Ethane

IDENTIFICATION

Ethane
Bimethyl
Dimethyl
R 170

ZVG No: 10010
CAS No: 74-84-0
EC No: 200-814-8
INDEX No: 601-002-00-X

CHARACTERISATION

SUBSTANCE GROUP CODE

140110 Hydrocarbons, aliphatic, saturated
162000 Organic gases

STATE OF AGGREGATION

The substance is gaseous.

PROPERTIES

colourless
odourless

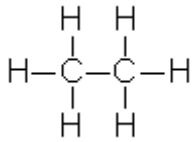
CHEMICAL CHARACTERISATION

Extremely flammable gas. Forms explosive mixtures with air.
Practically insoluble in water.
About as heavy as air, changes to a colourless liquid at normal pressure and

temperatures below -88.6 degree C or under pressure. Ignition or explosion possible in contact with strong oxidizing agents.
Mixtures with fluorine may only be produced after written coordination with the Federal Institute for Materials Research and Testing.

FORMULA

C2H6



Molar mass: 30,07 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: -182,8 °C
Pressure: 0,011 hPa

MELTING POINT

Melting point: -183,3 °C

BOILING POINT

Boiling Point: -88,6 °C

CRITICAL DATA

Crit. temperature: 32,3 °C
Crit. pressure: 48,8 bar
Crit. density: 0,203 g/cm³

DENSITY

VAPOUR DENSITY
under standard conditions (0 °C, 1013 mbar)
Value: 1,3551 kg/m³

DENSITY OF LIQUID PHASE AT BOILING POINT

Value: 0,5441 kg/l

RELATIVE VAPOUR DENSITY
Ratio of the density to dry air at the same temperature and pressure
Value: 1,05

VAPOUR DENSITY
Value: 1,2656 kg/m³
Temperature: 15 °C
at 1 bar

VAPOUR PRESSURE

Vapour pressure: 37,8 bar
Temperature: 20 °C

Vapour pressure: 46,9 bar
Temperature: 30 °C

FLASH POINT

Flash point: -135 °C

IGNITION TEMPERATURE

Ignition temperature: 515 °C
Temperature class: T1
Minimum ignition energy: 0,25 mJ
Max. exper. safe gap (MESG): 0,91 mm
Explosion group: IIA

EXPLOSION LIMITS

Lower explosion limit:
2,4 vol. %
31 g/m³
Upper explosion limit:
14,8 vol. %
182 g/m³
Limiting oxygen concentration (LOC):
8,8 vol. %

PARTITION COEFFICIENT (octanol/water)

log Kow: 1,81
Recommended value of LOG KOW Databank.

HAZARDOUS REACTIONS

Decomposition temperature: > 500 °C

Hazardous chemical reactions:
Risk of explosion in contact with:
strong oxidizing agents
chlorine (heat) / catalyst
The substance can react dangerously with:
fluorine
dinitrogen monoxide

FURTHER INFORMATION

global warming potential : 3
ozone depletion potential : 0

OCCUPATIONAL HEALTH AND FIRST AID

ROUTES OF EXPOSURE

Main Routes of exposure:
The main intake pathway for ethane (E.) is via the respiratory tract. [7748]

Respiratory tract:
E. is absorbed via the lungs but the largest proportion is rapidly exhaled again in an unchanged form. [8089]
There is a lack of data on the proportion which is retained under steady state conditions in the organism. [99983]

Skin:
Uptake through the skin seems to have no toxicological significance for E. [454]
Based on the physicochemical properties (gas of low solubility in water), it is not to be expected that significant amounts will penetrate the skin. [7748]

Gastrointestinal tract:
Ingestion of E. is only possible in the form of a refrigerated liquid. Based on rapid vaporization, absorption in the gastrointestinal tract is hardly to be expected even in this case. [99999]

TOXIC EFFECTS

Main toxic effects:
Acute:
Cold damage/frostbite following contact with the refrigerated liquid or expanded gas, [419]
in very high concentrations disturbance of the central nervous system and suffocating action due to oxygen displacement [7748]
Chronic:

No substance-specific data known [99983]

Acute toxicity:
Gaseous E. does not cause any irritating effects to the skin, eyes or airways. [454]
However, local damage is expected following contact with refrigerated liquefied gas or gas escaping from from compressed gas cylinders. Results are local undercooling or frostbite (symptoms: numbness, prickling, itching, in serious cases burning sensation, stiffness of the affected area, blistering, necrosis, gangrene). Following contact of the eyes with liquefied or compressed gas, the eyes can be damaged seriously, possibly even irreversibly. [419]
Regarding systemic-toxic effects, E. is considered practically non-toxic under usual conditions. [7748]
Concentrations of up to 50 000 ppm (5%) E. show no systemic effects to humans.
E. was reported to cause depressive effects to the central nervous system in higher concentrations. [8089]
By means of a physiologically based model and based on the solubility properties of E. (partition coefficient air/oil: 2 : 1), it was estimated that a substance-related effect to the central nervous system (narcosis) is to be expected from 130 000 ppm (13%) E. and above. [7748] The possibility of preliminary CNS symptoms as headache, nausea and vomiting is indicated.
Irrespective of this, very high concentrations of E. displace oxygen from the respiratory air and function as an asphyxiant. 140 000 ppm E. (14%) lead to a reduction of the oxygen content in the respiratory air to 18%. If the oxygen partial pressure is further reduced, the body suffers increasingly from oxygen deficiency including cardiovascular reactions (increased frequency of respiration and pulse) and CNS symptoms (such as headache, nausea, incoordination through to unconsciousness) and also damage to organs. These effects are intensified due to physical exertion (increased need of oxygen in the organism). [419]
At very high concentrations of E. (in animal experiments 15 - 90%), cardiac sensitization to the action of adrenaline can also occur. [8089] In particular in combination with stress situations and oxygen deficiency, there is a danger of cardiac arrest. [419]

