AISBL

Explanatory note on the need for a diversified use of refrigerants in the heat-pump sector

v.2

Introduction

The European Commission is preparing a proposal to revise *REGULATION (EU) No 517/2014 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006* (hereafter, F-gas Regulation). The proposal is expected to be adopted in April 2022 and submitted to the European Parliament and the Council, starting herewith an ordinary legislative procedure.

The European Heat Pump Association (EHPA), representing the heat-pump technologies value chain in Europe (heat pump and component manufacturers, research institutes, universities, testing labs and energy agencies) has expressed the views and suggestions of the industry in its position paper on the F-gas Regulation Review.

Given the **urgency to phase-out gas and other fossil fuels used for heating in Europe** and the undisputed need to quadruple the amount of heat pumps to be installed by 2030 for that very purpose, the paper leads to the conclusion that **any new measure that would limit the availability or the choice of refrigerants (bans, increased quotas) to be used by heat pumps in the foreseeable future cannot have any other effect than slowing-down the speed at which heat pumps must be installed and carbon-neutrality achieved**.

The paper states that in order to meet the European Green Deal objectives and the new level of ambition brought by the "Fit for 55" package it is crucial that the revised F-gas Regulation supports the required accelerated deployment of heat pumps by 2030, for which purpose *"**The Regulation should support a diversified use of refrigerants**. No heat-pump technology may be hampered, based on its refrigerants contents, to bring its necessary environmental contribution in a safest possible way today."*

This explanatory notes illustrates the reasons supporting a policy framework in which the diversified use of refrigerants could be maintained by presenting:

- the diversity in heat-pump applications;
- the diversity in heat-pump technologies;
- the diversity of aspects to be considered for each use case.

1. The diversity in heat-pump applications

Heat pumps fulfil space heating, cooling and hot water production needs across various parts of the society and the economy.

<u>Here is a non-exhaustive list of some heat-pumps applications:</u>

For further information, examples and illustrations, please consult the White paper *"Heat Pumps Integrating technologies to decarbonise heating and cooling"* and www.ehpa.org.

- single homes
- multi-family homes
- multi apartments buildings
- commercial areas offices
- public buildings, including social housing
- hospitals
- schools
- hotels
- large space areas
- industrial processes
- district heating and cooling

2. The diversity in heat-pump technologies

The benefits of heat pumps for the above-mentioned applications can be performed through a large range of technologies which all have their specific qualities and variations.

Here is a non-exhaustive list of some heat-pumps technological variations

For further information, examples and illustrations, please consult the White paper *"Heat Pumps Integrating technologies to decarbonise heating and cooling"* and www.ehpa.org.

- Variation in usages:
  - space heating
  - space cooling
  - water heating
  - combi (space and water heating)
  - multi functions (space/water heating + ventilation or space/water heating + air cooling)
  - district heating/cooling
  - industrial processes

- Variation in main thermal source:
  - Air
  - Water
  - Ground
  - Sewage water

- Variation in energy input:
  - Electricity
  - Gas
  - Hybrid solutions

- Variation in sinks:
  - air
  - water
  - brine

- Variation in capacities

- Variation in systems:
  - split systems
  - monobloc (outdoor , indoor)
  - integrated in ventilation systems

- Variation in compressor types:
  - rotary
  - scroll
  - screw
  - centrifugal

- Variation in capacity modulation:
  - on\off
  - staged
  - inverter

- Variation in refrigerants used:
  - HFCs
  - HFOs
  - Blends
  - Non-fluorinated (HC, $C0_2$, NH_3)

Overview of typical refrigerants used in heat pumps (source: *Heat Pumps Integrating technologies to decarbonise heating and cooling* (2018), based on Bitzer refrigerant report 19 (A-501-19)):

