



SAFETY DATA SHEET (SDS) 1, 3-BUTADIENE

1. Identification

SDS record number	:	PCS95003
Date of SDS	:	01 September 2023
Identity of the substance	:	1,3-Butadiene
Product Description	:	Di-olefin Hydrocarbon
Other names/synonyms	:	Buta-1,3-diene, Biethylene, Bivinyll, Butadiene, Divinyll, Erythrene, Vinylethylene
Name of the supplier	:	PCS Pte. Ltd.
Recommended uses	:	Chemical feedstock
Contact detail of the supplier	:	100 Ayer Merbau Road, Singapore 628277 +65 68672102
24-Hour Emergency contact	:	Asia Pacific +65 3158 1074 (Singapore) China 400 120 6011 Europe, Israel & Americas +44 (0) 1235 239 670 (UK) Middle East & Africa +44 (0) 1235 239 671 (UK)

2. Hazards Identification

GHS Classification

<u>Hazard Class</u>	<u>Hazard Category</u>
• Flammable Gas	1A
• Gases under pressure	Liquefied gas
• Serious eye damage/ eye Irritation	2
• Germ cell mutagenicity	1B
• Carcinogenicity	1A
• Reproductive Toxicity	1B
• STOT (Single Exposure)	3 (respiratory tract irritation, narcotic effects)
• STOT (Repeated Exposure)	1 (ovaries) 2 (haemal system, heart, liver)

Pictograms



Signal Word: Danger

Hazard Statements

- Extremely flammable gas
- Contains gas under pressure; may explode if heated
- Causes serious eye irritation
- May cause genetic defects
- May cause cancer
- May damage fertility or the unborn child.
- May cause respiratory irritation
- May cause drowsiness and dizziness
- Causes damage to ovaries through prolonged or repeated exposure



- May cause damage to haemal system, heart, liver through prolonged or repeated exposure.

Precautionary Statements

Prevention

- Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
- Wash hands thoroughly after handling.
- Wear eye protection/face protection.
- Obtain special instructions before use.
- Do not handle until all safety precautions have been read and understood.
- Wear protective gloves/protective clothing/eye protection/face protection.
- Do not breathe dust/fume/gas/mist/vapours/spray.
- Use only outdoors or in well-ventilated area.
- Do not eat, drink or smoke when using this product.

Response

- Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
- In case of leakage, eliminate all ignition sources.
- IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
- If eye irritation persists: Get medical advice/attention.
- IF exposed or concerned: Get medical advice/attention.
- If INHALED: Remove person to fresh air and keep comfortable for breathing.
- Call a POISON CENTER/doctor/physician if you feel unwell.

Storage

- Protect from sunlight. Store in well-ventilated place.
- Store locked up.
- Store in well-ventilated place. Keep container tightly closed.

Disposal

- Dispose of the contents in accordance to the local mandatory rules and regulations

3. Composition/Information on Ingredients

Chemical identification : 1,3-Butadiene
Common name(s) / synonym(s) : Buta-1,3-diene, Butadiene
CAS number / EC number : 106-99-0 / 203-450-8

Chemical Identification	CAS number	Concentration
1,3-Butadiene	106-99-0	≥ 99 wt%

4. First-Aid Measures

Ingestion: No emergency care anticipated. This material is a gas at standard temperature and pressure.

Eye: If frostbite has occurred, seek medical attention immediately; if tissue is not frozen, immediately and thoroughly flush the eyes with large amounts of water for at least 15 minutes, occasionally lifting the lower and upper eyelids. If irritation, pain, swelling, lacrimation, or photophobia persists, get medical attention as soon as possible.

Skin: If frostbite has occurred, seek medical attention immediately; do not rub the affected areas or flush them with water. In order to prevent further tissue damage, do not attempt to remove frozen



clothing from frostbitten areas. If frostbite has not occurred, immediately and thoroughly wash contaminated skin with soap and water. In case of cold burn, immediately place affected area in warm water (40°C/105°F) and keep at this temperature until circulation returns. Get medical attention.

