# Carbon dioxide

## IDENTIFICATION

**Carbon dioxide**
**Air fixe**
**Carbonic acid**
**Carbonic acid gas**
**Carbonic anhydride**

| | | |
|---|---|---|
| **ZVG No:** | 1120 | |
| **CAS No:** | 124-38-9 | carbon dioxide |
| **EC No:** | 204-696-9 | |

**Related**

| | | |
|---|---|---|
| **CAS No:** | 463-79-6 | carbonic acid |

## CHARACTERISATION

### SUBSTANCE GROUP CODE

125100 Carbon oxides
139100 Inorganic gases
120510 Acids, inorganic

### STATE OF AGGREGATION

The substance is gaseous.

### PROPERTIES

colourless
odourless

### CHEMICAL CHARACTERISATION

Non-combustible gas.
Upon cooling of the gas solid carbon dioxide is formed, known as dry ice.
In the liquid state carbon dioxide only exists under increased pressure. During expansion the liquid quickly vaporizes under cooling and formation of dry ice. Dry ice sublimates relativ slowly at room temperature.
Compared to oxygen and nitrogen, carbon dioxide is relatively soluble in water and reacts to a small proportion (about 0.2 %, depending on the temperature) to carbon dioxide. Colloquially, often also the gas is inaccurately named carbonic acid. "Free carbonic acid" refers to the sum of the actual acid and the dissolved carbon dioxide.
Evaporation of dry ice or expansion of the gas causes formation of cold mist spreading on the ground.
Gas is heavier than air.
Danger of suffocation at high concentrations.

## FORMULA

$CO_2$ (carbon dioxide)
$H_2CO_3$ (carbonic acid)

| | |
|---|---|
| **Molar mass:** | 44,01 g/mol |
| | 62,03 g/mol |

**Conversion factor** (gaseous phase) at 1013 mbar and 20 °C:
1 ml/m³ = 1,83 mg/m³

## PHYSICAL AND CHEMICAL PROPERTIES

### SUBLIMATION POINT

Sublimation point: -78,5 °C

### TRIPLE POINT

| | |
|---|---|
| Temperature: | -56,6 °C |
| Pressure: | 5,19 bar |

### MELTING POINT

Melting point under pressure see tripel point. Melting point at normal temperature does not exist.

### BOILING POINT

Boiling point at normal pressure does not exist.

### CRITICAL DATA

| | |
|---|---|
| Crit. temperature: | 31,0 °C |
| Crit. pressure: | 73,83 bar |
| Crit. density: | 0,468 g/cm³ |

## DENSITY

VAPOUR DENSITY
under standard conditions (0 °C, 1013 mbar)

| | |
|---|---|
| Value: | 1,9767 kg/m³ |

RELATIVE VAPOUR DENSITY
Ratio of the density to dry air at the same temperature and pressure

| | |
|---|---|
| Value: | 1,53 |

VAPOUR DENSITY

| | |
|---|---|
| Value: | 1,8474 kg/m³ |
| Temperature: | 15 °C |

at 1 bar

## VAPOUR PRESSURE

| | |
|---|---|
| Vapour pressure: | 57,3 bar |
| Temperature: | 20 °C |

| | |
|---|---|
| Vapour pressure: | 72,1 bar |
| Temperature: | 30 °C |

## SOLUBILITY IN WATER

soluble

## PARTITION COEFFICIENT (octanol/water)

| | |
|---|---|
| log Kow: | 0,83 |

Recommended value of LOG KOW Databank.

## HAZARDOUS REACTIONS

**Hazardous chemical reactions:**
Accidents due to electrostatic charging are reported.
Risk of explosion in contact with:
metal dust / heat
aluminium hydride (rare)
potassium (solid)
sodium peroxide (heat) / metal powder
The substance can react dangerously with:
amines
ammonia

sodium
strong bases
water
acetylides
acrylaldehyde (polymerization)
aziridine (polymerization)
barium peroxide (heat)
caesium oxide
ethylamine
lithium aluminium hydrid
lithium (heat)
methylamine

