

of the eyes and upper respiratory tract.

Direct contact of gas let down from compressed gas cylinders with the eyes and skin leads to reddening, edema and deep necrosis as a consequence of "chemical frostbites".

There is no information on the potential to sensitize the skin, not even at high gas concentrations.

Dermal toxicity is also hardly to be expected, not even if persons using effective respiratory protection are placed in a room containing a concentrated mixture of P. vapor in air. The odor threshold for P. is between 5000 and 20000 ppm. Slight irritation only appears at much higher concentrations.

From several studies on humans it appears that 1000 ppm does not initiate any systemic effects either. In further inhalation studies it was found that short-term exposure to even 10000 ppm (1 vol.%) did not cause any or only a slightly dazed feeling. Only at concentrations from 10 vol.% upwards the following symptoms can be produced, also dependent on the concentration: accelerated respiration, difficulties in breathing, disturbances to coordination, decreased alertness, emotional instability, rapid fatigue, nausea, vomiting, weakness, unconsciousness, cramps and deep coma.

One case of death due to asphyxia has been reported and this was following massive exposure to P.

Dogs exposed to 100000 ppm (10 vol.%) for 5 minutes developed sensitization of the heart muscle to epinephrine.

The EC50 for this effect was reported to be 18 vol.%.

Rhesus monkeys exposed to 100000 ppm (duration not given) only showed respiratory depression but no further poisoning symptoms.

Chronic toxicity :

In an experiment, 125 volunteers used a deodorant containing 65 - 70 weight % propane/isobutane twice per day for 12 weeks. No irritation to the skin was observed.

Employees in a filling plant for liquid gas (butane, propane) who were repeatedly exposed to a maximum of 8000 ppm P./butane showed the following symptoms: dry cough, dryness in the throat, gastrointestinal complaints, functional changes of the heart (sinus tachycardia, multiple extrasystoles and other changes noticeable from the ECG).

21 monkeys inhalatively exposed for 90 days to 750 ppm of a deodorant containing more than 50 % propane as a propellant did not show any exposure-related symptoms.

Reproductive toxicity, Mutagenicity, Carcinogenicity :

Reproductive toxicity:

Insufficient data is available.

Serious fetotoxic action of the homologous butane which led to cot death following high exposure of 2 pregnant women was considered not to follow a noxa-related mechanism but to be a definitive consequence of hypoxia caused by exposure.

Mutagenicity:

Concentrations of P. in air up to 50 % did not show any mutagenic potential to microorganisms but the highest concentration was cytotoxic.

Carcinogenicity:

No data is available.

Biotransformation and Excretion :

50000 ppm P. inhalatively taken in was partially metabolized to form isopropanol and acetone (no quantitative data available). Both of the metabolites were detected in the blood, liver, brain and kidneys after exposure for 1 hour. Because microsomal oxidation takes place on the (omega-1)-carbon, n-propanol is not formed. This was also confirmed experimentally.

Annotation :

This occupational health information was compiled on 11.11.05.

It will be updated if necessary.

FIRST AID

Data is available for the following sections :

Eyes | Skin | Respiratory tract | Swallowing | Information for physicians | Recommendations

Eyes :

If frostbite results from direct contact with propane gas released from pressure gas cylinders, contact lenses should initially remain in place. Immediately mildly rinse the eye concerned with water of normal temperature. Do not spread the lids.

Do not apply heat.

Arrange medical treatment.

Skin :

For frostbite resulting from contact with undercooled liquid propane, cut open contaminated clothing and remove it carefully.

Leave clothing caked to the skin in place initially.

Rinse frostbitten areas with luke-warm water. Never use hot water.

Do not move frostbitten extremities (do not massage).

Cover with sterile material, protect against further loss of warmth.

While these activities are proceeding, absolutely call a physician (danger of infection to the wounds, undercooling).

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.

If there is a danger of unconsciousness, put/transport the casualty in a stable side position.

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.

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.

Swallowing :

Not relevant.

Information for physicians :

- Symptoms of acute poisoning:

Eyes/skin: Frostbite due to direct contact with the undercooled liquid.

Inhalation (extremely high concentrations): vertigo, nausea, stupor, muscular weakness, cramps, narcosis, irregular respiration, unconsciousness, death through oxygen deficiency.

- Medical advice:

For extensive frostbite with a fall in the body temperature, immediately warm the patient in a water bath of 40 - 42 degrees C.

There is no consistent opinion on the optimal therapy for local frostbite without decrease of the core temperature (gradual warming or dipping into maximum 40 degrees C warm water with alleviation of pain as necessary).

Threatening suffocation requires application of fresh air or better air enriched with oxygen.

In serious cases artificial ventilation, shock therapy.

Resuscitation in hospital as necessary.

Careful observation of the circulatory system is necessary.

Do not apply epinephrine and derivatives because the heart is sensitized to their arrhythmogenic effect.

Recommendations :

Provide the physician information about the substance/product and treatment already administered.

Examination of the functions of the liver and kidneys and a neurologic postobservation is indicated in every case in order to recognize possible late sequels.

Annotation :

This first aid information was compiled on 12.09.05.

It will be updated if necessary.

The following main sections contain further information about this material.

Identification | Physical and chemical properties | Occupational health and first aid | Handling and usage | Regulations | Literature register

This material data sheet was carefully compiled. However no liability can be assumed for the data content, whatever the legal cause may be.

Propane

LITERATURE REGISTER

Quelle :00035

Sicherheitsdatenblatt der Firma Air Liquide

Quelle :00104

Sorbe: Sicherheitstechnische Kenndaten chemischer Stoffe
sicherheitsNet.de, Landsberg

Quelle :00200

Auerdata 98, Auergesellschaft GmbH, Berlin, 1998

Quelle :00240

E. Brandes, W. Möller: Sicherheitstechnische Kenngrößen,
Band 1: Brennbare Flüssigkeiten und Gase. Wirtschaftsverlag
NW, Verlag für neue Wissenschaft GmbH, Bremerhaven, 2003

Quelle :00260

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

Quelle :00330

U. Welzbacher: Neue Datenblätter für gefährliche
Arbeitsstoffe nach Gefahrstoffverordnung, Loseblattsammlung
mit Ergänzungslieferungen, WEKA-Verlag, Augsburg

Quelle :00336

Schriftreihe der Bundesanstalt für Arbeitsschutz
Gefährliche Arbeitsstoffe - (GA 32) GAS-ATLAS
2. Auflage; Dortmund 1992