Breathing: Respiratory support. If a person breathes large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform artificial resuscitation. Keep the affected person warm and at rest. Get medical attention as soon as possible.

Other Instructions: Clothing contaminated with liquefied flammable gases may give rise to delayed evaporation and cause a subsequent fire hazard. Drench individual with water and remove contaminated clothing if possible. Slowly warm affected area of skin. Do not attempt to reheat rapidly.

5. Fire-Fighting Measures

Recommended Fire Extinguishing Agents And Special Procedures:

- Fight fire from protected location or maximum possible distance.
- Stop flow of gas before attempting to extinguish flames.
- Use water spray to cool fire-exposed containers and to protect persons attempting to stop the flow of gas.
- Use flooding quantities of water as fog or spray.
- Use dry chemical or carbon dioxide to extinguish flames.

Unusual or Explosive Hazards:

- Danger: Extremely flammable.
- Flashback may occur along vapour trail.
- May form explosive peroxides on exposure to air.
- Containers may explode in fire.

Special Protective Equipment for Fire-fighters:

- Wear full protective clothing and positive pressure breathing apparatus.
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6. Accidental Release Measures

Evacuate danger area! Consult an expert!

Never direct water jet on liquid. Remove all ignition sources.

Chemical protection suit including self-contained breathing apparatus.

Procedures in Case of Accidental Release, Breakage or Leakage:

- Eliminate all sources of ignition.
 - Ventilate area of spill or leak.
 - Stop flow of liquid at source if possible.
 - Prevent liquid from entering sewers.
 - Dilute with water fog.
 - Keep people away.
 - Stay upwind and warn of possible downwind explosion hazard.
 - Avoid breathing vapour. Avoid contact with eyes, skin, and clothing.
 - Pressure demand air supplied respirators should always be worn when the airborne concentration of the contaminant or oxygen is unknown. Otherwise, wear respiratory protection and other personal protective equipment as appropriate for the potential exposure hazard.
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7. Handling and Storage

Precautions For Safe Handling

- Use spark-proof tools.
- Do not contact with copper or copper alloys as explosive copper compounds may be formed.
- Piping material for this gas must not contain over 63% of copper.

**Storage:**

- Earth (ground) and bond shipping container, transfer line, and receiving container.
- Keep away from heat, sparks, flame, and other sources of ignition.
- Protect containers against static electricity, lightning, and physical damage.
- Must be kept inhibited during storage and shipment.
- Closed system, ventilation, explosion-proof electrical equipment and lighting.
- Prevent build-up of electrostatic charges (e.g., by earthing/grounding) if in liquid state.

8. Exposure Controls/Personal Protection

Control Parameters/ Exposure Limits

- 1,3-Butadiene (CAS: 106-99-0)
Permissible Exposure Level (Long Term) in Singapore: 2ppm (4.4mg/m³)
TLV: 2 ppm as TWA; (ACGIH)
PEL: 1 ppm (2.21 mg/m³) (TWA), 5 ppm (11 mg/m³) (STEL) (OSHA Z-1)

Appropriate Engineering Controls

Ventilation: Use explosion-proof equipment to maintain adequate ventilation to meet occupational exposure limits, if applicable (see below), prevent accumulation of explosive air-gas mixtures, and avoid significant oxygen displacement.

Oxygen levels should be at least 19.5% in confined spaces or other work areas (OSHA value).

Personal Protective Equipment (PPE)

Eye/Face Protection: Safety glasses, chemical type goggles, or face shield recommended to prevent eye contact. Wear appropriate eye protection to prevent eye contact with the liquid that could result in burns or tissue damage from frostbite.

Skin Protection: Protective clothing such as coveralls or lab coats should be worn. Launder or dry-clean when soiled. Gloves and boots resistant to chemicals and petroleum distillates required. Insulated gloves also required if contact with liquid-cooled product or equipment is expected. Wear appropriate personal protective clothing to prevent the skin from becoming frozen. Leaks and uses that allow rapid expansion may cause a frostbite hazard.