NAME	GROUP	FLAMMABILITY	SAFETY CLASS	GWP (AR 4)
R32	HFC	mild	A2L	675
R125	HFC	no	A1	3500
R134A	HFC	no	A1	1430
R152A	HFC	yes	A2	124
R245FA	HFC		B1	1030
R404A	HFC	no	A1	3922
R407C	HFC	no	A1	1774
R410A	HFC	no	A1	2088
R1234YF	HFO	yes	A2L	4
R1234ZE	HFO	yes	A2L	7
R448A	HFO	no	A1	1387
R449A	HFO	no	A1	1397
R290 PROPANE	Hydrocarbon	high	A3	3
R600	Hydrocarbon	high	A3	3
R717	Amonia	no	B2L	0
R744	Carbondioxide	no	A1	1

3. The diversity of aspects to be considered for each use case

The large variety of applications for heat-pumps also comes with additional regulatory/environmental considerations that need to be taken into account before applying the best technological choice to a use case.

<u>Here is a non-exhaustive list of aspects to be considered when chosing the best technological variations:</u>

- installation constraints (limited spaces, longer pipping lengths, access to the heat pump)
- technical feasibility, performance
- safety of the product and related rules
- safety of people, installers and workers and related rules
- energy-efficiency requirements (and further improvements potential)
- material efficiency requirements
- cost-effectiveness and total cost of ownership for the end-user
- new building/renovation plans and standards
- easy installation and qualification of installers
- availability of components (including refrigerants)
- sound levels
- climate conditions
- demand-response requirements
- reusing, recycling, reclaiming of refrigerants
- practices on field from installers linked to their habits, and different in each country[1]
- other national, regional and local requirements, regulations and standards

Conclusion

Many aspects need to be considered when opting for the most suitable heat-pump solution for a given use case (see example in the annex below). Among the diversity of technological solutions at stake, refrigerant are only one piece of the puzzle. **A "silo" approach on refrigerants could lower EU's climate ambition level and lead to unwanted environmental, social, economic and political consequences for EU's citizens and businesses.**

The joint commitment by industry and policymakers to speed up the deployment of heat pumps by 2030 and beyond requires a flexible regulatory framework regarding the choice of refrigerants (such as the one offered by the current F-gas Regulation). On the contrary, **any new measure that would limit the availability or the choice of refrigerants (bans, increased quotas) to be used by heat pumps cannot have any other effect than slowing-down the speed at which heat pumps must be installed and carbon-neutrality achieved.**

Supporting a diversified use of refrigerants means supporting the implementation of an unprecedented level of ambition for emissions reduction in the EU made possible by the F-gas Regulation as it is today and the heat-pump growth as it is expected in the coming years, allowing the EU to **accelerate the phase-out of gas and other fossil fuels used for heating in Europe**.

[1] For instance, in France, the largest EU market for electric heat pumps today (with 267,000 electric heat pumps air to water installed in 2021), about 88% of electric heat pumps air to water installed were split technology.

Annex – Example of aspects to be considered for best technological choice (including refrigerants)

The example below provided by the German heat pump association (BWP) illustrates the restrictions that may apply when using a refrigerant with a lower GWP.

It is important to note that beyond limitations for safety reasons, any future restriction with regard to refrigerant used in heat-pumps is de facto slowing-down the much needed deployment of heat-pumps.

Heat Pumps with R290 – Restrictions on Use

Summary and main conclusions

With regards to thermodynamic properties and the availability of components, R290 (propane) is a well-established natural refrigerant to be used in heat pumps. However, special attention must be paid to safety requirements due to high flammability. The normative framework is set by EN 378 from Machinery Directive and EN 60335-2-40 from low voltage directive.

The most important charge limits for indoor installation of heat pumps with R290 are:

- up to 150 g without additional requirements - resulting capacity not sufficient
- up to 1 kg (1,5 kg) + requirements to floor space - not enough space available on site
- up to 5 kg + ventilated casing or indirect method – high effort and residual risks

Outdoor installation of R290 heat pumps is restricted by:

- up to 5 kg per unit, cascades possible
- availability of sufficient outdoor area close to the building
- distance to openings etc. with regards to movement of refrigerant in event of leakage
- for air source: distance to boundary properties regarding sound
- for ground source: availability of heat source.

