Summary of Initial Risk Assessment Report

Boron and its compounds

This substance is assessed based on the Guideline for Initial Risk Assessment Version 2.0.

>> Introduction <<

Boron and its compounds are the subject of this assessment report. Inorganic compounds exist as diverse chemical species which can change in the environment. These chemical species have different hazardous properties. However, very few measured environmental concentrations are available for each species. Taking that into consideration, risk assessments of inorganic compounds are conducted using slightly different procedures from those of organic compounds. Refer to the Guideline for more detail. In this report, units of concentrations and intake (e.g., mg/L, mg/kg-Bodyweight/day) refer to the concentration or amount of pure boron.

1. General Information

1.1 Physico-chemical properties

PRTR No. of Japan	304			
Name (typical substance)	Boron (single boron)	Boric acid	Borax (Sodium tetraborate)	Boron trifluoride
Chemical formula	B	H_3BO_3	$Na_2B_4O_7$(anhydride) $Na_2B_4O_7$-$10H_2O$ (decahydride)	BF_3
CAS No.	7440-42-8	10043-35-3	1330-43-4 (anhydride) 1303-96-4 (decahydride)	7637-07-2
Appearance	α rhombic system: red solid α tetragonal system, β rhobbic system: black solid amorphous: black or brown solid	White solid	White solid (anhydride, decahydride)	Colorless gas
Melting point	2075degC	Changed to metaborate at100degC	743degC (anhydride), 75degC (decahydride)	-126.8 degC
Boiling point	3500degC	No data	1,575 degC (decomposition, anhydride), Decahydride is changed to anhydride at 100degC or above	-101 degC
Water solubility	Insoluble	58.0 g/kg (25degC)	31.7 g/kg (25degC) (anhydride), 47g/kg(20degC) (decahydride, dissociation)	1,060 g/L(20degC) (partially hydrolyzed)

1.2 Environmental fate

Bioaccumulation	Low bioaccumulative Bioconcentration factor (BCF): (Boric acid) 3.2 (5mg/L), less than 33 (0.5 mg/L) (carp, measured)
Biodegradation	--
Stability and fate in the environment	(In soil) Boron is reported to be adsorbed onto the surfaces of soil particles. The degree of adsorption depends on the type of soil, pH, salinity, organic matter content, iron and aluminum oxide content, iron- and aluminum-hydroxy content, and clay content. (In air) Atmospheric emissions of boron occur as a result of volatilization of boric acid from the sea, volcanic activity, mining operations, glass and ceramics manufacturing, the application of agricultural chemicals, and coal-fired power plants. As volatilities of borates are low, boron would not be expected to be present to a significant degree as a vapor in the atmosphere. As a particulate, boron would be removed from the atmosphere either by dry deposition or by wet deposition because of its relatively high water solubility. (IPCS Environmental Health Criteria 204) (In water) Weathering of rock is the most important source of boron in the aquatic environment. Boron is widely distributed in nature with global average concentrations of 0.015 mg B/ L in fresh water and about 4.5 mg/liter in the ocean. In water, borax is dissociated into boric acid, boron oxide is hydrolyzed to boric acid, sodium perborate is hydrolyzed to sodium metaborate, and borontrifluoride forms oxyfluoroborate and hydronium oxyfluoroborate.

2. Sources of Release to the Environment

2.1 Annual Import in 2003(ton/year)

	Boron oxides	Boron acid	Boron
Import*	656	40,906	10

*Import only

2.2 Uses

Glass fiber (79.2%); borosilica glass (18.1%); additives for special steel, medical products, insecticides

2.3 Release from the industries within the scope of the PRTR system (in 2003)

Release sources		Air(ton)	Water(ton)	Soil(ton)	Remarks
Listed industries	Reported release	147	2,887	<5	Release into rivers: 2,476 tons
	Release outside notification	9	1,134	--	
Release outside notification from non-listed industry		-	1	4	
Households		<0.5	--	--	
Mobile sources		--	--	--	
Total		156	4022	4	

2.4 Releases from other sources

(Natural sources) Weathering of rock, volcanic eruptions, vaporization of boric acid from sea water and forest fires

(Anthropogenic sources) Municipal wastewater discharges, sewage sludge, combustion of fossil fuels

2.5 Main release routes

Boron compounds may be released anthropogenically to air, mainly during production of glass products in ceramic industry, and to the aquatic environment through sewage server systems and power plants.

Boron also occurs naturally.

3. Exposure Assessment

3.1 Measured environmental concentration

Media	No. of points detected / No. of points measured	No. of samples detected / No. of samples measured	Detection range*	95th percentile	Detection limit	Year of investigation, Institution
Air	--	--	--	--	--	--
River water (microg/L)	1,030/ 2,053	--	nd-5,200	1,200	10-100	2002, National Institute for Environmental Studies
Drinking water (microg/L)	25/351	--	nd-610	--	--	2003, Japan Water Research Center
Food	The dietary intake of boron was surveyed by the market basket method.* The maximum of intake of boron was 2.57 mg/person/day. *Market basket method survey: The Ministry of Health, Labour and Welfare surveyed the dietary intake of the Japanese population as part of the National Nutrition Survey, and conducted a study to determine the dietary intake of boron by sampling the foods purchased from markets.					1994-1997, Ministry of Health, Labour and Welfare

nd*: Not detected.