Respiratory Protection: Airborne concentrations should be kept to lowest levels possible. If vapor, mist or dust is generated and the occupational exposure limit of the product, or any component of the product, is exceeded, use appropriate.

Remove: When wet (flammable) Work clothing that becomes wet should be immediately removed due to its flammability hazard (i.e., for liquids with a flash point <100°F).

Provide: Frostbite wash 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.

Respirator Recommendations from NIOSH

Airborne Concentration or Condition of Use	Required Respirator
< or = 5 ppm (parts per million)	Air-purifying half-mask or full-face piece respirator equipped with approved butadiene or organic vapour cartridges or canisters. Cartridges or canisters shall be replaced every 4 hours.
< or = 10 ppm	Air-purifying half-mask or full-face piece respirator equipped with approved butadiene or organic vapour cartridges or canisters. Cartridges or canisters shall be replaced every 3 hours.
< or = 25 ppm	(1) Air-purifying half-mask or full-face piece respirator equipped with approved butadiene or organic vapour cartridges or canisters. Cartridges or canisters shall be replaced every 2 hours;



	(2) Any powered air-purifying respirator equipped with approved butadiene or organic vapour cartridges or canisters. Cartridges or canisters shall be replaced every [1] hour; or (3) Continuous-flow supplied-air respirator equipped with a hood or helmet.
< or = 50 ppm	(1) Air-purifying full-face piece respirator equipped with approved butadiene or organic vapour cartridges or canisters. Cartridges or canisters shall be replaced every [1] hour; or (2) Powered air-purifying respirator (PAPR) equipped with a tight-fitting face piece and approved butadiene or organic vapour cartridges. PAPR cartridges shall be replaced every [1] hour.
< or = 1,000 ppm	Supplied-air respirator equipped with a half-mask or full face piece and operated in a pressure-demand or other positive-pressure mode.
> 1,000 ppm, unknown concentration, or firefighting	(1) Self-contained breathing apparatus equipped with a full face piece and operated in a pressure-demand or other positive-pressure mode; or (2) Any supplied-air respirator equipped with a full face piece and operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode.
Escape from IDLH conditions (IDLH is 2,000 ppm)	(1) Any positive-pressure self-contained breathing apparatus with an appropriate service life; or (2) Any air-purifying full-face piece respirator equipped with a front- or back-mounted butadiene or organic vapour canister.

9. Physical and Chemical Properties

Property	Value, Description
Appearance (physical state, colour etc);	Colourless gas at normal temperature and pressure
Odour	Aromatic odour
Odour threshold	Not available
pH	Not available
Melting/freezing point	-109°C
Initial boiling point and boiling range	-4°C
Flash point	-76°C
Evaporation rate	Not available
Flammability	Extremely flammable gas
Upper/lower explosive limits/ flammability limit	2 to 12 % by volume
Vapour pressure	241 kPa at 20°C
Relative vapour density	1.92 at 21°C (Air = 1)
Density and/or Relative density	Vapour density: 2.36 kg/m ³ at 15°C
Solubility	Solubility in Water: 2 g/l at 20°C Soluble in organic solvents at 20 °C
Partition coefficient: n-octanol/water (log value)	log Pow: 1.99
Auto-ignition temperature	415°C
Decomposition temperature	Not available
Kinematic Viscosity @ 50 °C (cSt)	Not available
Particle characteristics	Not applicable



10. Stability and Reactivity

Reactivity/Chemical stability: This material reacts with Heat, Strong Oxidizers, and reducing agents, copper, and copper alloys.

Possibility of hazardous reactions: May spontaneously dimerize to 4-vinyl-1-cyclohexene in a temperature-dependent reaction. Vapours may form polymers which block vents or flame arrestors.

Incompatible materials: Phenol, chlorine dioxide, copper, crotonaldehyde.

Hazardous decomposition products: Carbon monoxide and carbon dioxide may be formed on burning in a limited air supply.

Hazardous Polymerizations: May Occur

Conditions to avoid: Avoid proximity or contact with hot surfaces, flames, electrostatic charges or sparks. Do not store at a temperature exceeding 25 °C.

