National regulations or industry practices relating to the control of mercury releases

Government of Japan

Japan welcomes the decision MC-4/5 on mercury releases, including the adoption of the guidance on the methodology for preparing inventories of releases and the development of the guidance on best available techniques and best environmental practices to control mercury releases.

We would like to hereby submit existing information on national regulations or industry practices relating to the control of mercury releases from relevant sources in response to the follow-up letter to the decisions at the COP4 (MC/COP4/2022/8). As submitted previously, there are no relevant sources pursuant to paragraph 2 (a) of Article 9 of the Convention in Japan. Therefore, it should be noted that below are general measures in Japan to control releases of pollutants including mercury or mercury compounds for the protection of public water and groundwater. More detailed information including technologies and practices to control mercury releases may be submitted by a technical expert nominated by Japan in the course of inter-sessional processes leading up to the COP5.

1. National regulations relating to the control of mercury releases

1.1. Releases to water

In Japan, releases of pollutants including mercury or mercury compounds from factories and business establishments are mainly controlled by the Water Pollution Prevention Act, the Sewerage Act, the Mine Safety Act and the Waste Management and Public Cleansing Act, based on the Environmental Quality Standards for Water under the Basic Act on the Environment, to prevent the pollution of public water bodies and groundwater. Information in this section is a summary of those regulations.

1.1.1. Water Pollution Prevention Act

The purpose of this Act is to prevent the pollution of water in areas of public waters and in groundwater, thereby protecting the public health and preserving living conditions.

I. Regulation of Effluent

The Water Pollution Prevention Act defines facilities that discharge certain polluted water or wastewater as "Specified Facilities", and those who intend to install or to change structures of such facilities must submit a report to prefectural governors on their installations or changes in advance. When prefectural governors find that effluent discharged by workplaces which have Specified Facilities (“Specified Workplaces”) may not conform effluent standards, they may order follows:

- the improvement of the construction or usage of Specified Facilities or means of treatment of polluted water within a certain time limit, or

- the suspension of use of Specified Facilities or discharging of effluent.

Examples of Specified Facilities are as follows.

- Facilities for mining or coal washing
- Facilities for manufacturing the pulp, papers or paper products
- Facilities for manufacturing chemical fertilizers
- Facilities for manufacturing inorganic pigment
- Facilities for manufacturing pharmaceuticals
- Mixing facilities for manufacturing agrochemicals
- Facilities for oil refining including reclamation of lubricating oil
- Facilities for manufacturing cement products
- Facilities for the iron and steel industry
- Facilities for manufacturing non-ferrous metals
- Flue gas cleaning facilities for coal-fired power plants
- Municipal waste incineration facilities
- Industrial waste treatment facilities
- Sewage treatment facilities

Nationally uniform effluent standards have been established for effluent discharged from Specified Workplaces to areas of public waters, covering 43 items including harmful substances. The substances specified by the effluent standards are classified into items related to effluent containing substances that may cause damage to human health (health items) and items indicating the state of water contamination (living environment items). Mercury or mercury compounds are substances related to health items, and effluent standards are 0.005 mg/L for total mercury and "not to be detected" for alkyl mercury compounds. The regulations for health items are applied for all Specified Workplaces that release harmful substances regardless of the volume of effluent.

Furthermore, for Areas of Public Waters where the prevention of water pollution may not be sufficient by the nationally uniform effluent standards, stricter standards (additional standards) can be established by prefectural bylaws.

II. Regulations on Underground penetration

The Act also prohibits business establishments where specified facilities that use, manufacture or store harmful substances are established ("Specified Workplaces that Use Harmful Substances") from discharging water containing harmful substances into the ground. Under this regulation, water discharge containing 0.0005 mg/L or more for total mercury or alkyl mercury, respectively, is prohibited. In addition, Specified Workplaces that Use Harmful Substances and facilities where water containing harmful substances are stored ("Designated Facilities that Store Harmful Substances") shall comply with standards

for structures or construction, inspection, and ways to use the facilities, etc. to prevent groundwater pollution.

