

# Boron tribromide

## Safety Data Sheet

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Division of Occupational Health and Safety  
National Institutes of Health



### WARNING:

This compound is acutely toxic. It is readily absorbed by various body tissues through the respiratory and intestinal tracts. It may cause severe irritation of tissues (skin, eyes, mucous membranes, and lungs). 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 cold water. Avoid washing with solvents. Avoid rubbing of skin or increasing its temperature.

Boron tribromide may react explosively with water. In case of fire, use carbon dioxide or dry chemical extinguishes.

For eye exposure, irrigate immediately with large amounts of water. For ingestion, drink water or sodium bicarbonate solution. Refer for gastric lavage. 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 alkaline solutions to dissolve compound. Use absorbent paper to mop up spill. Wash down area with 1% sodium hydroxide or sodium carbonate following water. Dispose of waste solutions and materials appropriately.

### A. Background

Boron tribromide ( $\text{BBr}_3$ ) is a colorless, fuming liquid, corrosive to metals and biological materials. In the presence of water it is quickly decomposed to boric acid and hydrogen bromide, and its toxic effects (irritation and corrosion) are due to formation of hydrogen bromide. It is used as a catalyst in polymerizations, alkylations, and acylations (Friedel-Crafts reactions) and, in ultra-pure form, to provide boron for “doping” semiconductors.

There is no federal standard for exposure to  $\text{BBr}_3$ ; a ceiling limit of 1 ppm ( $10 \text{ mg/m}^3$ ) has been recommended (ACGIH, 1987).

## B. Chemical and Physical Data

1. Chemical Abstracts No.: 10294-33-4.
2. Synonyms: Borane, tribromo-<sup>A</sup>; boron bromide.
3. Chemical structure and molecular weight: BBr<sub>3</sub>; 250.57
4. Density:  $d_{418.4} = 2.6431$ . Densities in the range of  $-20^{\circ}\text{C}$  to  $+90^{\circ}\text{C}$  may be calculated from the equation  $d = 2.698 - 2.996 \times 10^{-3} = C$  (Barber et al., 1964).
5. Absorption spectroscopy: Mass (Koski et al., 1959), near infrared (Wentink and Tiensuu, 1958), and far infrared (Finch *et al.*, 1965) spectra have been published.
6. Volatility: Selected vapor pressure data (1-760 mm Hg) are listed on p. D-199 in Weast (1982). In the range of  $0^{\circ}\text{C}$  to  $90^{\circ}\text{C}$  the equation:  $\log P \text{ (mm Hg)} = 6.9792 - 1311/(\text{C} + 230)$  is obeyed (Barber *et al.*, 1964). At  $20^{\circ}\text{C}$  the vapor pressure is 54.5 mm Hg.
7. Solubility: BBr<sub>3</sub> is soluble in CCl<sub>4</sub>, SiCl<sub>4</sub>, S<sub>2</sub>Cl<sub>2</sub>, SCl<sub>2</sub>, and SO<sub>2</sub> (Lower, 1978).
8. Description: Fuming liquid which is colorless when pure but turns colored when exposed to light. Most commercial samples are orange to red, due to varying amounts of bromine as an impurity; bromine can be removed by shaking with metallic mercury (Urry, 1967).
9. Boiling point: listed variously as  $89.9^{\circ}\text{C}$  (Massey, 1967) to  $91.3^{\circ}\text{C}$  (Weast, 1982); melting point:  $-45.8^{\circ}\text{C}$ .
10. Stability: Storage in presence of light leads to coloration, presumably due to liberation of bromine. Decomposes at high temperatures to yield toxic bromine-containing fumes. Reacts vigorously (sometimes explosively) with water.
11. Chemical reactivity: The reactions of boron tribromide with inorganic and organic compounds have been reviewed in detail (Massey, 1967; Urry, 1967; Lower, 1978). They may be divided into (a) those in which it reacts as an acid halide (protonolysis by active hydrogen reagents such as water, alcohol, or ammonia) and (b) those in which it reacts as a Lewis acid (formation of a donor-acceptor complex with many covalent compounds). Among boron trihalides the reactivity decreases in the order fluoride, chloride, bromide, and Iodide.
12. Flash point: No data.
13. Autoignition temperature: No data.
14. Explosive limits in air: No data.

## C. Fire, Explosion, and Reactivity Hazard Data

1. Because of the irritant effects of boron tribromide on skin, eyes, and lungs, fire-fighting personnel should wear protective clothing and air-supplied respirators with full face masks. Use carbon dioxide or dry chemical extinguishers.
2. Boron tribromide is incompatible with water, alkali, or ammonia.
3. Conditions contributing to instability are high temperatures which result in formation of toxic, bromine-containing fumes.
4. No other hazardous decomposition products are known.
5. Since boron tribromide is nonflammable, nonspark equipment is not required.

