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# Handbook of Pharmaceutical Excipients

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SIXTH EDITION

*Edited by*

**Raymond C Rowe** BPharm, PhD, DSC, FRPharmS, FRSC, CPhys, MInstP

**Chief Scientist**

*Intelligensys Ltd, Stokesley, North Yorkshire, UK*

**Paul J Sheskey** BSc, RPh

**Application Development Leader**

*The Dow Chemical Company, Midland, MI, USA*

**Marian E Quinn** BSc, MSc

**Development Editor**

*Royal Pharmaceutical Society of Great Britain, London, UK*




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www2.mst.dk/udgiv/publications/2006/87-7052-278-2/pdf/87-7052-279-0.pdf (accessed 13 February 2009)

- 6 Graham BE, Kuizenga MH. Toxicity studies on benzyl benzoate and related benzyl compounds. *J Pharmacol Exp Ther* 1945; 84: 358–362.
- 7 Draize JH *et al.* Toxicological investigations of compounds proposed for use as insect repellents. *J Pharmacol Exp Ther* 1948; 93: 26–39.
- 8 Sweet DV, ed. *Registry of Toxic Effects of Chemical Substances*. Cincinnati: US Department of Health, 1987: 965.
- 9 Hayes WJ, Jr, Laws ER, Jr, eds. *Handbook of Pesticide Toxicology*, vol. 3. *Classes of Pesticides*. New York, NY: Academic Press Inc, 1991; 1505.
- 10 Ohno O *et al.* Inhibitory effects of benzyl benzoate and its derivatives on angiotensin II-induced hypertension. *Bioorg Med Chem* 2008; 16(16): 7843–7852.

## 20 General References

- Gupta VD, Ho HW. Quantitative determination of benzyl benzoate in benzyl benzoate lotion NF. *Am J Hosp Pharm* 1976; 33: 665–666.
- Hassan MMA, Mossa JS. Benzyl benzoate. Florey K, ed. *Analytical Profiles of Drug Substances*, vol. 10. New York: Academic Press, 1981; 55–74.

## 21 Author

RA Storey.

## 22 Date of Revision

13 February 2009.

# Boric Acid

## 1 Nonproprietary Names

BP: Boric Acid

JP: Boric Acid

PhEur: Boric Acid

USP-NF: Boric Acid

## 2 Synonyms

Acidum boricum; boracic acid; boraic acid; *Borofax*; boron trihydroxide; E284; orthoboric acid; trihydroxyborene.

## 3 Chemical Name and CAS Registry Number

Orthoboric acid [10043-35-3]

Metaboric acid [13460-50-9]

## 4 Empirical Formula and Molecular Weight

H<sub>3</sub>BO<sub>3</sub> 61.83 (for trihydrate)

HBO<sub>2</sub> 43.82 (for monohydrate)

## 5 Structural Formula

See Section 4.

## 6 Functional Category

Antimicrobial preservative; buffering agent.

## 7 Applications in Pharmaceutical Formulation or Technology

Boric acid is used as an antimicrobial preservative<sup>(1)</sup> in eye drops, cosmetic products, ointments, and topical creams. It is also used as an antimicrobial preservative in foods.

Boric acid and borate have good buffering capacity and are used to control pH; they have been used for this purpose in external preparations such as eye drops.<sup>(2)</sup>

Boric acid has also been used therapeutically in the form of suppositories to treat yeast infections.<sup>(3,4)</sup> In dilute concentrations it is used as a mild antiseptic, with weak bacteriostatic and fungistatic

## 8 Description

Boric acid occurs as a hygroscopic, white crystalline powder, colorless shiny plates, or white crystals.

## 9 Pharmacopeial Specifications

See Table I.

**Table I:** Pharmacopeial specifications for boric acid.

Test	JP XV	PhEur 6.0	USP32-NF27
Identification	+	+	+
Characters	—	+	—
Appearance of solution	+	+	—
Loss on drying	≤0.50%	—	≤0.50%
Sulfate	—	≤450 ppm	—
Heavy metals	≤10 ppm	≤15 ppm	≤0.002%
Organic matter	—	+	—
Arsenic	≤5 ppm	—	—
pH	3.5–4.1	3.8–4.8	—
Solubility in ethanol (96%)	—	+	+
Completeness of solution	—	—	+
Assay	≥99.5%	99.0–100.5%	99.5–100.5%

## 10 Typical Properties

**Acidity/alkalinity** pH = 3.5–4.1 (5% w/v aqueous solution)

**Density** 1.435

**Melting point** 170.9°C. When heated slowly to 181.0°C, boric acid loses water to form metaboric acid (HBO<sub>2</sub>); tetraboric acid (H<sub>2</sub>B<sub>4</sub>O<sub>7</sub>) and boron trioxide (B<sub>2</sub>O<sub>3</sub>) are formed at higher temperatures.<sup>(6)</sup>

