Hydrogen bromide

MAK value (1996)	**2 ml/m^3 (ppm) ≙ 6.7 mg/m^3**
Peak limitation (1983)	**Category I**
Absorption through the skin	**–**
Sensitization	**–**
Carcinogenicity	**–**
Prenatal toxicity (1989)	**see Section IIc of the *List of MAK and BAT Values***
Germ cell mutagenicity	**–**
BAT value	**–**
Synonyms	hydrobromic acid
Chemical name (CAS)	anhydrous hydrobromic acid
CAS number	10035-10-6
Molecular formula	HBr
Molecular weight	80.92
Melting point	–87°C
Boiling point at 1013 hPa	–66.5°C
1 ml/m^3 (ppm) ≙ 3.358 mg/m^3	**1 mg/m^3 ≙ 0.298 ml/m^3 (ppm)**

1 Toxic Effects and Mode of Action

Hydrogen bromide is one of the strongest known acids and in aqueous solution is almost completely dissociated. Hydrogen bromide and its aqueous solution are caustic to the skin and mucous membranes of the eyes, nose and respiratory tract. The odour is perceivable from 2 ml/m^3. Inhalation of hydrogen bromide vapour or mists can lead to dry coughing, throat complaints, slight dizziness, shortness of breath, impairment of lung function, tight-chestedness, oedema of the glottis, bronchospasm, bronchopneumonia and acute lung oedema. After long-term exposure irritation of the respiratory passages, digestive problems, slight changes in reflexes and in the sense of smell, a decrease in the erythrocyte count, decalcification of the teeth and changes in the gums have been

described. Concentration difficulties, disorientation, vomiting, convulsions and coma are observed after exposure to high bromide concentrations.

There are no data available on the mechanisms of action of hydrogen bromide.

2 Toxicokinetics and Metabolism

There are only studies available with bromide.

Maximum bromide concentrations were detected in the urine (100 mg/l) of two volunteers about 2 hours after ingestion of 3 g sodium bromide, and after 4.5 hours in blood (19.6 mg/l). The bromide values had returned to the initial levels after about 5 hours (urine) and 6 hours (blood) (Flinn 1941).

Daily oral administration of 1.8 g sodium bromide to 55 volunteers and 2.7 g to 15 volunteers yielded average blood bromide levels in the 1.8 g group of 224.4 mg/l after 2 months and 155.5 mg/l after 4 months; only traces of bromide were still detectable 4 weeks after the end of the experiment. In the 2.7 g group the average bromide value in blood was 390.9 mg/l after 2 months, 500.9 mg/l after 4 months and 18.8 mg/l 4 weeks after the end of the experiment. The bromide level varied greatly from person to person. The range is not given in the study (Flinn 1941).

After injection of a 0.9 % sodium bromide solution into a ligated segment of the intestine, cats absorbed 28.6 % (n = 2) of the administered dose within an hour and 50.9 % (n = 1) within 2 hours (Flinn 1941).

3 Effects in Man

3.1 Single exposures

In chamber experiments, 6 volunteers inhaled hydrogen bromide for several minutes in concentrations from 2 to 6 ml/m^3. The odour of hydrogen bromide was already perceivable at 2 ml/m^3. From 3 ml/m^3 the exposure led to irritation of the nose and throat (Stokinger 1981).

Exposure to hydrogen bromide concentrations of 5 ml/m^3 led after a short time (no further details) to irritation of the respiratory passages (Kühn and Birett 1977), and longer exposure (no further details) to more than 35 ml/m^3 caused throat spasms and lung oedema (Braker and Mossman 1980).

Inhalation of hydrogen bromide vapour or mists (no further details) can lead to oedema of the glottis, bronchospasm, bronchopneumonia and acute lung oedema (Kühn and Birett 1977).

Concentrations of 1300 to 2000 ml/m^3 are lethal for man within a few minutes (NRC 1981). The IDLH value (immediately dangerous for life and health) for hydrogen bromide was set at 50 ml/m^3 (Perry *et al*. 1994).

A 60-year-old woman who mixed hydrogen bromide with phosphorous tribromide and was spattered with the reaction mixture on the chest, face and hair, inhaled the vapour released for 5 to 10 minutes. Four hours later she complained of a dry cough, a sore throat and slight dizziness. After 2 weeks, shortness of breath, severe coughing, impairment of lung function, tight-chestedness and pneumonitis developed. Crackling sounds could be heard on both sides above the basal lobes of the lung. After 4 months the woman still suffered from shortness of breath and slight pneumonitis (Kraut and Lilis 1988).

The effect of the bromide is only of minor importance. Only after uptake of higher doses (over 20 g; no further details) is chloride increasingly exchanged for bromide, which mainly affects central nervous processes. Co-ordination disturbances, confusion, excitation, stupor, psychotic symptoms, paralysis and collapse are seen (Ludewig 1974).

3.2 Repeated exposure

After long-term exposure to hydrogen bromide (no further details) irritation of the respiratory passages, digestive problems, slight changes in reflexes (no further details) and in the sense of smell, and a decrease in the erythrocyte count were reported (Alexandrov 1983).

After long-term exposure to vapour (no further details) also decalcification of the teeth and changes in the gums were described (Kühn and Birett 1977).

Concentration difficulties, disorientation, vomiting, convulsions, depression, psychosis, ataxia and coma are attributed to the effect of exposure to bromide (no further details) (Kühn and Birett 1977, Perry *et al*. 1994).