To sum up:
Outdoor Installation is an option for R290 in many cases, but it will not be possible to set up a heat pump with R290 everywhere in case of boundary conditions like openings (light wells) to the house. Alternatively, A1 or A2L refrigerants can still be used or heat pump is simply no solution in some cases. For indoor applications with R290 additional safety installations are necessary which limits the volume of applications.

General

R290 falls under refrigerant category A3, which is less toxic and highly flammable. The density is significantly greater than that of air. Charge limits are defined by EN 378 and EN 60335-2-40 for each individual refrigerant, depending on the conditions on site.

Indoor installation

For indoor installation, following applies beside national or even local installation requirements. Two legal frameworks are relevant for heat pumps in the light of requirements according to refrigerants. These are namely Machinery directive and EN 378 series as well Low Voltage Directive and EN 60335-2-40. The relevance is determined by intended use.

EN 378, based on Machinery Directive, is valid for all refrigeration systems and heat pumps unless a specific product standard applies.

EN 60335-2-40 is a relevant product standard following the Low Voltage Directive and has to be accounted for household appliances. A household appliance is defined by intended use as declared by the manufacturer. Clearly, capacity and size have to meet a “typical” use for domestic purposes, but there are no clear limits set, neither for capacity, for temperature or anything else. The common understanding is the typical operation in self-occupied houses or flats.

EN 378 Series (Machinery Directive)

Refrigerant charge limits are defined by access categories a, b , c and location classes I to IV. A charge of 150g is not subject to any requirements, but the resulting capacity is not sufficient, at least for domestic heating.

The access category for domestic heating will be “a – general” according to the standard. A supervised (b) or even authorized (c) access cannot be assumed in most cases, specifically for the huge amount of heat pumps in private domestic buildings, regardless they are rented or self-occupied.

Location Class I “Heat pump located in occupied space”:
A floor space of 570 m² to 1580m² per kg charge is required, depending on height of installation. This will not allow to install a heat pump of sufficient capacity for heating with state-of-the-art technology. A total charge limit of 1,5 kg (1 kg below ground) will additionally restrict the use.

Location Class II “Compressor located in machinery room” (or outdoor, see below):

Applicable to sealed systems only with the same requirements as for class I. Split installation is not recommendable due to danger from refrigerant connections made on site.

Location Class III "Heat Pump located in machinery room" (or outdoor, see below):
Safety requirements concerning machinery rooms cannot be reliably met in private households. Charge limit of 5 kg will additionally restrict the use.

Location Class IV "Ventilated enclosure":
Design concept seems to be the most feasible solution. The safety system must be completed on site (suction pipe, fan, flow switch, safety- and alarm system), the safety system requires additional energy for fan operation. Charge limit of 5 kg will restrict the use.

"Indirect Method":
This method supports the binding/destruction of the refrigerant within the housing and is technically very demanding to implement. Price effects on the product cannot yet be estimated and suitability for series production must be proven.

EN 60335-2-40 (Low Voltage Directive)

The standard is relevant for owner-occupied buildings or flats (see above, "Indoor Installation").

According to Low Voltage Directive (LWD) and the harmonized standard EN 60335-2-40, the requirements regarding the available space for A3 refrigerants are identical to those from EN 378-1 in access category "a" and location class I. Contrary to this, the maximum charge is limited to 1 kg.

An extension up to 5 kg is possible with additional safety measures as mentioned in the annexes. This is namely a ventilated enclosure, equal to location class IV of EN 378. In most cases, that high limit is not relevant since the resulting capacity exceeds the required load of an owner-occupied building.

