



White Paper

Effects of the EU F-gas regulation on
compressed air refrigeration dryers



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Position paper for operators, distributors and service providers

The new F-gas regulation EU 517/2014 is intended to effect the minimisation of fluorinated greenhouse gas emissions and to thus contribute to limiting climate change. This legislation is binding in Europe. The regulation prohibits the marketing of specific greenhouse gases and refrigeration machinery and uses a quota system to ensure a significantly-reduced offering of standard refrigerants. In the case of refrigeration specialists and operators, it also specifies extended rules for the handling of fluorinated greenhouse gases.

Typical refrigeration dryers available in the marketplace use fluorinated greenhouse gases as refrigerants. Fully prohibited are only R-404A refrigeration dryers. However, the progressive shortages in the market offering of currently-used refrigerants will complicate or even prevent the repair of leaking machines. Hence, new systems and, as much as possible, machines with significant remaining service life should be prepared for these new refrigerants. Operators are advised to complete leak checks extremely diligently and to learn about alternative and more climate-friendly alternatives prior to scheduled overhauls.



PSE & SPS low GWP fridge dryers.
Both operating with the new Low GWP
refrigerant R513A.



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(*) Contents refers to VDMA 2019; updates by Parker 2021.

1. Who is affected by the F-gas regulation?

This position paper is relevant for readers who purchase, sell, distribute, maintain, repair and dispose of refrigeration dryers within the EU.

2. Which refrigeration dryers are affected?

All refrigeration dryers imported, manufactured, operated, maintained, repaired and disposed in the EU are affected if they require fluorinated greenhouse gases for their operation. Typical refrigeration dryers currently available in the marketplace use, as a rule, fluorinated hydrocarbons (HFC) as refrigerant. These are fluorinated greenhouse gases.

This position paper classifies refrigeration dryers for compressed air and inert gases as stationary refrigeration systems in the meaning of the regulation. It evaluates refrigeration dryers as refrigeration systems designed for trade and industrial use.

The requirements for the marketing of household refrigerators and freezers or installations for commercial use are not applicable to refrigeration dryers.

3. What is the new F-gas regulation EU 517/2014 all about?

The objective of the regulation is to reduce the emissions of fluorinated greenhouse gases, as they contribute to global warming.

- For this purpose, regulations for emission limits, usage, recycling and disposal of greenhouse gases have been adopted.
- In addition, requirements for the placement of specific installations and products in the market, as well as for the usage of fluorinated greenhouse gases, have been decreed.
- Last but not least, quantity limits have been set for placing part-fluorinated greenhouse gases in the market.

4. What has changed compared to the previous F-Gas Regulation EU 842/2006?

The old F-gas regulation EU 842/2006 has been annulled with the commencement of the new regulation EU 517/2014 on 1 January 2015. The previous stipulations haven been mostly maintained but are now expanded. Particular

relevant areas for refrigeration dryers have been newly defined:

- Shortage of the market offering of currently-used refrigerants (Art. 14 ff);
- Publication obligations for refrigeration dryers and their refrigerants (Art. 12);
- Prohibition of R-404A for the repair of dryers with filling quantities from 10.2 kg (Art. 13);
- Prohibition of placing R-404A refrigeration dryers in the market (Art. 11);
- New limit values and documentation duties for leak checks (Art. 3-4, 6);
- Certification of service personnel (Art. 10);
- Recovery of refrigerants at end of life (Art. 8).

5. Will currently-used refrigerants no longer be offered?

At this point in time, all previously-standard refrigerants are available in the market. However, the availability of certain refrigerants will decrease. Some refrigerants, R-404A for example, will be completely removed from the market in the foreseeable future.