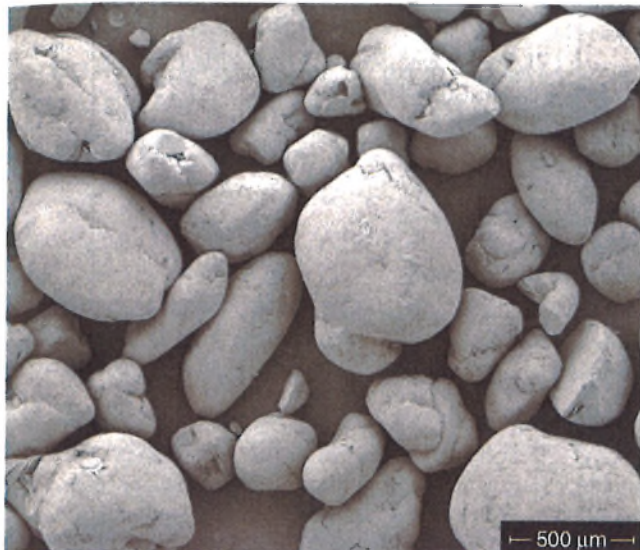
**Solubility** Soluble in ethanol, ether, glycerin, water, and other fixed and volatile oils. Solubility in water is increased by addition of hydrochloric, citric, or tartaric acids.

**Specific gravity** 1.517

## 11 Stability and Storage Conditions

Boric acid is hygroscopic and should therefore be stored in an air-

**SEM 1:** Excipient: boric acid; manufacturer: Alfa Aesar; lot no.: 23672; magnification: 100×; voltage: 5 kV.



**SEM 2:** Excipient: boric acid; manufacturer: Aldrich Chemical Company Inc.; lot no.: 01559BU; magnification: 100×; voltage: 5 kV.



## 12 Incompatibilities

Boric acid is incompatible with water, strong bases and alkali metals. It reacts violently with potassium and acid anhydrides. It also forms a complex with glycerin, which is a stronger acid than boric acid.

## 13 Method of Manufacture

Boric acid occurs naturally as the mineral sassolite. However, the majority of boric acid is produced by reacting inorganic borates with sulfuric acid in an aqueous medium. Sodium borate and partially refined calcium borate (colemanite) are the principal raw materials. When boric acid is made from colemanite, the fine-ground ore is vigorously stirred with mother liquor and sulfuric acid at about 90°C. The by-product calcium sulfate is removed by filtration, and the boric acid is crystallized by cooling the filtrate.

## 14 Safety

Boric acid is a weak bacteriostatic and antimicrobial agent, and has

and gargles. It has also been used in US- and Japanese-approved intravenous products. Solutions of boric acid were formerly used to wash out body cavities, and as applications to wounds and ulcers, although the use of boric acid for these purposes is now regarded as inadvisable owing to the possibility of absorption.<sup>(5)</sup> Boric acid is not used internally owing to its toxicity. It is poisonous by ingestion and moderately toxic by skin contact. Experimentally it has proved to be toxic by inhalation and subcutaneous routes, and moderately toxic by intraperitoneal and intravenous routes.

Boric acid is absorbed from the gastrointestinal tract and from damaged skin, wounds, and mucous membranes, although it does not readily permeate intact skin. The main symptoms of boric acid poisoning are abdominal pain, diarrhea, erythematous rash involving both skin and mucous membrane, and vomiting. These symptoms may be followed by desquamation, and stimulation or depression of the central nervous system. Convulsions, hyperpyrexia, and renal tubular damage have been known to occur.<sup>(7)</sup>

Death has occurred from ingestion of less than 5 g in young children, and of 5–20 g in adults. Fatalities have occurred most frequently in young children after the accidental ingestion of solutions of boric acid, or after the application of boric acid powder to abraded skin.

The permissible exposure limit (PEL) of boric acid is 15 mg/m<sup>3</sup> total dust, and 5 mg/m<sup>3</sup> respirable fraction for nuisance dusts.<sup>(8)</sup>

Ld<sub>Lo</sub> (man, oral): 429 mg/kg<sup>(9)</sup>

Ld<sub>Lo</sub> (woman, oral): 200 mg/kg<sup>(9)</sup>

Ld<sub>Lo</sub> (infant, oral): 934 mg/kg<sup>(9)</sup>

Ld<sub>Lo</sub> (man, skin): 2.43 g/kg<sup>(9)</sup>

Ld<sub>Lo</sub> (infant, skin): 1.20 g/kg<sup>(9)</sup>

LD<sub>50</sub> (mouse, oral): 3.45 g/kg<sup>(9)</sup>

LD<sub>50</sub> (mouse, IV): 1.24 g/kg

LD<sub>50</sub> (mouse, SC): 1.74 g/kg

LD<sub>50</sub> (rat, oral): 2.660 g/kg

LD<sub>50</sub> (rat, IV): 1.33 g/kg

LD<sub>50</sub> (rat, SC): 1.4 g/kg

## 15 Handling Precautions

Observe normal precautions appropriate to the circumstances and quantity of material handled. Boric acid is irritating to the skin and is potentially toxic by inhalation. Gloves, eye protection, protective clothing, and a respirator are recommended.