Note: May form explosive peroxides upon exposure to air.

11. Toxicological Information

Product is a gas - not expected to be absorbed through the skin.
Skin contact with liquid product can cause frostbite (cold burns).

Inhalation: Gas may be irritating and cause discomfort in nose and throat, nasal discharge, and coughing. Prolonged overexposure may cause difficulty breathing.
Inhalation may cause dizziness, drowsiness, euphoria, loss of coordination, disorientation, headache, nausea, and vomiting. In poorly ventilated areas or confined spaces, unconsciousness and asphyxiation may result. Prolonged or repeated overexposure may result in the absorption of potentially harmful amounts of material.

Ingestion: Product is a gas - not expected to cause toxic effects due to ingestion.

This material is a gas. Gas or liquid under pressure may cause frostbite (cold burns).

Sensitization Properties: Unknown.

Toxicological Information (Animal Toxicity Data)

Median Lethal Dose

Oral: LD50 Not applicable; material is a gas.

Inhalation: 4 hr. LC50 > 99000.00 ppm (gas, vapour) (rat) practically non-toxic

Dermal: LD50 Not applicable; material is a gas.

Irritation Index: Estimation of Irritation (Species)

Skin: (Draize) Believed to be < .50 /8.0 (rabbit) no appreciable effect

Eyes: (Draize) Believed to be > 15.00 - 25.00 /110 (rabbit) slightly irritating

There are reports that in eye irritation tests in which mice were exposed to this substance (gas) at 90,000-140,000 ppm and rabbits at 150,000-250,000 ppm, conjunctivitis or lacrimation occurred (EU-RAR (2002)), and there is a case of workers who were exposed to this substance (gas) at 2,000 ppm for 7 hours or at 4,000 ppm for 6 hours and showed eye irritation (ATSDR (2012), EU-RAR (2002)).

The current IARC classification of 1,3-butadiene is Class 2A, meaning that IARC finds there is "limited evidence" of 1,3-butadiene carcinogenicity in humans and "sufficient evidence" of 1,3-butadiene carcinogenicity in experimental animals.



Medical Conditions Aggravated by Exposure: There is no evidence that this product aggravates an existing medical condition.

Other: Prolonged and repeated inhalation of 1, 3-butadiene has produced tumours in multiple sites in rats and mice. In Sprague-Dawley rats exposed to 1000 or 8000 ppm butadiene, tumour sites have included the mammary gland, thyroid, and testes. The National Toxicology Program concluded there was "clear evidence" of carcinogenicity in B6C3F1 mice exposed to 6.25 ppm to 1250 ppm butadiene. This was based on increased tumours in the haematopoietic system, heart, lung, fore stomach, liver and harderian gland in males and females, pre-nuptial gland, brain, and kidney (males), and in ovary and mammary gland (females). IARC has concluded that there is sufficient evidence for 1, 3-butadiene carcinogenicity in experimental animals.

Repeated exposure to 1, 3-butadiene has produced genetic toxicity, bone marrow toxicity, and anaemia in the mouse. No carcinogenic damage to the ovary, testes, liver, nasal tissue, and fore stomach have also been observed in the mouse, and evidence of kidney damage has been observed in the rat. Exposure of pregnant rodents to maternally toxic 1, 3-butadiene concentrations has affected the developing foetus. Malformations (birth defects) have been reported in the developing foetus of pregnant rats exposed to 8000 ppm 1, 3-butadiene. There was no evidence of teratogenic effects in a second developmental study in the rat or a developmental study in the mouse, both involving butadiene exposures up to 1000 ppm.

The B6C3F1 mouse has been demonstrated to be substantially more susceptible to toxic and carcinogenic responses to 1, 3-butadiene exposure than the Sprague-Dawley rat. Repeated exposure to 6.25 ppm 1, 3-butadiene has produced lung tumours and ovarian atrophy in females, and evidence of genetic toxicity in males and females of this mouse strain. By contrast, evidence for toxic and carcinogenic responses in the rat is more limited and has been observed primarily following prolonged exposure to 1, 3-butadiene concentrations of 1000 ppm or higher.

