10	CAS No.: 7440-28-0 (Thallium)	Substance: Thallium and its compounds

Chemical Substances Control Law Reference No.:

PRTR Law Cabinet Order No.:

Chemical symbol: Tl

Atomic weight: 204.38

1. General information

Thallium compounds include thallium oxide and thallium nitrate. Monovalent thallium oxide is soluble in water, whereas trivalent thallium oxide is insoluble. The aqueous solubility of monovalent thallium nitrate is 9.55×10^4 mg/1,000g (20°C), while trivalent thallium nitrate hydrolyzes. The majority of dissolved thallium is believed to exist in the monovalent form, while some trivalent thallium may exist in strongly oxidized fresh water and in most seawater. In addition, the presence of Tl^+ as a dissolved species in seawater has been reported. The degree of bioconcentration of thallium ranges between 78 (minimum value) and 158 (maximum value) based on the findings of bioaccumulation tests using thallium (I) chloride.

The main uses of metallic thallium is as a component of alloys with silver, lead and mercury. Thallium nitrate and thallium fluoride are used in high refractive index glass.

Thallium is generally obtained via recovery as a byproduct from tailings, residue, extracts and fly ash from copper, lead and zinc sulfide ores.

The production and import quantities in fiscal 2014 for thallium oxide and thallium malonate were not disclosed because the number of reporting businesses was less than two.

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2. Exposure assessment

Because this substance is not classified as a Class 1 Designated Chemical Substance under the PRTR Law, release and transfer quantities could not be obtained. Nriagu identified coal combustion (power generation, industrial, residential) and cement manufacture as sources of thallium, and estimated global releases to the atmosphere (1983). Kida et al. estimated annual releases of thallium to be 41–164 t based on the total electricity supply from all of Japan's coal-fired power stations (fiscal 2000) and Nriagu's release coefficient for coal combustion. Further, Kida et al. estimated annual releases of thallium from general waste incinerators to be less than 0.3 t assuming three-quarters of Japan's annual waste volume of 50 million t/y was incinerated. Further, they estimated releases of less than 6 t when taking into account uncontrolled burning such as open burning. Further, the quantity of thallium present in printed circuit boards used in nine major types of small home appliances disposed of in Japan is estimated to be 26 kg/y. In addition, the quantity of thallium present in desktop computers manufactured in 1998 and subsequently discarded was reported to be less than 0.1 mg/kg, while that present in desktop computer circuit boards was less than 1 mg/kg and that present in laptop computer circuit boards was also less than 1 mg/kg.

Predicting the proportions distributed to individual media is inappropriate because thallium and its compounds transform into various chemical forms in the environment. Accordingly, the proportions distributed to individual media for tellurium and its compounds were not predicted.

The maximum expected concentration of exposure to humans via inhalation, based on general environmental atmospheric data, was generally 0.00015 μg Tl/m^3. Suitable data for estimating the maximum expected oral exposure could not be obtained. Further, the oral exposure obtained from data for a single freshwater public water body location (0.0030 μg Tl/L) was 0.00012 μg Tl/kg/day while the oral exposure obtained from literature data for public freshwater bodies was (0.11 μg Tl/L) was 0.0044 μg Tl/kg/day. In addition, if the daily intake of

0.53 μg Tl/day (average value) obtained from a past diet (portion) method study for a limited area is divided by a body mass of 50 kg, the oral exposure obtained is 0.011 μg Tl/kg/day (average value). Furthermore, the reference value based on a survey of a limited area of public freshwater bodies (location of maximum concentration was the estuary of a river in an industrial zone) and the maximum value from soil data is 0.070 μg Tl/kg/day.

Data for setting the predicted environmental concentration (PEC), which indicates exposure to aquatic organisms, for public freshwater bodies could not be obtained. The value for seawater was generally 0.015 μg Tl/L. Further, a past survey of the water quality of public water bodies in the vicinity of an industrial zone covering a limited area reported a PEC of around 1.4 μg Tl/L for freshwater and 0.090 μg Tl/L for seawater.

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3. Initial assessment of health risk

Oral exposure to thallium affects the gastrointestinal tract and nervous system, and causes abdominal pain, nausea, vomiting, headache, weakness, muscle pain, blurred vision, restlessness, convulsions and increased heart rate. In addition to these symptoms, it may cause alopecia.