Quelle :00442

Datenbank CHEMSAFE, Version 1.4.7 (2006), DECHEMA-PTB-BAM

Quelle :00451

HSDB-Datenbankrecherche 2004

Quelle :00500

RÖMPP Online ab 2003

Quelle :05000

Kühn-Birett-Gruppenmerkblätter

Quelle :05097

Kühn-Birett-Merkblätter: 97. Ergänzungslieferung; 03/97

Quelle :05350

TRGS 900: Arbeitsplatzgrenzwerte; Ausgabe Januar 2006;
zuletzt geändert März 2007

Quelle :06002

L. Roth, U. Weller: Gefährliche Chemische Reaktionen.
Loseblattsammlung mit Ergänzungslieferungen, ecomed-Verlag

Quelle :06501

DIN 8960: Kältemittel - Anforderungen und Kurzzeichen
(Ausgabe November 1998)

Quelle :06633

BG-Regel 192 (ZH 1/703): Benutzung von Augen- und
Gesichtsschutz; Ausgabe 7.01

Quelle :07504

Erste Allgemeine Verwaltungsvorschrift zum Bundes-
Immissionsschutzgesetz (Technische Anleitung zur Reinhaltung
der Luft - TA Luft) vom 24.07.2002, GMBI. 2002, Heft 25 - 29
S. 511 - 605.

Quelle :07558

Richtlinie 67/548/EWG für die Einstufung, Verpackung
und Kennzeichnung gefährlicher Stoffe, Anhang I

Quelle :07584

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

Quelle :07619

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

Quelle :07635

Auerdata Ausgabe 1998 und BG-Regel 190 (ZH 1/701)
Einsatz von Atemschutzgeräten; Fassung 10.96

Quelle :07748

American Conference of Governmental Industrial Hygienists
INC.: Documentation of the threshold limit values and
biological exposure indices; Loseblattsammlung mit
Ergänzungslieferungen

Quelle :07782

VCI: Konzept zur Zusammenlagerung von Chemikalien

Quelle :07877

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

Quelle :07902

Kühn-Birett: Gefahrgutschlüssel; Loseblattsammlung mit
Ergänzungslieferungen; ecomed-Verlag

Quelle :07975

H. F. Bender: Das Gefahrstoffbuch; VCH Weinheim, 1996

Quelle :08079

DFG Deutsche Forschungsgemeinschaft: MAK- und BAT-Werte-
Liste 2007, Senatskommission zur Prüfung gesundheitsschäd-
licher Arbeitsstoffe, Mitteilung 43; VCH

Quelle :99983

Literaturlisten - Standardwerke, erweitert

Quelle :99994
Projektgebundene Literaturliste Nr. 4

Quelle :99997
Projektgebundene Literaturliste Nr. 1

Quelle :99998
Angabe auf Basis des geltenden Vorschriften- und Regelwerks

Quelle :99999
Angabe des Bearbeiters

The following **main sections** contain further information about this material.
Identification | Physical and chemical properties | Occupational health and first aid | Handling and usage | Regulations | Literature register

This material data sheet was carefully compiled. However no liability can be assumed for the data content, whatever the legal cause may be.

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資料P-5(RTECS)

Propane

RTECS – Registry of Toxic Effects of Chemical Substances

1.0 SUBSTANCE IDENTIFICATION▲

RTECS Number: TX2275000

Chemical Name: Propane

CAS Number: 74-98-6

Molecular Formula: C₃H₈

Molecular Weight: 44.11

Wiswesser Notation: 3H

Substance Investigated as: Agricultural Chemical

Last Revision Date: 200608

2.0 SYNONYM(S)/TRADENAME(S)▲

1. Dimethylmethane
2. Liquefied petroleum gas
3. LPG
4. n-Propane
5. Propane (ACGIH:OSHA)
6. Propyl hydride
7. R 290

4.0 STANDARDS AND REGULATIONS▲

1. MSHA STANDARD: ASPHYXIANTS/GASES
2. OEL IN ARGENTINA, BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV;
3. OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGIH TLV
4. OEL-AUSTRALIA: Asphyxiant, JAN1993
5. OEL-BELGIUM: Asphyxiant, JAN1993
6. OEL-DENMARK: TWA 1000 ppm (1800 mg/m³), OCT 2002
7. OEL-FINLAND: TWA 800 ppm (1100 mg/m³), JAN1999
8. OEL-GERMANY: MAK 1800 mg/m³ (1000 mL/m³), 2005
9. OEL-HUNGARY: Asphyxiant, JAN1993
10. OEL-MEXICO: Simple asphyxiant, 2004
11. OEL-SWITZERLAND: MAK-W 1000 ppm (1800 mg/m³), JAN1999
12. OEL-THE PHILIPPINES: TWA 1000 ppm (1800 mg/m³), JAN1993
13. OSHA PEL (Fed Cont): 8H TWA 1000 ppm (1800 mg/m³)
14. OSHA PEL (Gen Indu): 8H TWA 1000 ppm (1800 mg/m³)

5.0 NIOSH DOCUMENTS▲

1. NIOSH REL TO PROPANE--air:10H TWA 1000 ppm
2. National Occupational Exposure Survey 1983: Hazard Code 26615; Number of Industries 396; Total Number of Facilities 129448; Number of Occupations 236; Total Number of Employees 2071479; Total Number of Female Employees 528348
3. National Occupational Hazard Survey 1974: Hazard Code 26615; Number of Industries 342; Total Number of Facilities 95086; Number of Occupations 192; Total Number of Employees 1005020

6.0 REVIEWS▲

1. ACGIH TLV-TWA 1000 ppm
2. TOXICOLOGY REVIEW

7.0 STATUS IN U.S.▲

1. EPA TSCA Section 8(b) CHEMICAL INVENTORY
2. EPA TSCA Section 8(d) unpublished health/safety studies
3. EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, JANUARY 2001

PROPANE

資料P-6(HSDB)

HSDB - Hazardous Substances Data Bank

0.0 ADMINISTRATIVE INFORMATION

Hazardous Substances Data Bank Number: 1672

Last Revision Date: 20070604

Review Date: Reviewed by SRP on 1/11/2007

Update History:

1. Complete Update on 2007-06-04, 78 fields added/edited/deleted
2. Field Update on 2006-04-18, 2 fields added/edited/deleted
3. Field Update on 2006-04-17, 2 fields added/edited/deleted
4. Complete Update on 2005-06-23, 1 fields added/edited/deleted
5. Complete Update on 2005-04-22, 1 fields added/edited/deleted
6. Field Update on 2005-01-29, 2 fields added/edited/deleted
7. Complete Update on 03/05/2003, 6 fields added/edited/deleted.
8. Field Update on 02/14/2003, 1 field added/edited/deleted.
9. Field Update on 11/08/2002, 1 field added/edited/deleted.
10. Complete Update on 08/09/2001, 1 field added/edited/deleted.
11. Complete Update on 05/15/2001, 1 field added/edited/deleted.
12. Complete Update on 02/08/2000, 1 field added/edited/deleted.
13. Complete Update on 02/02/2000, 1 field added/edited/deleted.
14. Complete Update on 11/18/1999, 1 field added/edited/deleted.
15. Complete Update on 09/21/1999, 1 field added/edited/deleted.
16. Complete Update on 08/24/1999, 6 fields added/edited/deleted.
17. Complete Update on 03/19/1999, 1 field added/edited/deleted.
18. Complete Update on 01/27/1999, 1 field added/edited/deleted.
19. Complete Update on 11/12/1998, 1 field added/edited/deleted.
20. Complete Update on 10/23/1997, 1 field added/edited/deleted.
21. Complete Update on 04/23/1997, 2 fields added/edited/deleted.
22. Complete Update on 02/27/1997, 1 field added/edited/deleted.
23. Complete Update on 06/11/1996, 1 field added/edited/deleted.
24. Complete Update on 03/19/1996, 7 fields added/edited/deleted.
25. Complete Update on 01/21/1996, 1 field added/edited/deleted.
26. Complete Update on 05/26/1995, 1 field added/edited/deleted.
27. Complete Update on 01/24/1995, 1 field added/edited/deleted.
28. Complete Update on 12/28/1994, 1 field added/edited/deleted.
29. Complete Update on 11/18/1994, 1 field added/edited/deleted.
30. Complete Update on 10/19/1994, 1 field added/edited/deleted.
31. Complete Update on 08/02/1994, 1 field added/edited/deleted.
32. Complete Update on 03/25/1994, 1 field added/edited/deleted.
33. Complete Update on 08/07/1993, 1 field added/edited/deleted.
34. Complete Update on 02/28/1993, 4 fields added/edited/deleted.
35. Field Update on 02/05/1993, 1 field added/edited/deleted.
36. Field update on 12/21/1992, 1 field added/edited/deleted.
37. Field Update on 04/16/1992, 1 field added/edited/deleted.
38. Field Update on 01/13/1992, 1 field added/edited/deleted.

39. Complete Update on 09/13/1990, 80 fields added/edited/deleted.
40. Field Update on 01/15/1990, 1 field added/edited/deleted.
41. Complete Update on 01/11/1990, 79 fields added/edited/deleted.
42. Field Update on 05/05/1989, 1 field added/edited/deleted.
43. Complete Update on 12/09/1988, 2 fields added/edited/deleted.
44. Complete Update on 07/12/1988, 2 fields added/edited/deleted.
45. Complete Update on 03/08/1988, 2 fields added/edited/deleted.
46. Complete Update on 10/14/1986
47. Created 19830315 by GCF

1.0 SUBSTANCE IDENTIFICATION

Name of Substance: PROPANE

CAS Registry Number: 74-98-6

Synonyms:

1. A-108 [Peer reviewed] [Estrin, N.F., Crosley, P.A. and Haynes, C.R. (eds.) CTFA Cosmetic Ingredient Dictionary. 3rd ed. Washington, D.C.: The Cosmetic, Toiletry and Fragrance Association, Inc. 1982., p. 260]
2. DIMETHYLMETHANE [Peer reviewed] [Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 14th Edition. John Wiley & Sons, Inc. New York, NY 2001., p. 926]
3. Hydrocarbon Propellant A-108 [Peer reviewed] [Estrin, N.F., Crosley, P.A. and Haynes, C.R. (eds.) CTFA Cosmetic Ingredient Dictionary. 3rd ed. Washington, D.C.: The Cosmetic, Toiletry and Fragrance Association, Inc. 1982., p. 260]
4. LIQUEFIED PETROLEUM GAS [Peer reviewed] [Bingham, E.; Cohnsen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001)., p. 4:9]
5. LPG (liquefied petroleum gas) [Peer reviewed] [DOE/AFDC; Alternative Fuels: Propane. Available from: <http://www.eere.energy.gov/afdc/altfuel/propane.html> as of October 11, 2006.]
6. N-PROPANE [Peer reviewed] [IPCS, CEC; International Chemical Safety Card on Propane. (November 2003). Available from <http://www.inchem.org/documents/icsc/icsc/eics0319.htm> as of October 11, 2006.]
7. PROPYL HYDRIDE [Peer reviewed] [Lewis, R.J. Sr. (ed) Sax's Dangerous Properties of Industrial Materials. 11th Edition. Wiley-Interscience, Wiley & Sons, Inc. Hoboken, NJ. 2004., p. 3060]
8. Propyldihydride [Peer reviewed] [IITII. Toxic and Hazardous Industrial Chemicals Safety Manual. Tokyo, Japan: The International Technical Information Institute, 1982., p. 440]
9. R 290 [Peer reviewed] [European Chemicals Bureau; IUCLID Dataset, Propane (74-98-6) (2000 CD-ROM edition). Available from the database query page: <http://ecb.jrc.it/esis/esis.php> as of October 12, 2006.]

Molecular Formula: C3-H8 [Peer reviewed] [Snyder, R. (ed.) Ethyl Browning's Toxicity and Metabolism of Industrial Solvents. 2nd ed. Volume 1: Hydrocarbons. Amsterdam - New York - Oxford: Elsevier, 1987., p. 261]

Shipping Name/Number - DOT/UN/NA/IMCO:

1. IMO 2.1 - Propane; Propane or liquefied petroleum gas
2. UN 1075 - Propane or liquefied petroleum gas
3. UN 1978 - PROPANE

STCC Number: 49 057 81 - Propane (Liquefied petroleum gas)

2.0 MANUFACTURING/USE INFORMATION

Methods of Manufacturing:

1. Removed from lower boiling hydrocarbons & permanent gases in petroleum refining & natural gas processing [Peer reviewed]
2. Constituent of natural gas and of crude petroleum. Obtained by the so called 'stabilization process' using fractional distillation under pressure. [Peer reviewed] [O'Neil, M.J. (ed.). *The Merck Index – An Encyclopedia of Chemicals, Drugs, and Biologicals*. 13th Edition, Whitehouse Station, NJ: Merck and Co., Inc., 2001., p. 1397]
3. Propane is obtained from natural gas by fractionation following absorption in oil, adsorption to surface-active agents, or refrigeration. [Peer reviewed] [21 CFR 184.1655; U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from: <http://www.gpoaccess.gov/ecfr> as of August 30, 2006]
4. A unique feature of propane is that it is not produced for its own sake, but is a by-product of two other processes, natural gas processing and petroleum refining... Natural gas plant production of propane primarily involves extracting materials such as propane and butane from natural gas to prevent these liquids from condensing and causing operational problems in natural gas pipelines. Similarly, when oil refineries make major products such as motor gasoline and heating oil, some propane is produced as a by-product of those processes. It is important to understand that the by-product nature of propane production means that the volume made available from natural gas processing and oil refining cannot be adjusted when prices and/or demand for propane fluctuate. [Peer reviewed] [DOE Energy Information Administration National Energy Information Center. Propane Prices. What Consumers Should Know. DOE/EIA-X04. May 2006. Available at <http://www.eia.doe.gov/bookshelf/brochures/propane06/propane.pdf> as of November 22, 2006.]