Outdoor Installation

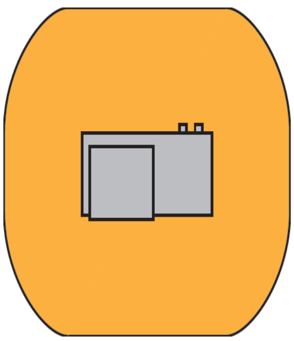
It must be said in advance, that outdoor installation is no universal heat pump solution: In case geothermal use is restricted and district heat is not available, an air-to-water heat pump would be the only option. This requires, among others, an appropriate location regarding sound emissions.

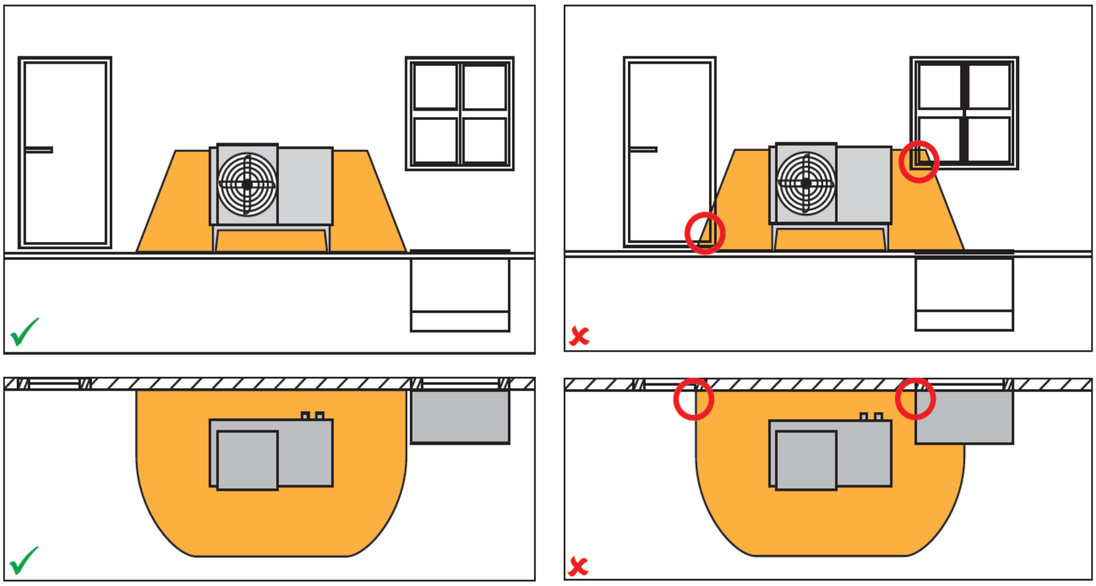
Additional requirements to the place of installation are due to the use of R290:
Restrictions to the outdoor installation are covered by both, EN 378 and EN 60335-2-40 in the same way. In EN 378, an outdoor installation for domestic application is located in class III. The charge for access category "a" is limited to 5 kg, which cannot satisfy every usage. Higher charge limits might be possible based on risk analyses or cascades. But nevertheless, several needs apply to the place of outdoor installation with regards to operational safety.

Since no European Standard is available for outdoor installation, the following might be considered as state of the art for application on site. It can be found in a guideline of the German Heat Pump Association. Besides that, national and local requirements might apply for installation and operation of heat pumps with R290. Specifications from the manufacturers must always be accounted.

Manufacturers define a safety sector including the heat pump and its near surrounding. At least the following shall not occur in this area.

- Building openings
    - Windows
    - Doors
    - Light wells
    - Flat roof windows
    - Air Inlet / Outlet of ventilation systems
    - others
- Pump chamber, inlets in sewers and waste-water shafts, etc.
- footpaths and driveways
- subsidence or depressions of the ground
- boundaries of the property





Sketch: The safety sector is limiting the freedom of choice of the installation location. This limitation will restrict the use. (yellow marking – indicative, distances to be defined by manufacturer)