

# R744 – Carbon Dioxide

The ecological and cost-effective alternative to classical refrigerants



With regard to the F-Gas Regulation, we have been following the 2014-2030 roadmap set by the European Commission to limit emissions of fluorinated greenhouse gases, many of which have a very high global warming potential (GWP). By 2030, F-gas emissions need to have been reduced by two thirds compared to 2014. To achieve this goal, the EU Directive provides a phase-out procedure for all HFC quantities (measured in CO<sub>2</sub> equivalents) placed on the market in the European

Union. In addition, in many new systems where less harmful alternatives are widely used, the use of gases with a high GWP content is prohibited. This is likely to have a major impact on accelerating the transition to innovative and climate-friendly refrigerant alternatives.

There is a natural, safe and cost efficient alternative to existing synthetic refrigerants: CO<sub>2</sub> (R744).



## Properties of R744 - CO<sub>2</sub>:

- excellent thermodynamic properties leading to lower energy consumption
- non-corrosive, non-toxic and non-flammable
- quota-free-product, no production or import restrictions
- environmentally friendly
  - lowest possible Ozone Depletion Potential, ODP=0
  - minimum Global Warming Potential, GWP=1
- useful in the implementation of the F-gas Regulation

ODP and GWP values of some refrigerants:

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

## Historical background of R744

The use of CO<sub>2</sub> as a refrigerant has been known since the 19th century. Driven by its non-flammable and non-toxic properties, CO<sub>2</sub>-based refrigeration machines were widely used in many areas such as cold stores, supermarkets, kitchens for cold stores and hospitals, theatres and especially in marine refrigeration. In the mid-20th century, the development and introduction of synthetic CFCs and (later) HCFCs as refrigerants, on the one hand, and the lack of technological improvements by the R744 refrigeration industry, on the other, pushed CO<sub>2</sub> out of the market.

Since the discovery of the adverse effects of synthetic refrigerants in the late 1980s, interest in R744 has dramatically renewed. The low environmental impact of R744 in terms of ozone depletion and global warming, together with technological advances and innovations within refrigeration systems, make R744 a very compelling alternative.

In commercial and industrial refrigeration, from cars to cold stores, R744 offers undeniable advantages in terms of environmental friendliness and price competitiveness over its synthetic competitors. Because of its remarkable advantages, R744 has become the first choice to reduce the global warming potential in the refrigeration industry:

The term R744 is usually applied when referring to CO<sub>2</sub> used as refrigerant in the refrigeration and air conditioning industry.

## Sources of CO<sub>2</sub>

In general, the formation of CO<sub>2</sub> is an unavoidable by-product of major chemical production processes in the chemical industry (fertilisers, bioethanol, etc.), including biological processes such as fermentation, digestion, etc.

CO<sub>2</sub> is part of the exhaust gases produced during each combustion process (in boilers, heaters, furnaces etc.). However, its concentration is too low to make extraction economically attractive.

Commercial CO<sub>2</sub> is normally recovered from relatively high-volume- and CO<sub>2</sub>-rich exhaust gas streams: It is collected, cleaned, liquefied and monitored. In addition, CO<sub>2</sub> is also extracted from natural wells in volcanic areas where, for example, it is released from the earth. Finally, it is analysed depending on the application, for example for use in the beverage industry for carbonation (sparkling beverages) or as refrigerant R744.

## Specification for R744 - CO<sub>2</sub> 4.5

Unlike most industrial carbon dioxide applications, where 99.9% purity ensures the desired results, the performance of cooling systems depends directly on the reliable quality of the refrigerant. Even a slight increase in moisture content can lead to corrosion of the refrigerant circuit due to carbonic acid formation. There is also a risk of ice crystal deposits blocking the piping system and causing malfunction or serious damage to the system. Non-condensable gases (e.g. nitrogen, air) can increase the pressure in the condenser.

It is important to note that carbon dioxide for technical purposes cannot meet the requirements for low moisture content and non-condensable gases.

As a responsible manufacturer of R744, Messer stands for the uninterrupted availability of this natural product.

### Specification for R744 - CO<sub>2</sub> 4.5

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

## Common system requirements for R744 – CO<sub>2</sub>

- dedicated system design
- systems operate at high pressures
- trained technical staff
- reliable and proven suppliers
- strict quality control of the refrigerant

## 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 CO<sub>2</sub> systems. Its use requires high working pressures, which necessitates appropriate equipment, but leads to more compact and, above all, more efficient systems in general:

- 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
- significant overall reduction in costs



## Quality

The quality of R744 is extremely important. Strict quality control of the refrigerant and a reliable, trustworthy supplier are therefore crucial:

We pay attention to 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 that apply to the entire Messer Group.

As carbon dioxide sources are as varied as their applications, Messer operates filling plants and bottles exclusively for R744 carbon dioxide 4.5.

Detailed product specification information can be found in the technical data sheet. Safety data sheets are prepared according to REACH and CLP / GHS.

The gas is supplied in steel cylinders of various sizes with up to 50 litre geometric volume and a net capacity of up to 37.5 kg R744. For higher consumption there are packs with 50 litre cylinders such as the 12 bundles.

## Dual Port Valves

At ambient temperature, CO<sub>2</sub> is liquid in the cylinders at a pressure of 50-60 bar. Messer cylinders are equipped with dual port valves and an immersion tube, allowing liquid and gaseous CO<sub>2</sub> to be extracted from the same cylinder.

The two ports are colour coded:

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

The use of clear colour coding significantly reduces operating errors that often occur when using cylinders with a single suction type or double valves with identical / interchangeable ports.

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.

## Safety

Regardless of the application, compressed and liquefied gases require increased user attention. We will be happy to answer any questions you might have on the safe handling of CO<sub>2</sub>.

Messer was founded in 1898 and today is the largest family-run specialist for industrial, medical and specialty gases worldwide. Under the brand 'Messer - Gases for Life' the company offers products and services in Europe, Asia and the Americas.

We are proud of the passion, motivation and know-how of our employees. For more than 120 years we have been the supplier of choice for our customers and have gained their trust in our reliability and the reliability of our products and services.



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