Information from Japan upon the Request from the Minamata Convention Secretariat on Capacity Building, technical assistance and technology transfer on the Minamata Convention on Mercury

June 2018

At the Diplomatic Conference of the Minamata Convention on Mercury, Japan expressed its intention to support developing countries and promote voices and messages from Minamata, through the actions titled "MOYAI Initiative." As part of this initiative, the MINAS (MOYAI Initiative for Networking, Assessment and Strengthening) is being promoted. MINAS is a program of Ministry of the Environment, Japan that is designed to support developing countries' efforts in mercury management by providing measures including the various activities with close cooperation and collaboration with relevant agencies.

1. Information relating to Paragraph 4 and 5, Article 14 of the Minamata Convention

The Paragraph 4, Article 14 the Minamata Convention stipulates that the information on alternative technologies and technology transfer shall be considered at COP2. The Paragraph 5 also stipulates that the COP shall make recommendations on how capacity-building, technical assistance and technology transfer could be further enhanced.

The first Conference of Parties of the Minamata Convention (COP1) held in September 2017 requested the secretariat to seek submissions and reports from Parties and other stakeholders on issues relating to existing initiatives and progress made in relation to alternative technologies, on the needs of parties, particularly developing-country parties, for alternative technologies and on challenges experienced by Parties, particularly developing-country Parties, in technology transfer, and to present the information received to the Conference of the Parties at its second meeting for consideration.

Japan, as an advanced country on mercury management, has developed many technologies and know-hows. The information is compiled in a 2-pages flyer as

'Mercury technology bulletin series'. 10 bulletins listed below are now available (Annexed to this document):

- 001: Mercury Free Technology in the Chlor-Alkali Industry
- 002: Collection of Mercury Waste discharged from Households
- 003: Recovery of Mercury from Fluorescent Lamps
- 004: Mercury Material Flow Analysis
- 005: Monitoring of Mercury in Hair Samples
- 006: Removal of Mercury from Flue Gas using Activated Carbon
- 007: Reduction of Atmospheric Mercury Emission through Improvement of Efficiency of Coal Combustion
- 008: Treatment of Mercury Sphygmomanometers
- 009: Stabilization and Solidification of Mercury
- 010: Monitoring of Mercury in Ambient Air

2. Information relating to the COP1 Decision MC-1/21

The COP1 recognized that some of the existing regional and subregional centres have been already developing projects and activities related with mercury to deliver capacity-building and technical assistance. It recognized capacity-building and technical assistance delivered by other multilateral and bilateral means as well, and through partnerships with private sector, which has been continuously contributing to various mercury-related activities.

Thus, the COP1 decided to collect information on the work undertaken by the existing regional, subregional and national arrangements in delivering capacity-building and technical assistance to assist parties in meeting their obligations under the Minamata Convention (MC-1/21: Capacity-building, technical assistance and technology transfer on the Minamata Convention on Mercury).

Minamata city and its surroundings in Japan is an area affected by the Minamata disease, thus, it was certificated as the Model Environment City concept in 1992. Since then, it lead Japan's eco-friendly city policy with waste segregation, reuse/recycle, reforestation, environmental 'Meister' certificate, etc. Also, it accommodates many organizations and individuals involved in mercury-related

issues. The resources which the area possesses have now become a precious asset to promote the Minamata Convention.

International meetings on mercury that were convened in Minamata in recent years are listed in Table 1 and one-day symposia or celebratory events are listed in Table 2. Minamata city also regularly receives training or visiting programmes that include multiple activities such as lectures, exercises, field visits, etc. The trainings or visits undertaken in the past 12 months are listed in Table 3.

Table 1: International Expert Meetings on Mercury Convened in Minamata

Date	Name, Venue	Participants
22 - 23 June 2015	Asia-Pacific Mercury Monitoring Network Workshop Venue: Umi-to-Yuyake	Countries: 14 (excl. Japan) Participants: 33 (27 from overseas)
29 November - 1 December 2016	Asia-Pacific Expert Workshop on Continuous Atmospheric Mercury Monitoring Venue: Minamata Environmental Academia	Countries: 6 (excl. Japan) Participants: 29 (13 from overseas)
29 - 30 June 2017	Western Pacific Regional Workshop: Health Sector Involvement in Implementation of the Minamata Convention on Mercury Venue: Minamata Environmental Academia	Countries: 18 (excl. Japan) Participants: 43 (25 from overseas)
30 - 31 May 2018	Lessons Learned Workshop of the Minamata Initial Assessment Project in Asia Venue: Minamata Environmental Academia	Countries: 6 (excl. Japan) Participants: 14 (7 from overseas)

Table 2: Events/Symposia on Minamata Convention Convened in Minamata

Date	Name, Venue	Participants
9 October 2013	Commemorative Opening: Diplomatic Conference on Minamata Convention of Mercury Venue: Minamata City Cultural Hall	Countries: 139 Participants: approx. 600 (Simultaneous interpretation provided)
18 October 2014	1st Minamata Convention Forum Venue: Minamata Disease Archives	Participants: approx. 200 (6 from overseas)
24 October 2015	2nd Anniversary of the Adoption of the Minamata Convention Venue: Minamata Disease Archives	Participants: approx. 250
7 October 2016	3rd Anniversary of the Adoption of the Minamata Convention Venue: Minamata Disease Archives	Participants: approx. 250
6 - 7 December 2016	NIMD Forum 2016 Venue: Minamata Disease Archives	Participants: approx. 100 (8 from 4 countries)
1 July 2017	Celebrating Event for the Minamata Convention on Mercury Venue: Minamata Disease Archives	Participants: 184 (35 from 28 countries) (Simultaneous interpretation provided)
21 December 2017	Reporting Event on Participation of Minamata COP1 Venue: Moyai Hall	Participants: approx. 250

Table 3: Training or Visit Programmes Undertaken in Minamata

Date	Training/Visiting	Participants
18 - 20 October 2017	Capacity Strengthening for Multi-media Mercury Monitoring	10 from 10 countries
30 October - 3 November 2017	Capacity Building for Ratification and Implementation of the Minamata Convention on Mercury	9 from 7 countries
11 - 12 December 2017	Group Training Programme for Capacity Development for Addressing Mercury Pollution from ASGM in Indonesia	8 from 1 country

Date	Training/Visiting	Participants
23 - 25 January 2018	International Seminar on Minamata Disease	9 from 7 countries
1 - 2 March 2018	Visit to Japan's Laboratories by Laboratory Analysts in Charge of Mercury Monitoring	8 from 5 countries

In Minamata, regular activities by many organizations can provide various opportunities to the participants/visitors under organized programmes. Organizers can coordinate with relevant facilities/individuals for suitable arrangements that fit to the purposes of the programmes.

One of the local organizers include Minamata Environmental Academia (Academia) that is owned by Minamata Municipal Government. The Academia is a central facility to develop and disseminate information not only on the environmental management technologies, environmental policies or government response, but also local know-hows through collaborative works by utilizing local resources. It provides a pivotal role to establish connections/ties among various stakeholders to promote Minamata.

The activities are classified by types and listed in the Table 4.