## FURTHER INFORMATION

**global warming potential : 1**
ozone depletion potential : 0

# OCCUPATIONAL HEALTH AND FIRST AID

## ROUTES OF EXPOSURE

**Main Routes of exposure:**
The main intake pathway for carbon dioxide (CO2) proceeds via the respiratory tract.[07619]

**Respiratory tract:**
CO2 diffuses very easily through cell membranes and is hydrated in the blood to form carbonic acid by means of carbonic anhydrase in the erythrocytes.
Absorption is dependent on the concentration of CO2 in the air inhaled: the endogenously formed CO2 which is transported by the blood into the lung normally causes[07900] loading of the expiratory air with about 4 % CO2. If the concentration of CO2 in the inspiration air exceeds the normal value of 0.035 %, the excretion of endogenous CO2 from the lung is initially decreased. If the concentration of CO2 in the air inhaled is further increased, to 4 %, an exchange no longer takes place. If the 4 %-limit is exceeded, additional CO2 is taken in from the air inhaled into the blood.[07830]

**Skin:**
It is assumed that gases pass through the epidermis and follicles by simple diffusion so that absorption is determined by the concentration gradient and temperature.
Under these conditions, it was calculated that approximately 2.7 % of the endogenous CO2 is eliminated from the organism by penetration through the skin. From this, it can be derived that a toxicologically relevant dermal intake of CO2 is to be expected only for very high concentrations.[07837]
No sufficient data is available on whether or not workers who stay in an atmosphere containing only CO2 and use breathing equipment independent of the outside air could be endangered via the skin.[99983]

**Gastrointestinal tract:**
It is well-known that intake via the gastrointestinal tract is possible and usual if beverages containing CO2 are ingested. Under occupational conditions, no pecularities are noticeable.[99999]

## TOXIC EFFECTS

**Main toxic effects:**
Acute:
Effects to respiratory center, biotransformation, heart/circulatory system and CNS[07619]
Chronic:
Effects to the CNS and heart/circulatory system[07866]

**Acute toxicity:**
In the organism, CO2 performs important physiological functions, e.g. it centrally regulates respiration. Because of its role in many processes relating to the maintenance of homeostasis, CO2 is not treated by the body as a foreign substance and there are regulatory mechanisms which level out minor to moderate exogenous changes in concentration in the short-term. On the other hand, high concentrations can immediately cause massive unphysiological reactions which are not only to be attributed to the acute oxygen deficiency.[07619]
CO2 should therefore be considered toxicologically by no means only as an asphyxiant (-> asphyxia) as is often the case.
The aqueous solution of CO2 is a very weak acid but it does not cause any corrosion.
CO2 in the air, even in high concentrations, only produces a stinging sensation in the eyes, nose and throat.
Following contact with the eyes, small particles of dry ice were reported not to have caused signs of cold damage to the tissue.[07866]
On the other hand, eye contact with splashes of the expanded liquid certainly causes local frostbite.
Similar experience is for skin contact. Frostbite with later blistering has occurred not only on contact with dry ice or expanded liquid but also with containers containing these materials.
Irrespective of the possible consequences of such frostbite, a direct dermal toxicity through contact with CO2 (in every form) is probably to be excluded if normal working conditions are assumed.[00451]
Inhalation of 0.1 vol.% CO2 by sensitive persons who stayed in closed, artificially conditioned rooms already produced pressure sensations in the head and headache.[07900]
However, the critical effect following inhalative short-term exposure consists in acidosis. For volunteers who were physically moderately loaded, it became distinct when they were exposed to 1 vol.% CO2 (10000 ppm) for 30 minutes.
However, if there is no physical load, a healthy adult person is able to compensate for this concentration (i.e.: the pH value decreased only from 7.4 to 7.37).[07619]
2 vol.% CO2 in the inspiratory air increased the respiratory frequency and the tidal volume, at 4 - 6 vol.% CO2 (no information on duration of exposure) the following

symptoms were observed: headache, ringing in the ears (tinnitus), palpitations, hypertension, psychic excitation (like the excitation status of narcosis) as well as dizziness and light-headedness.[07900]
In further studies on volunteers which were better documented, only distinct symptoms were observed or parameters determined, of which the following were particularly interesting: 5 vol.%/30 min: strong activation of the blood supply to the kidneys and brain; 6 vol.%/6 - 8 min: changes to the ECG (more distinctly pronounced for older persons; > 60 years old); from 10 vol.% upwards/1.5 up to 7 minutes: strong activation of the cardiac action, headache, vertigo, enlarged pupils, myoclonic jerks; from 10 vol.% upwards/10 - 20 min: loss of consciousness; 20 - 30 vol.% (about 1 min): narcosis, unconsciousness, cramps, changes to the EEG and ECG and serious eye damage (retinal degeneration).[07619]
On the other hand, it was reported that some persons have allegedly tolerated concentrations of 10 vol.% for up to 1 hour without apparent hazard.[07866]
Various cases of death have occurred in particular when subjects have entered basins, pits, wells or other rooms in which CO2 has accumulated because of its high specific density (compared with air). The autopsy mainly revealed changes to the eyes (retina) and brain.
As expected, oral poisoning with CO2 had not been reported.[07619]