The individual duration and scope of availability essentially depends on their contribution to the greenhouse effect. It is calculated from the product of the substance-specific greenhouse potential also called "GWP" (for "global warming potential") of any refrigerant and its specific mass in metric tonnes. This product is known as the "CO₂ equivalent".

$$\text{CO}_2 \text{ equivalent} = \text{GWP [-]} \times \text{Mass [kg]} / 1\,000 \text{ [kg/t]}$$

One can assume that the availability of any refrigerant will decrease faster the higher its GWP. The table below lists refrigerants and GWPs used in current refrigeration dryers:

Refrigerant	GWP (AR4)
R-404A	3 922
R-452A	2 140
R-407A	2 107
R-410A	2 088
R-407F	1 825
R-407C	1 774
R-134a	1 430
R-513A	573

Table: Refrigerants in current refrigeration dryers

6. What is the driving force behind the shortage of refrigerants on the market today?

In the years 2009 to 2012, the annual average of all fluorinated greenhouse gases in circulation in the EU was determined for the regulation. This quantity, expressed as CO₂ equivalent, was then defined as the 100% baseline for 2015. It must be incrementally reduced to 21% by 2030. This process is also known as the “phase-down”. The illustration below displays the temporal progression.

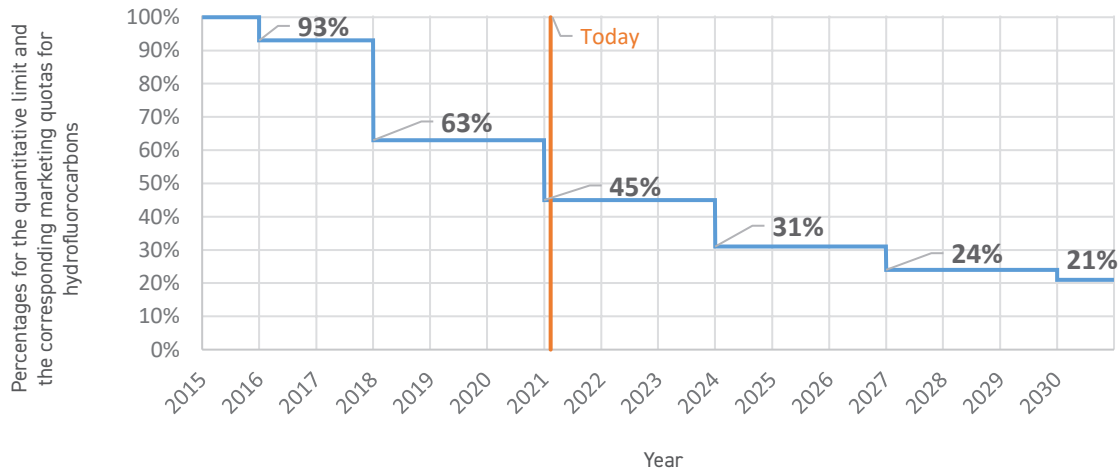


Fig.: Temporal progression of the phase-down for fluorinated greenhouse gases in the EU

7. How do the manufacturers of the affected refrigerants implement the phase-down?

The EU uses a complex system to assign quotas to the manufacturers of the greenhouse gases concerned. These quotas determine the CO₂ equivalent that a manufacturer may sell in the EU within one year. This value will be incrementally lowered until the end of the phase-down.

If a manufacturer plans to sell at least the same mass of refrigerant in the course of the phase-down, he must reduce the mean GWP of his offering accordingly. This is possible by switching to refrigerants with a lower GWP. The market availability of refrigerants with high GWP will successively drop. Furthermore, manufacturers may also supply refrigerants not subject to the phase-down.

8. Where is information about refrigerants, GWP and CO₂ equivalent found?

Since 4 July 2006, refrigeration dryers are labelled with the “Refrigerant” and “Filling quantity” data. Using these data, the GWP can be determined and the CO₂ equivalent can be calculated. In addition, ever since then it is also shown as to whether

an affected fluorinated greenhouse gas is used. Furthermore, any hermetic refrigerant circuit is also identified as such.

Since 2015, all refrigeration dryers must be explicitly labelled with GWP and CO₂ equivalent. In most cases, this information is provided in or near the nameplate. The refrigeration dryer’s operating manual also contains this information. For refrigerants with a GWP of 150 and higher, these data are also shown in the marketing material for the refrigeration dryers.

Refrigerant containers are also labelled with this information. They also show information as to whether the substance is reconditioned or recycled. In this case, the production number and address of the reconditioning or recycling facility are shown as well.