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<sup>A</sup> Chemical Abstracts name, used for listing in 9<sup>th</sup> Decennial Index and subsequently.

#### D. Operational Procedures

It should be emphasized that this data sheet and the NIH Guidelines are intended as starting points for the implementation of good laboratory practices when using this compound. The practices and procedures described in the following sections pertain to the National Institutes of Health and may not be universally applicable to other institutions. Administrators and/or researchers at other institutions should modify the following items as needed to reflect their individual management system and current occupational and environmental regulations.

1. Chemical inactivation: No validated method reported, but  $\text{BBr}_3$  is readily decomposed by alkali.
2. Decontamination: Turn off equipment that could be affected by  $\text{BBr}_3$  or the materials used for cleanup. If there is any uncertainty regarding the procedures to be followed for decontamination, call the Fire Department (dial 911 for assistance. Use absorbent paper to mop up spill. Wipe off surfaces with 1% sodium hydroxide or sodium carbonate, then wash with copious quantities of water. Glassware should be rinsed (in a hood) with 1% sodium hydroxide, followed by soap and water. Animal cages should be washed with dilute ammonia followed by water.
3. Disposal: No waste streams containing  $\text{BBr}_3$  shall be disposed of in sinks or general refuse. Surplus  $\text{BBr}_3$  or chemical waste streams contaminated with  $\text{BBr}_3$  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  $\text{BBr}_3$  shall be handled and packaged for incineration in accordance with the NIH medical-pathological waste disposal system. Potentially infectious waste (*e.g.*, tissue cultures) containing  $\text{BBr}_3$  shall be packaged for incineration, as above. Burnable waste (*e.g.*, absorbent bench top liners.) minimally contaminated with  $\text{BBr}_3$  shall be handled as potentially infectious waste and packaged for incineration, as above. Absorbent materials (*e.g.*, associated with spill cleanup) grossly contaminated shall be handled in accordance with the chemical waste disposal system. Radioactive waste containing  $\text{BBr}_3$  shall be handled in accordance with the NIH radioactive waste disposal system.
4. Storage: Store  $\text{BBr}_3$  and its solutions in dark-colored all-glass containers, under refrigeration. Avoid exposure to light and moisture. Store working quantities of  $\text{BBr}_3$  and its solutions in an explosion-safe refrigerator in the work area.

#### E. Monitoring and Measurement Procedures Including Direct Field Measurements and sampling for subsequent laboratory analysis.

No methods for sampling and analysis of boron tribromide have been published. Samples should be hydrolyzed by excess alkali, and analyzed for borate and/or bromide using standard procedures.

#### F. Biological Effects (Animal and Human)

1. Absorption: Boron tribromide is absorbed by inhalation and ingestion. It is a severe irritant of skin, eyes, and mucous membranes, especially those of the respiratory and alimentary tract but there is no indication whether systemic effects are produced via these routes.
2. Distribution: No data.
3. Metabolism and excretion: No data. Since boron tribromide is readily hydrolyzed in vitro and therefore presumably in the animal body to boric acid and hydrogen bromide, its metabolic fate is that of its hydrolysis products.
4. Toxic effects: There are no acute  $\text{LD}_{50}$  measurements because of the instability of boron tribromide in aqueous solution. It has been described as being "highly toxic" (Lower, 1978; Sax, 1984) but there is no reference in the literature to quantitative data. In any event, its highly irritating action on eyes, skin, and mucous membranes would preclude inhalation or ingestion of a lethal dose. Of the two

hydrolysis products, boric acid may be considered non-toxic in the Dose range encountered as a result of exposure to boron tribromide (oral and parenteral LD<sub>50</sub>s in animals are in the range of 1-3 g/kg). Toxic effects are therefore ascribable to the liberated hydrogen bromide, which may produce burns on skin contact, irritation, burns, and temporary blindness following eye exposure, bronchitis and bronchopneumonia on inhalation, and burns and necrosis of the gastrointestinal mucosa on ingestion (Sittig, 1981).

5. Carcinogenic effects: None reported.
6. Mutagenic and teratogenic effects: None reported.

#### G. Emergency Treatment

1. Skin and eye exposure: For skin exposure, remove contaminated clothing and wash skin with soap and water. Skin should not be rinsed with organic solvents. Since BBr<sub>3</sub> is readily absorbed through the skin, avoid rubbing of skin or increasing its temperature. For eye exposure, irrigate immediately with copious quantities of running water for at least 15 minutes. Obtain ophthalmological evaluation.
2. Ingestion: Drink plenty of water or sodium bicarbonate solution. Vomiting might response the mouth and esophagus. Refer for gastric lavage.
3. Inhalation: Remove victim promptly to clean air. Administer rescue breathing if necessary.
4. Refer to physician at once. Consider treatment for pulmonary irritation.

#### H. References

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