9	CAS No.: 7782-49-2 (Selenium)	Substance: Selenium and its compounds

Chemical Substances Control Law Reference No.:

PRTR Law Cabinet Order No.: 1-242

Chemical symbol: Se

Atomic weight: 78.96

1. General information

The major selenium compounds are selenous acid, sodium selenite, hydrogen selenide, selenium hexafluoride, and selenium disulfide. The aqueous solubilities of selenous acid, sodium selenite, and hydrogen selenide are 1.667×10^6 mg/1,000 g (20°C), 8.98×10^5 mg/1,000 g (25°C), and 2.7×10^3 mL/1,000 mL (22.5°C), respectively. Selenium hexafluoride and selenium disulfide are insoluble in water. The vapor pressures of sodium selenite and hydrogen selenide are 2.00 mmHg (15°C) and 9.1×10^3 mmHg (30.8°C), respectively. The biodegradability of sodium selenite is judged to be difficult and bioaccumulation is thought to be nonexistent.

Selenium and its compounds are designated as Class 1 Designated Chemical Substances under the Law Concerning Reporting, etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management (PRTR Law). Selenium is used in the photosensitive drums of photocopying machines and in solar photovoltaic cells. It is also used in colorants and pigments for glass and porcelain, as an achromatizing agent for glass, and as an additive for metallic alloys. Selenous acid is used as a reagent, an antioxidant, and a pigment. Sodium selenite is used as a colorant and achromatizing agent for glass, a pigment, a light metal plating treatment agent, and in animal feed. Hydrogen selenide is used in semiconductor fabrication processes. Selenium hexafluoride is used in electrical insulators and semiconductors. Selenium disulfide is used as an active ingredient in antidandruff shampoo for animals.

Selenium is produced as part of the copper refining process as well as through the refining of scrap from the photosensitive drums of photocopiers. The production quantity of selenium in fiscal 2013 was 739 t. The production and import quantities of selenous acid and sodium selenite for fiscal 2013 onwards were not disclosed because the number of reporting businesses was not more than two. The production and import quantity of hydrogen selenide in fiscal 2013 was less than 1,000 t.

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2. Exposure assessment

Total release to the environment in fiscal 2013 under the PRTR Law was approximately 21 t, of which approximately 16 t or 79% of overall releases were reported. The major destination of reported releases was public water bodies. In addition, approximately 31 t was transferred to waste materials and 0.004 t was transferred to sewage. Industry types with large reported releases were ceramics and soil and stone product manufacturing for the atmosphere, and non-ferrous metals manufacturing and sewage treatment 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 selenium and its compounds transform into various chemical forms in the environment. Accordingly, the proportions distributed to individual media for selenium and its compounds were not predicted.

The maximum expected concentration of exposure to humans via inhalation, based on general environmental atmospheric data, was around 0.002 μg Se/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 0.48 μg Se/m^3.

The predicted environmental concentration (PEC), which indicates exposure to aquatic organisms, was reported to be 6.8 μg Se/L for public freshwater bodies and 2 μg Se/L for seawater. 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 9.7 μg Se/L.

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3. Initial assessment of health risk

Selenium is irritating to the respiratory tract, and causes sore throat, coughs, nasal discharge, loss of olfaction and headache, if inhaled. Oral exposure causes garlic odor of the breath and diarrhea. Contact with the eyes or skin causes redness. The substance may cause effects on the gastrointestinal tract and nervous system.

Selenite, selenium dioxide and selenium trioxide are corrosive to the eyes, skin and respiratory tract. Inhalation of these substances causes burning sensation, coughs, labored breathing, sore throat and shortness of breath and may cause lung edema. Oral exposure to these substances causes abdominal pain, burning sensation, sore throat, diarrhea, nausea and shock or collapse. Contact with the eyes causes redness, pain and severe burns and may result in allergic-type reaction of the eyelids. Contact with skin causes redness, pain, blisters and skin burns.

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

Oral exposure to the substances was outside the scope of the assessment.

With regard to inhalation exposure, owing to lack of identified 'non-toxic level*', the health risk could not be assessed. For comparison, assuming that 100% of the ingested substances is absorbed, the NOAEL for inhalation exposure, derived by converting that for oral exposure in humans of 0.004 mg Se/kg/day, would be 0.013 mg Se/m^3. The MOE would be 6,500, when calculated from the converted NOAEL for inhalation exposure and the predicted maximum exposure concentration of approximately 0.002 μg Se/m^3.

