Deuterium

IDENTIFICATION

Deuterium
Heavy hydrogen

ZVG No:	490958
CAS No:	7782-39-0
EC No:	231-952-7

CHARACTERISATION

SUBSTANCE GROUP CODE

139100 Inorganic gases

STATE OF AGGREGATION

The substance is gaseous.

PROPERTIES

colourless
odourless

CHEMICAL CHARACTERISATION

Stable isotope of hydrogen.

Extremely flammable gas. Forms explosive mixtures with air.
Burns with invisible flame.
Danger of self-ignition if gas emits at high velocity.
Only slightly soluble in water.
Gas is lighter than air.

In gas cylinders it is present as a compressed gas.
Danger of suffocation at high concentrations.

FORMULA

D2

D_2

Molar mass: 4,03 g/mol
Conversion factor (gaseous phase) at 1013 mbar and 20 °C:
1 ml/m³ = 0,168 mg/m³

PHYSICAL AND CHEMICAL PROPERTIES

TRIPLE POINT

Temperature: -254,4 °C
Pressure: 0,171 bar

MELTING POINT

Melting point: -254,43 °C

BOILING POINT

Boiling Point: -249,5 °C

CRITICAL DATA

Crit. temperature: -234,8 °C
Crit. pressure: 16,65 bar
Crit. density: 0,067 g/cm³

DENSITY

VAPOUR DENSITY
under standard conditions (0 °C, 1013 mbar)
Value: 0,1796 kg/m³

DENSITY OF LIQUID PHASE AT BOILING POINT
Value: 0,1624 kg/l

RELATIVE VAPOUR DENSITY
Ratio of the density to dry air at the same temperature and pressure
Value: 0,14

VAPOUR DENSITY

Value:	0,1680 kg/m³
Temperature:	15 °C

at 1 bar

IGNITION TEMPERATURE

Ignition temperature:	560 °C
Temperature class:	T1

EXPLOSION LIMITS

Lower explosion limit:
6,67 vol. %
11 g/m³
Upper explosion limit:
79,6 vol. %
80 g/m³

SOLUBILITY IN WATER

Concentration:	3,6 mg/l
Temperature:	0 °C

HAZARDOUS REACTIONS

Hazardous chemical reactions:
The hazardous chemical properties and reactions of deuterium are similar to those of --> hydrogen.

SAFE HANDLING

TECHNICAL MEASURES - HANDLING

Workplace:
Provision of very good ventilation in the working area.
Install a ceiling exhaust.
Devices for detecting and reporting the presence of hazardous gases should be present.

Equipment:
Use only closed apparatus.
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.
There should be a shutoff for the lines at a safe distance.
Suitable materials:
For cylinders and valves:
All usual materials.
Heed the maximum strength number that is required for normalised/heat-treated steels; risk of hydrogen embrittlement
For seals:
Polytetrafluoro ethylene PTFE (Teflon)
Polychloro trifluoro ethylene PCTFE
Polyamide PA

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.
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.
Purge air from equipment before introducing the gas.
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.

TECHNICAL MEASURES - STORAGE

Storage:
Containers have to be labelled clearly and permanently.
Keep container below 50 °C in a well-ventilated place.
Keep upright, protect against falling over.
Store separately in fire resistant room with self operating ventilation through the roof.
If stored outside provide protective roof and maybe water sprinkler for cylinders.
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 is combustible.
Fire fighting equipment must be available.
Measures required by the "Explosionsschutz-Richtlinie":
- Preventing the formation of an explosive atmosphere (limiting and monitoring the concentration, making inert, sealing, ventilation, warning systems, etc.)
- Preventing the ignition of an explosive atmosphere (separation into zones, removal of sources of ignition, explosion-proof electrical installation, grounding, etc.)
- Architectural measures to limit the effects of an explosion (explosive-force-proof construction, release of explosive pressure, explosion suppression, etc.)

Take precautionary measures against static discharges.
Earth all parts which can be electrically charged.
Protect parts of the system from any warming; if necessary, provide cooling with sprayed water.
Suitable measures must be applied to seal off waste-water systems, cable and pipe access ways, etc. (e.g.: immersing and sand beds).

Precaution on handling:
The gas-air mixture is explosive.

Area with explosion risk.
Keep at a distance from sources of ignition (e.g. electrical devices, open flames, heat sources, sparks).
Observe the smoking prohibition!
Absolutely no welding in the working area.
Only work with vessels and lines after these have been thoroughly rinsed.
Displacement with air is only permissible under strict observance of special protective measures.
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.
It must be avoided that gases or vapours can escape into other rooms where sources of ignition are present.

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.
Observe the restrictions on juvenile employment as defined in the "Jugendarbeitsschutzgesetz".
Only employees are permitted to enter the work areas. Signposting to this effect must be displayed.

PERSONAL PROTECTION

Body protection:
Wear flameproof, antistatic 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.
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.

Occupational hygiene:
Avoid skin contact with the liquid phase: risk of frostbite.
Avoid inhalation of gas.

Change clothing that has been in contact with or taken up any of the gas and air the clothing far from any sources of ignition.

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

Shut off all sources of ignition.
Provide adequate ventilation.
Evacuate area. Warn affected surroundings.
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.
Use non-sparking tools.
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

Classes of fires:
C gaseous, also compressed substances

Suitable extinguishing media:
Water (spray - not splash)
Dry extinguishing powder
Carbon dioxide extinguisher with gas nozzle

Instructions:
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.
Heating causes a rise in pressure, risk of bursting and explosion.
Shut off sources of ignition.
Only put out fire if the gas flow can be interrupted.
Risk of explosion from gas accumulation and backfire.
Use only explosion proved equipment.

Special protective equipment:
Wear self-contained breathing apparatus.

REGULATIONS

Classification:
Flammable gases, Category 1; H220
Gases under pressure, compressed gas; H280

Signal Word: "Danger"

Hazard Statement - H-phrases:
H220: Extremely flammable gas.
H280: Contains gas under pressure; may explode if heated.

Precautionary Statement - P-phrases:
P210: Keep away from heat, hot surfaces, sparks, open flames and other sources of ignition. No smoking.
P377: Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381: Eliminate all ignition sources if safe to do so.
P403: Store in a well-ventilated place.

Manufacturer's specification by Air Liquide

Reference: 01400

COLOUR CODING OF GAS CYLINDERS

Shoulder colour: Red
(flammable 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

Warning label:

Caution - gas cylinder

Caution - explosive atmosphere

Precept label:

Use safety goggles

Wear safety shoes

Wear safety gloves

GERMAN WATER HAZARD CLASS

non-hazardous to waters
Manufacturer's specification by Air Liquide

TRANSPORT REGULATIONS

UN Number: 1957
Shipping name: Deuterium, compressed
Hazard Identification Number: 23
Class: 2.1 (Flammable Gases)
Packing Group: -
Danger Label: 2.1

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

SEVESO III - Directive

Annex I Part 1 Section:	P2
Flammable gases, Category 1 or 2	
Qualifying Quantity Column 2:	10 t
Qualifying Quantity Column 3:	50 t

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 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

Publications of EIGA (European Industrial Gases Association) Documents Download
Publications of the IGV (Industriegaseverband e.V.) (in german only)

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

Reference: 05200
Kühn-Birett "Merkblätter Gefährliche Arbeitsstoffe" Loseblattsammlung mit Ergänzungslieferungen, ecomed Sicherheit, Landsberg

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