Connected Efficiency

CAREL

Application note

Condensing units: scenario in Europe

The requirements established by F-gas and Ecodesign regulations in Europe have a great impact on condensing units.
On the one hand, the traditionally used R-404A will be unacceptable from 2020. On the other, new Ecodesign energy performance limits for condensing units will apply from July 2018.

This document summarises F-gas regulation and Ecodesign requirements, with special focus on condensing units, and their consequences on the design of the units.

Knowledge Center

1. F-gas

The revised **F-gas regulation**, published in 2014, aims to phase down fluorinated gases (F-gases) due to their negative contribution to the greenhouse effect. These include hydrofluorocarbons (**HFCs**), mixtures that contain them and unsaturated HFCs (**HFOs**). For each specific gas, the greenhouse effect is indicated by the Global Warming Potential (GWP). Accordingly, the F-gas regulation establishes **restrictions, leak checking and quotas based on the GWP of F-gases**. This has had a clear effect on the HVAC/R market, and has been especially noticeable in the last few months, with a drastic **increase in the prices** of high-GWP refrigerants and new refrigerant **trends**.

1.1. Restrictions

The F-gas regulation establishes restrictions based on the GWP of F-gases (namely, HFC and HFO refrigerants) for different applications:

Application	Fluorinated refrigerants	Unacceptable as of
Domestic refrigerators and freezers	GWP≥150	1 January 2015
Refrigerators and freezers for commercial use (Hermetically sealed[1])	GWP≥2500	1 January 2020
	GWP ≥ 150	1 January 2022
Stationary refrigeration and A/C equipment[2]	**GWP ≥2500**	**1 January 2020**
Multipack centralized refrigeration systems for commercial use with a rated capacity ≥40 kW	GWP ≥ 150	1 January 2022
Movable room air-conditioning equipment	GWP ≥ 150	1 January 2020
Single split air-conditioning systems containing less than 3 kg of fluorinated greenhouse gases	GWP ≥ 750	1 January 2025

Condensing units[3] fall within the category of "stationary refrigeration and A/C equipment", therefore **only refrigerants with a GWP lower than 2500 will be acceptable from 2020**.

1.2. Leak checking

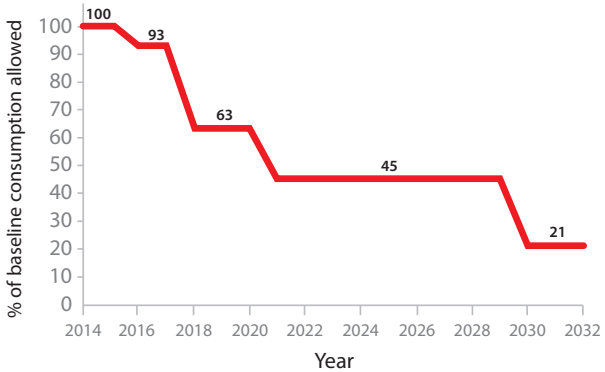
F-gas also establishes that a regular leak checking must be carried out with a frequency that depends on the tonnes of CO_2 equivalent per circuit, as shown in the following table. The tonnes of CO_2 equivalent are calculated by multiplying the charge of refrigerant (kg) by its GWP.
This means that **the higher the GWP and the higher the charge of refrigerant, the more frequently leak checking is required**.

Tonnes of CO_2-eq. per circuit	Frequency of leak checking
Less than 5 (=5000 kg) E.g. less than 2.4 kg of R-410A (GWP 2088); less than 3.9 kg of R-448A (GWP 1273)	Exempted
Less than 10, if hermetically sealed and labelled as such E.g. less than 4.8 kg of R-410A; less than 7.9 kg of R-448A	Exempted
5 - 50 E.g. 2.4-24 kg of R-410A; 3.9-39 of R-448A	Every 12 months (or 24 months with a leakage detection and monitoring system)
50-500 E.g. 24-240 kg of R-410A; 39-390 kg of R-448A	Every 6 months (or 12 months with a leakage detection and monitoring system)
Over 500 E.g. over 240 kg of R-410A; over 390 kg of R-448A	Every 3 months (or 6 months with a leakage detection and monitoring system) For stationary equipment with refrigerant charge over 500 tonnes of CO_2-eq, the leak detection system is compulsory.