**Chronic toxicity:**
Only a few cases have provided experience from repeated occupationally related inhalative exposure of workers to concentrations of about 1 vol.%. In one epidemiologic study on this subject minor metabolic changes (non-significant increase of the concentration of bicarbonate in the blood of brewers exposed) were determined as the only conspicuous feature.[07619]
Other older studies observed the circumstances of exposure of persons in submarines, for example, who were exposed to > 3 vol.% CO2 with simultaneous decreased concentration of oxygen for days through to weeks (24 h/d). This initially led to a short period of excitation, then to progressive CNS depression. The peripheral blood flow was increased but the core temperature of body was reduced.
Further functions of the heart/circulatory system were changed, the respiratory frequency decreased and the mental function was partially disturbed.
Following a stay in 0.8 - 1.2 vol.% CO2 for up to 27 days, acidosis in the blood and an increased metabolically related incorporation of calcium carbonate in the bone was demonstrated.[07866]

**Reproductive toxicity, Mutagenicity, Carcinogenicity:**
Reproductive toxicity:
No negative experience appears to be available concerning exposure of pregnant women to moderately increased concentrations of CO2. This is also plausibly explained by a metabolically favorable physiological situation of pregnant women. In order to hold the pCO2 pressure in the fetus at a level which is not dangerous for it, it was recommended to keep the maximum exposure of pregnant women at below 0.5 vol.% under all circumstances.[07866]
In the few reproductive-toxicological experiments available on rats, reversible influence to male fertility and an increased incidence of teratogenic effects, compared with a control group were found only in concentrations which would be unrealistically high for

humans.[07619]
Mutagenicity:
No data is available.
Carcinogenicity:
No data is available.[99983]

**Biotransformation and Excretion:**
Dependent on his level of physical exertion, a healthy adult person produces between about 200 ml and 2 l $CO_2$ per minute.
It diffuses from the cells into the blood. Here, it is reversibly fixed partially as a hydrogen carbonate ion (see "Respiratory tract") and partially through chemical bond to hemoglobin and plasma proteins. A further part is dissolved physically (at a partial pressure in venous blood of 46 mm Hg). It is transported into the lung and usually exhaled to the same degree as it is produced endogenously.[00451]
If $CO_2$ is inhaled at increased concentrations for a long time period, a respiratory acidosis is formed and this stimulates respiration (see "Acute toxicity"). This causes a quickening of the $CO_2$ intake which can lead to lethal acidosis under certain conditions when the exogenous $CO_2$ supply is sufficiently high.[07900]
If only a moderately increased concentration of $CO_2$ (about 1 vol.%) is inhaled for several weeks, it can be partially deposited in the bone as $CaCO_3$. As a result, changes to the physiological concentrations of calcium and phosphate in the blood plasma can occur.[07619]

**Annotation:**
This occupational health information was compiled on 03.11.06.
It will be updated if necessary.[99999]

## FIRST AID

**Eyes:**
Following contact of the eyes with the gas at concentrations causing irritation or with dry ice:
Rinse the affected eye with widely spread lids for 10 minutes under running water whilst protecting the unimpaired eye.
For persistent irritation or contact with splashes of the undercooled liquid:
Then, immediately transport the casualty to an eye doctor / to hospital.

