

R744 – Carbon Dioxide

The ecological and cost-effective alternative to classical refrigerants



Climate change is one of the biggest threats of this century. Similar to other countries and regions in the world, the F-Gas regulation by the European Commission is intended to limit the emission of fluorinated greenhouse gases, since many of these compounds have very high global warming potentials (GWP).

In particular, the EU Directive provides a phase-down procedure for all fluorinated greenhouse gases placed on the market in the European Union. By 2030, the F-gas quantities (measured in CO₂ equivalents) have to be reduced by 79% compared to 2015. In addition,

in many applications where less harmful alternatives are available, the use of gases with a high GWP content is banned. This forces the transition to new and climate-friendly refrigerants.

Besides the use of new transitional refrigerants, e.g., HFO's, there is a strong trend towards natural refrigerants, such as CO₂. Especially in commercial, industrial and mobile applications, CO₂ as the refrigerants R744 is a natural, safe, environmentally friendly and efficient alternative to existing synthetic refrigerants.



CO₂ as refrigerant R744

The use of CO₂ as a refrigerant has been known since the 19th century. Driven by its non-flammable and non-toxic properties, CO₂-based refrigeration machines were widely used in many areas such as breweries or meat processing facilities.

However, in the middle of the 20th century, on the one hand, the development and introduction of synthetic CFCs and (later) HCFCs as refrigerants and, on the other hand, the lack of further development of the CO₂ refrigeration technology pushed CO₂ out of the market.

Since the discovery of the climate-damaging effects of synthetic refrigerants in the late 1980s, interest in R744 has returned. The low environmental impact of R744 in terms of ozone depletion and global warming as well as technological advances and innovations in refrigeration systems make R744 a very promising alternative.

In commercial, industrial and mobile refrigeration, from cold stores to cars, R744 offers significant advantages in terms of environmental impact and efficiency compared to the synthetic refrigerants.

Properties of R744 - CO₂:

- excellent thermodynamic properties
- noncorrosive and nontoxic
- non-flammable
- environmentally friendly:
 - lowest possible Ozone Depletion Potential, ODP=0
 - minimum Global Warming Potential, GWP=1
- quota-free-product, no production or import restrictions by the EU F-gas regulation

ODP and GWP values of some refrigerants:

Refrigerant	ODP	GWP
R134a	0	1430
R404a	0	3922
R744 (CO ₂)	0	1
R717 (NH ₃)	0	0

Sources of CO₂

CO₂ is part of the exhaust gases produced during combustion process in boilers, heaters, furnaces etc. However, in most cases its concentration is too low to make extraction economically attractive.

On the other hand, CO₂ is a by-product of major synthetic production processes in the chemical industry (fertilizer, bioethanol production, etc.) and biological processes (fermentation, digestion, etc.).

Commercial CO₂ is usually recovered from high-volume, CO₂-rich exhaust gas streams. The collected raw CO₂ is purified and liquefied. In addition, CO₂ is also extracted from natural wells in volcanic areas.

Specification of R744 - CO₂ 4.5

The requirements for the CO₂ purity are determined by its application. In most technical application a purity of 99,9 % is sufficient. Special requirements are made, for example, for the use in the food or beverage industry.

There are also specific requirements for the use of CO₂ as refrigerant R744. A too high moisture content can lead to the formation of carbonic acid and the corrosion of the refrigerant circuit. There is also a risk that ice crystal deposits could block the piping system and cause malfunction or serious damage to the system. Non-condensable gases (e.g. nitrogen, air) can increase the pressure in the condenser.

Therefore, Messer recommends only utilizing CO₂ that is intended for use as refrigerant R744 and specified accordingly.

Specification for R744 - CO₂ 4.5

Purity	CO ₂	> 99,995 %
Humidity	H ₂ O	≤ 5 ppm (weight)

A detailed product specification can be found in the product data sheet.

General system requirements for the use of R744

The pressure/temperature characteristic of R744 differs from other, classical refrigerants. In general, the use of R744 necessitates higher working pressures, which cause special requirements for the system technology:

- dedicated system design
- system operating at high pressures
- trained technical staff required
- strict quality control of the refrigerant

Despite these requirements, the systems are more compact and above all more efficient.

R744 enables sustainable and efficient refrigeration

R744 is well suited for various applications, in particular industrial and commercial refrigeration systems, including transcritical, cascade or secondary CO₂ systems. The dedicated system design can take the advantages of R744:

- considerably higher thermal conductivity compared to classic refrigerants
- low viscosity leads to lower demands on the pump
- possibility of heat recovery
- cost stability and predictability through long-term availability



Dual Port Valves

CO₂ is stored and transported in liquid form. At ambient temperature, the pressure in the cylinders is about 50-60 bar. Messer cylinders are equipped with dual port valves and a dip tube, allowing liquid and gaseous CO₂ withdrawal.

In order to minimize the risk of operating errors, there is a clear color-coding of the two valve ports:

- The red valve for liquid withdrawal
- The blue valve for gas withdrawal

The valves are compact and allow the use of protective caps, indispensable during the transport and storage of cylinders. In case you need more information about the use of dual port valves, do not hesitate to contact your local Messer representative.



R744 supply

R744 is supplied in steel cylinders of various sizes with up to a 50-liter geometric volume and a net capacity of up to 37.5 kg R744. For higher consumptions, there are bundles, consisting of 12 (50 liter) cylinders and a net capacity of up to 450 kg.

Quality control

The purity of R744 is extremely important. Messer applies a strict quality management. We control the quality of the product, both during production and along the entire supply chain. All processes comply with ISO 9001 quality management standards and the internal quality and safety regulations. Messer operates dedicated filling plants and cylinders for R744 carbon dioxide 4.5.

Safety

Compressed and liquefied gases require increased user attention regardless of the application. The Safety data sheet, which is prepared according to REACH and CLP / GHS contains important safety information.

We will be glad to answer any questions regarding the safe handling of CO₂.



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