Formulations/Preparations:

1. A pressurized single phase disinfectant spray composition consists of 10–45 wt % water, 53–88% ethanol with balance being propane. [Peer reviewed] [FRENCH FR, PAIGE JN; US PATENT NO 4201764 05/06/80 (GOEDERS, CALVIN N)]
2. Grades: Research, instrument, pure: 99.35+% wt; technical: 97.50% wt. [Peer reviewed] [U.S. Coast Guard, Department of Transportation. CHRIS – Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984–5., p.]
3. Liquefied petroleum gas, known as lpg, is a mixture formed mainly of butane (about 62%) & propane (about 36%) ... [Peer reviewed] [International Labour Office. *Encyclopedia of Occupational Health and Safety*. Vols. I&II. Geneva, Switzerland: International Labour Office, 1983., p. 947]
4. According to the Gas Processors Association HD5 specification for LPG as a transportation fuel, LPG must consist of 90% propane, no more than 5% propylene, and 5% other which is primarily butane and butylene. It is produced as a by-product of natural gas processing and petroleum refining. The components of LPG are gases at normal temperatures and pressures. [Peer reviewed] [DOE/AFDC; *Alternative Fuels: Propane*. Available from: <http://www.eere.energy.gov/afdc/altfuel/propane.html> as of October 11, 2006.]

Manufacturers:

1. Amerada Hess Corp., 1185 Avenue of the Americas, New York, NY, 10036, (212) 997–8500; Production site: Port Reading, NJ [Peer reviewed] [SRI International; *Directory of Chemical Producers Program*. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
2. Bear Paw Energy LLC, 1625 Broadway, Suite 2300, Denver, CO, 80202, (303) 626–8282; Production site: Lignite, ND [Peer reviewed] [SRI International; *Directory of Chemical Producers Program*. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
3. CITGO Petroleum Corp., 6130 S. Yale Avenue, Tulsa, OK, 74136, (918) 495–4000; Production site: Lemont, IL [Peer reviewed] [SRI International; *Directory of Chemical*

- Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
4. ExxonMobil Refining & Supply Co., 3225 Gallows Rd., Fairfax, Virginia, 22037-0001, (703) 846-3000; Production sites: Joliet, IL; Torrance, CA; Beaumont, TX [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
 5. Flint Hills Resources L.P., 4111 East 37th St. North, Wichita, KS, 67220, (316) 828-6080; Production site: Corpus Christi, TX [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
 6. Frontier Refining, Inc., 2700 East 5th St., Cheyenne, WY, 82007, (307) 634-3551; Production site: Cheyenne, WY [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
 7. Javelina Co., 5438 Union St., Corpus Christi, TX, 78407, (361) 289-4900; Production site: Corpus Christi, TX [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
 8. Lion Oil Co., El Dorado Refinery, 1000 McHenry, P.O. Box 7005, El Dorado, AR, 71731-7005, (870) 862-8111; Production Site: El Dorado, AR [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
 9. Marathon Ashland Petroleum LLC, 539 South Main St., Findlay, OH, 45840-3295, (419) 422-2121; Production sites: Garyville, LA; Detroit, MI; Catlettsburg, KY; Canton, OH; Robinson, IL; St. Paul Park, MN; TX City, TX [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
 10. Motiva Enterprises LLC, 1100 LA, Houston, TX, 77002, (713) 277-8000; Production sites: Delaware City, DE; Convent, LA [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
 11. Petro-Hunt, LLC, 1601 Elm St., Suite 3900, Dallas, TX, 75201-7201, (214) 880-8400; Production site: Killdeer, ND [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
 12. Sulphur River Resources L.C., 5949 Sherry Lane, Suite 755, Dallas, TX, 75225, (214) 373-1091; Production site: Dike, TX [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
 13. Sunoco, Inc., Ten Penn Center, 1801 Market St., Philadelphia, PA, 19103-1699, (215) 977-3321; Production sites: Marcus Hook, PA; Philadelphia, PA [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
 14. Tesoro Hawaii Refinery, 91-325 Komohana, Kapolei, HI, 96707, (808) 547-3900; Production site: Kapolei, HI [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
 15. Unocal Corp., 2141 E. Rosecrans Ave., Suite 4000, El Segundo, CA, 90245, (310) 726-7600; Production sites: Van, TX; Chunchula, AL [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
 16. Valero Energy Corp., 1 Valero Place, San Antonio, TX, 78212, (210) 370-2000; Production sites: Paulsboro, NJ; Martinez, CA Houston, TX; Dumas, TX; Ardmore, OK; TX City, TX [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of

Oct 12, 2006.]

17. BP Canada Energy Co., 240 – 4th Avenue S.W., Calgary, Alberta, Canada T2P 4H4, (403) 233-1313; Production site: Sarnia, Ontario, Canada [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
18. Chevron Canada Resources, 500 – 5th Avenue S.W., Calgary, Alberta, Canada T2P 0L7, (403) 234-5000; Production sites: Fox Creek, Alberta, Canada; Mitsue, Alberta, Canada [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
19. Suncor Energy Inc., 112 – 4th Avenue S.W., P.O. Box 38, Calgary, Alberta, Canada T2P 2V5, (403) 269-8100; Production site: Fort McMurray, Alberta, Canada [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]
20. Westcoast Energy Inc., 1333 West Georgia St., Vancouver, British Columbia, Canada V6E 3K9, (604) 488-8000; Production site: Taylor, British Columbia, Canada [Peer reviewed] [SRI International; Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. /CD-ROM./ Available at <http://dcp.sric.sri.com/Public/> as of Oct 12, 2006.]

