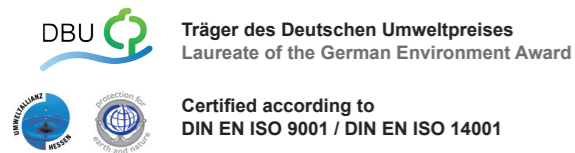




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Träger des Deutschen Umweltpreises
Laureate of the German Environment Award

Certified according to
DIN EN ISO 9001 / DIN EN ISO 14001

Background information

Today's world wide contribution of F-gases relating to the greenhouse effect, is approximately 1.4% (2011).

Why just the reduction of F-gases emissions?

- The requirement of F-gases or products, where F-gases are involved, is developing by leaps and bounds with increasing quality of life in emerging markets and industrialized countries.
- In direct relation to the increasing quality of life, globally installed cooling capacity and the need of refrigerants is rising contemporaneously.
- To phase out the use of ozone-depleting HCFCs leads to a massive increase in HFC and PFC emissions.
- F-gases are extremely durable, are broken down very slowly and thus accumulate steadily in the atmosphere.
- F-gases are highly climate-effective, that means, small increases have strong and long-lasting negative effects.
- A substitution of F-gases by natural substances has become technically possible in many areas, so that ambitious objectives can be pursued.
- F-gases are emitted not only as refrigerant, but also from a variety of other applications.

World-wide standards

With the climate and energy strategy - „20-20-20 targets“ the EU has adopted a Directive Pact that, among other things, **greenhouse gas emissions should be reduced by 20% in 2020.**

New regulations, such as the prohibition of greenhouse affected refrigerants, will help to achieve the EU's climate targets. Europe is setting new global standards for the reduction of CO₂ emissions.

Looking at the standing of still available future refrigerants, it is obvious that only natural refrigerants will be the alternative to the currently popular used damaging ones.

Characteristics are the environmental friendliness, the almost unlimited availability and the affordability of these substances.

What does this mean for public transport ?

For air conditioning of passenger compartments in buses refrigerants are required. These have a global warming potential GWP < 15004, based on CO₂ and a time horizon of 100 years to be observed.

From 1st January 2018 it is only allowed to use halogen-free refrigerants for eco-friendly air conditioning of two-axle city buses.

Also the DB has formulated in their vehicle's Climate Strategy (05/2015) that for all vehicles that go into operation from 2020, only air conditioning with natural refrigerants are to be used.

Quite naturally:
Refrigerant CO₂ – R-744



Quite naturally: The refrigerant R-744

Characteristics

- Sustainable, long-term gas at low prices that is available and approved
- Non-toxic or combustible
- Has no greenhouse-promoting effect on the Earth's atmosphere
- No effect on depleting the ozone layer
- No unknown long-term effects or harmful products of decomposition
- CO₂ greenhouse potential of 1 (R-134a has a greenhouse factor of approximately 1,430 times higher and may no longer be used in the medium term)

Performance

- Cooling power is approximately 20 % higher than with R-134a units (in the heating mode, the aim is to have a positive power dissipation up to -20°C / with R-134a this is possible only up to 0°C)
- High cooling power in volumetric terms
- Good heat transfer and lower pressure loss
- With electric buses an increase in the range by up to 40% is possible

Costs

- Lower price and savings in service costs by 70%
- Easy handling, no recycling necessary (the refrigerant can easily be discharged into the environment from where it has been removed)
- Lower absorption of moisture and hence, no dryer is necessary in the unit

Fit for the Phase-Down

The core elements of the F-Gas Regulation (01 January 2015):

Phase-Down

- Gradual reduction of F-gases
- Quantity reduction of 21% by 2030 in six stages

Restrictions on use

- Gradually phasing out climate damaging F-gases

Quota

- Manufacturers and importers are limited with F-gases quotas

Leakage control

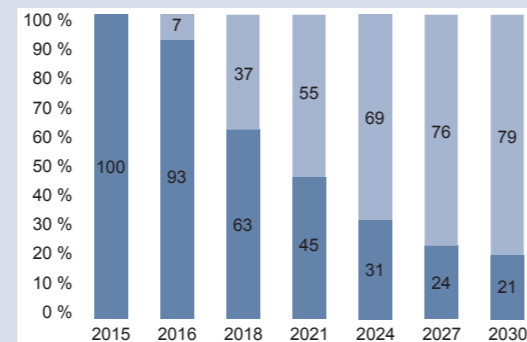
- Stricter requirements for leak tests of refrigeration and air conditioning systems

Advanced operator responsibilities

- Installation, maintenance, service, repair etc. may only be carried out exclusively by certified personnel

Impact of the new regulations

The availability of marketable synthetic refrigerants with a **GWP > 150** will be clearly reduced within the lifespan of existing and future air conditioning units.



Gradual reduction of F-gases

These refrigerants are in particular:

R-134a (GWP 1.430)

R-404A (GWP 3.922)

R-407C (GWP 1.774)

It is assumed that these marketable refrigerants are very expensive or not available any longer.

From 2020 onwards refrigerants with GWP > 2500 and from 2022 refrigerants with GWP > 150 are subject to certain conditions of application and service prohibitions.

Tax burden

To complement the F-Gas Regulation, the use of HFCs in some EU countries is more expensive and purposely increased by additional charges. The national rules are different, but they are aimed to a taxation of approximately € 20 / ton of CO₂-equivalent.

Promoting climate-friendly refrigerants

In the following EU countries do already exist subsidies and grants for climate-friendly refrigerant:

Germany

Austria

Belgium

Switzerland

Great Britain

Netherlands

Awards

2015 Busworld Innovation Label for the presentation of an environmentally friendly heat pump system with CO₂ (R-744) as refrigerant



2013 Busworld Innovation Label for the presentation of an environmentally friendly air conditioning system with CO₂ (R-744) as refrigerant



2007 German Environment Award for the development of an environmentally friendly air conditioning system



2005 Rail technology innovation award of ifv Bahntechnik



2000 Participation at Expo 2000 in Hanover, selected as one of 300 projects world-wide



2000 2nd prize at the „European competition for better environment“



1998 Presentation of world's first refrigeration system with CO₂ (R-744) as refrigerant



Product	GWP (CO ₂ = 1)
R-134a	1.430
R-404A	3.922
R-407C	1.774
R-744 (CO ₂)	1

Refrigerant compared - environmental influences if released

Existing tax	
Denmark	Slovakia
Norway	Spain
Planned tax	
France	Sweden
Poland	