BUTANE

CAS number:	106-97-8 (n-butane)
	75-28-5 (isobutane)
Synonyms:	Butyl hydride, diethyl, methylethyl methane
Chemical formula:	C_4H_{10}

Workplace exposure standard (interim)

TWA:	—
STEL:	**1,000 ppm (2,370 mg/m^3)**
Peak limitation:	—
Notations:	—
IDLH:	**1,600 ppm**
Sampling and analysis:	The recommended value is quantifiable through available sampling and analysis techniques.

Recommendation and basis for workplace exposure standard

A STEL of 1,000 ppm (2,370 mg/m^3) is recommended to protect for central nervous system depression and narcosis in exposed workers.

Given the limited data available from the primary sources for repeat-dose toxicity and carcinogenicity, it is recommended that a review of additional sources be conducted at the next scheduled review.

Discussion and conclusions

Butane gas is generally encountered as an isomeric mixture of *n*-butane and isobutane. It is commonly used as aerosol propellants, fuel sources and in the manufacturing of rubber, plastic, resins and polyurethane foams; also abused to produce inebriation (ACGIH, 2018). Technical grade mixture of butane isomers may contain butadiene which is a known human carcinogen.

Limited single exposure studies indicate that butane isomers have weak acute toxicity (DFG, 1999). Effects in humans following exposure were reported as respiratory tract irritation, vertigo and neurological and cardiac effects (ACGIH, 2018; DFG, 1999; HCOTN, 2004). A NOAEL of 1,000 ppm for physiological changes was identified in a single exposure, inhalational study in volunteers with a mixture of butane and isobutane (ACGIH, 2018; DFG, 1999). A NOAEL of 500 ppm was reported in a two week repeat inhalational study using the same mixture in the same volunteers for the same end points.

The recommended STEL is based on the reported NOAEL for acute exposure and is considered an interim value due to the lack of toxicological data particularly repeat-exposure or carcinogenicity studies (DFG, 1999; HCOTN, 2004). Further evaluation of additional data sources to identify further data for this end point is recommended.

Recommendation for notations

Not classified as a carcinogen according to the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

Not classified as a skin sensitiser or respiratory sensitiser according to the GHS.

There are insufficient data available relating to skin absorption and contribution to systemic burden. However, a skin notation is not recommended due to unlikely skin absorption.

APPENDIX

Primary sources with reports

Source	Year set	Standard
SWA	***1991***	***TWA: 800 ppm (1,900 mg/m^3)***
ACGIH	***2017***	***TLV-STEL: 1,000 ppm (2,370 mg/m^3)***

TLV-STEL is intended to minimise the potential for narcosis in exposed workers based on a NOAEL of 1,000 ppm from a controlled exposure study.

Insufficient data available to recommend Skin, SEN or carcinogenicity notations.

Summary of data:

ACGIH assessment groups both butane isomers (n-butane and isobutane); some of the results presented are not isomer-specific.

Human data:

- Reported upper respiratory tract irritation, vertigo as well as neurological and cardiac effects in overexposed workers (no exposure concentration provided)
- Gas abuse reported to cause neurological effects and deaths (from hypoxia and cardiac failure)
- No adverse effects in 53 refinery workers exposed ≈1–8 ppm (2.37–19 mg/m^3, 11 yr)
- No symptoms except drowsiness observed in 12 adults exposed ≈10,000 ppm (23,770 mg/m^3; 10 min)
- NOAEL: 1,000 ppm (2,370 mg/m^3; mixed exposure with isobutane) for physiological changes in a single-exposure experiment of volunteers (n=8; 1 min to 8 h)
    - Physiological measurements included, cardiac and pulmonary responses, blood parameters, ECG, visual evoked potential, cognitive tests and ACTH stimulation
    - NOAEL: 500 ppm (1,190 mg/m^3) for physiological changes in a repeat-exposure experiment (1–8 h/d, 5 d/wk, 2 wk) on same volunteers.

Animal data:

- CNS depression and deaths in animals reported at concentrations higher than the upper explosive limit (>8,400 ppm) *via* inhalation
    - LC_{50}: ≈280,000–300,000 ppm (≈658–680 g/m^3); (rats and mice, 2–4 h)
    - EC_{50}: ≈70,000–200,000 ppm (≈166–475 g/m^3); for cardiac sensitisation or CNS effects from isobutane (dogs and rats, 5–10 min)
    - LC_{50}: 570,000 ppm (1,355 g/m^3); (dogs, 15 min) although asphyxia is likely to have contributed to death of animals
    - anaesthetic effects observed in dogs and mice at concentrations >130,000 ppm (>309 g/m^3)
    - various studies report cardiac sensitisation or haemodynamic changes at concentrations 5,000–50,000 ppm (11.89–118.9 mg/m^3); (dogs, mice)
    - moderate skin irritation reported in mixtures containing isobutane (rabbits, concentration unspecified)
    - dermal contact with liquefied butane can cause frostbite to exposed area
- NOAEL: ≈140–1,400 ppm (500–5,000 mg/m^3); (monkeys, 90 d) during co-exposure with pentane
- NOAEL: ≈2,220 ppm (5,280 mg/m^3) for renal toxicity during co-exposure with pentane; (rats, 6 h/d, 5 d/wk, 3 wk)

