n-Butane

LITERATURE REGISTER

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 :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 :00500
RÖMPP Online ab 2003

Quelle :05000
Kühn-Birett-Gruppenmerkblätter

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, GMBl. 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 :07635
Auerdata Ausgabe 1998 und BG-Regel 190 (ZH 1/701) Einsatz von Atemschutzgeräten; Fassung 10.96

Quelle :07750
R. E. Lenga:
The Sigma-Aldrich Library of Chemical Safety Data.
2nd edition, Sigma-Aldrich, Milwaukee 1988

Quelle :07782
VCI: Konzept zur Zusammenlagerung von Chemikalien

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

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 gesundheitsschädlicher Arbeitsstoffe, Mitteilung 43; VCH

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

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資料B-5(RTECS)

Butane

RTECS - Registry of Toxic Effects of Chemical Substances

1.0 SUBSTANCE IDENTIFICATION▲

RTECS Number: EJ4200000

Chemical Name: Butane

CAS Number: 106-97-8

Molecular Formula: C4-H10

Molecular Weight: 58.14

Wiswesser Notation: 4H

Substance Investigated as: Human Data

Last Revision Date: 200608

2.0 SYNONYM(S)/TRADENAME(S)▲

1. Butane (ACGIH)
2. Butanen (Dutch)
3. Butani (Italian)
4. Diethyl
5. Methylethylmethane
6. n-Butane

3.0 HEALTH HAZARD DATA▲

ACUTE TOXICITY

TDLO/TCLO - LOWEST PUBLISHED TOXIC DOSE/CONC

Human

TCLo - ROUTE: Inhalation; **DOSE:** 280 mg/m3 ['Vrednie chemichescie veshestva, galogenproisvodnie uglevodorodov'. (Hazardous substances: Galogenated hydrocarbons) Bandman A.L. et al., Chimia, 1990. (-,26,1990)]
TOXIC EFFECTS:
Brain and Coverings - Changes in surface EEG

LD50/LC50 - LETHAL DOSE/CONC 50% KILL

Rat

LC50 - ROUTE: Inhalation; **DOSE:** 658000 mg/m3/4H ['Vrednie chemichescie

veshestva, galogenproisvodnie uglevodorodov'. (Hazardous substances: Galogenated hydrocarbons) Bandman A.L. et al., Chimia, 1990. (-,26,1990)]

Mouse

LC50 - ROUTE: Inhalation; **DOSE:** 680000 mg/m3/2H ['Vrednie chemichescie veshestva, galogenproisvodnie uglevodorodov'. (Hazardous substances: Galogenated hydrocarbons) Bandman A.L. et al., Chimia, 1990. (-,26,1990)]

OTHER LD/LC - OTHER LETHAL DOSE/CONC

Rat

LC16 - ROUTE: Inhalation; **DOSE:** 537000 mg/m3/4H ['Vrednie chemichescie veshestva, galogenproisvodnie uglevodorodov'. (Hazardous substances: Galogenated hydrocarbons) Bandman A.L. et al., Chimia, 1990. (-,26,1990)]

LC84 - ROUTE: Inhalation; **DOSE:** 790000 mg/m3/4H ['Vrednie chemichescie veshestva, galogenproisvodnie uglevodorodov'. (Hazardous substances: Galogenated hydrocarbons) Bandman A.L. et al., Chimia, 1990. (-,26,1990)]

Mouse

LC16 - ROUTE: Inhalation; **DOSE:** 530000 mg/m3/2H ['Vrednie chemichescie veshestva, galogenproisvodnie uglevodorodov'. (Hazardous substances: Galogenated hydrocarbons) Bandman A.L. et al., Chimia, 1990. (-,26,1990)]

LC84 - ROUTE: Inhalation; **DOSE:** 860000 mg/m3/2H ['Vrednie chemichescie veshestva, galogenproisvodnie uglevodorodov'. (Hazardous substances: Galogenated hydrocarbons) Bandman A.L. et al., Chimia, 1990. (-,26,1990)]

4.0 STANDARDS AND REGULATIONS▲

1. MSHA STANDARD-air:TWA 500 ppm (1200 mg/m3)
2. OEL IN ARGENTINA, BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV;
3. OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGIH TLV
4. OEL-AUSTRALIA: TWA 800 ppm (1900 mg/m3), JAN1993
5. OEL-BELGIUM: TWA 800 ppm (1900 mg/m3), JAN1993
6. OEL-DENMARK: TWA 500 ppm (1200 mg/m3), OCT 2002
7. OEL-FINLAND: TWA 800 ppm (1900 mg/m3), STEL 1000 ppm (2350 mg/m3), JAN1999
8. OEL-FRANCE: VME 800 ppm (1900 mg/m3), JAN1999
9. OEL-GERMANY: MAK 2400 mg/m3 (1000 mL/m3), 2005
10. OEL-HUNGARY: TWA 300 mg/m3, STEL 900 mg/m3, JAN1993
11. OEL-JAPAN: OEL 500 ppm (1200 mg/m3), JAN1999
12. OEL-MEXICO: TWA 800 ppm (1900 mg/m3), 2004
13. OEL-NORWAY: TWA 250 ppm (600 mg/m3), JAN1999
14. OEL-POLAND: TWA 1900 mg/m3, STEL 3000 mg/m3, JAN1999
15. OEL-RUSSIA: TWA 300 mg/m3, STEL 900 mg/m3, JUN2003
16. OEL-SWITZERLAND: MAK-W 800 ppm (1900 mg/m3), JAN1999
17. OEL-THE NETHERLANDS: MAC-TGG 1430 mg/m3, 2003
18. OEL-UNITED KINGDOM: TWA 600 ppm (1450 mg/m3);STEL 750 ppm, 2005

