Nitric oxide

IDENTIFICATION

Nitric oxide
Mononitrogen monoxide
Nitrogen monoxide

ZVG No:	1080
CAS No:	10102-43-9
EC No:	233-271-0

CHARACTERISATION

SUBSTANCE GROUP CODE

128300 Nitrogen oxides
139100 Inorganic gases

STATE OF AGGREGATION

The substance is gaseous.

PROPERTIES

colourless
odourless

CHEMICAL CHARACTERISATION

Oxidizing gas.
The substance itself does not burn, but in contact with combustible substances it increases the risk of fire and can fuel any existing fire substantially.
Only slightly soluble in water.
Chemically unstable at increased temperature.
With increasing concentration of NO in the air NO2 is formed.

Acute or chronic health hazards result from the substance.
(see: chapter REGULATIONS).

FORMULA

NO

Molar mass: 30,01 g/mol
Conversion factor (gaseous phase) at 1013 mbar and 20 °C:
1 ml/m³ = 1,25 mg/m³

PHYSICAL AND CHEMICAL PROPERTIES

TRIPLE POINT

Temperature: -163,6 °C
Pressure: 0,219 bar

MELTING POINT

Melting point: -164 °C

BOILING POINT

Boiling Point: -151,8 °C

CRITICAL DATA

Crit. temperature: -93,0 °C
Crit. pressure: 64,85 bar
Crit. density: 0,517 g/cm³

DENSITY

VAPOUR DENSITY
under standard conditions (0 °C, 1013 mbar)
Value: 1,3402 kg/m³

DENSITY OF LIQUID PHASE AT BOILING POINT
Value: 1,188 kg/l

RELATIVE VAPOUR DENSITY
Ratio of the density to dry air at the same temperature and pressure
Value: 1,04

VAPOUR DENSITY

Value:	1,254 kg/m³
Temperature:	15 °C
at 1 bar	

SOLUBILITY IN WATER

Concentration:	67 mg/l
Temperature:	10 °C

HAZARDOUS REACTIONS

Hazardous chemical reactions:
Risk of explosion in contact with:
ammonia
acetone/alkalies; dichlorine oxide; methanol; ozone; perchloryl fluoride; oxygen (liquid); carbon disulphide; nitrogen trichloride; vinyl chloride; hydrogen
The substance can react dangerously with:
combustible substances
fluorine
oxygen
phosphorus
reducing agents
acetylene (rare); boron; butadiene (rare); chromium (powder); difluorine oxide (rare); ethane (rare); ethene oxide (rare); hydrides; potassium sulphide; coal; magnesium; phosphine/ oxygen; hydrogen silicide (rare); vinyl methyl ether (rare)

OCCUPATIONAL HEALTH AND FIRST AID

TOXIC EFFECTS

Annotation:
At present time the occupational health information for this substance is only available in german. Please consult our database in german.

FIRST AID

Annotation:
At present time the first aid information for this substance is only available in German. Please consult our database in German.

SAFE HANDLING

TECHNICAL MEASURES - HANDLING

Workplace:
Provision of very good ventilation in the working area.
Devices for detecting and reporting the presence of hazardous gases should be present.
Eye bath required. These locations must be signposted
clearly.

Equipment:
Use only closed apparatus.
Use small cylinders and place them away from working area or in an exhausting hood.
Use only cylinders with a volume up to 85 l.
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.
Consider emission limit values, a purification of waste gases if necessary.
Label containers and pipelines clearly.
There should be a shutoff for the lines at a safe distance.
Suitable materials:
For cylinders and valves:
All usual materials; exceptions see below.
For seals:
Polytetrafluoro ethylene PTFE (Teflon)
Polychloro trifluoro ethylene PCTFE
Polyvinylidene fluoride
Unsuitable materials:
Copper
Copper alloys
Brass
These materials bear the risk of stress corrosion in humid air.

Steel is strongly affected in the presence of oxygen and humidity.

Advice on safer handling:
Purge system with dry inert gas before nitric oxide is introduced.
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.
As exit connection of valves always employ the 1"- thread used for chorine too.
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.
Refilling or transfer in storage rooms is prohibited.
Use acid resistant utensils.
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.

Cleaning and maintenance:
Regular inspection of leak test required!
Only conduct maintenance and other work on or in the vessel or closed spaces after obtaining written permission.
Only work with vessels and lines after they have been thoroughly rinsed.