(i) Standards for the structure or construction

- The floor and its surroundings must be made of materials to be able to prevent water penetration containing harmful substances into underground and flowing out of the facility.
- When pipe bodies, fittings, flanges, valves, pump equipment, etc.) are installed above the ground, they must be made of materials and constructed to be able to prevent leakage of water containing harmful substances, or be constructed so that leakage can be checked if any leakage occurs.
- Drainage system equipment, such as drainage ditches, catch basins, drainage pumps, must be made of a material and be constructed so that they can prevent water containing harmful substances from discharging into the ground.

(ii) Standards for the inspection of facilities

- A person that operates Specified Facilities that Use Harmful Substances or Designated Facilities that Store Harmful Substances must inspect the floor and its surroundings of the facility installation site, the facility itself, the piping, drainage ditches, etc. that accompany the facility by visual or other ways, and then must keep the results of these inspections for three years.
- If any abnormality or leakage of water containing harmful substances is confirmed by the inspection, a person that operates these Facilities must immediately take necessary measures such as repairs.

(iii) Standards for the way of use

- A person that operates Specified Facilities that Use Harmful Substances or Designated Facilities that Store Harmful Substances must prevent water from dispersal, spilling and penetrating the ground when receiving, transporting and distributing water containing harmful substances, as well as properly operate the facility, such as checking the supply status and the operating status of the equipment.
- If water containing harmful substances is leaked, a person that operates these Facilities must immediately take measures to prevent leakage and recover the leaked water, and then reuse or treat it properly so as not to hinder the protection of the living conditions.

1.1.2 Sewerage Act

The purpose of this Act is to contribute to the sound development of cities and the improvement of public health as well as the protection of water quality in public water bodies through the development of sewerage systems.

The Water Pollution Prevention Act applies when wastewater is discharged from a business establishment into public water bodies or underground, and the Sewerage Act applies when wastewater is discharged from a business establishment to a public sewerage system. The Sewerage Act applies not only to wastewater from specified workplaces under the Water Pollution Prevention Act but also to business establishments where specified facilities are not installed. The effluent standards under the Water Pollution Prevention Act and the discharge standards to sewerage under the Sewerage Act are the same (0.005 mg/L for total mercury and "not to be detected" for alkyl mercury compounds). As is the case of the Water Pollution Prevention Act, the discharge standards to sewerage are nationwide uniform standard values, and stricter standards (additional standards) can be set by prefectural ordinances.

1.1.3 Mine Safety Act

The purpose of this Act is to prevent harm to miners and the mine pollution and ensure the rational development of mineral resources. This Act requires the closure of a mining pit, installation of a mine water or wastewater treatment system and taking other measures to prevent the mine pollution from mine water or wastewater. Those mine water and wastewater discharged into public water bodies or sea shall comply with the effluent standards under the Water Pollution Prevention Act (0.005 mg/L for total mercury and "not to be detected" for alkyl mercury compounds).

1.1.4 Waste Management and Public Cleansing Act

The purposes of this Act are to preserve the living environment and improve the public health by preventing the waste generation and ensuring the proper sorting, storage, collection, transport, recycling and disposal of waste, and by keeping the living environment clean. The Ministerial order and ordinance of the Waste Management and Public Cleansing Act stipulate standards for the structure and the closure of leachate-control type landfills and measures to manage leachate from such landfills. Relevant standards for the management of leachate from leachate-control type landfills are as follows.

I. Standards for the structure of leachate-control type landfills (only those related to leachate control)

The following measures shall be taken to prevent pollution of public waters and groundwater by leachate from the landfill site.

(i). Liner that meets following requirements shall be installed.

a. An impermeable layer shall be provided with any of the following requirements:

- an impermeable liner shall be laid on a clay layer with a thickness of 50 cm or more and a permeability coefficient of 10 nm/second (=1×10^{-6} cm/second) or less,
- an impermeable liner shall be laid on a layer of asphalt concrete with a thickness of 5

cm or more and a permeability coefficient of 1 nm/second (=1×10^{-7} cm/second) or less, or

- a double layer of an impermeable liner shall be laid on the surface of the non-woven fabric or other material.

b. The required strength and level foundation ground shall be ensured under the impermeable layer.

c. The surface of the impermeable layer shall be lined with a non-woven fabric or other material having light-shielding properties.