**Skin:**
Following contact of the skin with concentrated gas of normal temperature, short-term rinsing with water is sufficient.
Very short contact with dry ice is generally not a problem. For undercooling/frostbite due to prolonged contact with dry ice (possibly under pressure) or wettening of the skin with the expanded liquid from compressed gas cylinders: Clothing frozen to the skin should initially be left; remove damp clothing, carefully wrap the frostbitten region loosely in dry clothes and protect the whole of the patient's body against further cooling. Do not rub and/or further undercool frozen areas (as has been previonsly recommended: "scrape off with snow").
Immediately transport the casualty to hospital! Only if the arrival at hospital will probably be delayed by at least 1 - 2 hours should the first aid operator start the reheating of the

frozen part of the body: dipping into water of 38 - 43 degrees C for 30 - 40 minutes (take care to adhere precisely to this given temperature through adding of hot water). In the area of the head, wet compresses which have the corresponding temperature must be used. Then, carefully dry the part of body, cover it with sterile material and finally with heat insulating material and place in a raised position. Transport the patient to hospital.
Under no circumstances should the reheating be carried out be means of an open flame or radiant heat. The application of alcohol must be avoided. Do not open any blisters!
[99997, 99999]

**Respiratory tract:**
Whilst protecting yourself remove the casualty from the hazardous area and take him to the fresh air.
In the case of breathing difficulties have the casualty inhale oxygen.
If the casualty is unconscious but breathing lay him in a stable manner on his side.
If the casualty has stopped breathing give mouth to nose resuscitation. If this is not possible use mouth to mouth resuscitation. Keep his respiratory tract clear.
Arrange medical treatment.
[99997]

**Swallowing:**
Under occupational conditions, this intake pathway is toxicologically irrelevant.
[99997]

**Information for physicians:**
In its liquified or solid status (if the contact is not of only very short duration), CO2 can cause mainly superficial frostbite.[08013]
In the organism, the gas performs important functions. Moderate up to very increased concentrations in the inspiratory air can cause massive short-term reactions which cannot only be attributed to hypoxemia.[07619]
- Symptoms of acute poisoning:
Eyes: irritation due to high concentrations in the ambient air or aqueous solutions (extremely short-term); frostbite through contact with splashes from the undercooled liquid[07979]
Skin: frostbite through prolonged (pressure-)contact with dry ice (at least several seconds) or in particular through contact with the expanded liquid from compressed gas cylinders: waxen or porcelain like pallor, swelling, sensation of coldness, numbness, pruritus, burning and stinging pain; reddening after reheating, formation of edema and blisters;[99997] systemic effects due to dermal absorption of the gas unlikely or to be expected only in extreme cases[99999]
Inhalation: only slight irritation to the airways at high concentrations; rapid onset of systemic effects
Ingestion: under conditions encountered in practice no poisoning possible (only bloated feeling, eructation)
Absorption (dependent on the concentration of CO2 in the inspiratory air, physical exertion and duration of exposure): increase of the respiratory frequency and minute volume, tachypnoea, hypertension, increased circulation in the kidneys and brain,

headache, tinnitus, palpitations, changes to ECG, psychic excitation, vertigo, mydriasis, narcosis, cramps, changes to the EEG; death mostly caused by respiratory paralysis but possibly also occurring after a delay.[07900]
Following serious poisoning which is survived, in particular eye damage can persist (mainly retinal degeneration).[07866]
- Medical advice:
Frostbite to the eyes should be further treated only by an ophthalmologist.[99999]
Frostbite to the skin possibly require first aid (see above) and prior to arrival at hospital probably only protection of the vital functions, analgesia and possibly systemic application of substances promoting blood circulation (e.g. low molecular dextran).
Following inhalative poisoning, forced pulmonary excretion through optimization of ventilation is the main issue. Initial application of oxygen, preferably by artificial ventilation, is the main requirement for this. Where there is danger of vomiting, intubation is absolutely necessary.[99997]
Raised upper body and hyperventilation are indicated.[08004]
In case of cardiac/pulmonary arrest, immediately use all further measures of the cardiopulmonary resuscitation.[07637]
Simultaneously/subsequently, respiratory acidosis requires immediate correction (extraclinical diagnosis on the basis of the following symptoms: headache, confusion, hypertension, disturbance of consciousness; signs of hypoxia). Only then, further drugs which can be symptomatically applied to support the functions of the respiratory and heart/circulatory systems will reach their full efficiency. Rapid hospitalization is therefore necessary.[99983]
This is also a requirement for further measures to decrease the brain pressure in order to avoid a hypoxidosis-related brain edema.[08004]

**Recommendations:**
Provide the physician information about the substance/product and treatment already administered.
Irrespective of the low toxicity of CO2, massive poisoning mainly requires rapid hospitalization alongside immediate measures for protection of the vital functions.[99999]

**Annotation:**
This first aid information was compiled on 03.11.06.
It will be updated if necessary.

## SAFE HANDLING

### TECHNICAL MEASURES - HANDLING

**Workplace:**
Provision of good ventilation in the working area.
The gas is heavier than air. Adequate ventilation of the floor area must be ensured as well.
Protect ducts and sewers against penetration by the gas.