Table 4: Regular Activities in Minamata

Facility/Resource	Key Activity
Research	
National Institute for Minamata Disease (NIMD)	Research on Minamata disease in various fields, International collaborative researches, Supports to laboratories in developing countries
Various research laboratories in near-by universities, International Mercury Laboratory Inc.	Environmental impacts and human impacts of mercury, Social impacts of environmental pollutions
Technical development	
NIMD	Rehabilitation for Minamata disease patients
International Mercury Laboratory Inc.	Simple and efficient mercury analysis methods
Educational activities	

Facility/Resource	Key Activity
Minamata Environmental Academia	Organizing public seminars, Organizing training programmes for developing countries
Kumamoto Prefecture Environmental Center	Educational programmes such as segregation of waste mercury-added products
Minamata High School	Volunteer guide at Minamata Disease Municipal Museum, Study programmes on mercury problems in developing countries
Kanshiranui Planning	Organizing environmental study tours for domestic and foreign high school students
Medical services	
Meisuien	Care services, medical services for inpatients
Kyoritsu Clinic	Medical services for patients
Public awareness	
Minamata Disease Municipal Museum	Collection, archiving, displaying information on Minamata diseases, Organizing a Minamata disease storyteller group
Minamata Disease Archives	Displaying scientific information on mercury
Soshisha	Collection and archiving of information on Minamata disease, Operating a private museum, Displaying archived materials
Toomi-no-ie, Hotto Hausu, Orange Hall	Supporting Minamata disease patients (care services, vocational supports, etc.), Supporting story-telling activities by patients at various international and domestic fora
Administrative services	
Department of Policy Planning/Department of Welfare and Environment, Minamata City	Social care services to Minamata disease patients,'Moyai-naoshi' reconciliation activities, Promoting Model Environment City, Solid waste management (segregation, collection, disposal)
Orange Hall, Moyai Hall, Minamata City Cultural Hall	Providing space and venue for various activities organized by local citizens
Private businesses	

Facility/Resource	Key Activity
Businesses in Eco-town industrial zone	Promotion of environment-oriented businesses such are solid waste management, Reduction of mercury-added products, Renewable energy, Cleaner production, etc.
Miscellaneous	Conservation of terraced paddy, Traditional handicrafts, Organic farming, Cultural heritages, Eco-friendly accommodation, Local specialties and tourism attraction

The facilities available in Minamata enable organizers to plan various types of activities. There are a couple of facilities that can provide venues for international conferences equipped with simultaneous interpretation booth. The largest theatre in Minamata can accommodate up to 800 spectaculars which is equipped with professional audio and visual equipment. Training and workshop venues are also available in a few facilities. The size of each training will depend on the nature of the training. Table 5 summarizes indicative capacities of the facilities available in Minamata.

Table 5: Indicative Capacities of Meeting Facilities in Minamata

Purpose	Capacity	Facility
International Conference	80 participants	• Moyai Hall, Minamata Disease Archives, • Minamata City Community Center
	30 participants	• Minamata Environmental Academia
Symposium / Lecture	800 participants	• Minamata City Cultural Hall
	200 participants	• Moyai Hall, • Minamata Disease Archives, • Minamata City Community Center
	80 participants	• Minamata Environmental Academia, • Orange Hall
Training	50 participants	• Minamata Environmental Academia, • Kumamoto Prefecture Environmental Center
Note: Numbers of facilities possess many small meeting rooms or tatami-mat rooms. Some tatami-mat rooms are available for stay-in trainings (Soshisha)		

Mercury Free Technology in the Chlor-Alkali Industry

Background

Mercury Use in the Chlor Alkali Industry

The mercury-cell process has been widely used for the production of chlorine and caustic soda. Concerns about the environmental impact of using mercury have led to a reduction in the number of mercury-cell. However, the process itself is still widely used in many countries.

Requirement of the Minamata Convention on Mercury (Article 5 and Annex B)

Article 5 of the Minamata Convention regulates manufacturing processes using mercury or mercury compounds. It is stated that the mercury use for Chlor-alkali production shall be phased-out **by 2025**.

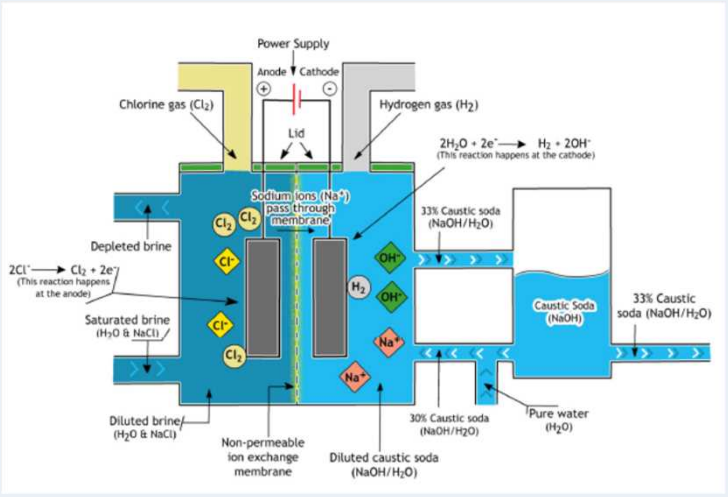
Overview of the Technology

Types of processes used in the Chlor-Alkali Industry

Caustic soda (sodium hydroxide) and chlorine are predominantly manufactured by the electrolysis of sodium chloride solution (Brine). Conventionally, *mercury process* and *diaphragm process* were used for the electrolysis process. Using *ion exchange membrane process* provides a lot of economic and environmental advantages and hence the conventional processes are being replaced by the ion exchange membrane process.

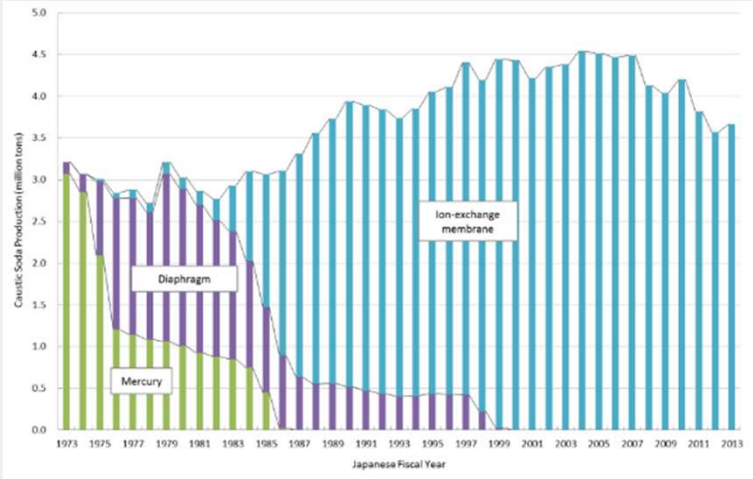
Mercury process , as the name suggests, utilizes mercury in the production process and is being phased out due to environmental challenges associated with the use of mercury. *Diaphragm process* utilizes diaphragm consisting of asbestos to separate the anode and cathode. The design of the *Ion exchange membrane process* is similar to diaphragm cell except that a cation permeable membrane acts as an ion exchanger and divides the cell into two sections. Only sodium ions and a little water pass through the membrane. Chlorine is collected at the anode. The consumption of electricity in this method is the lowest of the three processes This method is more efficient than the diaphragm method and newly constructed plants exclusively use this method.

Ion exchange membrane process



Source: Euro Chlor (http://www.eurocholor.org)

Trend of caustic soda production by process in Japan



Source: "Lessons from Minamata Disease and Mercury Management in Japan (Ministry of the Environment, Japan) https://www.env.go.jp/chemi/tmms/pr-m/mat01/en_full.pdf

Trend to mercury free technology in Japan

During the rapid economic growth period in the 1970s, the mercury-cell process was most common in the chlor-alkali industry, and the amount of mercury used in this process accounted for more than half of the total amount of mercury used in Japan. In Japan, as a result of effort made by the industry, all mercury cell processes were converted to mercury free process by 1986. Since 1999, Ion-exchange membrane process is the only process used in the chlor-alkali facilities of Japan.