(ii). If impermeable strata are present throughout the entire basement of the landfill, impermeable liner shall be provided with one of the following requirements:

a. the ground to the impermeable stratum shall be solidified by injection of chemicals, etc., until the Lugeon value of the ground to the impermeable stratum becomes 1 or less,

b. a continuous wall with a thickness of 50 cm or more and a permeability coefficient of 10 nm/sec (=1×10^{-6} cm/sec) or less shall be provided down to the impermeable stratum,

c. steel sheet piles shall be installed to impermeable strata, or

d. the requirements listed in (a) through (c) under (i).

(iii). If there is a risk of damage to the impermeable liner due to groundwater, a pipe culvert or other groundwater collection and drainage system must be installed.

(iv). Pipe culverts or other water collection and drainage facilities with a solid and durable structure that can effectively collect and promptly discharge retained water shall be installed.

(v). An adjustment tank with a water-resistant structure that can adjust for fluctuations in the quantity and quality of retained water shall be installed.

(vi). A leachate treatment facility that can make the retained water conform to the effluent standards shall be installed

II. Standard to manage leachate from leachate-control type landfills

(i) <u>From the start of landfill disposal to the end of aftercare period</u>

Below are the standards for leachate-control type landfills from the start of landfill disposal to the end of aftercare period.

Monitoring item	Standard	Standard value for Hg	Frequency
Released water（Treated leachate water）	Shall comply with effluent standards	• 0.005mg/L (mercury, alkyl mercury and other mercury compounds) • Not detected (alkyl mercury compounds)	Once or more a year
Groundwater	If water quality deteriorates, investigate the cause and take other necessary measures to	• 0.0005mg/L (total mercury) Not detected (alkyl mercury compounds)	Once or more a year

Monitoring item	Standard	Standard value for Hg	Frequency
	preserve the living environment.		

(ii) When ending the aftercare

Following standards should be satisfied to end the aftercare of leachate-control type landfills.

Monitoring item	Standard	Standard value for Hg	Frequency
Retained water (leachate)	Shall comply with effluent standards for at least two years or more	• 0.005mg/L (mercury, alkyl mercury and other mercury compounds) • Not detected (alkyl mercury compounds)	More than once every six months
Groundwater	Does not exceed the water quality standard and there are no possibilities of exceeding	• 0.0005mg/L (total mercury) Not detected (alkyl mercury compounds)	Once or more a year

2. Industry practices relating to the control of mercury releases

2.1. Overview of technologies to control mercury releases

The information in this section is a summary on technologies to control mercury releases to water bodies extracted from the necessary knowledge to acquire a qualification on a Pollution Control Manager that needs to be appointed under the Act on Improvement of Pollution Prevention Systems in Specified Factories (see reference).

A sulfur-coagulation and precipitation is usually applied to the treatment of wastewater containing inorganic mercury, but the treatment using sulfur-based heavy metal adsorbents has recently become the mainstream. Oher treatment methods include adsorption by activated carbon, chelating resin, amalgamation (reduction methods), and reduction vaporization methods.

2.1.1. A sulfur-coagulation and precipitation

The sulfide coagulation is a good method for the treatment of toxic metals because the solubility of heavy metal sulfides is extremely low, and heavy metal sulfides can be treated in the pH-neutral range. Due to the toxicity, odor and corrosiveness of hydrogen sulfide, there are few cases where this method is applied for wastewater treatment but was exceptionally applied to mercury because the water quality standards for mercury are extremely strict. In the sulfur-coagulation and precipitation, hydrogen sulfide (H_2S) or sodium sulfide (Na_2S) are added to wastewater containing mercury (II) to produce mercury sulfide, which

is then precipitated and separated.