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 0.48 μg Se/m^3 on the basis of the data reported in FY 2013 under the PRTR Law. The MOE would be 27, when calculated from this concentration.

Therefore, collection of further information would be required to assess the health risk of selenium 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*' (−) mgSe/kg/day	(−)	(−)	Drinking water	(−) μgSe/kg/day	MOE	(−)	(−)	(−)
				Ground water	(−) μgSe/kg/day	MOE	(−)	(−)	
Inhalation	'Non-toxic level*' — mgSe/m^3	—	—	Ambient air	0.002 μgSe/m^3	MOE	—	×	(▲)
				Indoor air	— μgSe/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

The initial assessment of ecological risk focused on tetravalent and hexavalent selenium.

With regard to the acute toxicity of tetravalent selenium, the following reliable data were obtained: a 96-h EC_{50} 2,900 of μg Se/L for growth inhibition in the green algae *Pseudokirchneriella subcapitata*, a 96-h LC_{50} of 676 μg Se/L for the amphipod crustacean *Hyalella azteca*, and a 96-h LC_{50} of 1,325 μg Se/L for the fish species *Morone saxatilis* (striped bass). Accordingly, based on these acute toxicity values and an assessment factor of

100, a predicted no effect concentration (PNEC) of 6.7 μg Se/L was obtained.

With regard to the chronic toxicity of tetravalent selenium, the following reliable data were obtained: a 72-h NOEC of 4,570 μg Se/L for growth inhibition in the green algae *P. subcapitata*, a 28-d NOEC of 70 μg Se/L for reproductive inhibition in the of crustacean *Daphnia magna*, and a 90-d NOEC of 21.0 μg Se/L for mortality in the fish species *Oncorhynchus mykiss* (rainbow trout). Accordingly, based on these chronic toxicity values and an assessment factor of 10, a PNEC of 2.1 μg Se/L was obtained.

The value of 2.1 μg Se/L obtained from the chronic toxicity to the fish species was used as the PNEC for tetravalent selenium.

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)			
Fish (rainbow trout)	Chronic	NOEC Mortality	10	2.1	Freshwater	6.8	3	■	■
					Seawater	2	0.95		

With regard to the acute toxicity of hexavalent selenium, the following reliable data were obtained: a 96-h EC_{50} of 199 μgSe/L for growth inhibition in the green algae *P. subcapitata*, a 96-h LC_{50} of 57 μgSe/L for the amphipod crustacean *Gammarus pseudolimneaeus*, a 96-h LC_{50} of 2,300μgSe/L for the fish species *Pimephales promelas* (fathead minnow), and a 48-h LC_{50} of 10,500 μg Se/L for the midge *Chironomus riparius*. Accordingly, based on these acute toxicity values and an assessment factor of 100, a predicted no effect concentration (PNEC) of 0.57 μg Se/L was obtained.

With regard to the chronic toxicity of hexavalent selenium, the following reliable data were obtained: a 28-d NOEC of 50 μg Se/L for reproductive inhibition in the planktonic crustacean *Daphnia pulicaria*, and a 32-d NOEC of 390 μgSe/L for growth inhibition in the fish species *P. promelas* (fathead minnow). Accordingly, based on these chronic toxicity values and an assessment factor of 100, a PNEC of 0.5 μg Se/L was obtained.

The value of 0.5 μg Se/L obtained from the chronic toxicity to the crustacean was used as the PNEC for hexavalent selenium.

Hazard Assessment（Basis for PNEC）			Assessment factor	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 *Daphnia pulicaria*	Chronic	NOEC reproductive inhibition	100	0.5	Freshwater	6.8	14	■	■
					Seawater	2	4		

The total selenium concentration in public water bodies is less than 5 μg Se/L for both freshwater bodies and seawater when viewed as an average. Setting a predicted environmental concentration (PEC) as an assessment value erring on the side of caution gave 6.8 μg Se/L for freshwater bodies and 2 μg Se/L for seawater.

Assuming that all of the selenium in the environment is either tetravalent or hexavalent, the PEC/PNEC ratio is greater than 1 in freshwater bodies when all of it is tetravalent and in freshwater bodies and seawater when all of it is hexavalent. Accordingly, selenium and its compounds are considered as candidates for further work.

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5. Conclusions

	Conclusions		Judgment
Health risk	Oral exposure	It was not the object of evaluation.	(－)
	Inhalation exposure	Further information collection would be required for risk characterization.	(▲)

Ecological risk	Candidates for further work.	■

［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.