For calculation of the 95th percentile, data less than the detection limit are replaced with a value equal to 1/2 of the detection limit.

3.2 Estimated environmental concentration

Estimation by mathematical model was not conducted because it is difficult to make assumptions about the effects on environmental concentration considering natural emission and dynamism in the environment.

3.3 Estimated environmental concentration in water (EEC)

EEC(microg/L)	1,200

	The ninety-fifth percentile of measured concentrations in river water is used for the risk assessment because an estimation by model was not conducted.

3.4 Estimated human intake

Intake route		Concentration used for estimation of intake	Estimated intake (microg/ person/ day)	Estimated intake (microg/ kg-Bodyweight (BW)/ day)
Inhalation	Air	--	--	--
		Intake via inhalation route could not be calculated since neither measured concentrations nor estimated values were available.		
Oral	Drinking water	610(microg/L)	1,200	24
		The maximum of the measured concentrations in tap water was used for the risk assessment.		
	Food	--	2,570	51
		The dietary intake of boron was surveyed by the market basket method. The ninety-fifth percentile of the measurements was 2,570 microg /person/ day.		
	Subtotal	--	3,770	75
Total route		--	--	--

4. Hazard Assessment

4.1 Effects on organisms in the environment

	Acute or Chronic	Species	Endpoint	Concentration
Algae (Na_2B4O_7-$10H_2O$)	Acute	*Selenastrum Capricornutum*	96 hours EC_{50} Growth inhibition	15.4 (mg/L)
Crustacea (H_3BO_3)	Chronic	*Daphnia magna*	21 days NOEC Reproduction, Growth	6 (mg/L)
Fish (H_3BO_3)	Chronic	*Oncorhynchus mykiss*	87 days NOEC Embryo mortality	2.1 (mg/L)
Key study		The data of fish was used for the key study because effects on fish were observed at the lowest concentration in the hazard assessment.		

4.2 Human health toxicity

Toxicity	Exposure route	Species	Duration / Dose method	Toxic effects	NOAEL (converted)
Repeated dose toxicity	Inhalation	--	--	--	--
	Oral	SD rat	2 years Boric acid and borax	General toxic appearance (coarse fur, stooping position, swelling of paws, inflammation of eyelids), reduced body weight gains, atrophy of seminiferous epithelium, decreased Hct and Hgb levels	NOAEL: 350 ppm (equivalent to 17.5 mg /kg-bodyweight/ day)
Reproductive and developmental toxicity	Oral	SD rat	Pregnancy 0-20 days	Decreased fetal body weight, increased incidence of wavy ribs and short rib XIII in fetuses	NOAEL: 750 ppm (equivalent to 9.6 mg /kg-bodyweight /day)
Carcinogenicity	Evaluation by IARC : This substance has not been evaluated by IARC.				
Genotoxicity	Not considered to be genotoxic				

5. Risk Assessment

5.1 Environmental organisms

	EEC (microg/L)	NOEC (mg/L)	MOE	Product of uncertainty factors	Conclusion
Risk characterization	1,200	NOEC: 2.1	1.8	50	Substance of concern
	Product of uncertainty factors (UF): Extrapolation from laboratory test (10) * Extrapolation from chronic toxicity data on two species representing two trophic levels (5)= 50				
Recommendation : The substance is considered to be of concern, and further investigation, analysis and assessment are necessary.					

5.2 Human health

5.2.1 Repeated dose toxicity

Exposure route	Intake (microg/kgBW/day)	NOAEL (mg/kgBW/day)	Risk characterization		
			MOE	Product of uncertainty factors	Conclusion
Inhalation	--	No data	--	--	Could not be assessed
Oral	75	17.5	230	100	No immediate concern
Product of uncertainty factors: Interspecies (10) * Intraspecies(10) = 100					

5.2.2 Reproductive and developmental toxicity

Exposure route	Intake (microg/kgBW/day)	NOAEL (mg/kgBW/day)	Risk characterization		
			MOE	Product of uncertainty factors	Conclusion
Oral	75	9.6	130	100	No immediate concern
Product of uncertainty factors: Interspecies (10) * Intraspecies(10) = 100					

5.2.3 Carcinogenicity

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5.2.4. Recommendation for Human Health

In terms of oral exposure, the substance is considered to be of no immediate concern and a low priority for further work. As for inhalation exposure, a risk assessment could not be conducted because toxicity data was not available and intake could not be calculated.

6. Supplement

The environmental risk assessment was conducted using the lowest NOEC for H_3BO_3. As a result, the assessment may be conservative.