

β -Propiolactone

Safety Data Sheet

Division of Occupational Health and Safety
National Institutes of Health



WARNING!

This compound is absorbed through the skin and the intestinal tract. It is toxic, carcinogenic, and mutagenic. It is flammable and explosive and it is an irritant. Avoid formation and breathing of aerosols or vapors.

Laboratory operations should be conducted in a fume hood, glove box, or ventilated cabinet.

Avoid skin contact: If exposed, wash with soap and water. For eye exposure, irrigate immediately with large amounts of water. For ingestion, drink plenty of milk or water. Induce vomiting. For inhalation, remove victim promptly to clean air. Administer rescue breathing if necessary. Refer to physician.

In case of laboratory spill, wear protective clothing during cleanup. Avoid skin contact or breathing of aerosols or vapors. Use water to dissolve compound. Wash down area with soap and water. Dispose of waste solutions and materials appropriately.

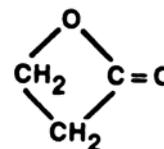
A. Background

β -Propiolactone (BPL) is a colorless, volatile, flammable liquid with a mild but irritating odor. It is an acute skin irritant with moderately low toxicity in rodents. BPL is very rapidly absorbed through the skin and acts as a strong alkylating agent, which is the basis for its carcinogenic action in rodents. It is a strong mutagen. BPL is in use as an intermediate in organic synthesis; its former use as a vapor-phase room disinfectant and sterilizer has been discontinued since its designation as a carcinogen.

B. Chemical and Physical Data

1. Chemical Abstract No.: 57-57-8
2. Synonyms: BPL; beta-Propiolactone; Betaprone; beta-Propionolactone; propanolide; beta-hydracrylic acid lactone; propiolactone; 3-hydroxypropanoic acid lactone; 2-oxetanone (9CI); 3-hydroxy- β -lactopropionic acid
3. Molecular formula: $C_3H_4O_2$
Molecular weight: 72.06
4. Density: 1.146 g/cm³.
5. Absorption spectroscopy: No data.
6. Volatility: Vapor pressure = 3.4 mm Hg at 25° C.
7. Solubility: 37% v/v in water at 25°C with hydrolysis; soluble in ethanol with decomposition,

structure:



acetone, ether, and most polar organic solvents.

8. Description, appearance, and odor: Colorless liquid with mild, sweet, irritating odor.
9. Boiling point: 162° C with decomposition.
Melting point: -33.4° C.
10. Stability: Polymerizes; should be stored at low temperature (0°C).
11. Chemical reactivity: Hydrolyzes in water (half-life of 3 hours at 25°C) to 3-hydroxypropanoic acid. High reactivity with nucleophiles (hydroxyl, acetate, halogen, thiocyanate, thiosulfate ions, thiols, hydroxylamine).
12. Flash point: 70° C.
13. Autoignition temperature: No data.
14. Explosive limits in air: No data.

C. Fire, Explosion, and Reactivity Hazard Data

1. Use dry chemical fire extinguishers. Fire-fighting personnel should wear air-supplied respirators with full-face mask.
2. BPL is flammable; its polymerization, especially when catalyzed by acids, bases, or salts, could be explosive.
3. Conditions contributing to instability are elevated temperatures and presence of acids or bases.
4. No incompatibilities, other than those mentioned above, are known.
5. No hazardous decomposition products have been identified.
6. Do not expose to spark or open flame. Use nonspark tools and explosion-safe freezer only.

D. Operational Procedures

The NIH Guidelines for the Laboratory Use of Chemical Carcinogens describe operational practices to be followed when potentially carcinogenic chemicals are used in NIH laboratories. The Guidelines should be consulted to identify the proper use conditions required and specific controls to be implemented during normal and complex operations or manipulations involving BPL.

1. Chemical inactivation: No validated method reported.
2. Decontamination: Turn off equipment that could be affected by BPL or the materials used for cleanup. If more than 10 ml has been spilled or if there is any uncertainty regarding the procedures to be followed for decontamination, call the NIH Fire Department (dial 116) for assistance. Wash surfaces with copious quantities of water. Glassware should be rinsed (in a hood) with water, followed by soap and water. Animal cages should be washed with water.
3. Disposal: No waste streams containing BPL shall be disposed of in sinks or general refuse. Surplus BPS or chemical waste streams contaminated with BPL shall be handled as hazardous chemical waste and disposed of in accordance with the NIH chemical waste disposal system. Nonchemical waste (*e.g.*, animal carcasses and bedding) containing BPL shall be handled and packaged for incineration in accordance with the NIH medical-pathological waste (MPW) disposal system. Potentially infectious waste (*e.g.*, tissue cultures) containing BPL shall be packaged for incineration, as above. Burnable waste (*e.g.*, absorbent bench top liners) minimally contaminated with BPL shall be handled as potentially infectious waste and packaged for incineration, as above. Absorbent materials (*e.g.*, those associated with spill cleanup) grossly contaminated shall be handled in accordance with the chemical waste disposal system. Radioactive waste containing BPL shall be handled in accordance with the NIH radioactive waste disposal system.