TECHNICAL MEASURES - STORAGE

Storage:
Keep in locked storage or only make accessible to specialists or their authorised assistants.
Containers have to be labelled clearly and permanently.
Keep container below 50 °C in a well-ventilated place.
Keep upright, protect against falling over.
Any gases that escape from storage rooms for toxic gases must be capable of being safely drawn off or collected and then disposed of. The facilities must be capable of being operated from a safe location.
Protect from exposure to sunlight.
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 has an oxidizing effect.
Fire fighting equipment must be available.
Inspect the electrical fittings regularly against the higher risk of corrosion.
All parts that come into contact with the gas must be kept free of oil and grease.
Protect parts of the system from any warming; if necessary, provide cooling with sprayed water.

Precaution on handling:
Keep away from open flames and other heat sources.
Observe the smoking prohibition!
Absolutely no welding in the working area.
Work done with fire or open flame should only be carried out with written permission if the risk of fire or explosion cannot be completely eliminated.

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.
The number of employees who work with the hazardous substance must be kept to a minimum.
Observe the restrictions on juvenile employment as defined in the "Jugendarbeitsschutzgesetz".
Observe the restrictions on the employment of expectant and nursing mothers as defined in the "Mutterschutzverordnung".
Only employees are permitted to enter the work areas. Signposting to this effect must be displayed.

PERSONAL PROTECTION

Body protection:
Depending on the risk, wear gas-tight protective clothing.
Use protective boots while handling gas cylinders.

Respiratory protection:
In an emergency (e.g.: unintentional release of the substance) respiratory protection must be worn. Consider the maximum period for wear.
Respiratory protection: Special filter NO - P3, colour code blue-white.
These filters may only be used when in their original condition.
Use insulating device for concentrations above the usage limits for filter devices, for oxygen concentrations below 17% volume, or in circumstances which are unclear.

Eye protection:
Sufficient eye protection must be worn.
Wear chemical safety goggles.
If there is a risk of gases escaping, eye safety is best protected by wearing a full mask.
When handling liquid gas, chemical safety goggles must be used as well as a protective shield.

Hand protection:
Wear leather gloves to prevent frostbite injuries from rapidly expanding gas when handling pressurised gas bottles.
Skin protection cremes do not protect sufficiently against the substance. When there is a risk of direct contact with the substance, chemical-resistant gloves are required.
Currently there is no information available regading suitable glove materials.
Ask the manufacturer for suitable materials.

Occupational hygiene:
Avoid contact with skin. In case of contact wash skin.
Avoid skin contact with the liquid phase: risk of frostbite.
Avoid contact with eyes. In case of contact rinse the affected eye(s).
Avoid inhalation of gas.
Change and air out clothing that has been in contact with or taken up any of the gas.
The gas is quickly absorbed by moist clothes. Remove moist clothes immediately.
Before cleaning clothes rinse thoroughly first in water.

DISPOSAL CONSIDERATIONS

Hazardous waste according to Waste Catalogue Ordinance (AVV).
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.
Evacuate area. Warn affected surroundings.
The hazardous area may only be entered once suitable protective measures are implemented. Only then can the hazardous situation be removed.
Wear respiratory protection, eye protection, hand protection and body protection (see chapter Personal Protection).
Attempt to stop the gas from escaping. Otherwise place leaky bottles under a

suctioning device or put them outdoors.
Contain escaping gases/vapours with water.
Afterwards ventilate area.
Use plenty of water to clean the area surrounding the leak and equipment that has been in contact with the gas.

Endangerment of watert:
Low hazard to waters. Inform the responsible authorities when very large quantities get into water, drainage, sewer, or the ground.

FIRE FIGHTING MEASURES

Instructions:
Substance is non-combustible, but has an oxidizing effect.
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.
Be watchful for frostbite in case of contact with fluid.

Special protective equipment:
Wear self-contained breathing apparatus and special tightly sealed suit.

REGULATIONS

Classification:
Gases under pressure, compressed gas; H280
Oxidising gases, Category 1; H270
Acute toxicity, Category 1, inhalation; H330
Skin corrosion, Category 1B; H314

Signal Word: "Danger"

Hazard Statement - H-phrases:
H280: Contains gas under pressure; may explode if heated.
H270: May cause or intensify fire; oxidiser.
H330: Fatal if inhaled.
H314: Causes severe skin burns and eye damage.

Supplemental Hazard Statement - EUH-phrases:
EUH071: Corrosive to the respiratory tract.

Manufacturer's specification by Air Liquide

The manufacturer has assigned more than 6 P-phrases (compare article 28(3) of CLP Regulation in connection with ECHA Guidance on the compilation of safety data sheets).

Reference: 01401

GHS-CLASSIFICATION OF MIXTURES

The classification of mixtures containing this substance results from Annex 1 of Regulation (EC) 1272/2008.