**Equipment:**

If dangerous pressure can arise from contact with heat, suitable safety measures and equipment should be provided.
If release of the substance cannot be prevented, then it should be suctioned off at the point of exit.
Label containers and pipelines clearly.
Suitable materials:
For cylinders and valves:
All usual materials.
Steels can be corroded if moisture is present.
For seals:
Polytetrafluoro ethylene PTFE (Teflon)
Polychloro trifluoro ethylene PCTFE
Polyvinylidene fluoride
Polyamide PA
Polypropylene PP

**Advice on safer handling:**
Do not store cylinders at the working area.
Do not force open valve.
When changing bottles, always inspect the leak-proof closure of the filled and empty bottles.
Withdraw the gas slowly. Quick relaxation can generate dry ice pieces which may be ejected forcefully.
Filling quantity has to be controlled by weighing.
Prior to filling, ensure that the cylinders are free from contaminants and humidity.
The gas has to be dry when filled. That means, the dew-point has to be < -10 °C.
Refilling or transfer in storage rooms is prohibited.
Prevent cylinders from falling over.
Suck back of water into the container must be prevented. Do not allow backfeed into the container.
Use leak-proof equipment with exhaust for refilling or transfer.
Only instructed personal should remove dry ice from storage vessels. Crush dry ice in a way that eliminates the danger of frostburn.
Usually transport occurs in containers with high pressure. Use suitable equipment for the transport.
Tightly screw on the protective caps and blind nuts when transporting. Secure cylinders against falling over, do not throw.
Use a suitable container to carry solid carbon dioxide (dry ice).

**Cleaning and maintenance:**
Regular inspection of leak test required!

## TECHNICAL MEASURES - STORAGE

**Storage:**
Containers have to be labelled clearly and permanently.
Keep container tightly closed.
Keep container in a well-ventilated place.

Recommended storage at room temperature.
Protect from exposure to sunlight.
Protect from overheating/heating up.
Keep upright, protect against falling over.
Do not store in escape routes, work rooms, or in direct proximity to them.
For transporting, storing, preparing, emptying, and maintaining pressurized gas bottles, the detailed rules in TRG 280 must be absolutely adhered to. For pressurised gas packaging, observe the applicable TRG 300.

**Conditions of collocated storage:**
Storage class 2 A (Gases)
Only substances of the same storage class should be stored together.
Collocated storage with the following substances is prohibited:
- Pharmaceuticals, foods, and animal feeds including additives.
- Infectious, radioactive und explosive materials.
- Flammable liquids of storage class 3.
- Other explosive substances of storage class 4.1A.
- Flammable solid substances or desensitized substances of storage class 4.1B.
- Pyrophoric substances.
- Substances liberating flammable gases in contact with water.
- Strongly oxidizing substances of storage class 5.1A.
- Oxidizing substances of storage class 5.1B.
- Organic peroxides and self reactive substances.
- Combustible and non combustible acutely toxic substances of stora-ge classes 6.1A and 6.1B.
- Combustible toxic or chronically acting substances of storage class 6.1C.
- Noncombustible toxic or chronically acting substances of storage class 6.1D.
- Combustible liquids of storage class 10.

Under certain conditions the collocated storage with the following sub-stances is permitted (For more details see TRGS 510):
- Aerosols (spray bottles).
- Ammonium nitrate and preparations containing ammonium nitrate.
- Combustible corrosive substances of storage class 8A.
- Combustible solids of storage class 11.

Consider the regulations of TRG 280 at collocated storage of different compressed gases.
The substance should not be stored with substances with which ha-zardous chemical reactions are possible.

## TECHNICAL MEASURES - FIRE AND EXPLOSION PROTECTION

**Technical, constructive measures:**
Substance is non-combustible. Select fire and explosion prevention measures according to the other used substances.
Protect parts of the system from any warming; if necessary, provide cooling with sprayed water.

## ORGANISATIONAL MEASURES

Instruction on the hazards and the protective measures using instruction manual ( TRGS 555) are required with signature if just more than one minor hazard was detected.
Instruction must be provided before employment and then at a minimum of once per annum thereafter.
An escape and rescue plan must be prepared when the location, scale, and use of the work-site so demand.
It must be assured that the workplace limit values are being maintained. If the limit values are exceeded, additional protection measures are necessary.
The measurements must be recorded and kept on file.
Observe the restrictions on juvenile employment as defined in the "Jugendarbeitsschutzgesetz".