4. Storage: Store BPL in an explosion-safe freezer (0° C or below) in sealed ampoules or screw-capped bottles or vials with Teflon cap liners with protection against moisture.

E. Monitoring and Measurement Procedures Including Direct Field Measurements and Sampling for Subsequent Laboratory Analysis

1. Sampling: Air samples may be drawn through bubblers containing alkaline hydroxylamine solution. The resultant hydroxamic acid is determined colorimetrically after addition of ferric chloride to the solution (Hoffman and Warshowsky, 1958). A personnel monitoring device has been developed (Segal *et al.*, 1978).
2. Separation and analysis: Colorimetric procedures, in addition to the above, include reaction with 4-(*r*-nitrobenzyl)pyridine (nonspecific in presence of other alkylating agents) (Preuss-mann *et al.*, 1969) and with other reagents (Pellerin and Letavernier, 1974). Polarography (detection limit of 10 ppm) has also been used (Pellerin and Letavernier, 1971).

F. Biological Effects (Animal and Human)

1. Absorption: BPL is very rapidly absorbed through unbroken skin of laboratory animals, in addition to producing local irritant effects. It is also absorbed via the gastrointestinal tract since oral administration produces toxic effects.
2. Distribution: After skin absorption, BPL reacts extensively with intracellular constituents in skin. There are no data concerning distribution to other sites. There is probably little, if any, distribution in view of (a) the fairly rapid hydrolysis of BPL to nontoxic products and (b) the local nature of its carcinogenic effects (see below).
3. Metabolism and excretion: BPL alkylates extensively and almost exclusively with purines in DNA and with the ϵ -amino group of lysine in intracellular proteins. No excretion products have been identified; the most likely hydrolysis product, β -hydroxy-propionic acid, is nontoxic and noncarcinogenic (IARC, 1974).
4. Toxic effects: The only reported LD₅₀ is 345 mg/kg in the mouse (intravenous). The LD_{Lo} is 3 mg/kg (mouse, intraperitoneal) and 50 mg/kg (rat, oral). No specific target organs have been identified, other than skin after exposure via this route (local irritation).
5. Carcinogenic effects: Target organs are primarily dependent on route of administration. Local sarcomas and squamous cell carcinomas are produced by painting the skin with BPL (mouse, guinea pig, hamster), carcinomas of the forestomach after oral administration (rat), and hepatomas and lymphomas after intraperitoneal dosage (mouse).
6. Mutagenic and teratogenic effects: BPL is an active mutagen in yeast, bacteria, and phage. There are no data regarding its teratogenicity.

G. Emergency Treatment

1. Skin and eye exposure: For skin exposure, remove contaminated clothing and wash skin with soap and water. For eye exposure, irrigate immediately with copious quantities of running water for at least 15 minutes.
2. Ingestion: Drink plenty of milk or water. Induce vomiting.
3. Inhalation: Remove victim promptly to clean air. Administer rescue breathing if necessary.
4. Refer to physician. Consider ophthalmological consultation for eye exposure.

H. References

- Hoffman, R.K., and B. Warshowsky. 1958. Beta-propiolactone vapor as a disinfectant. *Appl Microbiol* 66:358-362.
- IARC, International Agency for Research on Cancer. 1974. Pages 259-269 in IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man. Some Aromatic Amines, Hydrazine & Related Substances, N-Nitroso Compounds and Miscellaneous Alkylating Substances, N-Nitroso Compounds and Miscellaneous Alkylating Agents, Vol. 4. World Health Organization, Geneva, Switzerland.
- Pellerin, F., and J.F. Letavernier. 1971. Detection of traces of propiolactone using colorimetry. *Ann Pharm Fr* 29:444.
- Pellerin, F., and J.F. Letavernier. 1974. Detection of traces of propiolactone using colorimetry. *Ann Pharm Fr* 32:535-539.
- Preussmann, R., H. Schnieder, and F. Epple. 1969. Investigations for the determination of alkylating agents. II. The determination of different classes of alkylating agents with a modification of the color reaction with alkylating agents with a modification of the color reaction with 4-(4-nitrobenzyl)pyridine (NBP). *Arzneim Forsch* 19:1059-1073.
- Segal, A., G. Loewengart, and S. Sudberg. 1978. A new personal monitoring device for the detection of β -propiolactone and other alkylating agents. *Arch Environ Health* 33:33-35.