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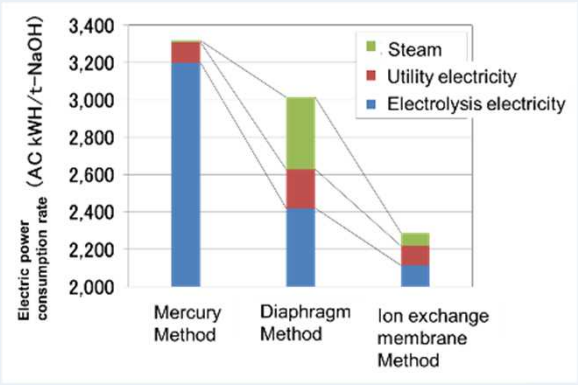
Advantages/Strengths

Co-Benefits from Conversion

When the Japanese industry started to use the ion-exchange membrane, they encountered issues of high energy cost and poor quality of caustic soda. However, extensive R&D has led to the improvement of electric current efficiency to 96% or more. The total energy consumption is lower by more than 30% compared to the diaphragm or mercury-cell processes, while yielding a better quality (higher purity) product.

Energy efficiency comparison



Source: AGC Inc.

Ion-exchange membrane equipment

Photo provided by AGC Inc.

Conversion to ion-exchange membrane ensures the following "**CO-BENEFITS**": the reduction of energy consumption and the elimination of hazardous chemicals (e.g., mercury, asbestos) in the system. Furthermore, membranes manufactured in Japan have a high durability (long lifetime) thus ensuring stable operation of the system; these are factors essential for profitable operations of the chlor-alkali industry.

Applicability

World wide Use

Japanese ion-exchange membranes are used in salt electrolysis plants in over 50 countries all over the world.

Challenges to Technology Adoption

Although ion-exchange membrane processes are more energy conserving and profitable than mercury-cells in the long run, the initial investment cost for the process conversion is high. Therefore, It takes many years for the initial cost to be recovered from the revenue of the converted facility.

The excess mercury recovered from decommissioned mercury cell must be disposed of in environmental sound manner. As the waste management is not profit-producing component, the overall conversion process must incorporate the waste management within the feasibility study.

Further Reading

Detailed information about this technology can be found in the following website.

- Lessons from Minamata Disease and Mercury Management in Japan (https://www.env.go.jp/chemi/tmms/pr-m/mat01/en_full.pdf)
- UNEP, Mercury Reduction in the Chlor-Alkali Sector (http://www.unep.org/chemicalsandwaste/global-mercury-partnership/mercury-reduction-chlor-alkali-sector)

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Collection of Mercury Waste discharged from Households

Background

Requirement of the Minamata Convention on Mercury

Under Article 11 of the Minamata Convention on Mercury, each Party is required to take appropriate measures so that mercury waste is managed in an environmentally sound manner.

The Convention identifies three categories of mercury wastes:
(1) wastes consisting of mercury or mercury compounds,
(2) wastes containing mercury or mercury compounds and
(3) wastes contaminated with mercury or mercury compounds.

Environmentally Sound Management (ESM) of waste mercury products (e.g., waste fluorescent lamps and batteries) is a common challenge for all developing countries, since mercury and its compounds are used in various products for our daily lives. Developing mechanisms for source separation and collection of mercury waste discharged from households is essential for the implementation of the Convention.

Source: UNEP "Practical Sourcebook on Mercury Waste Storage and Disposal"

Overview of the Technology

Due to increasing social concern about mercury since the outbreak of Minamata Disease, Japan has formulated and incrementally developed a collection system for waste mercury-added products generated from households.

In Japan, the local governments are responsible for collecting mercury waste generated from households. The system comprises of utilizing the existing collection system, including door-to-door collection and curbside collection, suited to the characteristics of the locality. Collection boxes are placed at various points where consumers visit frequently; for example at consumer-electronics retailer shops for waste fluorescent lamps/batteries and pharmacies for used thermometers, ensuring that an efficient collection system is in place.

Companies licensed by the local municipalities are contracted to recycle and dispose of mercury waste discharged from households that is collected by the municipality, in an environmentally sound manner.

Example of Collection System of Waste Fluorescent Lamps disposed from Households in Japan

Source of the pictures above: Guideline for separation and collection of mercury containing wastes from households (MOEJ)

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Advantages/Strengths

Measures to prevent breakage during disposal and transportation

Waste mercury-added products such as thermometers or fluorescent lamps are fragile and there is a possibility of mercury spilling and scattering, resulting in the pollution to the environment. Furthermore, the appropriate treatment methods vary according to different types of products and it is essential to take appropriate measures to ensure that mercury waste is not mixed with other waste.

The specific measures in practice include using containers suited to the shape, size and quantity of the waste to ensure the prevention of breakage, which improves the waste collection rate as well as pollution prevention.

Awareness raising among local governments and citizens

For segregation and collection of municipal waste to be carried out effectively, it is crucial that the stakeholders cooperate and have a clear and common understanding of pertinent issues. In Japan, an effective collection system has been established through institution building while simultaneously raising awareness of stakeholders.

The MOEJ has developed guidelines with examples of the actual cases and good practices of mercury waste collection by municipality , along with other awareness raising pamphlets. Additionally, seminars for local governments are also organized occasionally.

Applicability

Japan has developed one of the most effective waste segregation and collection systems of mercury waste in the world. This has been possible due to the cooperation and understanding of the public.

Establishing such system will be challenging, but the Japanese approach can be a good reference and the know-hows can be applied to the establishment of similar approach in other countries. Furthermore, the Japanese experience of policy formulation, carrying out awareness raising activities, and carrying out the collection system by local governments can provide valuable information for establishing segregation and collection systems for mercury wastes in other countries.

Further Reading

MOEJ, Collection Methods of Waste Mercury-added Products discharged from Households (English DVD)
MOEJ, Guidelines for Separation and Collection of Mercury Containing Waste discharged from Households (Japanese only) (http://www.env.go.jp/recycle/waste/mercury-disposal/h2712_guide1.pdf)

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http://www.env.go.jp/en/chemi/mercury/mcm.html

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Ministry of the Environment

Recovery of Mercury from Fluorescent Lamps

Background

Article 11 of the Minamata Convention on Mercury requires each Party to take appropriate measures so that mercury waste is managed in an environmentally sound manner. Mercury contained in waste products such as fluorescent lamps and batteries need to be recovered to the extent possible, in order to prevent contamination of the environment from improper handling of these products. However, mercury is an element, and unlike other organic pollutants cannot be treated easily with conventional treatment measures.