GWP values are calculated on the basis of models that are optimised continuously. Hence, the GWP of any refrigerant may change over time. When complying with the F-gas regulation however, the data shown there are binding. In other publications, they are usually identified with the addition (AR4 = Fourth Assessment Report).

9. Which currently-available refrigerants will be prohibited?

After 1 January 2020, refrigerants with a GWP of 2,500 or more may be used for maintenance or repair only as reconditioned or recycled refrigerant. This prohibition also affects refrigeration dryers containing 10.2 kg or more R-404A. From 1 January 2030, its use will be prohibited completely. Any contravention will be considered a criminal offence in Germany.

Refrigeration dryers with R-404A filling quantities below 10.2 kg are not subject to this ban.

Because the F-gas regulation will shorten the availability of refrigerants with high GWP and the refrigerant recovery quotas are currently very low, it is not sure as to whether there will be sufficient quantities of reconditioned or recycled R-404A when required.

Other standard refrigerants are not prohibited.

10. Are there manufacturers no longer offering specific refrigerants?

Yes. Honeywell has stopped selling R-404A and R-507A in the EU 28 prior to the actual implementation date of the prohibition.

11. Would it make sense for operators to stockpile R-404A for servicing existing machines?

No Fluorinated greenhouse gases may be sold for installation, maintenance, service and repair only to companies which are certified as specified in the regulation or employ certified personnel.

Furthermore, it must be noted that, after 1 January 2020, new R-404A for service purposes may be used only in machines with filling quantities below 10.2 kg. Hence, the conversion to alternative refrigerants must be considered.

12. Are commercial and service providers allowed to procure non-quoted refrigerant from outside of the EU?

Yes, however, according to F-gas regulation, the annual import volume of the refrigerants in Annex I must be less than 100 tonnes CO₂ equivalent (e.g., < 25.5 kg R-404A p.a.). For larger quantities, quotas are required. Any such import should be documented, as the relevant state authorities are permitted to audit when there is a suspicion of exceeding permissible import volumes. Any contravention will be considered a criminal offence in Germany.

13. What is the advice to operators regarding refrigerant for existing machines?

The refrigerant circuits in refrigeration dryers are sealed. In failure-free operation, leaks of a serious nature will not occur during their typical service life. Hence, they can be operated without taking any additional measures.

Prescribed regular leak checks must be performed to detect and remedy any refrigerant losses as early as possible. Other recommendations by the manufacturers for inspections of the refrigeration circuit should be also implemented.

The conversion to an alternative refrigerant is not recommended as long as an opening of the refrigeration circuit can be avoided. A proactive conversion is sensible in very few exceptions:

- When the procurement of refrigerant is expected to be difficult (e.g., long delivery times, very large filling volumes);
- When the access to certified specialists for conversion is expected to be a problem;
- For logistical reasons, if only one refrigerant should be used at the site and some machines have already been converted to an alternative.

For repair tasks, the refrigerant recommended by the manufacturer should be used as long as it is available. This is generally the least expensive solution. However, the use of R-404A should be critically reviewed, due to the coming service restrictions and associated high procurement effort.

If an alternative must be used, it is recommended to convert to a refrigerant with lowest possible GWP, which will also represent the best chance of availability for as long as possible. The conversion requires an in-advance analysis of appropriate technical and economic efforts. This also includes that the manufacturer of the refrigeration dryer has granted his approval for the use of the alternative refrigerant. This will contribute to avoiding potential damage to the refrigeration compressor or other components. The approval is also required for maintaining the CE conformity of the refrigeration dryer. Where an approval is not provided, the specialist company completing the conversion becomes the de-facto manufacturer.

14. What must be considered when converting to an alternative refrigerant?

As a first step, the availability of an alternative refrigerant for conversion must be checked. If this is not the case, these refrigeration dryers must not be refilled after a refrigerant leak. They must be replaced with new equipment.

In all other refrigeration dryers, the conversion effort largely depends on the suitability of the existing components for the new refrigerant. At best, it will be sufficient to replace the filter dryer when changing the refrigerant. In some cases, an adjustment or replacement of the expansion unit may be necessary as well. In more difficult cases, a refrigeration compressor approved for the alternative refrigerant may need to be installed.