5.0 NIOSH DOCUMENTS▲

1. NIOSH REL TO BUTANE-air:10H TWA 800 ppm

2. National Occupational Exposure Survey 1983: Hazard Code 13480; Number of Industries 307; Total Number of Facilities 69613; Number of Occupations 200; Total Number of Employees 988880; Total Number of Female Employees 186786
3. National Occupational Hazard Survey 1974: Hazard Code 13480; Number of Industries 55; Total Number of Facilities 5871; Number of Occupations 53; Total Number of Employees 61958

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

資料B-6(HSDB)

BUTANE

HSDB – Hazardous Substances Data Bank

0.0 ADMINISTRATIVE INFORMATION

Hazardous Substances Data Bank Number: 944

Last Revision Date: 20050624

Review Date: Reviewed by SRP on 05/29/2003

Update History:

1. Complete Update on 2005-06-24, 1 fields added/edited/deleted
2. Field Update on 2005-01-27, 2 fields added/edited/deleted
3. Complete Update on 2003-10-15, 77 fields added/edited/deleted
4. Complete Update on 2003-04-05, 73 fields added/edited/deleted
5. Field Update on 02/14/2003, 1 field added/edited/deleted.
6. Complete Update on 11/08/2002, 1 field added/edited/deleted.
7. Complete Update on 10/16/2002, 1 field added/edited/deleted.
8. Complete Update on 07/22/2002, 1 field added/edited/deleted.
9. Complete Update on 01/18/2002, 5 fields 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 07/27/1999, 4 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, 2 fields added/edited/deleted.
20. Complete Update on 03/26/1998, 3 fields added/edited/deleted.
21. Field Update on 10/20/1997, 1 field added/edited/deleted.
22. Complete Update on 07/22/1996, 6 fields added/edited/deleted.
23. Complete Update on 04/15/1996, 1 field added/edited/deleted.
24. Complete Update on 01/19/1996, 1 field added/edited/deleted.
25. Complete Update on 05/26/1995, 1 field added/edited/deleted.
26. Complete Update on 01/18/1995, 1 field added/edited/deleted.
27. Complete Update on 12/22/1994, 1 field added/edited/deleted.
28. Complete Update on 11/18/1994, 1 field added/edited/deleted.
29. Complete Update on 06/29/1994, 1 field added/edited/deleted.
30. Complete Update on 03/25/1994, 1 field added/edited/deleted.
31. Complete Update on 08/07/1993, 1 field added/edited/deleted.
32. Complete Update on 04/30/1993, 1 field added/edited/deleted.
33. Complete Update on 02/05/1993, 1 field added/edited/deleted.
34. Field update on 12/16/1992, 1 field added/edited/deleted.
35. Complete Update on 12/08/1992, 1 field added/edited/deleted.
36. Complete Update on 12/03/1992, 1 field added/edited/deleted.
37. Complete Update on 01/23/1992, 1 field added/edited/deleted.
38. Complete Update on 09/13/1990, 82 fields added/edited/deleted.

39. Field Update on 01/15/1990, 1 field added/edited/deleted.
40. Complete Update on 01/11/1990, 81 fields added/edited/deleted.
41. Field Update on 05/05/1989, 1 field added/edited/deleted.
42. Complete Update on 04/24/1987
43. Created 19830401 by GCF

1.0 SUBSTANCE IDENTIFICATION

Name of Substance: BUTANE

CAS Registry Number: 106-97-8

Synonyms:
1. A-17 [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. 31]
2. BUTANEN (DUTCH) [Peer reviewed] [Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 541]
3. BUTANI (ITALIAN) [Peer reviewed] [Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 541]
4. BUTYL HYDRIDE [Peer reviewed] [ITII. Toxic and Hazarous Industrial Chemicals Safety Manual. Tokyo, Japan: The International Technical Information Institute, 1982., p. 83]
5. Hydrocarbon propellant A-17 [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. 31]
6. Liquified petroleum gas [Peer reviewed] [Sittig, M. Handbook of Toxic and Hazardous Chemicals and Carcinogens, 1985. 2nd ed. Park Ridge, NJ: Noyes Data Corporation, 1985., p. 154]
7. METHYLETHYLMETHANE [Peer reviewed] [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry of Toxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file., p. 84/8312]
8. N-BUTANE [Peer reviewed]
9. PYROFAX [Peer reviewed] [Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984., p. II-150]
10. R 600 [Peer reviewed]

Molecular Formula: C4-H10 [Peer reviewed] [Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 541]

Shipping Name/Number - DOT/UN/NA/IMCO:
1. IMO 2.1 - Butane
2. UN 1011 - Butane

STCC Number:
1. 49 057 02 - Butane (waste, petroleum by-product)
2. 49 057 06 - Butane

2.0 MANUFACTURING/USE INFORMATION

Methods of Manufacturing:
1. From raw natural gas and from petroleum streams by catalytic cracking, reforming, and other refining processes. [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. 268]

2. ...From ethyl iodide and sodium amalgam. [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. 255]

Formulations/Preparations:

1. GRADES: RESEARCH, 99.99 MOLE %; PURE, 99 MOLE %; TECHNICAL, 95 MOLE %; ALSO AVAILABLE IN VARIOUS MIXTURES WITH ISOBUTANE, PROPANE, PENTANES, ETC. [Peer reviewed] [Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. 1997., p. 171]
2. Propane is the principal ingredient of bottled gas particularly in northern states, whereas butane with its considerably higher boiling and freezing points is more widely used in warmer southern states. Mixtures of the two are also common. [Peer reviewed] [Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984., p. II-150]

Manufacturers:

1. Bear Paw Energy, L.L.C., 1625 Broadway, Suite 2300, Denver, CO 80202 (303)626-8282; Production site: Lignite, ND [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. Menlo Park, CA: SRI Consulting. CD-ROM (2003)]
2. Exxon Mobil Chemical Company,13501 Katy Freeway, Houston, TX 77079 (281)870-6000; Production site: Beaumont, TX [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. Menlo Park, CA: SRI Consulting. CD-ROM (2003)]
3. Exxon Mobil Refining & Supply Company, 3225 Gallows Road, Fairfax, VA 22037-0001 (703)846-3000; Production site: Torrance, CA [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. Menlo Park, CA: SRI Consulting. CD-ROM (2003)]
4. Frontier Refining, Inc., 2700 East 5th Street, Cheyenne, WY 82007 (307)634-3551; Production site: Cheyenne, WY [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. Menlo Park, CA: SRI Consulting. CD-ROM (2003)]
5. Lion Oil Company, El Dorado Refinery, 1000 McHenry, P.O. Box 7005, El Dorado, AK 71731-7005 (870)862-8111; Production site: not specified [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. Menlo Park, CA: SRI Consulting. CD-ROM (2003)]
6. Motiva Enterprises LLC, 1100 Louisiana, Houston, TX 77002 (713)277-8000; Production site: Convent, LA [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. Menlo Park, CA: SRI Consulting. CD-ROM (2003)]
7. Sunoco, Inc., Ten Penn Center, 1801 Market Street, Philadelphia, PA 19103-1699 (215) 977-3321; Production sites: Marcus Hook, PA; Philadelphia, PA; Toledo, OH [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. Menlo Park, CA: SRI Consulting. CD-ROM (2003)]
8. Tesoro Hawaii Refinery, 91-325 Komohana, Kapolei, HI 96707 (808)547-3900; Production site: not specified [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. Menlo Park, CA: SRI Consulting. CD-ROM (2003)]
9. Tom Brown, Inc., 555 Seventeenth Street, Suite 1850, Denver, CO 80202-3918 (303)260-5000; Production site: Moab, UT [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. Menlo Park, CA: SRI Consulting. CD-ROM (2003)]
10. Unocal Corporation, 2141 E. Rosecrans Ave. Suite 4000, El Segundo, CA 90245 (310)726-7600; Production sites: Chunchula, AL; Van, TX [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. Menlo Park, CA: SRI Consulting. CD-ROM (2003)]
11. Valero Energy Corporation, 1 Valero Place, San Antonio, TX 78212 (210)370-2000; Production sites: Dumas, TX; Martinex, CA; Paulsboro, NJ [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. SRI Consulting, Menlo Park, CA. CD-ROM (2003)]

12. Flint Hills Resources, L.P., 4111 East 37th Street North, Wichita, Kansas 67220 (316)828-6080; Production site: Corpus Christi, TX [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. Menlo Park, CA: SRI Consulting. CD-ROM (2003)]
13. Phillips Petroleum Company, Phillips Building, Bartlesville, OK 74004 (918)661-6600; Production site: Rodeo, CA [Peer reviewed] [SRI International; 2003 Directory of Chemical Producers Program. Menlo Park, CA: SRI Consulting. CD-ROM (2003)]

Other Manufacturing Information:

For transportation it may be stenched. [Peer reviewed] [Association of American Railroads. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, D.C.: Assoc. of American Railroads, Hazardous Materials Systems (BOE), 1987., p. 104]

Major Uses:

1. As producer gas; raw material for motor fuels, in the manuf of synthetic rubbers. [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. 256]
2. Organic synthesis, raw material for synthetic rubber and high-octane liquid fuels, fuel for household and many industrial purposes; manufacture of ethylene; solvent; refrigerant; standby and enricher gas; propellant in aerosols; food additive; pure grades used in calibrating instruments. [Peer reviewed] [Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. 1997., p. 171]
3. In the synthesis of acetic acid, maleic anhydride, isobutane, and other chemicals; in the synthesis of high octane blend stocks of motor fuel [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. 268]
4. Manufacture of thiophene [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. 2087]
5. Both isomers of butane are used as components of aerosol propellants and as fuel sources. Both isomers occur in natural gas and are in liquified petroleum gas. n-Butane is used as a chemical feedstock for special chemicals in the solvent, rubber, and plastics industries. Isobutane is used as a raw material for petrochemicals, an industrial carrier gas, and in the chemical industry for the production of propylene glycols, oxides, polyurethane foams, and resins. [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices for 2001. Cincinnati, OH. 2001., p. 1]
6. Butane is used in the production of ... 1,3-butadiene; ... as a constituent in liquefied natural gas and substitute natural gas; ... and as a solvent in the liquid-liquid extraction of heavy oils in deasphalting processes. [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. V4 14]

Consumption Patterns:

ABOUT 90% AS A GASOLINE BLENDING ADDITIVE; ABOUT 4% AS A CHEM INT FOR BUTADIENE; ABOUT 3% AS A CHEM INT FOR ETHYLENE; ABOUT 3% AS A CHEM INT FOR ACETIC ACID & ITS BY-PRODUCTS & FOR MALEIC ANHYDRIDE (1975) [Peer reviewed]