Chronic toxicity:
There are no field reports on damage to humans as a consequence of prolonged inhalation of E. [99983]
An impairment of health due to this noxa is also not expected. [419]

Reproductive toxicity, Mutagenicity, Carcinogenicity:
Reproductive toxicity:
No substance-specific data is available. [99983]
Mutagenicity:
No substance-specific data is available. [99983]
Carcinogenicity:
No data is available either for humans or from animal experiments. [99983]
There is no suspicion that E. could be carcinogenic. [419]

Biotransformation and Excretion:
The majority of inhaled E. is exhaled unchanged. The elimination half-life was reported

to be 0.95 h. In tests on rats, the elimination kinetics at the concentration level examined (0.5 - 5000 ppm) was linear and there were no indications of a saturation of the elimination process at high concentrations.
Ethanol seems not to be a significant metabolite of E. [8089]
Nevertheless, in an experiment on rats which had inhaled radioactively labeled E. a significant proportion of the radioactivity was exhaled as CO2. [7784] This indicates that a proportion of the dose is decomposed oxidatively. [99999]

Annotation:
This occupational health information was compiled on 14.09.2011.
It will be updated if necessary.

FIRST AID

Eyes:
Following contact with the liquefied or expanded gas, rinse the eyes only shortly under running (lukewarm) water. Do not part lids, leave contact lenses in their place initially. Do not attempt to rewarm. Cover with a sterile dressing.
Arrange medical treatment.
[419, 99996]

Skin:
Whilst protecting yourself, relocate the casualty away from the source of danger.
Remove contaminated clothing while protecting yourself.
Following contact with liquefied ethane or expanded gas, first thaw off clothing frozen to the body by rinsing with a lot of cold or lukewarm water and only after that, peel it off carefully.
Also rinse skin areas which are suspected to be frozen following contamination with refrigerated ethane. Do not rub affected areas and do not use dry heat but cover with a sterile dressing.
Lay the casualty down in a quiet place to rest and protect him against hypothermia.
Arrange for medical treatment.
[419]

Respiratory tract:
Whilst protecting yourself remove the casualty from the hazardous area and take him to the fresh air.
Lay the casualty down in a quiet place and protect him against hypothermia.
In the case of breathing difficulties have the casualty inhale oxygen.
Arrange medical treatment.
After very massive inhalation, the following measures may become necessary:
If the casualty is unconscious but breathing lay him in a stable manner on his side.
In the case of cardiac arrest (lack of heart beat or pulse) immediately apply heart lung resuscitation. The protection of the vital functions (heartbeat and respiration without assistance) takes priority over every other activity.
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.
[419]

Swallowing:
Swallowing of the refrigerated liquid is unlikely. [419]
If it nevertheless has happened: Have the casualty slowly drink 1 - 2 glass of water. [454]
Further measures as established for “Respiratory tract”.
Call a physician to the site of the accident. [99999]

Information for physicians:
Ethane gas does not cause any irritation and is considered to be non-toxic under normal conditions. Only very high concentrations have a depressive effect on the CNS as well as asphyxiating due to the displacement of oxygen in the breathable air.
Liquefied gas or gas escaping from compressed gas cylinders can cause cold damage. [419]

- Symptoms of acute poisoning:
Eyes: frostbite due to liquefied or expanded gas
Skin: frostbite due to liquefied or expanded gas (numbness, prickling, itching, burning, stiffness of the affected area, later possible blistering, necrosis, gangrene) [419]
Inhalation: at very high concentrations (above 50 000 ppm) CNS depression (headache, nausea, dazed feeling) and above 140 000 ppm increasing anoxic effects, intensified following additional physical exertion: increased frequency of respiration and pulse, muscle incoordination, emotional disturbances, difficulties in breathing; danger of collapse, unconsciousness, cramps, respiratory arrest and sudden cardiac arrest; following survival possible damage to organs as consequences of hypoxia, in particular organs with high need of oxygen (such as CNS and heart), [8089, 419] possibly also functional disturbances of the kidneys (as a consequence of rhabdomyolysis), [454] following direct inhalation of refrigerated aerosol from compressed gas cylinders: danger of reflective cardiac arrest due to cold irritation to the nervus vagus [99996]
Ingestion: following swallowing of refrigerated liquid possible cold damage or acute cardiovascular reactions (see above). [99999]