Daily oral administration of 1.8 g sodium bromide to 55 volunteers and 2.7 g to 15 volunteers for 4 months had no effect on reactions, pulse frequency, blood pressure, oxygen and carbon dioxide capacity, haemoglobin level, and erythrocyte and leukocyte count. Acne developed in one young woman and furunculosis in another person. The authors note that these skin diseases were possibly not caused by the bromide alone, but were also the result of the warm weather at the time (Flinn 1941).

3.3 Local effects on skin and mucous membranes

Skin contact with hydrogen bromide vapour or acid caused severe skin irritation and necrosis (Braker and Mossman 1980). High concentrations (no further details) can cause dermatitis (NRC 1981). Hydrogen bromide vapour led to severe irritation (no further details) of the mucous membranes of the eyes, nose and upper respiratory tract (Braker and Mossman 1980, NRC 1981; see also Section 3.1).

There are no studies available on the reproductive toxicity, genotoxicity or carcinogenicity of hydrogen bromide in man.

4 Animal Experiments and *in vitro* Studies

4.1 Acute toxicity

The LC_{50} for rats was found to be 2858 ml/m^3 and for mice 814 ml/m^3 after inhalation of hydrogen bromide for 1 hour (Office of Hazardous Materials 1972). After intraperitoneal administration, the LC_{50} for rats was 76 mg/kg body weight (NIOSH 1986).

Rats were exposed for 30 minutes to hydrogen bromide concentrations of 1300 ml/m^3 exclusively via the nose or trachea. Significant weight losses were observed in the animals 24 hours after exposure. Severe necrosis occurred which after exposure via the nose extended to the bones in the foremost nasal regions and in tracheotomized animals to the cartilage of the trachea. At the same time accumulation of inflammatory cells, exudates and the extravasation of erythrocytes were observed. The lung weights were unchanged. Mortality was 8 % in rats which inhaled hydrogen bromide via the nose. With exposure via the trachea mortality was 19 % (Stavert *et al*. 1991).

4.2 Subacute, subchronic and chronic toxicity

After oral administration of a 1.7 % aqueous hydrogen bromide solution (10 ml/kg body weight, 2 days/week) for 17 weeks to 4 white rats, no damage to the gastrointestinal mucous membranes or changes in behaviour, appetite or weight were observed. Diffuse hydropic changes in the liver tissue and in some cases considerable fatty degeneration of the liver cells were observed (Manz and Lorke 1953).

There are no other studies available.

5 Manifesto (MAK value/classification)

No data from long-term studies have been published. An inhalation experiment with volunteers showed that an exposure concentration of 2 ml/m^3 should not be exceeded. It must be said, however, that this is an unpublished study. The results of this study are, however, the only evidence of the concentration at which hydrogen bromide first causes irritation in man. To prevent irritation occurring at the workplace, the MAK value for hydrogen bromide was lowered in 1996 from 5 to 2 ml/m^3. Until valid studies are avail-

able, this value must be regarded as provisional. Peak limitation category I has been retained. Because of the inadequate database for reproductive toxicity, hydrogen bromide is listed in Section IIc of the *List of MAK and BAT Values*. The substance is not designated with an "H" (for substances that can be absorbed through the skin) or "S" (for substances with sensitizing potential).

6 References

Alexandrov DD (1983) Bromine and compounds. in: Parmeggiani L (Ed.) *Enzyclopedia of Occupational Health and Safety*, International Labour Office, Genf, 326–329

Braker W, Mossman AL (1980) Hydrogen bromide. in: Braker M (Ed.) *Matheson Gas Data Book*, Matheson, East Rutherford, 372–373

Flinn FB (1941) The appearance of blood bromide after oral ingestion. *J Lab Clin Med 26*: 1325–1329

Kraut A, Lilis R (1988) Chemical pneumonitis due to exposure to bromine compounds. *Chest 94*: 208–210

Kühn R, Birett K (1977) Bromwasserstoff. in: Ecomed Verlagsgesellschaft (Ed.) *Merkblätter Gefährliche Arbeitsstoffe*, Verlag Moderne Industrie, München, Sheet No. B 35

Ludewig R (1974) Brom. in: Ludewig R (Ed.) *Akute Vergiftungen*, Fischer Verlag, Stuttgart, 126–128

Manz R, Lorke D (1953) Über die Wirkung protrahierter stomachaler Säurezufuhr auf Parenchym und Stützgewebe der Leber. *Dtsch Z Gerichtl Med 42*: 139–151

NIOSH (National Institute for Occupational Safety and Health) (1986) *Registry of toxic effects of chemical substances*. DHHS Publ No 87-114

NRC (National Research Council) (1981) *Prudent practices for handling hazardous chemicals in laboratories*, National Academy Press, Washington DC, 98

Office of Hazardous Materials (1972) *Reclassification of materials listed as transportation health hazards*, Report No TSA-20-72-2, NTIS/PB-214270

Perry WG, Smith FA, Kent MB (1994) Bromine. in: Clayton GD, Clayton FE (Eds) *Patty's Industrial Hygiene and Toxicology*, Vol IIB, Wiley-Interscience, New York, 4505–4513

Stavert DM, Archuleta DC, Behr MJ, Lehnert BE (1991) Relative acute toxicities of hydrogen fluoride, hydrogen chloride, and hydrogen bromide in nose- and pseudo-mouth-breathing rats. *Fundam Appl Toxicol 16*: 636–655

Stokinger HE (1981) Bromine. in: Clayton GD, Clayton FE (Eds) *Patty's Industrial Hygiene and Toxicology*, Vol IIB, Wiley-Interscience, New York, 2970

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