Any conversion has a differently severe impact in respect to drying capacity, electric power consumption and achievable pressure dew point. For example, numerous standard refrigeration dryers have been converted from R-134a to R-513A and from R-404A/R-407A to R-449A easily and without significant changes to the performance data.

15. Is the placing on the market of refrigeration equipment, in this case refrigerant dryers, banned with certain refrigerants?

Refrigeration dryers using refrigerant with a GWP of 2,500 or more can no longer be marketed after 1 January 2020. This prohibition concerns R-404A-refrigeration dryers. Any contravention will be considered a criminal offence in Germany.

Refrigeration dryers previously marketed are defined as those provided for use or sale in the EU prior to 1 January 2020. Thus, inventory of distributors or second-hand dealers will not be affected by the prohibition. These machines can still be operated after their sale. The prohibition is focused on manufacturers and importers. Despite the above, maintenance options for leaking R-404A refrigeration dryers will be severely limited in the future.

There are no other prohibitions for the marketing of refrigeration dryers.



16. Are there further bans on the placing on the market of refrigeration systems for commercial use?

The following refrigeration systems may no longer be placed on the market (see EU 517/2014, Art. 11 (1) and Annex III):

- Refrigerators and freezers for commercial use with refrigerants, if the refrigerants have
 - From 01.01.2020 a GWP of 2,500 and more or
 - From 01.01.2022 a GWP of 150 and more;
- Multipack centralised refrigeration systems for commercial use with a rated capacity of 40 kW or more [...] if the refrigerants have a GWP of 150 or more as from 01.01.2022;
- Single split air conditioning systems with less than 3 kg of fluorinated greenhouse gases if the refrigerants have a GWP of 750 or more as of 01.01.2025.

“Commercial use” here means the use for storage, presentation or distribution of products for sale to end users, retailers and restaurants.

These further bans from the market in 2022 and 2025 do not apply to an industrial use such as refrigeration dryers, but do apply to commercial refrigeration and air conditioning equipment.

Looking at typical refrigerants used in refrigerant dryers today, R404A and R507 are affected by the ban at a GWP limit of 2 500 (see also Figure 2).

The following bans on placing on the market at the GWP limit of 750 or 150 for commercial use could indirectly influence the distribution of other typical gases such as R410A, R407C and R134a in the industrial sector.