U.S. Production:

1. (1972) 1.64X10+13 G (EST) [Peer reviewed]
2. (1975) 3.24-3.84X10+13 G [Peer reviewed]

3. (1984) 1.08X10+12 g [Peer reviewed] [USITC. SYN ORG CHEM-U.S. PROD/SALES 1984 p.15]
4. (1987) 2.03X10+9 lb [Peer reviewed] [USITC. SYN ORG CHEM-U.S. PROD/SALES 1987 p.2-2]

U.S. Imports:
1. (1972) 1.48X10+12 G [Peer reviewed]
2. (1975) 1.69X10+12 G (INCL PROPANE MIXTS) [Peer reviewed]
3. (1984) 5.17X10+9 g [Peer reviewed] [BUREAU OF THE CENSUS. U.S. IMPORTS FOR CONSUMPTION AND GENERAL IMPORTS 1984 p.1-395]
4. (1986) 3.87X10+7 bbl [Peer reviewed] [BUREAU OF THE CENSUS. US IMPORTS FOR CONSUMPTION AND GENERAL IMPORTS 1986 P.1-554]

U.S. Exports:
1. (1972) 7.7X10+10 G [Peer reviewed]
2. (1975) 4.23X10+11 G [Peer reviewed]
3. (1984) 3.27X10+8 g [Peer reviewed] [BUREAU OF THE CENSUS. U.S. EXPORTS, SCHEDULE E, 1984 p.2-67]
4. (1987) 8.25X10+4 bbl [Peer reviewed] [BUREAU OF THE CENSUS. U. S. EXPORTS, SCHEDULE E, DECEMBER 1987, P.2-70]
5. (1988) 5.01X10+4 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 [Note: Shipped as a liquefied compressed gas. A liquid below 31 degrees F]. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997., p. 34]

Odor:
1. Faint, disagreeable odor [Peer reviewed] [Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 541]
2. Gasoline-like or natural gas odor. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office, 1997., p. 34]

Boiling Point: -0.50 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. 256]

Melting Point: -138.2 deg C [Peer reviewed] [Lide, DR (ed.). CRC Handbook of Chemistry and Physics. 81st Edition. CRC Press LLC, Boca Raton: FL 2000, p. 3-90]

Molecular Weight: 58.12 [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. 255]

Corrosivity: Has no corrosive action on metals [Peer reviewed] [Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. 1997., p. 171]

Critical Temperature and Pressure: Critical temperature: 153.2 deg C; critical pressure (absolute): 525 psi [Peer reviewed] [Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. 1997., p. 171]

Density/Specific Gravity: 0.6012 @ 0 DEG C/4 DEG C; 0.5788 @ 20 DEG C/4 DEG C [Peer reviewed] [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989., p. C-162]

Heat of Combustion: -19,512 BTU/lb= -10,840 cal/g= -453.85x10+5 J/kg [Peer reviewed] [Weiss, G.; Hazardous Chemicals Handbook. 1986, Noyes Data Corporation, Park Ridge, NJ 1986., p. 186]

Heat of Vaporization: 5801.2 g cal/g mole [Peer reviewed] [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989., p. C-674]

Octanol/Water Partition Coefficient: log Kow= 2.89 [Peer reviewed] [SRI International. 2000 Directory of Chemical Producers -- United States. SRI Consulting, Menlo Park: CA 2000, p. 10]

Solubilities:

1. > 10% in ethyl ether [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. V1 315]
2. > 10% in ethanol [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. V1 315]
3. > 10% in chloroform [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. V1 315]
4. In water, 61.2 mg/l @ 25 deg C [Peer reviewed] [McAuliffe C; Nature 200: 1092-3 (1963)]

Spectral Properties:

1. INDEX OF REFRACTION: 1.3543 @ -13 DEG C/D, 1.3326 @ 20 DEG C/D [Peer reviewed] [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989., p. C-162]
2. IR: 2286 (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. V2 1769]
3. MASS: 61290 (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. V2 1769]
4. 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. V2 1769]

Surface Tension: 14.7 dynes/cm @ 0 deg C [Peer reviewed] [Weiss, G.; Hazardous Chemicals Handbook. 1986, Noyes Data Corporation, Park Ridge, NJ 1986., p. 186]

Vapor Density: 2.07 @ 0 deg C (Air= 1) [Peer reviewed] [Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. 1997., p. 171]

Vapor Pressure: 1820 mm Hg @ 25 deg C [Peer reviewed] [Riddick, J.A., W.B. Bunger, Sakano T.K. Techniques of Chemistry 4th ed., Volume II. Organic Solvents. New York, NY: John Wiley and Sons., 1985., p. 78]

Viscosity: 0.007 mN.s/sq m @ 20 deg C (gas) [Peer reviewed] [Dean, J.A. Handbook of Organic Chemistry. New York, NY: McGraw-Hill Book Co., 1987., p. 4-49]

Other Chemical/Physical Properties:

1. Liquid density (at saturation pressure; 15.6 deg C), kg/cu m: 583.0 /from table/ [Peer

reviewed] [Gerhartz, W. (exec ed.). Ullmann's Encyclopedia of Industrial Chemistry. 5th ed.Vol A1: Deerfield Beach, FL: VCH Publishers, 1985 to Present., p. VA15 349 (1990)]