Source	Year set	Standard
• Negative results in an Ames test and clastogenicity study using *Drosophila melanogaster.*		
DFG	***2003***	***MAK: 1,000 ppm (2,400 mg/m³)***
MAK value derived from NOAEL of 1,000 ppm from single exposure study to isobutane. No relevant data available for *n*-butane in humans. No toxicity data is available for repeat exposure studies at the MAK value level. Assessment of both isomers grouped. Summary of additional data: Human data: • No studies available on the absorption of both isomers by oral and dermal routes ○ dermal absorption is considered negligible due to the high vapour pressure of butane and resulting brief contact time • Not an irritant to eyes or skin in gas form • Irreversible muscle weakness, hemiplegic gait or memory loss observed in teenagers (concentration unknown, substance abuse as an inhalant) • Severe prenatal intoxication reported to lead to intrauterine anoxia and severe cephalic disorders in newborns (concentration unknown, substance abuse as an inhalant, not directly related to butane). Animal data: • Not irritating to eyes and respiratory tract in rabbits (no further information) • Reversible increased respiration rate and chewing movements or sniffing observed in guinea pigs exposed to concentrations >21,000 ppm (≈5 g/m³) • Elaboration on Ames test presented in ACGIH 2017: no evidence of genotoxicity at concentrations of 50,000–500,000 ppm (≈118.9–1,189 mg/m³) on *S. typhimurium* strains TA98, TA100, TA1535, TA1537 and TS1538 with and without metabolic activation ○ separate study confirms no evidence of n-butane genotoxicity based on Ames test on same *Salmonella* strains and *E. coli Wp2uvrA* at concentrations ≤10,000 ppm (25 g/m³). No data available on carcinogenicity. Based on chemical structure and negative genotoxicity results, genotoxicity is not expected.		
SCOEL	***NA***	***NA***
No report.		
OARS/AIHA	***NA***	***NA***
No report.		
HCOTN	***2004***	***TWA: 600 ppm (1,430 mg/m³)***
Insufficient data available. Summary of additional data: Absorption of butane stated to be 30–45% of the dose inhaled (no additional information provided). No toxicity data available for repeat exposure to butane isomers. Human data: • Irreversible disintegration of grey matter and cerebral atrophy observed in 1 case of repeat excessive inhalation (concentration unknown, 4 wk, substance abuse as an inhalant). Animal data: • No microscopic or macroscopic organ lesions (rats, estimated conc. 2950 mg/m³)		

Source	Year set	Standard
		• No sex-linked recessive lethal mutation observed in *Drosophila melanogaster* exposed to 350,000 ppm (≈ 832 g/m^3) of *n*-butane.

Secondary source reports relied upon

Source		Year	Additional information
HSE	✓	2002	• TWA: 600 ppm, STEL: 750 ppm • No additional information.
NICNAS	✓	2014	• Grouped Tier II assessment of petroleum and refinery gases (C1-C6) • Report concluded that based on available data alkanes (including butane) are not expected to pose an unreasonable risk to human health • Butane is not classified as carcinogenic or mutagenic when <0.1% butadiene is present in the gas mix.
ECHA	✓	2019	• Classified as carcinogenic and mutagenic when gas is a mixture containing >0.1% butadiene.
US NIOSH	✓	2016	• IDLH of 1,600 mg/m^3 based on 10% LEL due to explosivity concerns.

Carcinogenicity — non-threshold based genotoxic carcinogens

Is the chemical mutagenic? No

The chemical is not a non-threshold based genotoxic carcinogen.

Notations

Source	Notations
SWA	—
HCIS	—
NICNAS	—
EU Annex	—
ECHA	Carcinogenicity – category 1A, if impure (>0.1% butadiene)
ACGIH	—
DFG	—
SCOEL	NA
HCOTN	NA
IARC	NA

Source	Notations
US NIOSH	NA

NA = not applicable (a recommendation has not been made by this Agency); — = the Agency has assessed available data for this chemical but has not recommended any notations

Skin notation assessment

Calculation
Insufficient data to assign a skin notation.

IDLH

Is there a suitable IDLH value available?	Yes, based on LEL.

Additional information

Molecular weight:	58.12
Conversion factors at 25°C and 101.3 kPa:	1 ppm = Number mg/m^3; 1 mg/m^3 = Click or tap here to enter text. ppm
This chemical is used as a pesticide:	☐
This chemical is a biological product:	☐
This chemical is a by-product of a process:	✓
A biological exposure index has been recommended by these agencies:	☐ ACGIH ☐ DFG ☐ SCOEL

Workplace exposure standard history

Year	Standard
Click here to enter year	

References

American Conference of Industrial Hygienists (ACGIH®) (2018) TLVs® and BEIs® with 7th Edition Documentation, CD-ROM, Single User Version. Copyright 2018. Reprinted with permission. See the *TLVs® and BEIs® Guidelines section* on the ACGIH website.

Deutsche Forschungsgemeinschaft (DFG) (2003) Butane (both isomers) – MAK value documentation.

European Chemicals Agency Regulation (ECHA) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

Health Council of the Netherlands (HCOTN) (2004) Butane. Health-based reassessment of administrative occupational exposure limits. The Hague: Health Council of the Netherlands; publication no. 2000/15OSH/134.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2014) Petroleum and refinery gases (C_1-C_6): Human health tier II assessment – IMAP report.

US National Institute for Occupational Safety and Health (NIOSH) (2016) Immediately dangerous to life or health concentrations – Butane.