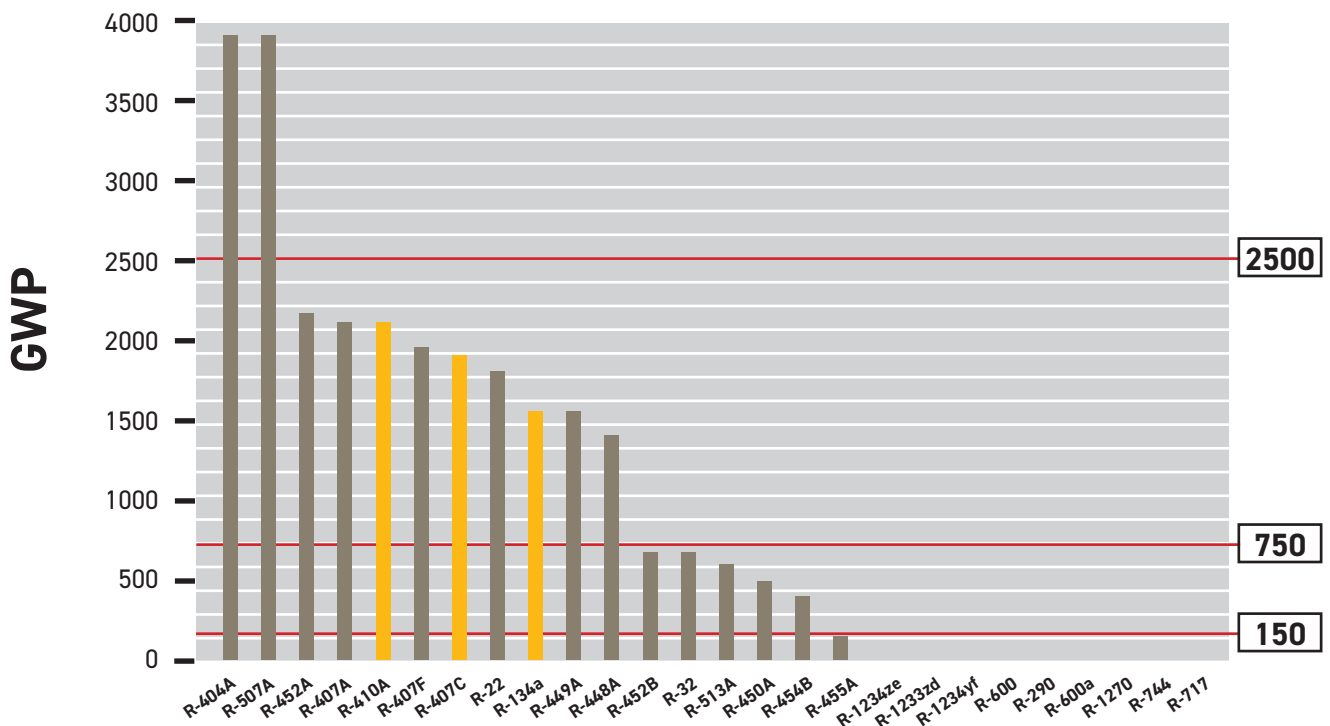


Fig.: GWP of refrigerants, partly in use in refrigerant dryers which are typical at the publication of the guideline



17. What are the inspection requirements for the operators of refrigeration dryers?

The operator is obliged to take all technical and economical measures for reducing refrigerant leaks to a minimum. This includes compliance with the stipulated leak tests. Inspection requirement and interval of refrigeration dryers are determined by the individual CO₂ equivalent.

The obligation to inspect small and mid-sized refrigeration dryers can be omitted when their CO₂

equivalent is less than 10 tonnes and the refrigerant circuit is sealed hermetically. However, the recommendations of the manufacturer in regard to inspections should be complied with.

Extended inspection intervals can be achieved by installing a leak detection system, however, such systems are not standard for refrigeration dryers.

The table below is provided in order to determine inspection obligations and associated intervals for some refrigerants:

Refrigerant	GWP (IPCC 4th AR)	Hermetically-sealed equipment with FM < 10 t CO ₂ equivalent	Others with 5 ≤ FM < 50 t CO ₂ equivalent	Others with 50 ≤ FM < 500 t CO ₂ equivalent	Others with FM ≥ 500 t CO ₂ equivalent
R-404A	3 922	2.5	1.3 ... 12.7	12.7 ... 127.5	127.5
R-452A	2 140	4.7	2.3 ... 23.4	23.4 ... 233.6	233.6
R-407A	2 107	4.7	2.4 ... 23.7	23.7 ... 237.3	237.3
R -410A	2 088	4.8	2.4 ... 24.0	24.0 ... 239.5	239.5
R-407F	1 825	5.5	2.7 ... 27.4	27.4 ... 274.0	274
R-407C	1 774	5.6	2.8 ... 28.2	28.2 ... 281.9	281.9
R-134a	1 430	7.0	3.5 ... 35.0	35.0 ... 349.7	349.7
R-449A	1 397	7.2	3.6 ... 35.8.0	35.8.0 ... 357.9	357.9
R-466A	733	13.6	6.8 ... 68.2.0	68.2.0 ... 682.1	682.1
R-513A	631*	15.8	7.9 ... 79.2.0	79.2.0 ... 792.4	792.4
Mandatory leak inspection		No	Yes		
Without leak detection system		-	12 months minimum	6 months minimum	Prohibited
With leak detection system		-	24 months minimum	12 months minimum	6 months minimum

* The actual GWP value of the refrigerant R513A is 573 according to the more recent AR5 (Assessment Report 5th).

Table: Inspection periods for leak inspections at refrigeration dryers

Attention: Non-hermetic refrigeration dryers with a refrigerant filling volume of less than 3 kg which were not subject to inspection in the past but are using the following refrigerants, must now be inspected: R-404A, R-410A, R-407A, R-407F and R-407C.

