14	CAS No.: 7440-42-8 (Boron)	Substance: Boron and its compounds

Chemical Substances Control Law Reference No.:

PRTR Law Cabinet Order No.: 1-405 (As boron compounds)

Chemical symbol: B

Atomic weight: 10.81

1. General information

Boron is insoluble in water. The aqueous solubilities of boric acid and sodium tetraborate are 5.80×10^4 mg/1,000 g (25°C) and 3.13×10^4–3.17×10^4 mg/1,000 g (25°C), respectively. The vapor pressure of boron is 0.0119 mmHg (1.58 Pa) (2,140°C), and the vapor pressure of the boric acid is 7.4×10^{-7} mmHg (9.9×10^5 Pa) (25°C). The biodegradability (aerobic degradation) of boric acid is judged to be difficult, and bioaccumulation is thought to be nonexistent.

Boron compounds are designated as a Class 1 Designated Chemical Substance under the Law Concerning Reporting, etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management (PRTR Law).

The main uses of boron are as a raw material for residential thermal insulation materials and glass fiber reinforcement for plastic composites. It is also used in the manufacture of specialty glasses for liquid crystal displays and as an enamel for pottery. To a lesser extent, boron is also used in chemical reaction catalysts, cardboard box adhesives, eye drops, pesticides, insect repellents, and control rods for nuclear power stations. Boric acid is used in boric acid residual for exterminating cockroaches. Other applications include glass, pharmaceuticals (antiseptic and disinfectants, compresses), enamels, nickel plating additives, condensers, fire retardants, sterilizers, dyestuff manufacturing, pesticides, pigments, fluxes, catalysts, boric acid salt manufacture, artificial jewels, cosmetics, photographic chemicals, leather finishing, pottery glazing, high grade cement, candle wicks, as a raw material for fire-proofing, paints, hair oil (in stick form), soap, and fiber manufacture. The main uses of sodium tetraborate are found in enameled ironware, glass, pottery, metal brazing, leather tanning, printing, disinfectants, pharmaceuticals, cosmetics, heat treatment agents, photography, pigments (Guinea green), increasing rapeseed production, drying agents (lead borate, manganese borate), perboric acid salt manufacture, soft water hardening agents, antifreeze raw materials, and chemical raw materials for condensers.

The production and import quantities of boron compounds in fiscal 2013 reported under the PRTR Law were 100,000 t of boric acid, 30,000 t of sodium borate, and 3,000 t of boron trioxide. The production and import category under the PRTR Law is more than 100 t.

Boron compounds normally exist in water as boric acid or ionic salts of boric acid. Undissociated boric acid is the main component of inorganic boron in environmental water that is close to neutral. Furthermore, bottom sediment and soil adsorb boron compounds with the adsorption force being determined by pH. The adsorption force is strongest when the pH is between 7.5 and 9.0.

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2. Exposure assessment

Total release to the environment in fiscal 2013 under the PRTR Law was approximately 4,100 t, of which approximately 2,600 t or 62% of overall releases were reported. The major destination of reported releases was public water bodies. Approximately 54 t was transferred to sewage and approximately 2,900 t was transferred to waste materials. Industry types with large reported releases were ceramics and soil and stone product manufacturing for the atmosphere, and sewage treatment, the chemical industry, oil & gas and mining, and non-ferrous metals manufacturing for public water bodies. The largest release among releases to the environment including those unreported was to water bodies. Predicting the proportions distributed to individual media is inappropriate because boron compounds transform into various chemical forms in the environment. Accordingly, the proportions distributed to individual media for boron and its compounds were not predicted.

The maximum expected concentration of exposure to humans via inhalation, based on general environmental atmospheric data, was around 0.14 μg B/m^3. The mean annual value for the atmospheric concentration in fiscal 2013 was calculated by using a plume-puff model on the basis of releases to the atmosphere reported according to the PRTR Law; this model predicted a maximum level of 8.2 μg B/m^3.

Setting the predicted environmental concentration (PEC) based on data from locations downstream of businesses with large releases gave 310 μg B/L for public freshwater bodies. No assessment is planned for seawater in the foreseeable future.

When releases to public freshwater bodies in fiscal 2013 reported according to the PRTR Law were divided by the ordinary water discharge of the national river channel structure database, estimating the concentration in rivers by taking into consideration only dilution gave a maximum value of 910 μg B/L.

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3. Initial assessment of health risk

Boron oxide is irritating to the eyes, skin and respiratory tract. Inhalation exposure to this substance causes coughs and sore throat. Oral exposure causes abdominal pain, diarrhea, nausea and vomiting. Contact with skin causes redness, and contact with the eyes causes redness and pain.

Boric acid is irritating to the eyes, skin and respiratory tract and may cause effects on the gastrointestinal tract, liver and kidneys. Inhalation exposure to this substance causes coughs and sore throat. Oral exposure causes abdominal pain, convulsions, diarrhea, nausea, vomiting and skin rash. Contact with skin causes redness, and contact with the eyes causes redness and pain.

Boron trifluoride is corrosive and lachrymatory. Inhalation exposure to this substance may cause lung edema, and causes burning sensation, coughs and labored breathing. Rapid evaporation of the substance on skin may cause frostbite. Contact with skin causes redness, burning sensation and pain, and contact with the eyes causes redness, pain and blurred vision.