In an effort to explain the higher toxic and carcinogenic potency of 1,3-butadiene in the mouse and evaluate the relevance of these animal bioassay results to humans, pharmacokinetic and metabolism studies have been conducted using rodents, monkeys, and tissues from rodents and humans. The results of these studies suggest that the mouse may not be an appropriate model from which to predict human health effects from exposure to 1, 3-butadiene.

In a test in which male mice were exposed by inhalation at 200-5,000 ppm for 5 days and were mated with untreated females, an increase in the number of females that showed intrauterine deaths was observed at or above 200 ppm (ATSDR (2012)). In addition, in the two tests in which male mice were exposed by inhalation at 65 ppm for 4 weeks or at 12.5 ppm for 10 weeks, and subsequently were mated with untreated females, an increase in early fetal death in the former, and an increase in late fetal death, exencephaly, and skeletal abnormalities in the latter were observed (ATSDR (2012)). On the other hand, in the developmental toxicity test in which pregnant rats or pregnant mice were exposed by inhalation at up to 1,000 ppm during organogenesis period (gestational day 6-15), no abnormality was observed in rats even in the 1,000 ppm exposure group, and only slight effects (low values of fetuses body weight, extra rib, delayed ossification) were observed in mice (ATSDR (2012), Hazard Assessment Report (CERI, NITE, 2008), EU-RAR (2002)). However, in a developmental toxicity test in which pregnant rats were exposed by inhalation at up to 8,000 ppm during the organogenesis period (gestational day 6-15), decreased body weight gain in maternal animals at or above 200 ppm, increased frequency of skeletal abnormality (wavy ribs) in fetuses at or above 1,000 ppm were observed, and at 8,000 ppm, increased frequency of major skeletal defects including the skull, vertebra, sternum, long bones, and ribs in the fetuses were observed additionally (ATSDR (2012), Hazard Assessment Report (CERI, NITE, 2008), EU-RAR (2002)).

From the above, in the three tests in which male mice were mated with untreated females after inhalation exposure, increased fetus deaths were observed at a dose where no general toxicity effect was manifested in parental animals, and in one test among them, external malformations and skeletal abnormalities were observed. Skeletal abnormalities were also detected in the developmental toxicity tests where pregnant rats were exposed at high concentrations during an organogenesis period. Therefore, it was classified in Category 1B for this hazard class.

Chronic: A study conducted at the Texaco Chemical Company 1,3-butadiene manufacturing facility (subsequently acquired by Huntsman Corporation) and updated through 1990 showed that workers had



a lower overall death rate than the general U.S. population. There was a two-fold increase in mortality from lymph sarcoma and reticulum cell sarcoma. However, the increase was not consistently seen in all job groups potentially exposed to higher levels of 1,3-butadiene. In addition, the increase was seen primarily in short term employees whose employment began during World War II and not in those employed ten years or more. This pattern of results suggests that exposure to 1,3-butadiene was not responsible for the increased lymph sarcomas. Several other studies involving workers manufacturing styrene-butadiene rubber have shown increases of leukaemia and lymphomas. These workers were potentially exposed to 1, 3-butadiene and other chemicals, especially styrene and possibly benzene. Due to the presence of multiple chemicals and inconsistent results, these studies also do not demonstrate 1, 3-butadiene exposure to be responsible for increased leukaemia or lymphoma in these workers.

12. Ecological Information

Acute Toxicity

Fish: Expected to be harmful: $10 < LC/EC/IC50 \leq 100$ mg/l

Aquatic Invertebrates: Expected to be harmful: $10 < LC/EC/IC50 \leq 100$ mg/l

Algae: Expected to be harmful: $10 < LC/EC/IC50 \leq 100$ mg/l

Mobility: Floats on water.

Persistence/degradability: Expected to be inherently biodegradable. Oxidizes rapidly by photochemical reactions in air.