Reference: 99999

COLOUR CODING OF GAS CYLINDERS

Cylinder shoulder colour: Yellow
(toxic and/or corrosive gases)

WORKPLACE LABELLING ACCORDING TO GERMAN ASR A1.3

Prohibition label:

No open flame; fire, open ignition sources and smoking prohibited

No admittance for unauthorized persons

No eating and drinking

Warning label:

Caution - toxic material

Caution - corrosive material

Caution - oxidizing material

Caution - gas cylinder

Precept label:

Use safety goggles

Wear safety shoes

Wear safety gloves

GERMAN WATER HAZARD CLASS

Substance No: 285

WGK 1 - low hazard to waters

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

TECHNICAL INSTRUCTIONS ON AIR QUALITY CONTROL (TA LUFT)

Chapter 5.2.4 Gaseous inorganic substances
Class IV
Following values are not allowed to be exceeded in the exhaust gas

Mass flow: 1,8 kg/hr

or

Mass conc.: 0,35 g/m³

Specified as nitrogen dioxide.
For further information see TA Luft.

TRANSPORT REGULATIONS

UN Number: 1660
Shipping name: Nitric oxide, compressed
Hazard Identification Number: 265
Class: 2.3 (Toxic gases)
Packing Group: -
Danger Label: 2.3/5.1/8

Tunnel restrictions:
Passage forbidden through tunnels of category D and E.

RECOMMENDATIONS OF MAK-COMMISSION

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

0,5 ml/m³
0,63 mg/m³

Peak limitation: Excursion factor 2
Duration 15 min, mean; 4 times per shift; interval 1 hour
Category I - Substances for which local irritant effects determine the exposure limit value, also respiratory allegens

Pregnancy: Group D
A classification according to groups A-C is not possible, because either there is no data available or the available data is insufficient for a final evaluation.

SEVESO III - Directive

Annex I Part 1 Section: H1

Acute toxic, Category 1

Qualifying Quantity Column 2:	5 t
Qualifying Quantity Column 3:	20 t

Annex I Part 1 Section:	P4

Oxidising gases, Category 1

Qualifying Quantity Column 2:	50 t
Qualifying Quantity Column 3:	200 t

RESTRICTIONS OF USE / BANS OF USE

Directives on Safety in School (BGR/GUV-SR 2003)
Activity ban for pupils.
Substance list to GUV-SR 2004 (as of 11.2010)

FURTHER REGULATIONS

TRGS 200
Einstufung und Kennzeichnung von Stoffen, Zubereitungen und Erzeugnissen; Ausgabe Oktober 2011

TRGS 201
Einstufung und Kennzeichnung bei Tätigkeiten mit Gefahrstoffen; Ausgabe Oktober 2011

TRGS 400
Gefährdungsbeurteilung für Tätigkeiten mit Gefahrstoffen; Ausgabe Dezember 2010; geändert und ergänzt September 2012

TRGS 555
Betriebsanweisung und Information der Beschäftigten; Ausgabe Januar 2013

TRGS 600
Substitution; Ausgabe August 2008

TRGS 401
Gefährdung durch Hautkontakt, Ermittlung - Beurteilung - Maßnahmen; Ausgabe Juni 2008; zuletzt berichtigt März 2011

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

TRGS 800
Brandschutzmaßnahmen; Ausgabe Dezember 2010

LINKS

International Limit Values
Suitable analytical methods
The MAK Collection for Occupational Health and Safety
Principles for the Safe Handling and Distribution of Highly Toxic Gases and Mixtures (IGC Doc 130/11/E)
Publications of the IGV (Industriegaseverband e.V.) (in german only)
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: 00260
1x1 der Gase. Physikalische Daten für Wissenschaft und Praxis. Herausgeber: AIR LIQUIDE Deutschland GmbH, Düsseldorf, 1. Auflage 2005

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

Reference: 01400
Sicherheitsdatenblatt (Material Safety Data Sheet), Air Liquide

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

Reference: 01420

Sicherheitsdatenblatt (Material Safety Data Sheet), Air Products

Reference: 05000
Kühn-Birett-Gruppenmerkblätter

Reference: 05114
Kühn-Birett-Merkblätter: 114. Ergänzungslieferung; 02/99

Reference: 05150
Kühn-Birett-Merkblätter: 150. Ergänzungslieferung; 6/2002

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

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

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

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

Reference: 80105
BG-Chemie-Merkblatt M 005 Ausgabe 8/2009 (BGI 576) Fluorwasserstoff, Flußsäure und anorganische Fluoride

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