18. Are the refrigerants without mandatory leak inspections?

Yes. The leak inspections shown do not apply to substances listed in Annex II of the regulation. For example, they do not apply to HFOs (hydrofluoroolefins) or organic refrigerants. At this point in time, these refrigerants are not used in typical refrigeration dryers.

The leak inspections defined in the F-gas regulations apply only to refrigerants shown in Annex I of the regulation or for compounds of the substances listed in Annex I. This includes all refrigerants currently used as standard in refrigeration dryers.

19. Who can perform services at refrigeration units?

Only certified organisations may be employed for maintenance, servicing, repair and decommissioning of refrigeration dryers. These organisations must employ certified personnel. The technicians must carry proof of certification and provide it upon request. Existing certificates and proof of training according to the predecessor regulation EU 842/2006 remain valid.

Operators are obliged to ensure that any tasked service personnel is appropriately certified. They are also obliged to maintain documentation. Any contravention is considered an administrative offence in Germany.

20. What are the duties of documentation for the operators of refrigeration dryers subject to inspection?

For each refrigeration dryer subject to inspection, the operator must maintain these records:

- Type and quantity of the fluorinated greenhouse gases contained;
- Quantity of the fluorinated greenhouse gases added during installation, repair, maintenance or subsequent to a leak;
- Information as to whether the fluorinated greenhouse gases used have been recycled or reconditioned, including name and address of the recycling or reconditioning facility and, possibly, its certification number;
- Quantity of the recovered fluorinated greenhouse gases;
- Information about the company having installed or maintained the unit and, where appropriate, repaired or decommissioned, including, possibly, its certification number;
- Times and results of the leak inspections completed.
- Measures for recovery and disposal of the

fluorinated greenhouse gases if the unit has been decommissioned (refrigerant disposal certificate).

These records must be retained for at least five years. Furthermore, service providers commissioned with refrigeration service of the installations are also required to retain the records for at least five years. The records must be provided to the authorities upon request. Any contravention is considered an administrative offence in Germany.

21. Do operators have to take action when a leak in the refrigeration circuit is detected?

Yes. The operator must immediately eliminate the leak. Only certified personnel can be employed in this task. Any contravention is considered an administrative offence in Germany.

22. Is the operator required to have the repair's effectiveness to be verified?

Article 3 (3) of the F-gas regulation demands, in general terms, that the effectiveness of the elimination of a leak must be verified by certified personnel within one month following the repair.

On its Internet page, in the "FAQ - F-gas regulation" section, the German Federal Environmental Agency presents this understanding in question 17: "In most cases, it is sufficient when the inspection for tightness is performed directly after the completion of the repair. This would mean that the inspection is done 'within one month'. The European Commission agrees with this interpretation. An inspection at a later date may be required only in the event that the machine must be 'run in' after the repair. This must be decided on a case-by-case basis."

23. Do operators have to take care of the refrigerant recovery?

Yes. Operators of refrigeration dryers are obliged to ensure that recycling, reconditioning and destruction of fluorinated greenhouse gases is done by certified personnel. It is expressly prohibited to simply discharge fluorinated greenhouse gases into the atmosphere.

The recovery of F-gases for recycling, reconditioning or destruction must be completed prior to the disposal of the refrigeration dryer and, if necessary, in the course of maintenance and servicing work.

Due to the shortage of currently standard refrigerants, different refrigerants should be collected in individual containers and returned for reuse. The proper disposal must be documented. Any contravention is considered an administrative offence in Germany.



Service providers too must ensure that any residual fluorinated refrigerant in containers is recovered prior to disposal. Any contravention is considered an administrative offence in Germany.

24. Are there refrigeration dryers that are future-proof in respect to their refrigerant?

A refrigeration dryer can be considered “future-proof” in respect to its refrigerant, if:

- An efficient operation with the selected refrigerant has been realised;
- All components of its refrigeration circuit are approved for the refrigerant and available in the marketplace;
- The availability of the refrigerant for manufacturing and repair is ensured for the entire typical service life.

The last item becomes more likely the lower the GWP is of the refrigerant used.