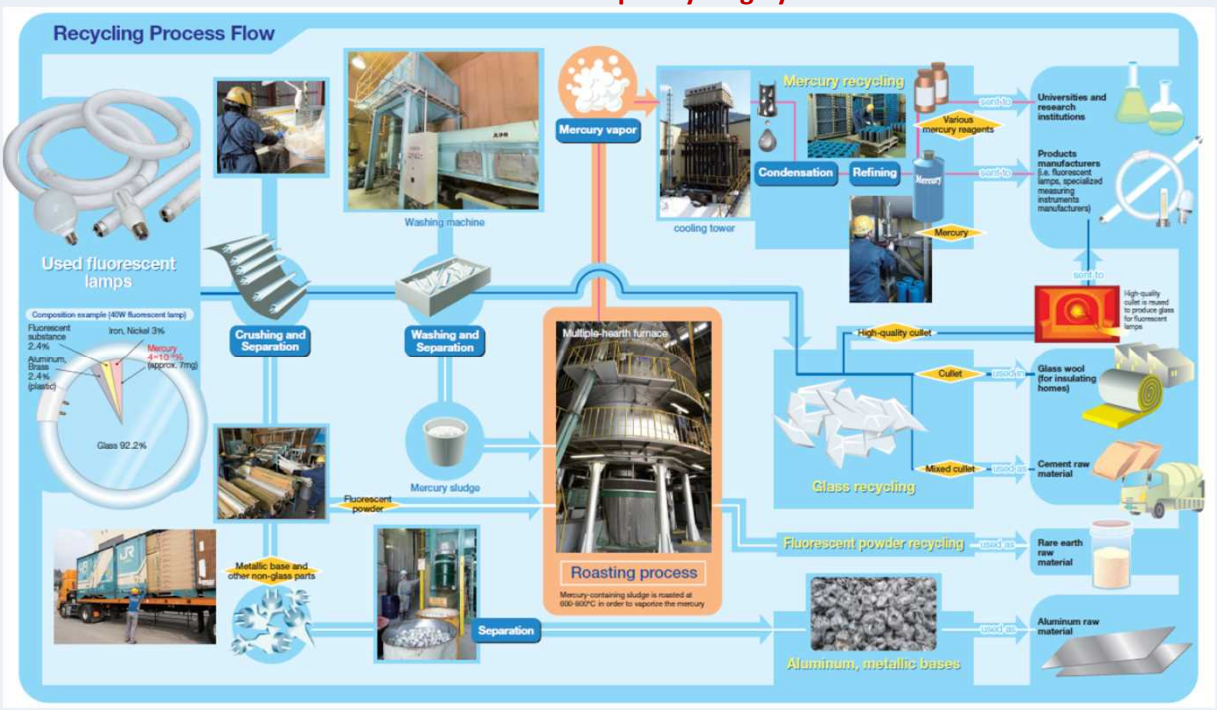
Website of UNEP

Overview of the Technology

This technology involves the recovery of mercury from fluorescent lamps. This involves the separation of the components (glass, fluorescent power, aluminum, etc.) followed by a process to increase the purity of the mercury. Although this general process is the same across all companies, the exact process may slightly differ according to the process adopted by each company.

The process employed by the largest recycler of fluorescent lamps in Japan is described below. In this plant, fluorescent lamps brought into the facility are pre-treated in a crusher and sorting facility where the glass, cap and fluorescent powder are separated. Aluminum is recovered while the glass is washed, and mercury is separated along with other fine particles. The resulting mercury sludge is passed onto a multiple hearth furnace (Herreshoff furnace), and is treated at a temperature of 600-800 degrees Celsius where the mercury is vaporized. The mercury vapor then passes through a condenser, where it is cooled and returns to liquid mercury. The collected mercury is refined and recovered as 'high purity' mercury.

Used Fluorescent Lamp Recycling System



Source: Website of Nomura Kohsan Co., Ltd. (http://nkcl.jp/wp-content/uploads/2014/07/recycle_flow1.pdf)

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Advantages/Strengths

High recovery rate of mercury

The recovery rate of mercury is quite high, meaning that very little mercury contained in the fluorescent lamps is discarded into the environment. Furthermore, the mercury recovered is of high purity, and this is recycled through means allowed by the Minamata Convention.

Recycling of components

In addition to mercury, this process allows for the recovery of other materials like aluminum and glass. The collected aluminum is also recycled whereas the remaining fluorescent powder after mercury extraction is used as a raw material for rare earth elements . Collected glass can be recycled to make raw materials for fluorescent lamps, glass wools, etc. These processes ensure that the fluorescent lamp is treated in an Environmentally Sound Manner as required by the Minamata Convention.

Photo provided by Nomura Kohsan Co., Ltd

Safety

Although the most of the process is automated, the workers carrying out some manual works use gloves and masks to prevent their exposure to any fugitive mercury; hence the process is considered very safe.

Applicability

No restriction on shape or size

Fluorescent lamps of any shapes or sizes, including Circular lamps, linear lamps, ball shaped lamps, CFLs, CCFLs, can all be treated using this method (some manual work is required to remove the coatings for lamps with anti-shattering coatings)

Proven Track record

This treatment method of fluorescent lamps is currently successfully being practiced in Japan. Furthermore, fluorescent lamps have been brought from other countries into Japan, through the procedures required by the Basel Convention, for the purpose of treatment and recovery of mercury. This arrangement has helped ensure an environmentally sound treatment of fluorescent lamps generated overseas, which otherwise may not have been possible.
Japanese recycling companies have installed lamp crushers in the partner countries to reduce transportation cost by volume reduction, subsequently supporting to promote the recycling of fluorescent lamps in the partner country.

Japanese lamp crusher installed in the Philippines

Photo provided by Nomura Kohsan Co., Ltd

Further Reading

UNEP, Practical Sourcebook on Mercury Waste Storage and Disposal
(http://www.unep.org/chemicalsandwaste/global-mercury-partnership/mercury-waste-management/activities-and-projects/practical-sourcebook)

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http://www.env.go.jp/en/chemi/mercury/mcm.html

Mercury Technology Bulletin Series:

004

Mercury Material Flow Analysis

Background

Requirement of the Minamata Convention on Mercury

Baseline information of mercury use and its emission and release is essential for national policy-making, and for identifying the mercury emission hotspots in the respective countries. Under the Convention, Parties have several obligations relevant to inventory development and reporting. The information obtained through reporting is used for evaluating the effectiveness of the Convention.

Article 8 (Emissions) and Article 9 (Releases)
Parties shall establish and maintain thereafter, an inventory of emissions/release from relevant sources.

Article 19 (Research, Development and Monitoring)
Parties shall endeavor to cooperate and develop/improve inventories including information of the use, consumption, and anthropogenic emissions into the atmosphere, and releases to the water and land of mercury and mercury compounds.

Article 21 (Reporting)
Parties shall include the information as called for in Articles 3, 5, 7, 8 and 9 of this Convention in its reporting.

Article 22 (Effectiveness Evaluation)
The Conference of the Parties (COP) shall evaluate the effectiveness of this Convention. Evaluation shall be conducted on the basis of available information, including those obtained from: (a) reports and other monitoring information provided to the COP; and (b) reports submitted pursuant to Article 21.

Overview of the Technology

Japanese Experience of Mercury Material Flow Development.

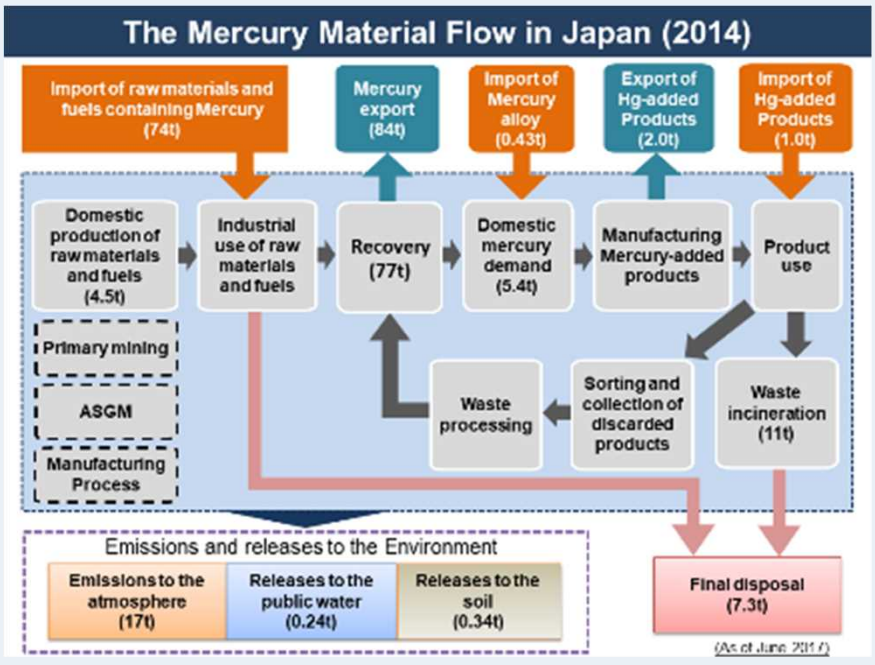
Japan has developed and upgraded the "**Mercury Material Flow (MMF)",** which contains comprehensive information on the flow of mercury in Japan through its life cycle, since 2007.