## 16 Regulatory Status

Accepted for use as a food additive in Europe. Included in the FDA Inactive Ingredients Database (IV injections; ophthalmic preparations; (auricular) otic solutions; topical preparations). Reported in the EPA TSCA Inventory. In the UK, the use of boric acid in cosmetics and toiletries is restricted. Included in the Canadian List of Acceptable Non-medicinal Ingredients.

## 17 Related Substances

Sodium borate.

## 18 Comments

Boric acid has been used experimentally as a model oxo-acid to retard mannitol crystallization in the solid state.<sup>(10)</sup>

The EINECS number for boric acid is 233-139-2. The PubChem Compound ID (CID) for boric acid includes 7628 and 24492.

## 19 Specific References

1. Borokhov O, Schubert D. Antimicrobial properties of boron deriva

- 2 Kodym A *et al.* Technology of eye drops containing aloe (*Aloe arborescens* M-Liliaceae) and eye drops containing both aloe and neomycin sulphate. *Acta Pol Pharm* 2003; 60(1): 31–39.
- 3 Prutting SM, Cervený JD. Boric acid vaginal suppositories: a brief review. *Infect Dis Obstet Gynecol* 1998; 6: 191–194.
- 4 Sobel JD. Current treatment options for vulvovaginal candidiasis. *Women's Health* 2005; 1(2): 253–261.
- 5 Sweetman SC, ed. *Martindale: The Complete Drug Reference*, 36th edn. London: Pharmaceutical Press, 2009; 2268.
- 6 Lund W, ed. *The Pharmaceutical Codex: Principles and Practice of Pharmaceutics*, 12th edn. London: Pharmaceutical Press, 1994; 109.
- 7 Hubbard SA. Comparative toxicology of borates. *Biol Trace Elem Res* 1998; 66: 343–357.
- 8 Dean JA, ed. *Lang's Handbook of Chemistry*, 13th edn. New York: McGraw-Hill, 1985; 4–57.
- 9 Lewis RJ, ed. *Sax's Dangerous Properties of Industrial Materials*, 11th edn. New York: Wiley, 2004; 536.
- 10 Yoshinari T *et al.* Crystallisation of amorphous mannitol is retarded using boric acid. *Int J Pharm* 2003; 258: 109–120.

## 20 General References

## 21 Authors

DD Ladipo, AC Bentham.

## 22 Date of Revision

19 January 2009.

# Bronopol

## 1 Nonproprietary Names

BP: Bronopol

## 2 Synonyms

2-Bromo-2-nitro-1,3-propanediol;  $\beta$ -bromo- $\beta$ -nitrotrimethylene-glycol; *Myacide*.

## 3 Chemical Name and CAS Registry Number

2-Bromo-2-nitropropane-1,3-diol [52-51-7]

## 4 Empirical Formula and Molecular Weight

$C_3H_6BrNO_4$  200.00

## 5 Structural Formula



## 6 Functional Category

Antimicrobial preservative; antiseptic.

## 7 Applications in Pharmaceutical Formulation or Technology

Bronopol 0.01–0.1% w/v is used as an antimicrobial preservative either alone or in combination with other preservatives in topical pharmaceutical formulations, cosmetics, and toiletries; the usual concentration is 0.02% w/v.

## 8 Description

Bronopol is a white or almost white crystalline powder; odorless or with a faint characteristic odor.

## 10 Typical Properties

**Antimicrobial activity** Bronopol is active against both Gram-positive and Gram-negative bacteria including *Pseudomonas aeruginosa*, with typical minimum inhibitory concentrations (MICs) between 10–50  $\mu$ g/mL;<sup>(1–8)</sup> see also Table II. At room temperature, a 0.08% w/v aqueous solution may reduce the viability of culture collection strains of *Escherichia coli* and

**Table I:** Pharmacopeial specifications for bronopol.

Test	BP 2009
Identification	+
Characters	+
Acidity or alkalinity (1% w/v solution)	5.0–7.0
Related substances	+
Sulfated ash	$\leq$ 0.1%
Water	$\leq$ 0.5%
Assay (anhydrous basis)	99.0–101.0%

**Table II:** Minimum inhibitory concentrations (MICs) of bronopol.<sup>(2,9)</sup>

Microorganism	MIC ( $\mu$ g/mL)
<i>Aspergillus niger</i>	3200
<i>Bacillus subtilis</i>	12.5
<i>Burkholderia (Pseudomonas) cepacia</i>	25
<i>Candida albicans</i>	1600
<i>Escherichia coli</i>	12.5–50
<i>Klebsiella aerogenes</i>	25
<i>Legionella pneumophila</i>	50
<i>Penicillium roqueforti</i>	400
<i>Penicillium funiculosum</i>	1600
<i>Pityrosporum ovale</i>	125
<i>Proteus mirabilis</i>	25–50
<i>Proteus vulgaris</i>	12.5–50
<i>Pseudomonas aeruginosa</i>	12.5–50
<i>Saccharomyces cerevisiae</i>	3200
<i>Salmonella gallinarum</i>	25
<i>Staphylococcus aureus</i>	12.5–50
<i>Staphylococcus epidermidis</i>	50
<i>Streptococcus faecalis</i>	50

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