Other Manufacturing Information:

1. Propane naturally occurs as a gas at atmospheric pressure but can be liquefied if subjected to moderately increased pressure. It is stored and transported in its compressed liquid form, but by opening a valve to release propane from a pressurized storage container, it is vaporized into a gas for use. [Peer reviewed] [DOE Energy Information Administration National Energy Information Center. Propane Prices. What Consumers Should Know. DOE/EIA-X04. May 2006. Available at <http://www.eia.doe.gov/bookshelf/brochures/propane06/propane.pdf> as of November 22, 2006.]
2. Propane was prepared by the gas permeation membrane method for the calibration of air pollutant monitoring instruments. [Peer reviewed] [IBUSUKI T ET AL; NIPPON KAGAKU KAISHI (6): 882-7 (1978)]
3. Propane ... is a constituent in the paraffin fraction of crude oil and natural gas ... Propane is odorless when pure; a foul smelling odorant is often added when propane is used for fuel purposes. [Peer reviewed] [Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001)., p. 4:9]
4. Natural gas fraction ... propane (0.1 to 3%). /From table/ [Peer reviewed] [Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001)., p. 1:775]
5. Ethyl mercaptan is used ... as an odorant for natural gas and propane. It can be detected in human blood after propane exposure. [Peer reviewed] [Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001)., p. 7:691]

Major Uses:

1. Component of liquid petroleum gas for commercial and industrial usage; feedstock in thermal cracking processes used to manufacture ethylene and propylene; refrigerant in chemical refining and gas processing operations; fuel in welding and cutting operations [Peer reviewed] [Snyder, R. (ed.) Ethyl Browning's Toxicity and Metabolism of Industrial Solvents. 2nd ed. Volume 1: Hydrocarbons. Amsterdam - New York - Oxford: Elsevier, 1987., p. 262]
2. Organic synthesis, household and industrial fuel, manufacture of ethylene, extractant, solvent, gas enricher, refrigerant, aerosol propellant, mixture for bubble chambers [Peer reviewed] [Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 14th Edition. John Wiley & Sons, Inc. New York, NY 2001., p. 926]
3. Used in flame control of weeds in corn, soybeans, cotton, tobacco, strawberries [Peer

- reviewed] [Farm Chemicals Handbook 1989. Willoughby, OH: Meister Publishing Co., 1989., p. C-239]
- Alternative /transportation/ fuel [Peer reviewed] [DOE/AFDC; Alternative Fuels: Propane. Available from: <http://www.eere.energy.gov/afdc/altfuel/propane.html> as of October 11, 2006.]
 - Propane is used as ... a basic material in chemical synthesis, for oxidation, alkylation, nitration and chlorination; as an aerosol propellant, to replace the chlorofluorocarbons ... and as a solvent and extractant in deasphalting and degreasing of crude oils. [Peer reviewed] [Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001)., p. 4:9]
 - Farm use is the third largest retail propane market, accounting for about 6% of total demand. Farm or agricultural uses of propane include crop drying, weed control, and fuel for farm equipment and irrigation pumps. [Peer reviewed] [DOE Energy Information Administration National Energy Information Center. Propane Prices. What Consumers Should Know. DOE/EIA-X04. May 2006. Available at <http://www.eia.doe.gov/bookshelf/brochures/propane06/propane.pdf> as of November 22, 2006.]

Consumption Patterns:

- Excluding propane gas grills, residential and commercial use accounts for 43% of all propane used in the U.S. Of the 107 million households in the U.S., 9.4 million depend on propane for one use or another... 53% of these households rely on propane for their primary heating fuel... [Peer reviewed] [DOE Energy Information Administration National Energy Information Center. Propane Prices. What Consumers Should Know. DOE/EIA-X04. May 2006. Available at <http://www.eia.doe.gov/bookshelf/brochures/propane06/propane.pdf> as of November 22, 2006.]
- About 44 percent of the propane consumed in the U. S. is used in the petrochemical industry. [Peer reviewed] [DOE Energy Information Administration National Energy Information Center. Propane Prices. What Consumers Should Know. DOE/EIA-X04. May 2006. Available at <http://www.eia.doe.gov/bookshelf/brochures/propane06/propane.pdf> as of November 22, 2006.]
- ... Farm or agricultural uses of propane include crop drying, weed control, and fuel for farm equipment and irrigation pumps. [Peer reviewed] [DOE Energy Information Administration National Energy Information Center. Propane Prices. What Consumers Should Know. DOE/EIA-X04. May 2006. Available at <http://www.eia.doe.gov/bookshelf/brochures/propane06/propane.pdf> as of November 22, 2006.]

U.S. Production:

- This chemical is listed as a High Production Volume (HPV) (65FR81686). Chemicals listed as HPV were produced in or imported into the U.S. in >1 million pounds in 1990 and/or 1994. The HPV list is based on the 1990 Inventory Update Rule. (IUR) (40 CFR part 710 subpart B; 51FR21438). [Peer reviewed] [EPA/Office of Pollution Prevention and Toxics; High Production Volume (HPV) Challenge Program on Propane (74-98-6). Available from: <http://www.epa.gov/hpv/pubs/general/opptsrch.htm> as of October 12, 2006]
- (1972) 4.36X10+12 G [Peer reviewed]
- (1975) 2.7X10+9 G [Peer reviewed]
- (1984) 3.43X10+12 g [Peer reviewed] [USITC. SYN ORG CHEM-U.S. PROD/SALES 1984 p.15]
- (1987) 1.11X10+10 lb [Peer reviewed] [USITC. SYN ORG CHEM-U.S. PROD/SALES 1987 p.2-2]
- Production volumes for non-confidential chemicals reported under the Inventory Update Rule.

Year	Production Range (pounds)
1986	>1 billion
1990	>1 billion

1994	1 billion
1998	1 billion
2002	1 billion

[Peer reviewed] [US EPA; Non-confidential Production Volume Information Submitted by Companies for Chemicals Under the 1986-2002 Inventory Update Rule (IUR). Propane (74-98-6). Available at <http://www.epa.gov/oppt/iur/tools/data/2002-vol.htm> as of November 8, 2006]

U.S. Imports:

1. (1972) NEGLIGIBLE [Peer reviewed]
2. (1975) 8.7X10+9 G [Peer reviewed]
3. (1984) 5.27X10+9 g [Peer reviewed] [BUREAU OF THE CENSUS. U.S. IMPORTS FOR CONSUMPTION AND GENERAL IMPORTS 1984 p.1-385]
4. (1986) 3.88X10+7 barrels [Peer reviewed] [BUREAU OF THE CENSUS. US IMPORTS FOR CONSUMPTION AND GENERAL IMPORTS 1986 P.1-554]

U.S. Exports:

1. (1972) NEGLIGIBLE [Peer reviewed]
2. (1975) 9.3X10+7 G [Peer reviewed]
3. (1984) 7.96X10+8 g [Peer reviewed] [BUREAU OF THE CENSUS. U.S. EXPORTS, SCHEDULE E, 1984 p.2-67]
4. (1987) 1.51X10+6 bbl [Peer reviewed] [BUREAU OF THE CENSUS. U. S. EXPORTS, SCHEDULE E, DECEMBER 1987, P.2-70]
5. (1988) 1.90X10+6 bbl [Peer reviewed] [BUREAU OF THE CENSUS. U. S. EXPORTS, SCHEDULE E, DECEMBER 1988, P.2-73]

3.0 CHEMICAL AND PHYSICAL PROPERTIES

Color/Form: Colorless gas [Shipped as a liquefied compressed gas]. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases CD-ROM. Department of Health & Human Services, Centers for Disease Prevention & Control. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2005-151 (2005), p.]