2. Condensing pressure: approx 30 lb @ 32.5 deg C; specific volume: 6.4 cu ft/lb @ 21.1 deg C; does not react with moisture [Peer reviewed] [Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. 1997., p. 171]
3. SATURATION PRESSURE (AIR): 100% @ 25 DEG C, 760 MM HG [Peer reviewed] [Patty, F. (ed.). Industrial Hygiene and Toxicology: Volume II: Toxicology. 2nd ed. New York: Interscience Publishers, 1963., p. 1197]
4. Liquid water interfacial tension (est): 65 dynes/cm= 0.065 N/m @ 22 deg C; Ratio of specific heats of vapor: 1.092 [Peer reviewed] [Weiss, G.; Hazardous Chemicals Handbook. 1986, Noyes Data Corporation, Park Ridge, NJ 1986., p. 186]
5. CONVERSION FACTOR: 1 PPM= APPROX 2.38 MG/CU M [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. 3178]
6. Heat of fusion: 19.18 cal/g [Peer reviewed] [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989., p. C-667]
7. Heating value: 3266 BTU/cu ft @ 25 deg C [Peer reviewed] [Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. 1997., p. 171]
8. 1 vol of water dissolves 0.15 vol and 1 vol of alcohol /dissolves/ 18 vols of the gas @ 17 deg C, 770 mm Hg; 1 vol of ether or chloroform @ 17 deg C dissolves 25 or 30 vol of the gas, respectively. [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. 256]
9. Vapor Pressure: 1 mm Hg @ -101.5 deg C; 10 mm Hg @ -77.8 deg C; 40 mm Hg @ -59.1 deg C; 100 mm Hg @ -44.2 deg C; 400 mm Hg @ -16.3 deg C; 760 mm Hg at -0.5 deg C. [Peer reviewed] [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989., p. D-199]
10. Hydroxyl radical reaction rate constant= 2.54X10-12 cu cm/molecule-sec @ 25 deg C [Peer reviewed] [Atkinson R; J Phys Chem Ref Data, Monograph 2, (1994)]
11. Critical temperature: 425.17 K; Critical pressure: 3796 kPa; Specific gravity, liquid, at saturation pressure, 288.72 K: 0.5840; Gross heating value at 288.72 K, 101.325 kPa (1 atm): 121.37 MJ/cu m. /from table/ [Peer reviewed] [Kirk-Othmer Encyclopedia of Chemical Technology. 4th ed. Volumes 1: New York, NY. John Wiley and Sons, 1991-Present., p. V12 325 (1994)]

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. [QC 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. 2004G-115]
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. [QC 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. 2004G-115]

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. [QC 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. 2004G-115]
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. [QC 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. 2004G-115]
5. /GUIDE 115: GASES - FLAMMABLE (INCLUDING REFRIGERATED LIQUIDS)/ Evacuation: Large spill: Consider initial downwind evacuatin for at least 800 meters (1/2 mile). Fire: If tank, rail car or tank truck is involved in a fire, ISOLATE for l600 meters (1 mile) in all directions; also, consider initial evacuation for 1600 meters (1 mile) in all directions. [QC 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. 2004G-115]
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. [QC 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. 2004G-115]
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. [QC 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. 2004G-115]
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. [QC 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. 2004G-115]

FLAMMABLE PROPERTIES ▲

Fire Potential:

1. Highly flammable, dangerous fire... risk. [Peer reviewed] [Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. 1997., p. 171]
2. Very dangerous fire hazard when exposed to heat, flame... [Peer reviewed] [Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 541]

NFPA Hazard Classification:

1. Health: 1. 1= Materials that, on exposure, would cause significant irritation, but only minor residual injury, including those requiring the use of an approved air-purifying respirator. These materials are only slightly hazardous to health and only breathing protection is needed. [Peer reviewed] [Fire Protection Guide to Hazardous Materials. 13 ed. Quincy, MA: National Fire Protection Association, 2002., p. 325-21]
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. 325-21]
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. 325-21]

Flammable Limits:

LOWER: 1.9%; UPPER: 8.5% (% BY VOLUME) [Peer reviewed] [Fire Protection Guide to Hazardous Materials. 13 ed. Quincy, MA: National Fire Protection Association, 2002., p. 325-21]

Flash Point:

Gas: -76 deg F (-60 deg C) (closed cup) [Peer reviewed] [Fire Protection Guide to Hazardous Materials. 13 ed. Quincy, MA: National Fire Protection Association, 2002., p. 325-21]

Autoignition Temperature:

550 DEG F (287 DEG C) [Peer reviewed] [Fire Protection Guide to Hazardous Materials. 13 ed. Quincy, MA: National Fire Protection Association, 2002., p. 325-21]

FIRE FIGHTING INFORMATION ▲

Fire Fighting Procedures:

1. Stop flow of gas if possible. Let fire burn. 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. If fire becomes uncontrollable or container is exposed to direct flame consider evacuation of one-half (1/2) mile radius. [Peer reviewed] [Prager, J.C. Environmental Contaminant Reference Databook Volume 2. New York, NY: Van Nostrand Reinhold, 1996., p. 184]
2. Evacuation: If fire becomes uncontrollable or container is exposed to direct flame -- consider evacuation of one-half (1/2) mile radius. [Peer reviewed] [Association of American Railroads. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, DC: Association of American Railroads, Bureau of Explosives, 1994., p. 166]
3. 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. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, DC: Association of American Railroads, Bureau of Explosives, 1994., p. 166]

Other Fire Fighting Hazards:

Vapors are heavier than air and a flame can flash back to the source of leak very easily. The leak can be either a liquid or vapor leak. Under fire conditions the cylinders or tank cars may violently rupture and rocket. [Peer reviewed] [Association of American Railroads. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, D.C.: Assoc. of American Railroads, Hazardous Materials Systems (BOE), 1987., p. 104]

Explosive Limits and Potential:

1. ...Dangerous ...explosion risk. [Peer reviewed] [Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. 1997., p. 171]
2. 1.9 TO 8.5% IN AIR. [Peer reviewed] [Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. 1997., p. 171]
3. 1.9-8.5% by volume in air at ambient temp /from table/ [Peer reviewed] [Bretherick, L. Handbook of Reactive Chemical Hazards. 4th ed. Boston, MA: Butterworth-Heinemann Ltd., 1990, p. 1843]
4. upper 8.5% ; lower 1.9% [Peer reviewed] [Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 541]

HAZARDOUS REACTIONS ▲

Reactivities and Incompatibilities:

1. Very dangerous fire hazard when exposed to ... oxidizers. [Peer reviewed] [Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 541]
2. Addition of nickel carbonyl to an n-butane-oxygen mixture causes an explosion at 20-40 deg C. [Peer reviewed] [Fire Protection Guide to Hazardous Materials. 13 ed. Quincy, MA: National Fire Protection Association, 2002., p. 491-123]
3. Strong oxidizers, (e.g., nitrates and perchlorates), chlorine fluorine (nickel carbonyl + oxygen). [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other

Databases. U.S. Department of Health & Human Services, Public Health Service, Center for Disease Control & Prevention. DHHS (NIOSH) Publication No. 2001-145 (CD-ROM) August 2001., p.]

Decomposition:

When heated to decomposition it emits acrid smoke and fumes. [Peer reviewed] [Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 541]

WARNING PROPERTIES ▲

Odor Threshold:

1. Butane's odor can be detected between 2.9 and 14.6 mg/cu m and in water at 6.2 ppm. [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. V4 13]
2. 2700 ul/l [Peer reviewed] [Amoore JE, Hautala E; J Appl Toxicol 3 (6): 272-90 (1983)]
3. Butane has an odor threshold of 2.8500 mg/cu m (low) and 14.6300 mg/ cu m (high). [Peer reviewed] [Ruth JH; Am Ind Hyg Assoc J 47: A-142-51 (1986)]

Skin, Eye and Respiratory Irritations:

1. Vapor not irritating to eyes, nose, or throat. [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. ... Direct contact with liquid may cause frostbite. [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. 256]

PREVENTIVE MEASURES ▲

Protective Equipment and Clothing:

1. Self-contained breathing apparatus & safety goggles. [Peer reviewed] [Prager, J.C. Environmental Contaminant Reference Databook Volume 2. New York, NY: Van Nostrand Reinhold, 1996., p. 184]
2. Wear rubber gloves ... protective clothing ... . [Peer reviewed] [ITII. Toxic and Hazarous Industrial Chemicals Safety Manual. Tokyo, Japan: The International Technical Information Institute, 1982., p. 83]
3. Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the liquid or from contact with vessels containing the liquid. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases. U.S. Department of Health & Human Services, Public Health Service, Center for Disease Control & Prevention. DHHS (NIOSH) Publication No. 2001-145 (CD-ROM) August 2001., p.]
4. Wear appropriate eye protection to prevent eye contact with the liquid that could result in burns or tissue damage from frostbite. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases. U.S. Department of Health & Human Services, Public Health Service, Center for Disease Control & Prevention. DHHS (NIOSH) Publication No. 2001-145 (CD-ROM) August 2001., p.]
5. Quick drench facilities and/or eyewash fountains should be provided within the immediate work area for emergency use where there is any possibility of exposure to liquids that are extremely cold or rapidly evaporating. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases. U.S. Department of Health & Human Services,

Public Health Service, Center for Disease Control & Prevention. DHHS (NIOSH) Publication No. 2001-145 (CD-ROM) August 2001., p.]

Other Preventative Measures:

1. If material is not on fire and not involved in fire: Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Attempt to stop leak if without undue personnel hazard. Use water spray to knock down vapors. If material leaking (not on fire) consider evacuation from downwind area based on amt of material spilled, location, and weather conditions. Avoid breathing vapors. Keep upwind. [Peer reviewed] [Prager, J.C. Environmental Contaminant Reference Databook Volume 2. New York, NY: Van Nostrand Reinhold, 1996., p. 184]
2. If material not on fire and not involved in fire: Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Attempt to stop leak if without undue personnel hazard. Use water spray to knock-down vapors. [Peer reviewed] [Association of American Railroads. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, DC: Association of American Railroads, Bureau of Explosives, 1994., p. 166]
3. Evacuation: If material leaking (not on fire) consider evacuation from downwind area based on amount of material spilled, location and weather conditions. [Peer reviewed] [Association of American Railroads. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, DC: Association of American Railroads, Bureau of Explosives, 1994., p. 166]
4. Personnel protection: Avoid breathing vapors. Keep upwind. ... Do not handle broken packages unless wearing appropriate personal protective equipment. Approach fire with caution. [Peer reviewed] [Association of American Railroads. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, DC: Association of American Railroads, Bureau of Explosives, 1994., p. 166]
5. Work clothing that becomes wet should be immediately removed due to its flammability hazard. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases. U.S. Department of Health & Human Services, Public Health Service, Center for Disease Control & Prevention. DHHS (NIOSH) Publication No. 2001-145 (CD-ROM) August 2001., p.]
6. Compatible protective equipment construction materials include: Neoprene, neoprene/styrene-butadiene rubber, nitrile rubber, polyurethane, viton. [Peer reviewed] [Association of American Railroads. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, DC: Association of American Railroads, Bureau of Explosives, 1994., p. 166]
7. SRP: Contaminated protective clothing should be segregated in such a manner so that there is no direct personal contact by personnel who handle, dispose, or clean the clothing. Quality assurance to ascertain the completeness of the cleaning procedures should be implemented before the decontaminated protective clothing is returned for reuse by the workers. Contaminated clothing should not be taken home at end of shift, but should remain at employee's place of work for cleaning. [Peer reviewed]

