Summary of Initial Risk Assessment Report

Manganese and its compounds

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

>> Introduction <<

Manganese 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 Manganese.

1. General Information

1.1 Physico-chemical properties

PRTR No. of Japan	311			
Name (typical substance)	Manganese	Manganese dioxide	Manganese (II) chloride	Manganese (II) sulfate
Chemical formula	Mn	MnO_2	$MnCl_2$	$MnSO_4$
CAS No.	7439-96-5	1313-13-9	7773-01-5	7785-87-7
Appearance	Gray solid	Black solid	Pink solid	White solid
Melting point	1,246 degC	535 degC	650 degC	700 degC
Boiling point	2,061 degC	--	1,190 degC	850 degC(degradation)
Water solubility	Powdered manganese reacts with water	Insoluble	773 g /kg (25degC)	637 g /kg (25degC)

1.2 Environmental fate

Bioaccumulation	Potassium permanganate: Low bioaccumulative Bioconcentration factor (BCF): 81 or less (measured)
Biodegradation	--
Stability and fate in the environment	(In water and soil) Manganese has multiple oxidation stages. Common oxidation stages in the environment are Mn (II), Mn(III) and Mn(IV). The most stable oxidation stage in water is Mn (II). Mn (III) and Mn (IV) are insoluble. Mn (III) and Mn (IV) are reduced to Mn (II) by organic substances. Soluble Mn (II) can transfer in aquatic environments and soil. Mn (II) is not expected to associate strongly with organic substances or soil components. (In air) When manganese compounds are released into air, they occur as suspended matter in air, and then they are removed by adsorption onto particle matter, sedimentation or rain. Although manganese are not biodegraded, it can be ingested by some microorganisms.

2. Sources of Release to the Environment

2.1 Annual import and export in 2002(ton/year)

	Manganese and its products (including scraps)	Manganese dioxide	Oxides of manganese (excuding manganese dioxide)	Potassium permanganate
Import	45,779	2,289	309	1,395
Export	29	23,855	2,391	6

2.2 Uses

Ninety percent or more of the manganese imported into Japan is used for steelmaking. Manganese compounds are applied to various uses. They are used in agricultural chemicals, aluminum alloys, dry batteries and soft ferrites.

2.3 Release from industries within the scope of the PRTR system (in 2002)

Release sources		Air(ton)	Water(ton)	Soil(ton)	Remarks
Listed industries	Reported release	30	1,085	<0.5	Release into rivers: 798 tons
	Release outside notification	270	91	2	
Release outside notification from non-listed industry		--	--	--	
Households		--	--	--	
Mobile sources		--	--	--	
Total		300	1,176	3	

2.4 Releases from other sources

(Natural sources)

Soil entrained into air by wind, volcanic eruption, spray of sea water, weathering of rocks and forest fires

(Anthropogenic sources)

Municipal wastewater discharges, sewage sludge, mining and mineral processing, combustion of fossil fuels, emissions from alloy and iron production

2.5 Main release routes

Release sources include both anthropogenic sources and natural sources. The main anthropogenic sources are from the machine industries and metal industries. The chemical industry also frequently releases manganese to the aquatic environments. Manganese is released to soil during the agricultural use of maneb. Crustal rock is a major source of manganese found in the atmosphere. Ocean spray, forest fires, vegetation, and volcanic activity are other major natural sources of manganese in the atmosphere.

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[1)]	95th percentile[2)]	Detection limit	Year of investigation, Institution
Air (microg/m^3)	312/312	-/3,493	nd-2.0	0.20	Not specified	2003, Ministry of the environment
River water (microg/L)	35/35	35/35	3.4-170	146	0.05	2001, Ministry of the environment
Drinking water (microg/L)	5,626	--	200 or less[3)]	--	--	2002, Japan Water Works Association
Food	The Ministry of Health, Labor and Welfare surveyed the average manganese intake of the Japanese population by age and sex. In the survey, the maximum intake of the groups was 4,120microg/ person/ day.					1996, Ministry of Health, Labor and Welfare

1) nd: Not detected

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

3) Japan Water Works Association has surveyed the manganese concentration in water. The survey covered 5,626 water treatment plants in 2002. The maximum concentration was 200microg/L or less.

3.2 Estimated environmental concentration

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

3.3 Estimated environmental concentration in water (EEC)

EEC(microg/L)	146
	The ninety-fifth percentile of measured concentrations in river water was used for the risk assessment.

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	0.20(microg/m^3)	4.0	0.080
		The ninety-fifth percentile of measured concentrations in air was used for the risk assessment.		
Oral	Drinking water	200(microg/L)	400	8.0
		The maximum of annual average concentrations in drinking water measured at public water systems throughout the country was used for the risk assessment.		
	Food	--	4,120	82
		The maximum intake of manganese, surveyed by Ministry of Health, Labor and Welfare, (4,120 microg/ person/day) was used for the risk assessment.		
	Subtotal	--	4,520	90
Total route		--	4,520	90

4. Hazard Assessment

4.1 Effects on organisms in the environment

	Acute or Chronic	Species	Endpoint	Concentration
Algae ($MnCl_2$)	Acute	*Ditylum brightwellii*	5 days EC_{50} Growth inhibition	1.5(mg/L)
Crustacea ($MnCl_2$)	Chronic	*Daphnia magna*	21 days NOEC Reproductive inhibition	5.2(mg/L)
Fish ($MnSO_4$)	Chronic	*Oncorhynchus mykis*	100days NOEC Mortality	0.77(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	monkey	10 months (MnO_2)	Lymphoid hyperplasia of pulmonary interstitium, interstitial pulmonary dark brown deposit, appearance of dust-containing pulmonary cell necrosis, bronchial exudates, hyperplasic alveolar wall, pulmonary emphysema, pulmonary atelectasis	0.7 mg /m^3 (equivalent to 0.18 mg/kgBW/day)
	Oral	The Tolerable Upper Intake Level specified in the Dietary Reference Intakes recommended by Ministry of Health, Labor and Welfare in Japan as 10 mg/day (equivalent to 0.2 mg/kgBW/day) is used as the NOAEL.			
Reproductive and developmental toxicity	--				
Carcinogenicity	Evaluation by IARC : This substance has not been evaluated by IARC				
Genotoxicity	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	146	NOEC: 0.77	5.3	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	0.080	0.18	2200	2,000	No immediate concern
Oral	90	0.20	2.2	1	No immediate concern

Product of uncertainty factors (UF):

Inhalation - Interspecies (10) * Intraspecies (10) * Test duration (2) * Using of LOAEL (10)=2,000

Oral - UF is (1), the Tolerable Upper Intake Level specified in the Dietary Reference Intakes was used.

5.2.2 Reproductive and developmental toxicity

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5.2.3 Carcinogenicity

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5.2.4. Recommendation for Human Health

The substance is considered to be of no immediate concern for the moment and a low priority for further work.

6. Supplement

1) The risk assessment for organisms in the environment was conducted using the lowest NOEC for $MnSO_4$. As a result, the assessment may be conservative.

2) Manganese is an essential element for human health. The Ministry of Health, Labor and Welfare recommends daily intake for males is 4 mg/day and for females is 3.0-3.5 mg/day.