Year	Relevant activity
2007	Development of the 2005-base MMF
2009	Active discussions and studies of the MMF initiated
2011	Update of the 2005-base MMF to 2010-base MMF
2017	Development of the 2014-base MMF

In order to develop the MMF, the Ministry of the Environment, Japan (MOEJ) took the lead in data collection, in cooperation with other governmental bodies and industries. MOEJ also established a Technical Committee with experts from the academia and industry, with various backgrounds.

In order to estimate the overall mercury flow in Japan, MMF utilizes all available information, such as those listed below.:

- Statistical data
- Monitoring data
- Data obtained from interview with industries
- Questionnaire surveys to local government
- Research results



*No operation in Japan

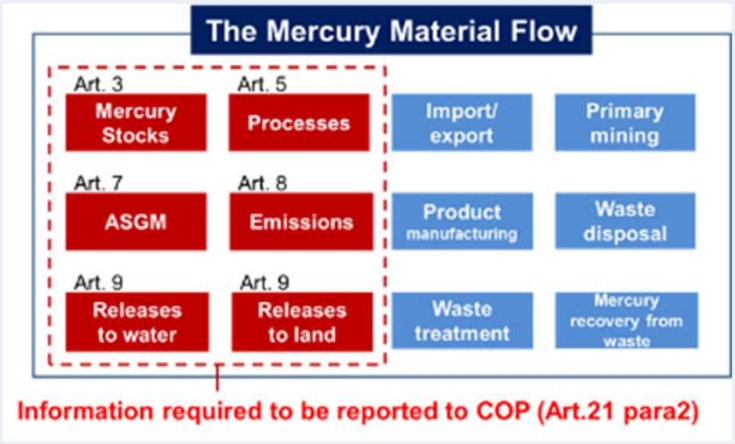
Advantages/Strengths

Database Supporting the Policy Making and Reporting Process

Many countries are in the process of preparing a national mercury emission inventory as part of the "*Minamata Initial Assessment (MIA)",* using the "*Toolkit for identification and quantification of mercury releases*" developed by UNEP. This is an effective tool for countries at the initial stage of developing a preliminary inventory.

Japan's MMF, however, also covers other aspects not covered by the UNEP Toolkit, and visually presents the life-cycle flow of mercury in the country by integrating relevant information. Moreover, the MMF provides more accurate estimate of mercury flow compared to the Toolkit since it is based on actual country-specific information. The method used for developing MMF assists policy makers to obtain a clear and accurate understanding of the overall picture of the mercury flow and to identify the key sectors and mercury emission hotspots where mercury management must be improved on a priority basis.

Furthermore, the MMF also assists the competent authorities in fulfilling their reporting obligations since it contains all the information required to report to the COP, pursuant to Article 21 para2 of the Convention. If updated and upgraded periodically, the MMF could also be used to examine the impact and effectiveness of domestic policy measures.



Applicability

Potential to develop MMF in your country

Mercury inventory to be developed using UNEP Toolkit is a good initial step for countries to understand their current situation of mercury emissions. Japan is able to share its expertise to develop a more comprehensive MMF after this initial step, if there is need from the partner countries.
Japanese experts have shared their know-how and experiences in developing MMF at a series of workshops organized by MOEJ in ten partner countries. The next step would be the consultation with the stakeholders to obtain useful information such as the monitoring data and reports published by international organizations for the partner countries.

Presentation by a Japanese expert in a workshop held in Kenya

The lack of information/data is a common challenge for developing countries. Japan's support to developing countries in searching appropriate methodologies to collect or develop data/ information will provide the most relevant basis on the circumstances of each country.

Further Reading

MOEJ, Outcomes of Mercury Material Flows Analysis (Japanese only)
(http://www.env.go.jp/chemi/tmms/materialflow.html)

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Ministry of the Environment

Monitoring of Mercury in Hair Samples

Background

People engaged in activities using mercury or consuming food containing mercury such as fish are 'exposed' to mercury. Thus it is essential to monitor the level of human exposure and develop appropriate strategies to address the resulting health impacts. Article 19 of the Minamata Convention also calls on the parties to cooperate and develop and improve monitoring of mercury and its compounds, particularly in vulnerable populations and environmental biota.

Japanese experience of the Minamata disease in the 1950s, caused by ingestion of methylmercury via contaminated fish, resulted in various groundbreaking research on mercury. Hence, Japan now possesses various technologies related to mercury identification, management and risk reduction.

Source : Website of NIMD

Overview of the Technology

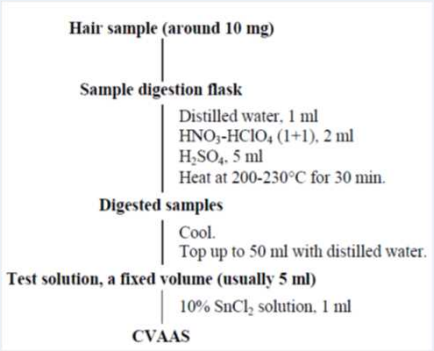
Analysis of Mercury in human bio samples like scalp hair are useful methods for evaluating the level of human exposure and burden to the human body from mercury exposure. Hair is the most suitable media for estimating methylmercury exposure of humans.

However, the mercury concentration in hair can increase as a result of adhesion of external mercury vapor and inorganic mercury . In cases of no exposure to external inorganic mercury or mercury vapor, almost all mercury in hair is in the form of methylmercury; therefore, the level of methylmercury exposure from diet can be evaluated by measuring total mercury. However, since people involved in gold mining and gold refining have a high risk of contamination from metallic mercury and mercury vapor, evaluation of actual methylmercury exposure is possible only by measuring methylmercury as well as total mercury in hair.

The National Institute for Minamata disease (NIMD), under the Ministry of the Environment, Japan (MOEJ), has carried out multiple researches to develop analytical methods for mercury, and published a "**Mercury Analysis Manual**". Analytical methods for measuring total mercury in hair samples is described below. Conventional methods for measuring total mercury include absorption spectrometry (dithizone colorimetry), neutron activation analysis, X-ray fluorescent spectrometry and cold vapor atomic absorption spectrometry (CVAAS). CVAAS is superior to other methods in terms of sensitivity, convenience, and cost-effectiveness. CVAAS is classified into reduction/aeration procedure and sample combustion procedure according to the generation mode for mercury in the elemental form. The former involves wet digestion with a mixture of strong acids following my addition of a reducing agent to generate mercury in the elemental form , whereas the latter involves elemental vapor generation through direct combustion of the sample. Analysis method for hair samples using wet digestion , reduction and CVAAS offers substantial improvements over the conventional method and has been explained in detail in the "Mercury Analysis Manual".

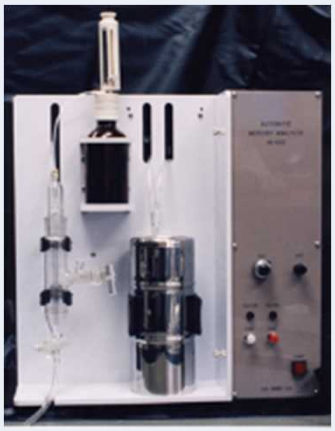
In Japan, data obtained from biomonitoring (including scalp hair samples), is used for implementing various policy measures, aimed at protecting human health. For example, the report: "Advice for Pregnant Women on Fish Consumption and Mercury" has been prepared by the Ministry of Health, Labor and Welfare, which provides a guide on the types and amounts of fish that can be safely consumed.