OTHER SAFETY AND HANDLING ▲

Stability/Shelf Life:

Extremely stable. [Peer reviewed] [Prager, J.C. Environmental Contaminant Reference Databook Volume 2. New York, NY: Van Nostrand Reinhold, 1996., p. 184]

Shipment Methods and Regulations:

1. No person may /transport,/ offer or accept a hazardous material for transportation in

commerce unless that person is registered in conformance ... and the hazardous material is properly classed, described, packaged, marked, labeled, and in condition for shipment as required or authorized by ... /the hazardous materials regulations (49 CFR 171-177)./ [QC reviewed] [49 CFR 171.2; U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from: http://www.gpoaccess.gov/ecfr/ as of February 15, 2006]

2. The International Air Transport Association (IATA) Dangerous Goods Regulations are published by the IATA Dangerous Goods Board pursuant to IATA Resolutions 618 and 619 and constitute a manual of industry carrier regulations to be followed by all IATA Member airlines when transporting hazardous materials. [QC reviewed] [International Air Transport Association. Dangerous Goods Regulations. 47th Edition. Montreal, Quebec Canada. 2006., p. 153]
3. The International Maritime Dangerous Goods Code lays down basic principles for transporting hazardous chemicals. Detailed recommendations for individual substances and a number of recommendations for good practice are included in the classes dealing with such substances. A general index of technical names has also been compiled. This index should always be consulted when attempting to locate the appropriate procedures to be used when shipping any substance or article. [QC reviewed] [International Maritime Organization. International Maritime Dangerous Goods Code. London, UK. 2004., p. 42]

Storage Conditions:

1. Butane in liquid form may be stored both above and below ground. Besides storage in liquefied form under its vapor pressure at normal atmospheric temperatures, refrigerated liquid storage at atmospheric pressure may be used. Such systems are closed and insulated and the liquid petroleum gas vapor is circulated through pumps and compressors to serve as the refrigerant for the system. Butane may be stored in pits in the earth capped by metal domes and in underground chambers. [Peer reviewed] [Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 13th ed. New York, NY: John Wiley & Sons, Inc. 1997., p. 171]
2. Storage temp: ambient; venting: safety relief. [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.]

Cleanup Methods:

Spills and leakage: Keep gas concn below the explosive mixture range by forced ventilation. Remove the container to an open area and allow dissipation to the atmosphere. [Peer reviewed] [Prager, J.C. Environmental Contaminant Reference Databook Volume 2. New York, NY: Van Nostrand Reinhold, 1996., p. 184]

Disposal Methods:

SRP: At the time of review, criteria for land treatment or burial (sanitary landfill) disposal practices are subject to significant revision. Prior to implementing land disposal of waste residue (including waste sludge), consult with environmental regulatory agencies for guidance on acceptable disposal practices. [Peer reviewed]

5.0 TOXICITY/BIOMEDICAL EFFECTS

SUMMARY ▲

Toxicity Summary:

n-Butane is a colorless, flammable gas at room temperature. It occurs as a component in natural gas from which it is refined. n-Butane is used as fuel, refrigerant and aerosol propellant. The acute toxicity of n-butane has been studied after inhalation exposure in experimental animals. LC50 (4h) was 658 mg/l in rats and LC50 (2h) was 680 mg/l in mice. In dogs, lethal concentrations ranged from 474 to 592 mg/l. A concentration of 308 mg/l caused light anesthesia in mice within 25 minutes, and an exposure to 521 mg/l had similar effect within one minute. n-Butane ... sensitiz/ed/ the myocardium to epinephrine-induced cardiac arrhythmias in dogs after inhalation. No reports on acute toxicity of n-butane in experimental animals by other administration routes were located in the available literature. In a 21-day inhalation toxicity study of a mixture of n-butane, isobutane, n-penta and isopentane, containing 25% of each, the absence of toxicity was evident up to 11.8 mg/l which was the highest concentration tested. The study was performed in Sprague-Dawley rats which were exposed 6 hours per day over three weeks for a total of 15 exposures. No long-term studies using pure n-butane were located in the available literature. No mutagenic activity was observed in several tests in Salmonella typhimurium strains TA 1535, TA 1537, TA 1538, TA 98 and TA 100 with or without the addition of an exogenous metabolism system. No studies on carcinogenicity, reproduction toxicity and teratogenicity, immunotoxicity or allergy were located in the available literature. Several reports on human exposure to n-butane were available. The increasing abuse of volatile substances, n-butane being among them, increases the risk of sudden death in connection to inhalation of the gas. The range of concentrations that may lead to 'high' feelings or to death has been noted to be very narrow. The use of a oven cleaner containing n-butane as propellant has caused transient myoclonus in one patient. No other physical abnormalities were noted. An aerosol spray which contained n-butane as propellant, was reported to cause deep frostbite symptoms ir the skin when sprayed directly on it. Because of the anesthetic effect of n-butane, truck drivers and terminal operators from different loading facilities and service stations were examined for exposure gasoline vapours containing 90 to 92 percent n-butane, isobutane, n-pentane and isopentane. Exposures to the gasoline vapor were substantially lower than the established ACGIH threshold values (300 ppm or 0.89 mg/l for gasoline, and 800 ppm or 1.9 mg/l for n-butane). Occupational exposure of 53 male refinery workers for an average of 11 years to n-butane (concentration varied from 0.0004 mg/l to 0.0178 mg/l) did not cause any clinical symptoms in the workers. ... In conclusion, exposure to low concentrations of n-butane has not been reported to cause adverse effects in humans. It is anesthetic to both humans and experimental animals. Sudden death may occur when n-butane is inhaled at high concentrations. The safety margin between anesthetic and lethal concentrations appears to be very narrow. Chronic exposure to n-butane has been reported to cause some symptoms in the central nervous system. Critical effects might be lethality when inhaled in high doses, and effects on the central nervous system in chronically exposed individuals. [Peer reviewed] [Berzins T; Nord 28: 10-26 (1995)]