## PERSONAL PROTECTION

**Body protection:**
Use protective boots while handling gas cylinders.

**Respiratory protection:**
In an emergency (e.g.: unintentional release of the substance, exceeding the occupational exposure limit value) respiratory protection must be worn. Consider the maximum period for wear.
Wear self-contained breathing apparatus.
Do not use filter respirator.

**Eye protection:**
Sufficient eye protection should be worn.
When handling compressed gas, at least glasses with side protection should be worn.

**Hand protection:**
Wear leather gloves to prevent frostbite injuries from rapidly expanding gas when handling pressurised gas bottles.
Also when handling dry ice.

**Occupational hygiene:**
Avoid skin contact with solid carbon dioxide (dry ice), danger of frostburn.
Avoid inhalation of gas.

## DISPOSAL CONSIDERATIONS

Compressed gas cylinders can normally be returned to the supplier. Pressurised cans are non-returnable and must be disposed of.
Do not empty pressure vessels to the point of pressure compensation. Mark empty vessels to avoid confusion with full ones.

## ACCIDENTAL RELEASE MEASURES

Provide adequate ventilation.

Wear respiratory protection (see chapter Personal Protection).
Attempt to stop the gas from escaping. Otherwise place leaky bottles under a suctioning device or put them outdoors.
Gas is moving on the ground.
Get damaged containers for cryogenic liquid into safety and evaporate content outdoors without personal risk.
Afterwards ventilate area.

Endangerment of watert:
No hazards to sources of water are to be feared if released into water, drainage, sewer, or the ground.

## FIRE FIGHTING MEASURES

**Instructions:**
Substance is incombustible. Select fire fighting measures according to the surrounding conditions.
In the case of fire advise fire fighters on the presence of gas cylinders.
Cool surrounding containers with water spray.
If possible, take container out of dangerous zone.
Rise in pressure and risk of bursting when heating.

**Special protective equipment:**
Wear self-contained breathing apparatus.

## REGULATIONS

**Classification:**
Gases under pressure, compressed gas; H280

**Signal Word:** "Warning"

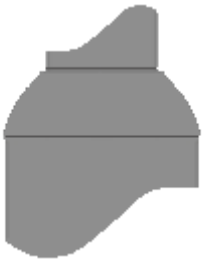
**Hazard Statement - H-phrases:**
H280: Contains gas under pressure; may explode if heated.

**Precautionary Statement - P-phrases:**
P403: Store in a well-ventilated place.

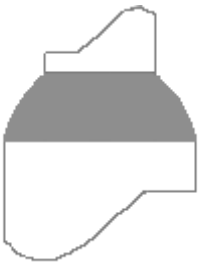
Manufacturer's specification by Air Liquide

Reference: 01401

## COLOUR CODING OF GAS CYLINDERS



Shoulder colour: Gray
(Carbon dioxide)



Shoulder colour: Gray
Cylinder colour: White
(Carbon dioxide for medical applications)

Shoulder colour: Gray and white
Cylinder colour: White
(Oxygen-Carbon dioxide mixture for medical applications)

## WORKPLACE LABELLING ACCORDING TO GERMAN ASR A1.3

**Warning label:**

Caution - gas cylinder

**Precept label:**

Use safety goggles

Wear safety shoes

## GERMAN WATER HAZARD CLASS

Substance No: 256

non-hazardous to waters

Classification according to the Administrative Regulation of Substances Hazardous to Water (VwVwS)

carbon dioxide

Substance No: 354

non-hazardous to waters

Classification according to the Administrative Regulation of Substances Hazardous to Water (VwVwS)

carbonic acid

## TRANSPORT REGULATIONS

UN Number: 1013
Shipping name: Carbon dioxide
Hazard Identification Number: 20
Class: 2.2 (Non-flammable, non-toxic gases)
Packing Group: -
Danger Label: 2.2

Tunnel restrictions:

Transports in tanks: passage forbidden through tunnels of category C, D and E.
Other transports: passage forbidden through tunnels of category E.