Determination of total mercury in hair



Source : Mercury Analysis Manual, MOEJ

Apparatus for reduction/aeration



Source : Website of NIMD

Mercury Technology Bulletin Series:

Advantages/Strengths

Ease of sampling

Mercury analysis through hair samples is simple, and it is a non-invasive sampling method where samples are also easy to preserve. Since the hair grows at a rate of roughly 1cm per month, evaluation of past exposure is also possible.

Decent tool for policy making and concrete action

For people concerned about their mercury exposure, providing their hair sampling results can be useful to help decision makers formulate policies, and take concrete actions to protect the population from mercury exposure.

Data accuracy

Methods developed by Japan using CVAAS for the analysis of total mercury is a highly sensitive method and offers substantial improvements over the conventional methods, hence providing much more accurate data.

Hair Weighing

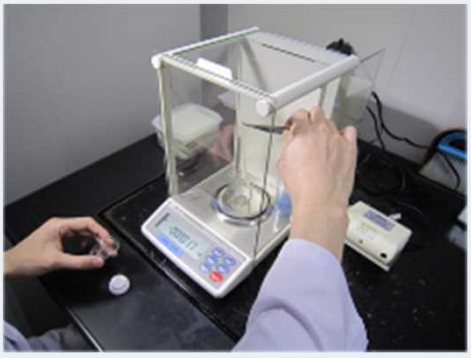


Photo provided by IDEA Consultants, Inc.

Applicability

Sampling and analysis of hair samples can be done easily and accurately, by following the mercury analysis manual prepared by NIMD.

Measurement using CVAAS

Photo provided by IDEA Consultants, Inc.

Further Reading

National Institute for Minamata Disease – Japan (NIMD)
(http://www.nimd.go.jp/english/index.html)

Advice for Pregnant Women on Fish Consumption and Mercury (2005)
(http://www.mhlw.go.jp/topics/bukyoku/iyaku/syoku-anzen/suigin/dl/051102-1en.pdf)
*this version has been updated in 2010 – Updated Japanese version is available at
(http://www.mhlw.go.jp/topics/bukyoku/iyaku/syoku-anzen/suigin/dl/index-a.pdf)

MOEJ, Mercury Analysis Manual
(http://www.nimd.go.jp/kenkyu/docs/march_mercury_analysis_manual(e).pdf)

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http://www.env.go.jp/en/chemi/mercury/mcm.html

Removal of Mercury from Flue Gas using Activated Carbon

Background

Control of emission of mercury and its compounds to the atmosphere from various industrial sources is essential in decreasing the total emission of mercury. Article 8 of the Minamata Convention requires for the control and reduction of mercury and its compounds to the atmosphere through measures to control emission from point sources falling within the source categories listed in Annex D of the convention (Coal-fired Power Plants, Coal-fired Industrial Boilers, Smelting and roasting processes used in the production of non-ferrous metals, Waste Incineration facilities and Cement Clinker production facilities).

For countries that are in a phase of transition to industrialized economy, increase in the number of facilities specified in Annex D of the Minamata Convention can be expected. In order to prevent and alleviate atmospheric pollution from these facilities, application of BAT is deemed to be essential.

Overview of the Technology

Facilities with combustion processes like incinerators, boilers, cement kilns etc. are typically equipped with a combination of various flue gas treatment devices like denitrification devices, Fabric Filters(FF), Dry or Wet Scrubbers, Flue gas Desulphurization (FGDs) units etc.

Although these devices are effective in reducing the emission of mercury to a certain extent, they are designed for the treatment of NOx, SOx, PM etc. and not specifically for the removal of mercury from flue gases.

In Japan, after the bitter experience with Minamata disease, an increase in public awareness to mercury has resulted in the development of various products that utilize activated carbon and now it is deemed to be a proven and effective technique for controlling the emission of mercury from flue gas. Due to their high degree of microporosity, activated carbons have a large surface area and hence mercury present in the flue gas is adsorbed into the activated carbon, thus preventing its emission. Activated carbon can either be installed in the form of pellets in an activated carbon tower, or through the injection of activated carbon into the flue gas (activated carbon sorbent injection). In Japan, various types of gas treatment devices that utilize activated carbon are used in incineration plants to control mercury emissions.

Granular Activated Carbon

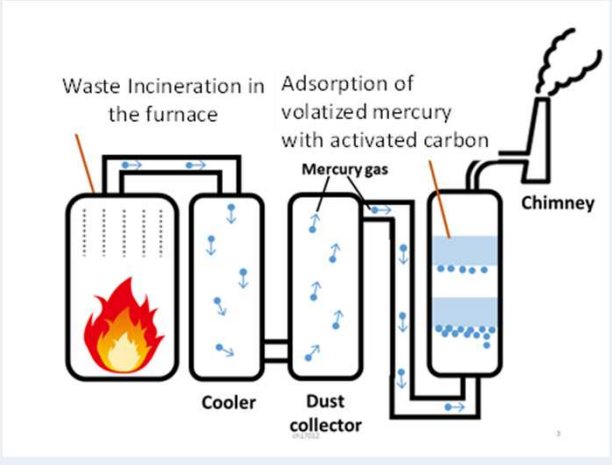
Crushed type

Pellet type

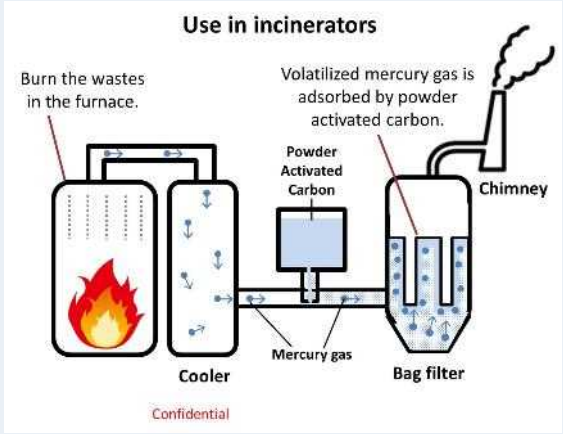
Powder Activated Carbon

Photos provided by Ajinomoto Fine-Techno Co., Inc.

Mercury removal from a typical incineration plant using Granular activated carbon



Mercury removal from a typical incineration plant using Powder activated carbon



Source: Ajinomoto Fine-Techno Co., Inc.

Mercury Technology Bulletin Series:

Advantages/Strengths

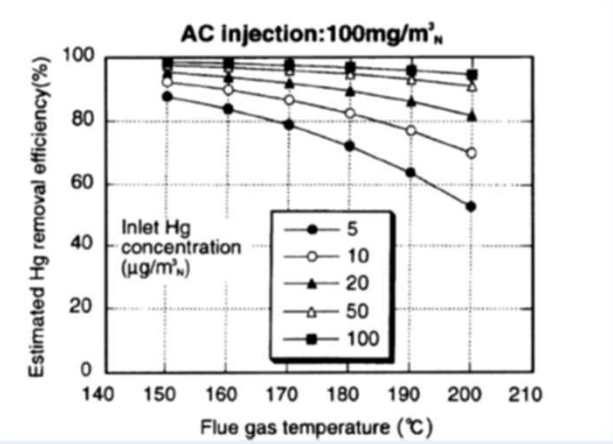
Effective Removal of Mercury

Activated Carbon is very effective in the removal of mercury and although factors like temperature, inlet mercury concentration impact the performance, the removal efficiency of mercury can reach to over 90%. Using Activated Carbon, in conjunction with other flue gas treatment methods, can further improve mercury removal efficiency.