Future-proof are also those refrigeration dryers that can be converted to a sustainable refrigerant at acceptable expense and while retaining similar performance data.

The manufacturers of refrigeration dryers should be able to provide detailed information.

25. What refrigerants are suited for future-proof refrigeration dryers?

The phase-down of the F-gas regulation reduces the availability of refrigerants with high global warming potential. High and constant availability are more likely the lower the GWP of a refrigerant.

This prerequisite is optimally met by the natural refrigerant CO₂ (carbon dioxide) with a GWP of 1. In addition, it is not subject to the phase-down, not flammable and toxic only in high concentrations. However, its use requires very high working pressures. Components designed for these pressures are not available at this point in time. Hence, CO₂ cannot be used in current refrigeration dryers.

The use of other natural refrigerants in refrigeration dryers is conceivable as well, as they are also not affected by the phase-down and have low GWPs. However, the natural refrigerants suitable for refrigeration dryers are either flammable (e.g., propane) or toxic (e.g., ammonia).

Manufacturers have also developed new syn-

thetic refrigerants with very low GWPs. The GWPs of the so-called HFO refrigerants (hydrofluoroolefins) are also very low. They also are not subject to the phase-down of the F-gas regulation. However, the HFO refrigerants suitable for refrigeration dryers are, without exception, flammable.

Any currently-available refrigeration dryer is not approved for the use of flammable or toxic refrigerants for safety reasons. The dryers' conformity expires if they are used. Such refrigerants will eventually play a role in the development of future refrigeration dryers. This problem is apparent in many refrigeration systems today.

The manufacturers of synthetic refrigerants have recognised this and offer compounds from HFOs and current refrigerants (e.g., R-134a, R-125, R-32). Some of these HFO blends not only have quite low GWPs but are not flammable either. They also are subject to the phase-down but their manufacturers anticipate a permanent availability in the market. This is quite probable as many refrigerants with high GWP are eliminated and numerous applications will allow the future use of unquoted refrigerants, thus freeing quotas. They can then be used for such non-flammable HFO blends. For this reason, component manufacturers have also tested these refrigerants and offer corresponding approvals for existing, and also newly-designed, components. They can then be used to manufacture new refrigeration dryers that are sustainable in respect to refrigerants.

Such solutions are not yet available for all refrigeration dryers. For these systems, special care should be taken during leak tests and inspections. It is also recommended that the market availability of refrigerants used by manufacturers is monitored and, if necessary, plans are implemented for a timely investment in new equipment.

Refrigerants currently in use ¹	Selection of alternative refrigerants ¹				
	For currently standard refrigeration dryer designs	For new refrigeration dryer designs			
		non-flammable, non-toxic	non-flammable, non-toxic	limited flammable, non-toxic	flammable, non-toxic
R-404A [3922, A1]	R-449A [1397, A1]	R-744 (CO ₂) [1, A1] R-450A [601, A1] R-513A [631, A1]* R-466A [733, A1] ²	R-1234yf [4, A2L] R-32 [675, A2L]	R-290 (propane) [3, A3]	R-717 (ammonia) [0, B2L]
R-452A [2140, A1]	R-449A [1397, A1]				
R-407A [2107, A1]	R-449A [1397, A1]				
R-410A [2088, A1]	R-466A [733, A1] ²				
R-407C [1774, A1]	-				
R-134a [1430, A1]	R-450A [601, A1] R-513A [631, A1]*				

*: The actual GWP value of the refrigerant R513A is 573 according to the more recent AR5 (Assessment Report 5th).

1: [GWP according to IPCC 4th AR; Safety group according to EN 378-1:2017]

2: Currently in approval phase or not yet available in the market (as of 08/2018)

Table: Selection of alternative refrigerants

26. What is an administrative or a criminal offence in the meaning of the F-gas regulation?

Elements of an offence and corresponding sanctions are individually defined by the EU member states. This position paper identifies sanctions that seem to be relevant for operators, distributors and service providers of refrigeration dryers in Germany.

In the Federal Republic of Germany, violations of the F-gas regulation are punished, on the basis of the sanction system for chemical legislation, with a fine of up to € 50,000, while criminal offences carry imprisonment of up to two years or a fine.



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