UN Number: 2187
Shipping name: Carbon dioxide, refrigerated, liquid
Hazard Identification Number: 22
Class: 2.2 (Non-flammable, non-toxic gases)
Packing Group: -
Danger Label: 2.2

Tunnel restrictions:

Transports in tanks: passage forbidden through tunnels of category C, D and E.
Other transports: passage forbidden through tunnels of category E.

UN Number: 1845
Shipping name: Carbon dioxide, solid
Hazard Identification Number: *
Class: 9 (Miscellaneous items and materials)
Packing Group: III (low danger)
* is not subject to the regulations of the ADR/RID
- when used as a coolant, see 5.5.3 (ADR)

Tunnel restrictions:
Passage allowed through all tunnels.

## TRGS 900 - GERMAN OCCUPATIONAL EXPOSURE LIMIT VALUES

5000 ml/m³
9100 mg/m³

Peak limitation: Excursion factor 2
Duration 15 min, mean; 4 times per shift; interval 1 hour
Category II - Substances with systemic effects

Source: DFG, EU

## EC OCCUPATIONAL EXPOSURE LIMIT VALUES

Commission Directive 2006/15/EC
Recommended indicative occupational exposure limit value for the European Community
A national occupational exposure limit value has to be set.
8 hours limit value: 9000 mg/m³ (5000 ppm)

## RECOMMENDATIONS OF MAK-COMMISSION

This data is recommended by scientific experience and is not established law.

5000 ml/m³
9100 mg/m³

Peak limitation: Excursion factor 2
Duration 15 min, mean; 4 times per shift; interval 1 hour
Category II - Substances with systemic effects

## RESTRICTIONS OF USE / BANS OF USE

**Directives on Safety in School (BGR/GUV-SR 2003)**
Pupil and teacher experiments with this substance are authorised without restrictions.
Substance list to GUV-SR 2004 (as of 11.2010)

## FURTHER REGULATIONS

TRGS 402
Ermitteln und Beurteilen der Gefährdungen bei Tätigkeiten mit Gefahrstoffen: Inhalative Exposition; Ausgabe Januar 2010, zuletzt geändert und ergänzt April 2014

TRGS 407
Tätigkeiten mit Gasen - Gefährdungsbeurteilung; Ausgabe Juni 2013, berichtigt Dezember 2013

TRGS 725/TRBS 3145
Ortsbewegliche Druckgasbehälter - Füllen, Bereithalten, innerbetriebliche Beförderung, Entleeren; Ausgabe Juni 2013

TRGS 726/TRBS 3146
Ortsfeste Druckanlagen für Gase; Ausgabe April 2014

TRGS 510
Lagerung von Gefahrstoffen in ortsbeweglichen Behältern; Ausgabe Januar 2013, geändert und ergänzt November 2014

TRGS 500
Schutzmaßnahmen; Ausgabe Januar 2008, ergänzt Mai 2008

## LINKS

International Limit Values
Suitable analytical methods
The MAK Collection for Occupational Health and Safety
Oxygen depletion – Hazard of asphyxia (in german only)
Oxygen depletion (in german only)
Hazards of inert gases and oxygen depletion(Doc 44/09)
Safety instructions - safeness handling dry ice (in german only)
Publications of the IGV (Industriegaseverband e.V.) (in german only)
Recommendations for safe filling of CO2 cylinders and bundles (Doc 83/08)
Safe handling of liquid carbon dioxide containers that have lost pressure (Doc 164/10)
Code of Practice - Dry ice (Doc 150/08)
Publications of EIGA (European Industrial Gases Association) Documents Download

## REFERENCES

Reference: 00001
IFA: Erfassungs- und Pflegehandbuch der GESTIS-Stoffdatenbank (nicht öffentlich)
Data acquisition and maintenance manual of the GESTIS substance database (not publicly)

Reference: 00105

Sorbe "Sicherheitstechnische Kenndaten chemischer Stoffe" ("Safety-related characteristics of chemical substances"), sicherheitsNet.de, Landsberg

Reference: 00260
1x1 der Gase. Physikalische Daten für Wissenschaft und Praxis. Herausgeber: AIR LIQUIDE Deutschland GmbH, Düsseldorf, 1. Auflage 2005

Reference: 00336
Schriftreihe der Bundesanstalt für Arbeitsschutz Gefährliche Arbeitsstoffe - (GA 32) GAS-ATLAS, 2. Auflage, Dortmund 1992