The refrigerant charge for condensing units is variable, but usually quite in the range 5-50 tonnes of CO_2-eq-per circuit, thus they will be affected by this part of the regulation.

1.3. Quota

The Commission has allocated **quotas for placing F-gases on the European market** for each producer and importer from 2015.
The percentages for each year, calculated with reference to the average consumption of HFCs in the period 2009-2012, are shown in the following graph:

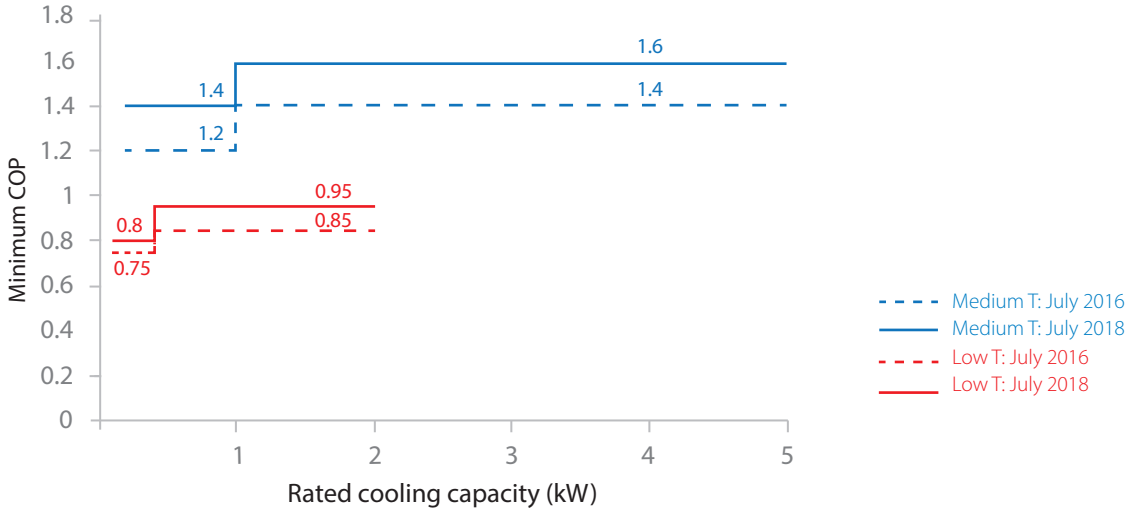


It should be noted that **the biggest leap is from 2017 to 2018**. This explains why the situation is becoming critical at the moment.