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

The NOAEL for oral exposure of 0.04 mg Tl/kg/day (based on alopecia accompanied by atrophy of hair follicles), determined from medium-term toxicity tests in rats exposed to thallium sulfate, was divided by a factor of 10 to account for extrapolation from sub-chronic to chronic exposure. The calculated value of 0.004 mg Tl/kg/day was deemed to be the lowest reliable dose and was identified as the 'non-toxic level*' for oral exposure. The 'non-toxic level*' for inhalation exposure could not be identified.

With regard to oral exposure, owing to lack of identified exposure levels, the health risk could not be assessed.

Based on the concentration in public freshwater bodies reported at one location, the maximum exposure level of the substance was 0.00012 μg Tl/kg/day. The MOE (Margin of Exposure) would be 3,300, when calculated from this level and the 'non-toxic level*' of 0.004 mg Tl/kg/day, and subsequently divided by a factor of 10 to account for extrapolation from animals to humans. For comparison, based on the maximum concentration in public freshwater bodies reported in a restricted area, the exposure level was 0.0044 μg Tl/kg/day. The MOE would be 91, when calculated from this level. For additional comparison, based on the maximum concentrations in public freshwater bodies in a restricted area, soil and food, as previously reported, the exposure level was 0.070 μg Tl/kg/day. The MOE would be 6, when calculated from this level. Therefore, collection of further information would be required to assess the health risk of the substance via oral exposure.

With regard to inhalation exposure, owing to lack of identified 'non-toxic level*', the health risk could not be assessed. Assuming that 100% of the ingested substances is absorbed, the 'non-toxic level*' for inhalation exposure, derived from the conversion of oral exposure concentration, would be 0.013 mg Tl/m^3. The predicted maximum exposure concentration in ambient air was 0.00015 μg Tl/m^3. The MOE would be 8,700, when calculated from the predicted maximum exposure concentration and the converted 'non-toxic level*' for inhalation exposure, and subsequently divided by a factor of 10 to account for extrapolation from animals to humans. Therefore, collection of further information would not be required to assess the health risk of this substance 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*' 0.004 mgTl/kg/day	Rats	Alopecia accompanied by atrophy of hair follicles.	Drinking water	— μgTl/kg/day	MOE	—	×	(▲)
				Public Freshwater bodies	— μgTl/kg/day	MOE	—	×	
Inhalation	'Non-toxic level*' — $mgTl/m^3$	—	—	Ambient air	0.00015 $\mu gTl/m^3$	MOE	—	×	(○)
				Indoor air	— $\mu gTl/m^3$	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, the following reliable data for monovalent thallium were obtained: a 96-h LC_{50} of 81 μg Tl/L for the amphipod crustacean *Gammarus minus*, a 96-h LC_{50} of 1,900 μg Tl/L for the fish species *Oncorhynchus mykiss* (rainbow trout), and a 96-h LC_{50} of 2,200 μg Tl/L for the freshwater snail *Physa heterostropha*. Accordingly, based on these acute toxicity values and an assessment factor of 1,000, a predicted no effect concentration (PNEC) of 0.081 μg Tl/L was obtained.

With regard to chronic toxicity, the following reliable data for monovalent thallium was obtained: a 30-d NOEC of less than 40 μg Tl/L for mortality in the fish species *Pimephales promelas* (fathead minnow). Accordingly, based on this chronic toxicity value and an assessment factor of 100, a PNEC of 0.4 μg Tl/L was obtained.

Toxicity data that could be utilized in an initial assessment of the ecological risk of tellurium (III) could not be obtained, and a PNEC could not be determined.

The value of 0.081 μg Tl/L obtained from the acute toxicity of thallium (I) to the crustacean was used as the PNEC for this substance.

Assuming that the total thallium concentration in the environment is monovalent, the PEC/PNEC ratio is 0.2 for both freshwater bodies and seawater. Furthermore, past data gave reference values of around 1.4 μg Tl/L for freshwater and 0.090 μg Tl/L for seawater. Assuming that the total thallium concentration in the environment is monovalent, the PEC/PNEC ratio is 17 for freshwater and 1.1 for seawater. Accordingly, efforts to collect data on this substance are needed, environmental concentration data needs to be augmented taking into consideration emission sources, and there is a need to consider gathering more comprehensive toxicity data for this substance.

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 *Gammarus minus*	Acute	LC_{50} mortality	1,000	0.081	Freshwater	—	—	▲	▲
					Seawater	0.015	0.2		

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5. Conclusions

	Conclusions		Judgment
Health risk	Oral exposure	Collection of further information would be required.	(▲)
	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.