As sufficient information on the carcinogenicity of boron and its compounds was not available, the initial assessment was conducted on the basis of information on their non-carcinogenic effects.

Oral exposure to boron and its compounds is outside the scope of the assessment.

With regard to inhalation exposure, owing to lack of identified 'non-toxic level*' of boron and its compounds, the health risk could not be assessed. For comparison, assuming that all of the ingested substances are absorbed, the NOAEL for inhalation exposure, derived by converting that for oral exposure in rats of 9.6 mg B/kg/day, would be 32 mg B/m^3. The MOE would be 23,000, when calculated from the converted NOAEL for inhalation exposure and the predicted maximum exposure concentration of 0.14 μg B/m^3 in ambient air, and subsequently divided by a factor of 10 to account for extrapolation from animals to humans.

In addition, the maximum concentration (annual mean) in ambient air near the operators releasing large amount of the substance to ambient air was estimated to be 8.2 μg B/m^3 on the basis of the data reported in FY 2013 under the PRTR Law. The MOE would be 390, when using this value and the NOAEL. Therefore, collection of information on inhalation exposure would not be required to assess the health risk of boron and its compounds via inhalation in ambient air.

Toxicity						Exposure assessment			Result of risk assessment			Judgment
Exposure Path	Criteria for risk assessment			Animal	Criteria for diagnoses (endpoint)	Exposure medium	Predicted maximum exposure dose and concentration					
Oral	'Non-toxic level*'	(−)	mgB/kg/day	(−)	(−)	Drinking water	(−)	μgB/kg/day	MOE	(−)	(−)	(−)
						Underground water	(−)	μgB/kg/day	MOE	(−)	(−)	
Inhalation	'Non-toxic level*'	—	mgB/m^3	—	—	Ambient air	0.14	μgB/m^3	MOE	—	×	(○)
						Indoor air	—	μgB/m^3	MOE	—	×	×

Non-toxic level *

・When a LOAEL is available, it is divided by 10 to obtain a NOAEL-equivalent level.

・When an adverse effect level for the short-term exposure is available, it is divided by 10 to obtain a level equivalent to an adverse effect level for the long-term exposure.

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4. Initial assessment of ecological risk

With regard to acute toxicity of the trivalent boron normally present in water, the following reliable data were obtained: a 72-h EC_{50} of 50,000 µg B/L for growth inhibition in the green algae *Pseudokirchneriella subcapitata*, a 48-h LC_{50} of 45,500 µg B/L for the crustacean *Ceriodaphnia dubia*, a 96-h LC_{50} of 125,000 µg B/L for the fish species *Catostomus latipinnis* (flannelmouth sucker), and a 10-d EC_{50} of 11,700 µg B/L for growth inhibition in the greater duckweed *Spirodella polyrrhiza*. Accordingly, based on these acute toxicity values and an assessment factor of 100, a predicted no effect concentration (PNEC) of 455 µg B/L was obtained.

With regard to the chronic toxicity of trivalent boron, the following reliable data were obtained: a 72-h NOEC of 14,400 µg B/L for growth inhibition in the green algae *P. subcapitata*, a 21-d NOEC of 6,000 µg B/L for reproductive inhibition in the crustacean *Daphnia magna*, an 87-d NOEC exceeding 2,100 µg B/L for growth inhibition or mortality in the fish species *Oncorhynchus mykiss* (rainbow trout), and a 10-d NOEC of 6,100 µg B/L for growth inhibition in the greater duckweed *S. polyrrhiza*. Accordingly, based on these chronic toxicity values and an assessment factor of 10, a PNEC of 600 µg B/L was obtained.

The value of 455 µg B/L obtained from the acute toxicity to the crustacean was used as the trivalent boron PNEC for this substance.

The PEC/PNEC ratio for trivalent boron normally present in water is 0.7 for freshwater bodies. Accordingly, efforts to collect data on boron and its compounds are needed. Furthermore, there is a need to consider the augmentation of toxicity data for marine organisms.

Hazard Assessment（Basis for PNEC）			Assessment Coefficient	Predicted no effect concentration PNEC (µg/L)	Exposure Assessment		PEC/PNEC ratio	Judgment based on PEC/PNEC ratio	Assessment result
Species	Acute/ chronic	Endpoint			Water body	Predicted environmental concentration PEC (µg/L)			
Crustacean *Ceriodaphnia dubia*	Acute	LC_{50} mortality	100	455	Freshwater	310	0.7	▲	▲
					Seawater	―	―		

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5. Conclusions

		Conclusions	Judgment
Health risk	Oral exposure	It was not the object of evaluation.	(−)
	Inhalation exposure	Although risk to human health could not be confirmed, collection of further information would not be required.	(○)
Ecological risk	Requiring information collection.		▲

［Risk judgments］ ○: No need for further work ▲: Requiring information collection

■: Candidates for further work ×: Impossibility of risk characterization

（○）: Although risk to human health could not be confirmed, collection of further information would not be required.

（▲）: Further information collection would be required for risk characterization.