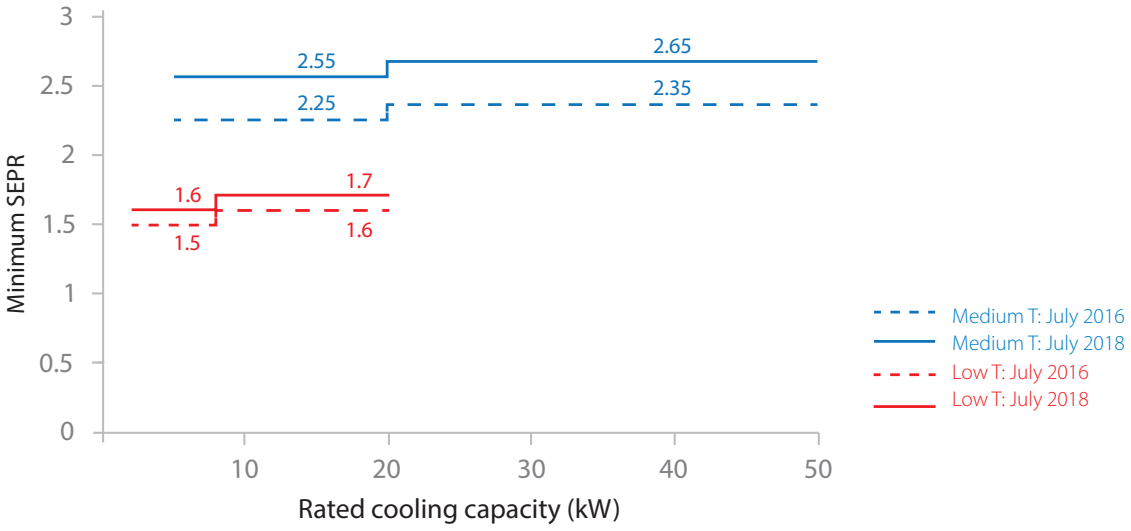
2. Ecodesign

Ecodesign is an approach to product design, taking into account the **environmental impacts** throughout its life cycle, but not lowering its functionality, safety, affordability or impact on consumer health. The Ecodesign Directive in 2005 established a framework aimed at setting Ecodesign requirements for energy-using products. In 2009, it was extended to all energy-related products.
Ecodesign specifications for condensing units (Commission Regulation 2015/1095) refer to units operating at low temperature (-35 °C, 0.1-20 kW), medium temperature (-10 °C, 0.2-50 kW) or both. The **coefficient of performance (COP)** needs to be calculated only for low rated cooling capacities, whereas for high rated cooling capacities, variations in temperature throughout the year also need to be considered, leading to the **seasonal energy performance ratio (SEPR)**.

- Low capacities (0.2-5 kW): the minimum COP allowed for medium-temperature condensing units will increase from 1.2 to 1.4 (for capacities from 0.2 to 1 kW). This means a **14% increase**. For higher capacities (up to 5 kW) the increase from the 2016 levels will be **13%** (from 1.4 to 1.6).
  If the condensing unit is designed to operate at low temperature, the **increase will be 6%** for low capacities (from 0.75 to 0.8) and **11%** (from 0.85 to 0.95) for capacities in the range 0.4-2 kW.



- High capacities (above 5 kW and up to 50 kW): for medium-temperature condensing units at capacities in the range 5-20 kW, the minimum SEPR will vary from 2.25 to 2.55, namely **12%**, whereas for capacities higher than 20 kW it will **increase by 11%** (from 2.35 to 2.65).
  The minimum SEPR for low-temperature condensing units will **increase by 6%** (from 1.5 to 1.6) up to 8 kW, and by **6%** (from 1.6 to 1.7) from 10 kW up to 20 kW.



As a reference, among the medium temperature condensing units with cooling capacity lower than 5 kW that were in the market in 2014, 9% had a COP below the 2016 tiers whereas 40% would have been out of the market considering 2018 tiers.[4]

[1] 'Hermetically sealed equipment' means equipment in which all fluorinated greenhouse gas containing parts are made tight by welding, brazing or a similar permanent connection, which may include capped valves or capped service ports that allow proper repair or disposal, and which have a tested leakage rate of less than 3 grams per year under a pressure of at least a quarter of the maximum allowable pressure (EU Commission Regulation 517/2014).

[2] Stationary' means not normally in transit during operation and includes moveable room air-conditioning appliances (EU Commission Regulation 517/2014).

[3] Condensing unit is a product integrating at least one electrically driven compressor and one condenser, capable of cooling down and continuously maintaining low or medium temperature inside a refrigerated appliance or system, using a vapour compression cycle once connected to an evaporator and an expansion device (EU Commission Regulation 2015/1095).

[4] Chillventa Congressing, 13.10.2014, Dina Kopke, Emerson Climate Technologies.

3. Consequences

3.1. Prices and availability of refrigerants

The prices of high GWP refrigerants are dramatically increasing. For instance, from April to July 2017 **the prices of R-404A and R-507 increased by 225%**. In the same period, R-410A and R-134a prices (GWP of 2088 and 1430, respectively) doubled, i.e. a 100% increase[5].