Odor: Odorless [Note: A foul smelling odorant is often added when used for fuel purposes]. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases CD-ROM. Department of Health & Human Services, Centers for Disease Prevention & Control. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2005-151 (2005), p.]

Boiling Point: -42.1 deg C at 1 atm [Peer reviewed] [O'Neil, M.J. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. 13th Edition, Whitehouse Station, NJ: Merck and Co., Inc., 2001., p. 1397]

Melting Point: -187.6 deg C [Peer reviewed] [O'Neil, M.J. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. 13th Edition, Whitehouse Station, NJ: Merck and Co., Inc., 2001., p. 1397]

Molecular Weight: 44.10 [Peer reviewed] [O'Neil, M.J. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. 13th Edition, Whitehouse Station, NJ: Merck and Co., Inc., 2001., p. 1397]

Corrosivity: Non-corrosive [Peer reviewed] [Lewis, R.J. Sr.; Hawley's Condensed Chemical Dictionary 14th Edition. John Wiley & Sons, Inc. New York, NY 2001., p. 926]

Critical Temperature and Pressure: Critical temperature: 96.81 deg C; critical pressure: 42.01

atm [Peer reviewed] [O'Neil, M.J. (ed.). The Merck Index – An Encyclopedia of Chemicals, Drugs, and Biologicals. 13th Edition, Whitehouse Station, NJ: Merck and Co., Inc., 2001., p. 1397]

Density/Specific Gravity: 0.493 at 25 deg C [Peer reviewed] [Lide, D.R., G.W.A. Milne (eds.). Handbook of Data on Organic Compounds. Volume I. 3rd ed. CRC Press, Inc. Boca Raton ,FL. 1994., p. V5: 4273]

Heat of Combustion: (constant vol) 528.4 cal; (constant pressure) 553.5 cal [Peer reviewed] [O'Neil, M.J. (ed.). The Merck Index – An Encyclopedia of Chemicals, Drugs, and Biologicals. 13th Edition, Whitehouse Station, NJ: Merck and Co., Inc., 2001., p. 1397]

Heat of Vaporization: 14.79 kJ/mol at 25 deg C [Peer reviewed] [Lide, D.R. CRC Handbook of Chemistry and Physics 86TH Edition 2005–2006. CRC Press, Taylor & Francis, Boca Raton, FL 2005, p. 6–99]

Octanol/Water Partition Coefficient: log Kow = 2.36 [Peer reviewed] [Hansch, C., Leo, A., D. Hoekman. Exploring QSAR – Hydrophobic, Electronic, and Steric Constants. Washington, DC: American Chemical Society., 1995., p. 6]

Solubilities:

1. Slightly soluble in acetone; soluble in ethanol; very soluble in ethyl ether, benzene, chloroform [Peer reviewed] [Lide, D.R., G.W.A. Milne (eds.). Handbook of Data on Organic Compounds. Volume I. 3rd ed. CRC Press, Inc. Boca Raton ,FL. 1994., p. V5: 4273]
2. 100 vol water dissolve 6.5 vol at 17.8 deg C, 753 mm Hg; 100 vol absolute alcohol dissolve 790 vol at 16.6 deg C, 754 mm Hg; 100 vol ether dissolve 926 vol at 16.6 deg C, 757 mm Hg; 100 vol chloroform dissolve 1299 vol at 21.6 deg C, 757 mm Hg; 100 vol benzene dissolve 1452 vol at 21.5 deg C, 757 mm Hg; 100 vol turpentine dissolve 1587 vol at 17.7 deg C, 757 mm Hg [Peer reviewed] [O'Neil, M.J. (ed.). The Merck Index – An Encyclopedia of Chemicals, Drugs, and Biologicals. 13th Edition, Whitehouse Station, NJ: Merck and Co., Inc., 2001., p. 1397]
3. In water, 62.4 ppm at 25 deg C [Peer reviewed] [Yalkowsky, S.H., He, Yan., Handbook of Aqueous Solubility Data: An Extensive Compilation of Aqueous Solubility Data for Organic Compounds Extracted from the AQUASOL dATABASE. CRC Press LLC, Boca Raton, FL. 2003., p. 77]

Spectral Properties:

1. Index of refraction: 1.2898 @ 20 deg C [Peer reviewed] [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985., p. V2 140]
2. IR: 6404 (Sadtler Research Laboratories Prism Collection) [Peer reviewed] [Lide, D.R., G.W.A. Milne (eds.). Handbook of Data on Organic Compounds. Volume I. 3rd ed. CRC Press, Inc. Boca Raton ,FL. 1994., p. V5: 4273]
3. 13C NMR: 56 (Stothers, Carbon-13 NMR Spectroscopy. Academic Press, New York) [Peer reviewed] [Lide, D.R., G.W.A. Milne (eds.). Handbook of Data on Organic Compounds. Volume I. 3rd ed. CRC Press, Inc. Boca Raton ,FL. 1994., p. V5: 4273]
4. MASS: 61297 (NIST/EPA/MSDC Mass Spectral database, 1990 version) [Peer reviewed] [Lide, D.R., G.W.A. Milne (eds.). Handbook of Data on Organic Compounds. Volume I. 3rd ed. CRC Press, Inc. Boca Raton ,FL. 1994., p. V5: 4273]

Surface Tension: 16 dynes/cm= 0.016 N/m @ -47 deg C [Peer reviewed] [U.S. Coast Guard, Department of Transportation. CHRIS – Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984–5., p.]

Vapor Density: 1.56 at 0 deg C (Air= 1) [Peer reviewed] [Lewis, R.J. Sr.; Hawley's Condensed

Chemical Dictionary 14th Edition. John Wiley & Sons, Inc. New York, NY 2001., p. 926]

Vapor Pressure: 7150 mm Hg at 25 deg C [Peer reviewed] [Daubert, T.E., R.P. Danner. Physical and Thermodynamic Properties of Pure Chemicals Data Compilation. Washington, D.C.: Taylor and Francis, 1989., p.]