Products with Enhanced Performance

Activated Carbon products that provide enhanced performance compared to traditionally used ones have been developed. These products have a comparatively higher adsorption potential (up to 1000 times) ensuring that the flue gas treatment device can be smaller in size. As these products last longer, they do not need to be replaced as often. This helps in reduction of the amount of waste generated, contributing to the reduction of the total operation cost of the flue gas treatment devices. These products also provide improved stability at higher temperature.

Mercury Removal Efficiency of Activated Carbon Injection in incinerators of municipal solid waste (MSW)



Source : Japan Environmental Facilities Manufacturers Association

Activated Carbon products with enhanced performance

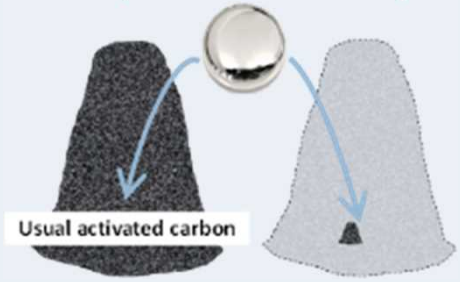


Photo provided by Ajinomoto Fine-Techno Co., Inc.

Applicability

Mercury control needs to considered as part of a comprehensive pollution control measure that includes other pollutants. From the viewpoint of mercury removal, activated carbon is considered to be one of the most effective methods for the removal of mercury and is being successfully used in facilities like incinerators to control emission of mercury from flue gas.

Activated Carbon products come in various forms like granular (crushed type/pellet type), powders which have been engineered into various forms like towers or sorbent powders. Depending upon the requirement, the appropriate product can be chosen and applied.

Further Reading

MOEJ, Technologies for the treatment of flue gas from incinerators (Japanese only)
(https://www.env.go.jp/council/07air-noise/y079-03/mat02_7.pdf)

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http://www.env.go.jp/en/chemi/mercury/mcm.html

環境省 Ministry of the Environment

Reduction of Atmospheric Mercury Emission through Improvement of Efficiency of Coal Combustion

Background

In some cold countries, combustion of coal for heating purpose is a common practice. This results not only in the emission of CO_2 from households and buildings that contributes to global warming, but also increase in the emission of other pollutants, including mercury contained in coals, causing an aggravation of atmospheric pollution during cold months.

Although this particular source of mercury emission is not listed in Annex D of the Minamata Convention and therefore is out of the scope of Article 8, it is nevertheless an important issue that has been identified as a priority by some countries and requires action to alleviate air pollution and hence protect human health and the environment. This document introduces a technology , as exemplified with a project in Mongolia, that can be utilized for the reduction of atmospheric emissions of conventional air pollutants through improvement of efficiency of coal combustion.

Air pollution in Ulaanbaatar

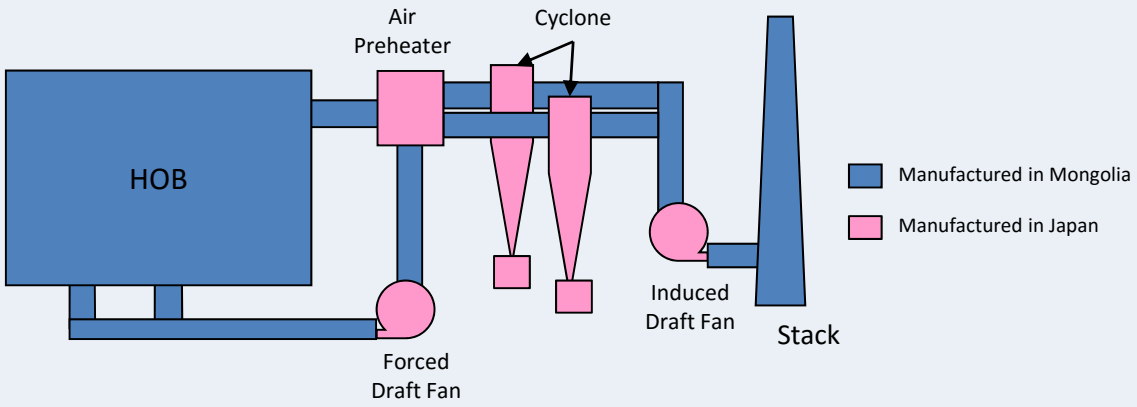
Summer Winter

Overview of the Technology

In some countries with cold climate, a large amount of coal is used for the purpose of heating during winter time. In addition, in urban areas many apartment complexes and school buildings use HOBs (Heat Only Boilers) for heating purpose as well. These HOBs tend to be old and rudimentary with an inferior combustion efficiency which can lead to serious problems of atmospheric pollution resulting in restriction of visibility even during day time.

In addition to the mass consumption of coal, inefficiency of coal combustion by existing HOBs also contributes to the deterioration of air quality.

Overview of the Upgrade of HOB



Source: Overseas Environmental Cooperation Center, Japan

Existing Heat-Only-Boilers (HOBs) can be upgraded to obtain a stable combustion, to reduce coal consumption and emission of air pollutants, to improve thermal efficiency and to reduce HOB dust. The improvement includes the upgrading of Cyclone (improvement of flow dust collection), upgrading of Air Preheater (replacement of heat exchange tube) and improvement of Forced Draft Fan and Induced Draft Fan (air flow adjustment, using corrosion protection material). The upgrading of HOBs in Mongolia has resulted in the reduction of coal consumption amount with the co-benefit of reduction in the emission of NOx, SOx, CO_2 and dust.

Mercury Technology Bulletin Series:

Advantages/Strengths

Co-benefit of reduction of pollutants

A major advantage is that the prevention of emission of a variety of air pollutants can be achieved along with decrease in the emission of CO_2, while simultaneously benefiting from the increase in the amount of power generated due to efficiency improvement. In this example, the following reductions were achieved :

Coal consumption: Reduction of 10-30 % CO (Carbon monoxide) Exhaust: Reduction of 30-60 %
NOx , SOx Exhaust: Reduction of 8-20 % Dust Exhaust: Reduction of 50-80 %

Reduction of coal consumption and dust exhaust also leads to the reduction of emission of heavy metals (Hg, Se, etc.).

Co-benefit of improvement to operation and maintenance

Improvement of boiler also results in the improvement of the safety of the workers through improvement in the work procedures, improvement of indoor air quality in the boiler room (through reduction of soot, fire overflow) and improvement in safety.

Before modifications

After modifications

Applicability

Over 1,000 HOBs are in operation in Mongolia. The improvement of coal combustion efficiency using Japanese boiler technology contributes to co-benefit of pollution control, reduction of mercury emission and decrease of coal consumption. This technology can also be applied to other partner countries.

Depending on the requirement and availability of funding sources, the improvements can be carried out incrementally in multiple stages. Further, Japanese technology can be utilized for manufacturing of required components locally, hence making it possible to keep the cost down.

Further Reading

MOEJ, JCM Project in Mongolia (Japanese only)
(https://www.env.go.jp/press/102859.html)
IGES, Workshop on JCM
(https://www.iges.or.jp/en/climate-energy/mm/20151110_1.html)
Carbon market express, Project Details
(https://www.carbon-markets.go.jp/eng/en_column/en_energy_efficiency/1780/)

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環境省
Ministry of the Environment

Treatment of Mercury Sphygmomanometers

Background

Requirement of the Minamata Convention on Mercury

Article 4 of the Minamata Convention requires the phase out of mercury added product including sphygmomanometers containing mercury by 2020.