Heavy metal ions react with sulfide ions to form extremely insoluble salts. It is reasonable to assume that the mercury concentration in wastewater is constantly changing, in which case it is normal to determine the amount of sodium sulfide to be added according to the expected maximum mercury concentration. Therefore, when the mercury concentration is low, the sulfide ion becomes excessive, and re-dissolution occurs. Since the formation of complex ions should be suppressed in order to treat mercury to a trace concentration level, excess sulfur ions are usually fixed as FeS by using iron (II) or iron (III), and the co-precipitation effect of hydroxides generated at the same time improves coagulation.

The sulfide-coagulation and precipitation method has problems of odor and corrosiveness of hydrogen sulfide and difficulty of treatment operation, but there is a method to precipitate and separate mercury by adding heavy metal adsorbent to wastewater instead of sodium sulfide, to make mercury insoluble chelate compound.

2.1.2. Adsorption method

A sulfur- coagulation and precipitation may not treat substances with strict standards such as mercury enough to meet the effluent standards. Therefore, another process is usually deployed at the subsequent treatment processes in which adsorbent is often used. Below are the overview of treatment method using chelating resin and activated carbon.

I. Chelating resin

This method selectively adsorbs and removes mercury by a resin having chelate-forming groups containing sulfur such as thiol group (-SH), thiourea group (-NH・CS・NH_2), thiocarbamic acid group and dithizone group. After separating suspended solids in wastewater by filtration, it is desirable to completely ionize mercury in the liquid by adding a small amount (about 5 mg/L) of chlorine under acidic conditions (pH 2-6) and make the liquid pass through a reaction tower filled with chelating resin to adsorbs and remove mercury. In Japan, recyclable mercury chelating resins are commercially available, but since it is difficult to recycle used adsorbents, mercury is recovered as metallic mercury by roasting at 600-800°C by a mercury waste treatment company.

II. Activated carbon

Since the activated carbon can adsorb relatively large amount of mercury (about 50 mg-Hg/g-activated carbon), the activated carbon is effective to apply not only at subsequent processes but also a pretreatment process with the combination of mercury adsorbent and powdered activated carbon, depending on characteristics of wastewater. Mercury can be adsorbed better when the pH is between 1 and 6, and coexisting salts have a slightly positive effect on adsorption. However, since activated carbon

also adsorbs organic matter, it should not be used in a system where organic matter coexists, and if it is applied, the adsorption amount should be checked using actual wastewater. In the treatment with adsorbent, suspended solids and insoluble mercury compound particles are first removed by filtration, then the pH is adjusted to 2-6, and colloidal mercury is ionized by chlorination before adsorption. Since the sulfur functional group of mercury chelating resin is sensitive to chlorine, the amount of chlorine added should be limited to about 5 mg/L.

2.1.3. Treatment of wastewater containing organic mercury

Oxidation, reduction and adsorption methods have been studied for treating the wastewater from organic mercury compound synthesis plants, but it has been found that the most effective method is to oxidize and decompose organic mercury compounds by chlorine under strong acidity of pH1 or lower to inorganic mercury compounds, and then treat them by the sulfide method. The difficulty in decomposing organic mercury compounds to mercury (II) chloride by chlorine depends on the type of alkyl group of the organic mercury compound, and the smaller the carbon number of the alkyl noble, the more difficult it is to decompose. The pH during chlorination greatly affects the decomposition, and the CH_3-Hg bonds are completely destroyed in strongly acidic solutions with pH 1 or lower.

Reference

1) Editorial committee on pollution prevention technology and regulations. (2022). *New Pollution Prevention Technology and Regulations in 2022 (Water Quality Edition)*. Japan Environmental Management Association for Industry. ISBN978-4-86240-196-0 (in Japanese)

2) Misorogi, N. (2015). *Theories on Hazardous Substances in Water (Revised Edition)*. Japan Environmental Management Association for Industry. ISBN978-4-86240-131-1 (in Japanese)

2.2. Industry practices to control mercury releases in Japan

We are going to collect further information on industry practices to control mercury releases in Japan through questionnaire and interview surveys with business operators in Japan. Such information may be submitted by a technical expert nominated by Japan in the course of considering the BAT/BEP guidance document by the expert working group.