Viscosity: 8.3 uPa.s at 300K; 10.9 uPa.s at 400K; 13.4 uPa.s at 500K; 15.8 uPa.s at 600K [Peer reviewed] [Lide, D.R. CRC Handbook of Chemistry and Physics 86TH Edition 2005–2006. CRC Press, Taylor & Francis, Boca Raton, FL 2005, p. 6–174]

Other Chemical/Physical Properties:

1. Burns with a luminous, smoky flame; heavier than air; 1 liter weighs 2.0200 g at 0 deg C, 760 mm Hg /and/ 1.8324 g at 25 deg C, 760 mm Hg; liquefies at –42 deg C; solid at –187.7 deg C [Peer reviewed] [O'Neil, M.J. (ed.). The Merck Index – An Encyclopedia of Chemicals, Drugs, and Biologicals. 13th Edition, Whitehouse Station, NJ: Merck and Co., Inc., 2001., p. 1397]
2. Liquid water interfacial tension (est): 50 dynes/cm = 0.05 N/m at –50 deg C; ratio of specific heats of vapor (gas): 1.130 [Peer reviewed] [U.S. Coast Guard, Department of Transportation. CHRIS – Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984–5., p.]
3. 1 mg/cu m = 0.55 ppm; 1 ppm = 1.83 mg/cu m [Peer reviewed] [Verschueren, K. Handbook of Environmental Data on Organic Chemicals. Volumes 1–2. 4th ed. John Wiley & Sons. New York, NY. 2001, p. V2: 1833]
4. Heating value for ideal gas at 60 deg F and 14.7 psi, dry basis: 2517 BTU/cu ft; specific volume of real gas at 60 deg F and 14.7 psi: 8.4515 cu ft/lb /Research grade/ [Peer reviewed] [Flick, E.W. Industrial Solvents Handbook. 3rd ed. Park Ridge, NJ: Noyes Publications, 1985., p. 4]
5. Heat of formation: 127.2 kJ/mol [Peer reviewed] [Kirk–Othmer Encyclopedia of Chemical Technology. 4th ed. Volumes 1: New York, NY. John Wiley and Sons, 1991–Present., p. V13: 813 (1995)]
6. Heat of fusion: 350 kJ/mol (triple point) [Peer reviewed] [Lide, D.R. CRC Handbook of Chemistry and Physics 86TH Edition 2005–2006. CRC Press, Taylor & Francis, Boca Raton, FL 2005, p. 6–113]
7. Enthalpy of melting: 0.842 kcal/mol; enthalpy of sublimation at 298 K: 3.605 kcal/mol [Peer reviewed] [Dean, J.A. Handbook of Organic Chemistry. New York, NY: McGraw–Hill Book Co., 1987., p. 5–70]
8. Critical molar vol: 203 cu cm/mol [Peer reviewed] [Dean, J.A. Handbook of Organic Chemistry. New York, NY: McGraw–Hill Book Co., 1987., p. 5–87]
9. Ionization potential: 10 eV [Peer reviewed] [NIOSH. Pocket Guide to Chemical Hazards. 2nd Printing. DHHS (NIOSH) Publ. No. 85–114. Washington, D.C.: U.S. Dept. of Health and Human Services, NIOSH/Supt. of Documents, GPO, February 1987., p. 198]
10. VP: 1 Pa at –156.9 deg C; 10 Pa at –145.6 deg C; 100 Pa at –130.9 deg C; 1kPa at –111.4 deg C; 10kPa at –83.8 deg C; 100 kPa at –42.3 deg C [Peer reviewed] [Lide, D.R. CRC Handbook of Chemistry and Physics 86TH Edition 2005–2006. CRC Press, Taylor & Francis, Boca Raton, FL 2005, p. 6–63]
11. VP fluid: 0.8 kPa at 160K; 20.1 kPa at 200K; 311 kPa at 260K; 998 kPa at 300K [Peer reviewed] [Lide, D.R. CRC Handbook of Chemistry and Physics 86TH Edition 2005–2006. CRC Press, Taylor & Francis, Boca Raton, FL 2005, p. 6–91]
12. Henry's Law constant = 7.07X10⁻¹ atm-cu m/mol at 25 deg C (est) [Peer reviewed] [SRC; The Physical Properties Database (PHYSPROP). Syracuse, NY: Syracuse Res Corp. Available from <http://www.syrres.com/esc/physprop.htm> as of Oct 5, 2006.]
13. Hydroxyl radical reaction rate constant = 1.15X10⁻¹² cu cm/molec-sec at 25 deg C [Peer reviewed] [Atkinson R; J Phys Chem Ref Data Monograph No. 1 (1989)]

4.0 SAFETY AND HANDLING

EMERGENCY GUIDELINES ▲

DOT Emergency Guidelines:

1. /GUIDE 115: GASES – FLAMMABLE (INCLUDING REFRIGERATED LIQUIDS)/ Fire or Explosion: EXTREMELY FLAMMABLE. Will be easily ignited by heat, sparks or flames. Will form explosive mixtures with air. Vapors from liquefied gas are initially heavier than air and spread along ground. ... Vapors may travel to source of ignition and flash back. Cylinders exposed to fire may vent and release flammable gas through pressure relief devices. Containers may explode when heated. Ruptured cylinders may rocket. [Peer reviewed] [U.S. Department of Transportation. 2004 Emergency Response Guidebook. A Guide book for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident. Washington, D.C. 2004]
2. /GUIDE 115: GASES – FLAMMABLE (INCLUDING REFRIGERATED LIQUIDS)/ Health: Vapors may cause dizziness or asphyxiation without warning. Some may be irritating if inhaled at high concentrations. Contact with gas or liquefied gas may cause burns, severe injury and/or frostbite. Fire may produce irritating and/or toxic gases. [Peer reviewed] [U.S. Department of Transportation. 2004 Emergency Response Guidebook. A Guide book for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident. Washington, D.C. 2004]
3. /GUIDE 115: GASES – FLAMMABLE (INCLUDING REFRIGERATED LIQUIDS)/ Public Safety: CALL Emergency Response Telephone Number. ... As an immediate precautionary measure, isolate spill or leak area for at least 100 meters (330 feet) in all directions. Keep unauthorized personnel away. Stay upwind. Many gases are heavier than air and will spread along ground and collect in low or confined areas (sewers, basements, tanks). Keep out of low areas. [Peer reviewed] [U.S. Department of Transportation. 2004 Emergency Response Guidebook. A Guide book for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident. Washington, D.C. 2004]
4. /GUIDE 115: GASES – FLAMMABLE (INCLUDING REFRIGERATED LIQUIDS)/ Protective Clothing: Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection. Always wear thermal protective clothing when handling refrigerated/cryogenic liquids. [Peer reviewed] [U.S. Department of Transportation. 2004 Emergency Response Guidebook. A Guide book for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident. Washington, D.C. 2004]
5. /GUIDE 115: GASES – FLAMMABLE (INCLUDING REFRIGERATED LIQUIDS)/ Evacuation: Large spill: Consider initial downwind evacuation for at least 800 meters (1/2 mile). Fire: If tank, rail car or tank truck is involved in a fire, ISOLATE for 1600 meters (1 mile) in all directions; also, consider initial evacuation for 1600 meters (1 mile) in all directions. [Peer reviewed] [U.S. Department of Transportation. 2004 Emergency Response Guidebook. A Guide book for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident. Washington, D.C. 2004]
6. /GUIDE 115: GASES – FLAMMABLE (INCLUDING REFRIGERATED LIQUIDS)/ Fire: DO NOT EXTINGUISH A LEAKING GAS FIRE UNLESS LEAK CAN BE STOPPED. ... Small fires: Dry chemical or CO₂. Large fires: Water spray or fog. Move containers from fire area if you can do it without risk. Fire involving tanks: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. [Peer reviewed] [U.S. Department of Transportation. 2004 Emergency Response Guidebook. A Guide book for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident. Washington, D.C. 2004]