Antidote and Emergency Treatment:

1. Basic treatment: Establish a patent airway. Suction if necessary. Watch for signs of respiratory insufficiency and assist ventilations if necessary. Administer oxygen by nonrebreather mask at 10 to 15 L/min. Monitor for shock and treat if necessary ... . Anticipate seizures and treat if necessary ... . For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with normal saline during transport ... . Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated charcoal ... . /Aliphatic hydrocarbons and related compounds/ [Peer reviewed] [Bronstein, A.C., P.L. Currance; Emergency Care for Hazardous Materials Exposure. 2nd ed. St. Louis, MO. Mosby Lifeline. 1994., p. 206-7]

2. Advanced treatment: Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious or in respiratory rest. Positive pressure ventilation techniques with a bag-valve-mask device may be beneficial. Monitor cardiac rhythm and treat arrhythmias as necessary ... . Start an IV with D5W /SRP: 'To keep open', minimal flow rate/. Use lactated Ringer's if signs of hypovolemia are present. Watch for signs of fluid overload. Consider drug therapy for pulmonary edema ... . Treat seizures with diazepam (Valium) ... . Use proparacaine hydrochloride to assist eye irrigation ... . /Aliphatic hydrocarbons and related compounds/ [Peer reviewed] [Bronstein, A.C., P.L. Currance; Emergency Care for Hazardous Materials Exposure. 2nd ed. St. Louis, MO. Mosby Lifeline. 1994., p. 207]

TOXICITY EXCERPTS ▲

Human Toxicity Excerpts:

1. /HUMAN EXPOSURE STUDIES/ Mildly toxic by inhalation. Causes drowsiness. An asphyxiant. [Peer reviewed] [Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 541]
2. /HUMAN EXPOSURE STUDIES/ A 10-minute exposure at 10,000 ppm (1%) butane gas results in drowsiness, but no other evidence of systemic effects. [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices for 2001. Cincinnati, OH. 2001., p. 2]
3. /HUMAN EXPOSURE STUDIES/ ... A spray /from a cigarette lighter/ on the eye (pre-ignition) repeatedly caused transient blurring of vision. [Peer reviewed] [Grant, W.M. Toxicology of the Eye. 3rd ed. Springfield, IL: Charles C. Thomas Publisher, 1986., p. 162]
4. /HUMAN EXPOSURE STUDIES/ On direct contact, liquefied butane may cause burns or frostbite to the eyes, skin, or mucous membranes. The inhalation of 10,000 ppm for 10 min may result in CNS depression but produces no systemic effects. It can cause blurred vision and can be aspirated resulting in pneumonitis. [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. V4 15]
5. /HUMAN EXPOSURE STUDIES/ Potential symptoms of overexposure are drowsiness, narcosis, asphyxia; direct contact with liquid may cause frostbite. [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. 256]
6. /CASE REPORTS/ ...A case of hemiparesis resulting from acute intoxication following inhalation of butane gas from a canister in a 15 year-old boy /is reported/. [Peer reviewed] [Gray MY, Lazarus JH; J Toxicol 31(3): 483-485 (1993)]
7. /CASE REPORTS/ ...Recently, there has been sporadic information suggesting that nonhalogenated hydrocarbons may cause potentially fatal cardiac arrhythmias. This report documents five sudden deaths due to inhalation of nonhalogenated hydrocarbons: n-butane, isobutane and propane. The hydrocarbons were identified by headspace gas chromatography in blood, brain, and lung tissue. Case histories, toxicological findings and analytical procedures are discussed. [Peer reviewed] [Rohrig TP; Am J Forensic Med Pathol 18 (3): 299-302 (1997)]
8. /CASE REPORTS/ ... A case of out-of-hospital defibrillation in a 15-yr-old schoolgirl who developed ventricular fibrillation (VF) in association with butane gas inhalation /is described/. Although defibrillation performed by an attending paramedic was successful in restoring a cardiac output, her clinical course was complicated by severe neurological impairment... . [Peer reviewed] [Williams DR, Cole S; Resuscitation 37 (1): 43-45 (1998)]
9. /CASE REPORTS/ The toxicological properties of butane mainly affect the heart and the CNS. A serious pathophysiological mechanism is asphyxia due to the replacement of oxygen by butane. ...an abusive butane inhalation in a 15-yr old girl, resulting in