Reference: 00440
Datenbank CHEMSAFE, Version 2.10 (2014), DECHEMA-PTB-BAM

Reference: 00451
HSDB-Datenbankrecherche 2004

Reference: 01401
GHS-Sicherheitsdatenblatt (GHS Material Safety Data Sheet), Air Liquide

Reference: 02000
Internet-Quelle, nicht spezifiziert

Reference: 02070
LOG KOW Databank, compiled by Dr. James Sangster, Sangster Research Laboratories, Montreal, Canada, distributed by Technical Database Services (TDS), New York

Reference: 05116
Kühn-Birett-Merkblätter: 116. Ergänzungslieferung; 04/99

Reference: 05240
TRGS 407 "Tätigkeiten mit Gasen - Gefährdungsbeurteilung" Ausgabe Juni 2013, berichtigt Dezember 2013

Reference: 05300
TRGS 510 "Lagerung von Gefahrstoffen in ortsbeweglichen Behältern" Ausgabe Januar 2013, geändert und ergänzt November 2014

Reference: 05350
TRGS 900 "Arbeitsplatzgrenzwerte" Ausgabe Januar 2006, zuletzt geändert und ergänzt November 2015

Reference: 06002
L. Roth, U. Weller "Gefährliche Chemische Reaktionen" Loseblattsammlung mit Ergänzungslieferungen ("Dangerous chemical reactions" loose-leaf collection with supplement deliveries), ecomed-Verlag

Reference: 06501
DIN EN 378-1 "Kälteanlagen und Wärmepumpen" Ausgabe Juni 2008 mit Berichtigung

Januar 2010

Reference: 07584
Allgemeine Verwaltungsvorschrift zur Änderung der Verwaltungsvorschrift wassergefährdende Stoffe - VwVwS vom 27. Juli 2005; Bundesanzeiger Jahrgang 57, Nr. 142a, vom 30. Juli 2005

Reference: 07619
DFG: Toxikologisch-arbeitsmedizinische Begründungen von MAK-Werten; Verlag Chemie

Reference: 07635
AUERDATA 98 und BGR/GUV-R 190 "Einsatz von Atemschutzgeräten" Ausgabe 11/2009

Reference: 07637
S. Moeschlin "Klinik und Therapie der Vergiftungen" 7. Auflage, Thieme-Verlag, Stuttgart 1986

Reference: 07796
L. Roth "Wassergefährdende Stoffe" Loseblattsammlung mit Ergänzungslieferungen, ecomed-Verlag

Reference: 07830
M. Kühnert (Hrsg.): Veterinärmedizinische Toxikologie: Allgemeine und klinische Toxikologie, Grundlagen der Ökotoxikologie; 1. Auflage, Gustav Fischer Verlag, Jena 1991

Reference: 07837
W.J. Hayes, E.R. Laws (edit.) "Handbook of Pesticide Toxicology" Vol. 1 bis 3. Academic Press, Inc., San Diego California 1991

Reference: 07866
G.D. Clayton, F.E. Clayton (edt.) "Patty's Industrial Hygiene and Toxicology" Volume II "Toxicology", 4. Auflage, John Wiley & Sons, New York 1993

Reference: 07900
H. Marquardt, S.G. Schäfer (Hrsg.): Lehrbuch der Toxikologie; BI-Wissenschaftsverlag, Mannheim 1994

Reference: 07902
ADR 2015 - Europäisches Übereinkommen über die internationale Beförderung gefährlicher Güter auf der Straße (ADR)

Reference: 07979
W.M. Grant, J.S. Schuman: Toxicology of the eyes; 4th Edition, Charles C Thomas Publisher, Springfield, Illinois; 1993

Reference: 08004

H.P. Schuster "Notfallmedizin" 5. Auflage, Ferdinand Enke Verlag, Stuttgart 1996

Reference: 08013
Ludewig "Akute Vergiftungen" 9. Auflage, Wissenschaftliche Verlagsgesellschaft, Stuttgart 1999

Reference: 08102
DFG Deutsche Forschungsgemeinschaft: MAK- und BAT-Werte-Liste 2015, Senatskommission zur Prüfung gesundheitsschädlicher Arbeitsstoffe, Mitteilung 51; VCH

Reference: 99983
Literaturlisten - Standardwerke, erweitert (Bibliographical reference - standard works, extended)

Reference: 99997
Projektgebundene Literaturliste Nr. 1
(Project related bibliographical reference No 1)

Reference: 99999
Angabe des Bearbeiters (Indication of the editor)