7. /GUIDE 115: GASES – FLAMMABLE (INCLUDING REFRIGERATED LIQUIDS)/ Spill or Leak: ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Stop leak if you can do it without risk. If possible, turn leaking containers so that gas escapes rather than liquid. Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material. Do not direct water at spill or source of leak. Prevent spreading of vapors through sewers, ventilation systems and confined areas. Isolate area until gas has dispersed. CAUTION: When in contact with refrigerated/cryogenic liquids, many materials become brittle and are likely to break without warning. [Peer reviewed] [U.S. Department of Transportation. 2004 Emergency Response Guidebook. A Guide book for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident. Washington, D.C. 2004]
8. /GUIDE 115: GASES – FLAMMABLE (INCLUDING REFRIGERATED LIQUIDS)/ First Aid: Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. Clothing frozen to the skin should be thawed before being removed. In case of contact with liquefied gas, thaw frosted parts with lukewarm water. In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin. Keep victim warm and quiet. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. [Peer reviewed] [U.S. Department of Transportation. 2004 Emergency Response Guidebook. A Guide book for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident. Washington, D.C. 2004]

FLAMMABLE PROPERTIES ▲

Fire Potential:

Highly dangerous when exposed to heat, flame [Peer reviewed] [Lewis, R.J. Sr. (ed) Sax's Dangerous Properties of Industrial Materials. 11th Edition. Wiley-Interscience, Wiley & Sons, Inc. Hoboken, NJ. 2004., p. 3060]

NFPA Hazard Classification:

1. Health: 2. 2= Materials that, on intense or continued (but not chronic) exposure, could cause temporary incapacitation or possible residual injury, including those requiring the use of respiratory protective equipment that has an independent air supply. These materials are hazardous to health, but areas may be entered freely if personnel are provided with full-face mask self-contained breathing apparatus that provides complete eye protection. [Peer reviewed] [Fire Protection Guide to Hazardous Materials. 13 ed. Quincy, MA: National Fire Protection Association, 2002., p.]
2. Flammability: 4. 4= This degree includes flammable gases, flammable cryogenic materials, pyrophoric liquids, and Class IA flammable liquids. The preferred method of fire attack is to stop the flow of material or to protect exposures while allowing the fire to burn itself out. [Peer reviewed] [Fire Protection Guide to Hazardous Materials. 13 ed. Quincy, MA: National Fire Protection Association, 2002., p.]
3. Instability: 0. 0= This degree includes materials that are normally stable, even under fire exposure conditions, and that do not react with water. Normal fire fighting procedures may be used. [Peer reviewed] [Fire Protection Guide to Hazardous Materials. 13 ed. Quincy, MA: National Fire Protection Association, 2002., p.]

Flammable Limits:

Lower flammable limit: 2.1% by volume; Upper flammable limit: 9.5% by volume [Peer

reviewed] [Fire Protection Guide to Hazardous Materials. 13 ed. Quincy, MA: National Fire Protection Association, 2002., p. 325-100]

Flash Point:

-156 deg F (Closed cup) [Peer reviewed] [U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5., p.]

Autoignition Temperature:

842 deg F (450 deg C) [Peer reviewed] [Fire Protection Guide to Hazardous Materials. 13 ed. Quincy, MA: National Fire Protection Association, 2002., p. 325-100]

FIRE FIGHTING INFORMATION ▲

Fire Fighting Procedures:

1. Stop flow of gas. For small fires use dry chemicals. Cool adjacent areas with water spray. [Peer reviewed] [U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5., p.]
2. If material on fire or involved in fire: Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. [Peer reviewed] [Association of American Railroads; Bureau of Explosives. Emergency Handling of Hazardous Materials in Surface Transportation. Association of American Railroads, Pueblo, CO. 2005, p. 753]
3. Evacuation: If fire becomes uncontrollable or container is exposed to direct flame consider evacuation of one half mile radius. [Peer reviewed] [Association of American Railroads; Bureau of Explosives. Emergency Handling of Hazardous Materials in Surface Transportation. Association of American Railroads, Pueblo, CO. 2005, p. 753]
4. Shut off supply; if not possible and no risk to surroundings, let the fire burn itself out; in other cases extinguish with powder, carbon dioxide ... [Peer reviewed] [IPCS, CEC; International Chemical Safety Card on Propane. (November 2003). Available from <http://www.inchem.org/documents/icsc/icsc/eics0319.htm> as of October 11, 2006.]

Toxic Combustion Products:

1. The practice of burning propane and kerosene to heat ... produces NO_x in potentially toxic concentrations ... [Peer reviewed] [Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001)., p. 3:639]
2. With sufficient oxygen, it burns to carbon dioxide and water, but to carbon monoxide when oxygen deficient. [Peer reviewed] [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982., p. 3181]

Other Fire Fighting Hazards:

1. Behavior in fire: Containers may explode; vapor is heavier than air & may travel a long distance to a source of ignition & flash back. [Peer reviewed] [U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5., p.]
2. The gas is heavier than air and may travel along the ground; distant ignition possible, and may accumulate in low ceiling spaces causing deficiency of oxygen. As a result of flow, agitation, etc, electrostatic charges can be generated ... On loss of containment this liquid