Furthermore, **the taxes applied to HFC refrigerants** are being extended in Europe: Spain (target tax of 20 €/tonne of CO_2 eq.), Denmark (~20 €/ tonne of CO_2 eq.), Norway (~43 €/ tonne of CO_2 eq.), Slovenia (target tax of 0.71€/tonne of CO_2 eq.) and Poland (~6.52 €/kg).
The French Government also announced several days ago a tax that is said to be around € 30.50 per tonne of CO_2 eq.

Additionally, refrigerant manufacturers such as Honeywell and Chemours have announced their **intention to stop selling high GWP refrigerants** from next year.

3.2. Trends

In this context, the trends are clearly oriented to the **use of low GWP refrigerants and highly-efficient systems**.

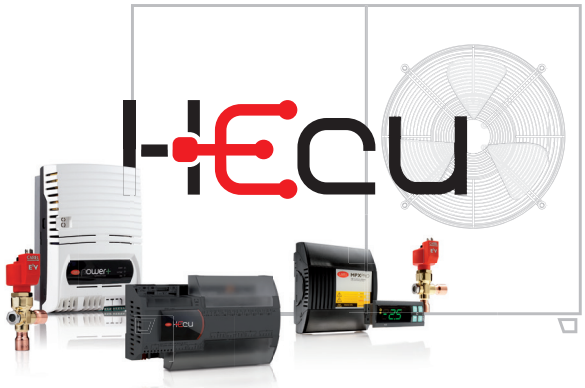
As regard refrigerants, some medium GWP refrigerants will most probably be used. In the case of condensing units, **R-448A** and **R-449A** can retrofit R-404A systems, thus they are being used to replace R-404A in already installed systems. Additionally, **R-410A** is also accepted in stationary equipment and its use is being extended to refrigeration systems. Indeed, the GWP of R-410A is much lower than that of R-404A, with the consequent reduction in leak checking frequency as well as its lower price. Moreover, **R-744 (CO_2)** is the lowest GWP alternative among the refrigerants currently considered for condensing units. However, the lower efficiency (specially in warmer climates), the higher cost of the system and the technical knowledge needed are making some manufacturers consider higher GWP options.

Furthermore, the increase in performance of condensing units that help to comply with Ecodesign requirements and reduce operating costs can be achieved by the use of **variable speed compressors, electronic expansion valves** and **efficient control systems**.

4. Conclusions

Initially, the bans and leak checking requirements established by F-gas created great concern among manufacturers. However, the fact that quotas will be reduced by 30% from 2017 to 2018 has caused a much greater impact over the last few months. Prices are rising dramatically, whereas availability is likely to be lower and lower. Thus, beyond F-gas restrictions, manufacturers are looking for alternative solutions with low GWP refrigerants. It has also became a marketing issue: the use of low-GWP refrigerants is associated with green products. However, this is not exactly true, as **there are other CO_2 emissions with a greenhouse effect resulting from electricity consumption and leaks, the latter depending on the refrigerant charge and tightness of the equipment**.
Moreover, the search for alternative refrigerants is not easy. Some of them can only be used in systems with specific requirements, and compressors are still not available for most options.

In this scenario, Carel proposes a solution that helps overcome the bans and consequences created by the F-gas regulation: **HECU** is a condensing unit solution available for both traditional HFC refrigerants (**R-410A** and **R-448A**) and natural refrigerants such as **CO_2**.
This system is a **highly efficient solution** (with a consequent reduction in CO_2 emissions due to electricity consumption) thanks to the use of electronic expansion valve, DC technology and efficient control systems. As regards the latter, the function that anticipates leak warnings, available in the three applications, helps manage leaks and reduce the number of tonnes of CO_2 eq. released into the atmosphere.



[5] http://www.coolingpost.com/world-news/price-of-r404a-to-double-next-month/

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