Bioaccumulation: Does not bioaccumulate significantly.

13. Disposal Considerations

Recover or recycle if possible. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste classification and disposal methods in compliance with applicable regulations.

Disposal should be in accordance with applicable regional, national, and local laws and regulations.

14. Transport Information

Land (ADR)

UN Number: 1010

UN proper shipping name: BUTADIENES, STABILIZED

Class: 2

Packing Group: Not assigned

Labels: 2.1

Hazard Identification Number: 239

Air (IATA)

UN Number: 1010

UN proper shipping name: BUTADIENES, STABILIZED

Class: 2

Packing Group: Not assigned

Labels: 2.1

Sea (IMDG)

UN Number: 1010

UN proper shipping name: BUTADIENES, STABILIZED

Class: 2

Packing Group: Not assigned

Labels: 2.1

Marine pollutant: No

Transport in Bulk (Annex II of MARPOL 73/78 and the IBC code)

Not applicable



15. Regulatory Information

Workplace Safety and Health Act & Workplace Safety and Health (General Provisions) Regulations:
This product is subject to the SDS, labelling and PEL and other requirements in the Act/Regulations.

Fire Safety Act and Fire Safety (Petroleum and Flammable Materials) Regulations:
This product is subject to the requirements of this Regulations.

Maritime and Port Authority of Singapore (Dangerous Goods, Petroleum and Explosives) Regulations:
This product is subject to the requirements of this Regulations.

Chemical inventory status:

Australia, AIC: Yes
China, IECSC: Yes
Japan, ENCS: Yes
USA, TSCA: Yes

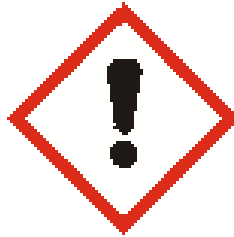
16. Other Information

Prepared By: Material Safety Committee
SDS Prepared on: 1/10/2010
Reviewed 1 on: 1/10/2013
Reviewed 2 on: 1/9/2018
Revised 3 on: 1/9/2023

Revision (3) Notes	
1	Revised according to SS 586-3:2022
2	Sect. 2: Revised Flammable Gas hazard to Cat 1A, according to SS 586-2:2022
3	Sect. 2: Added classification as Category 2 for Serious eye damage/ eye irritation; and Category 1B for Reproductive toxicity
4	Sect. 8: Added Control Parameters and Exposure Limits
5	Sect. 11: Updated toxicological information relevant to classification of serious eye damage/ eye irritation and reproductive toxicity
6	Sect. 14: Updated relevant transport information
7	Sect. 15: Included applicable national regulations (Singapore)

CAUTION: The information given above (“**the Information**”) relates only to the substance or mixture listed herein. The Information may not be valid when used in combination with any other substance or mixture or in any process. If the substance or mixture is to be used for a purpose other than that stated herein or under conditions other than specified herein, the Information cannot be relied upon as being complete or accurate, and the user is advised to consult the supplier before using the substance or mixture for such other purpose or under such other conditions. The Information is given based on information available at the indicated date of preparation and no representation or warranty is given that it will be correct as of any time after the indicated date of preparation.

1,3-Butadiene



DANGER

Hazard Statements

- Extremely flammable gas
- Contains gas under pressure; may explode if heated
- May cause genetic defects
- May cause cancer
- May cause respiratory irritation
- May cause drowsiness and dizziness
- Causes damage to organs through prolonged or repeated exposure

Precautionary Statements

- Keep away from heat/sparks/open flames/hot surfaces. – No smoking.
- Obtain special instructions before use.
- Do not handle until all safety precautions have been read and understood.
- Use personal protective equipment as required.
- Use only outdoors or in well-ventilated area.
- Avoid breathing dust/fume/gas/mist/vapours/spray.
- Do not eat, drink or smoke when using this product.
- Wash hands thoroughly after handling.

For further information on this product, refer to Manufacturer's Safety Data Sheet

Contact detail of the supplier : 100 Ayer Merbau Road, Singapore 628277
Emergency contact : +65 68672102