- Medical advice:
If eyes come into contact with liquefied gas or expanded gas, ophthalmologic treatment is indicated as soon as rinsing has been completed.
Frostbite on the skin or undercooling as a consequence of extensive contact can be treated in the usual way.
Following massive inhalation, administer fresh air and oxygen as soon as possible. Lay the casualty down in a quiet place and treat according to symptoms. [419, 454]
After very massive contact, measures for cardiopulmonary and cerebral resuscitation can rapidly become necessary. In this connection, caution is recommended when catecholamines are administered because very high concentrations of ethane can cause cardiac sensitization to catecholamines. [8089]
Following massive exposure and in every case when disturbances to the CNS became noticeable hospitalization should be considered in order to be able to identify possible hypoxic damage. [454]

Recommendations:
Provide the physician information about the substance/product and treatment already

administered.
[99999]

Annotation:
This first aid information was compiled on 14.09.2011.
It will be updated if necessary.

SAFE HANDLING

TECHNICAL MEASURES - HANDLING

Workplace:
Provision of very good ventilation in the working area.
The gas is heavier than air. Adequate ventilation of the floor area must be ensured as well.
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.
Do not open apparatus or ovens while they are hot. Before filling the hot apparatus with gas, render pipes and reactor inert. Before heating up the cold apparatus ensure that it is free of oxygen.
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.
For seals:
Polytetrafluoro ethylene PTFE (Teflon)
Polychloro trifluoro ethylene PCTFE
Polyvinylidene fluoride
Polyamide PA
Polypropylene PP
Acrylonitrile butadiene rubber NBR
Fluoro rubber FKM

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.
Ensure that cylinders are leak-tight.
Store in a cool place.
Keep container in a well-ventilated place.
If cylinders are stored outdoors provide a protective roof and optionally install a water sprinkling system.
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.
Do not use any tools that cause sparks.
It must be avoided that gases or vapours can escape into other rooms where sources of ignition are present.
Creeping gases from afar may cause ignition.

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.
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.

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:
In the case of a fire hazardous substances can be released.
Carbon monoxide and carbon dioxide
Wear self-contained breathing apparatus.

REGULATIONS

Classification:
Flammable gases, Category 1; H220
Gases under pressure, liquefied 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: 01401

The substance is listed in appendix VI, table 3.1 of CLP regulation.
The given classification can deviate from the listed classification, since this classification is to be complemented concerning missing or divergent danger classes and categories for the respective substance.

Reference: 99999

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

GERMAN WATER HAZARD CLASS

Substance No: 91

non-hazardous to waters

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

TECHNICAL INSTRUCTIONS ON AIR QUALITY CONTROL (TA LUFT)

Chapter 5.2.5 Organic Substances.

The following values, specified as overall carbon, are in all not allowed to be exceeded in exhaust gas:

Mass flow: 0,50 kg/hr

or

Mass conc.: 50 mg/m³

At old units with an annual mass flow till 1,5 Mg/a, specified as total carbon, the

emissions in exhaust gas are not allowed to exceed 1,5 kg/h.

TRANSPORT REGULATIONS

UN Number: 1035
Shipping name: Ethane
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.

UN Number: 1961
Shipping name: Ethane, refrigerated liquid
Hazard Identification Number: 223
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 2 Number: 18
Liquefied flammable gases, Category 1 or 2
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 till grade 4 (form) inclusive.
Substance list to GUV-SR 2004 (as of 11.2010)
Special substitute check required (substances with CMR, T+, E, and C with R35).
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 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
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: 00106
Sorbe "Sicherheitstechnische Kenndaten chemischer Stoffe" ("Safety-related characteristics of chemical substances"), sicherheitsNet.de, Landsberg, 07/2011

Reference: 00240
E. Brandes, W. Möller "Sicherheitstechnische Kenngrößen" Band 1 "Brennbare Flüssigkeiten und Gase" ("Safety-related characteristics" Vol. 1 "Combustible liquids and gases"), Wirtschaftsverlag NW, Verlag für neue Wissenschaft GmbH, Bremerhaven, 2003

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

Reference: 00419
CHEMINFO-Datenbankrecherche (CHEMpendium) ab 2001

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

Reference: 00454
Hazardous Substances Data Bank (HSDB)

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

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

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

Reference: 07729
Chemisch-toxikologische Schadstoffkartei, Akademie der Wissenschaften, Leipzig

Reference: 07748
American Conference of Governmental Industrial Hygienists "Documentation of the threshold limit values and biological exposure indices Loseblattsammlung mit Ergänzungslieferungen

Reference: 07784
M.L. Richardson, S. Gangolli "The Dictionary of Substances and their Effects" Royal Society of Chemistry, 1992

Reference: 07877
BUA Stoffbericht 144: Flüssiggas (Propan, Butan, Isobutan und Gemische) - Stand 06/94

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

Reference: 08089
Bingham E., Cohrssen B., Powell C.H. (edts.) "Patty´s Toxicology" fith edition, John Wiley & Sons, New York 2001

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

Reference: 99996
Projektgebundene Literaturliste Nr. 2 (Project related bibliographical reference No 2)

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