Mercury contained in these devices needs to be recovered to the extent possible, in order to prevent contamination of the environment from improper handling of these products. However, mercury is a chemical element, and unlike other organic pollutants, cannot be treated easily with conventional treatment measures.

Furthermore, Article 11 of the Convention requires each Party to take appropriate measures so that mercury waste is managed in an environmentally sound manner. Sphygmomanometers contain about 50 grams of mercury. Hence, mercury should be extracted from these devices and treated/disposed in an environmentally sound manner.

Sphygmomanometers with mercury

Overview of the Technology

Sphygmomanometers are manually dismantled under fumed hoods which are setup inside an enclosed dismantling facility. The dismantling facility is closed off from other areas to prevent accidental leaking of mercury vapor to other areas.

Mercury vapor generated in the fume hood or the facility is processed through the exhaust air treatment process using activated carbon. Mercury is collected in an iron bottle attached to the bottom of the fume hood. Workers are required to wear hard hats, masks, goggles and work clothing and gloves. Parts that come in contact with mercury are dismantled separately from those that do not. All the parts are collected separately according to the composition of the material. Dismantling of the mercury tank itself is carried out inside a fume hood. Iron and aluminum are recycled whereas glass and other materials are treated further by roasting (600^{0}C to 800^{0}C) where mercury is vaporized and collected.

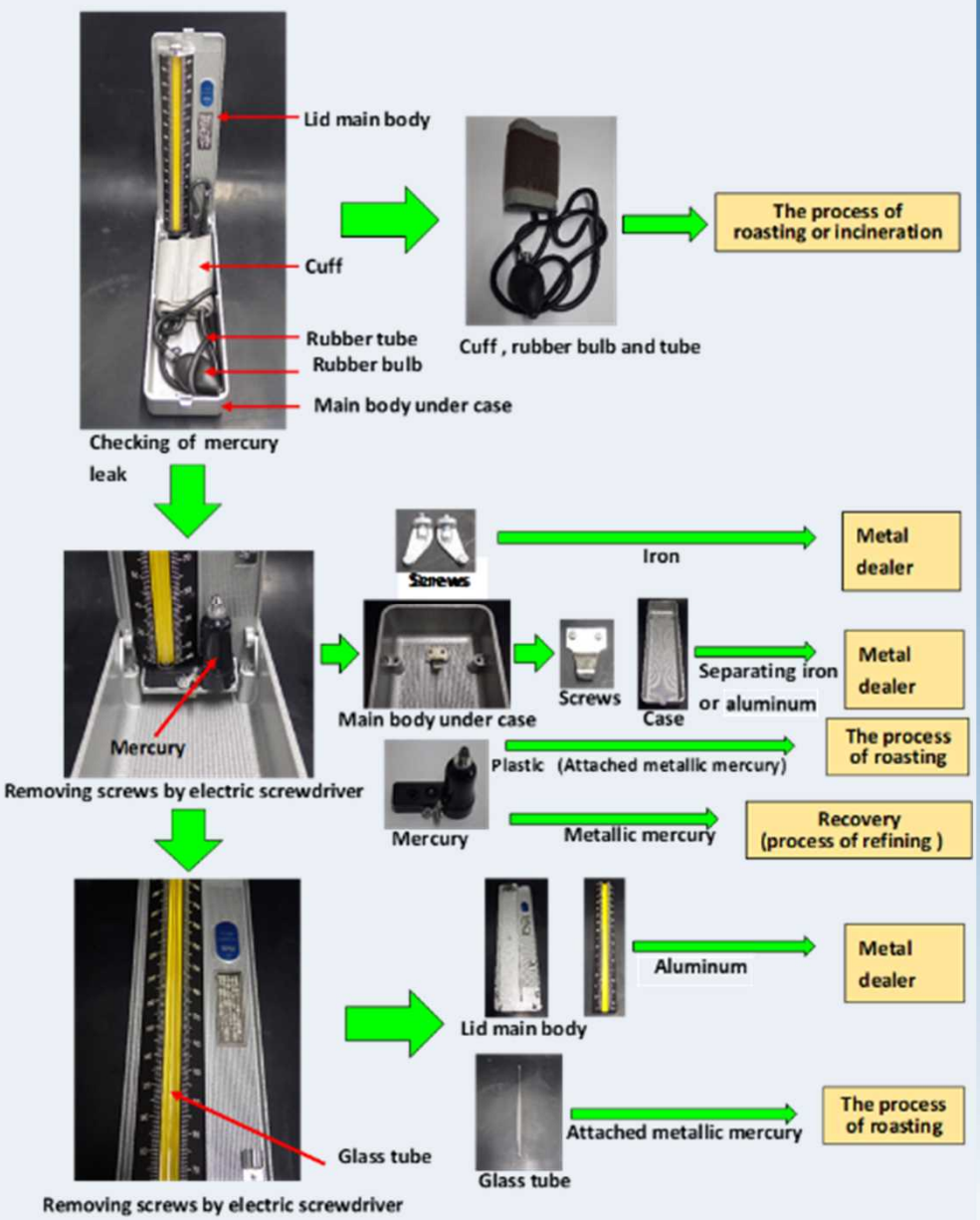

Photo provided by Nomura Kohsan Co., Ltd.

Mercury Technology Bulletin Series:

Advantages/Strengths

High recovery rate of mercury

A combination of manual dismantling and roasting ensures that the recovery rate of mercury is very high. On average, about 50g of mercury is recovered from one sphygmomanometer.

Safe and environmentally friendly method

Combination of fumed hood and sound care during dismantling ensures that no leakage of mercury occurs. Any material that comes in contact with mercury is sent for roasting whereby the mercury is vaporized and collected. Workers use safety gears while dismantling ensuring that the process is safe and environmentally friendly.

Recycling of components

One advantage of manual segregation is that in addition to recovery of mercury, other components of the devices like iron, aluminum, etc. can be separated and recycled.

Dismantling process

Photo provided by Nomura Kohsan Co., Ltd.

Applicability

In many countries, phase out of mercury containing medical measuring devices is being promoted through their health ministries. However, there is a lack of institutional framework to treat these devices once they become waste.

Hence, these devices end up being stored in containers inside interim storage facilities located within the hospital premises until an adequate treatment/disposal method becomes available. Japan has a lot of experience and know how on safe methods of handling of mercury containing medical measuring devices without breakage. Further, Japan also has established a scheme to collect thermometers and sphygmomanometers from households and hospitals which can be of reference to other countries.

Further Reading

UNIDO, Nomura Kohsan's mercury waste management technology
(http://www.unido.or.jp/en/technology_db/1716/)
MOEJ, Guidelines for Separation and Collection of Mercury Containing Waste discharged from Households (Japanese only)
(http://www.env.go.jp/recycle/waste/mercury-disposal/h2712_guide1.pdf)

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http://www.env.go.jp/en/chemi/mercury/mcm.html

Stabilization and Solidification of Mercury

Background

The Minamata Convention on Mercury has placed various restrictions on usage, import and export, and transboundary movement of mercury. The demand for mercury is expected to decrease in the future as the usage of mercury will only be allowed for certain uses specified in the Convention. Article 11 of the Minamata Convention calls for each Party to take appropriate measures to manage mercury waste in an environmentally sound manner. Hence, mercury that has become surplus will become waste and will require environmentally sound management (ESM). Furthermore, the Minamata Convention requires the phase out of Chlor-Alkali production facilities using mercury by 2025 and a lot of excess mercury is expected to be generated as a result. The paragraph 5 (b) of the Article 3 of the Convention specifically requires the environmentally sound disposal of excess mercury from the decommissioning of chlor-alkali facilities. Hence it is expected that the ESM of waste elemental mercury will become a very important issue and a common challenge for many Parties in the future.

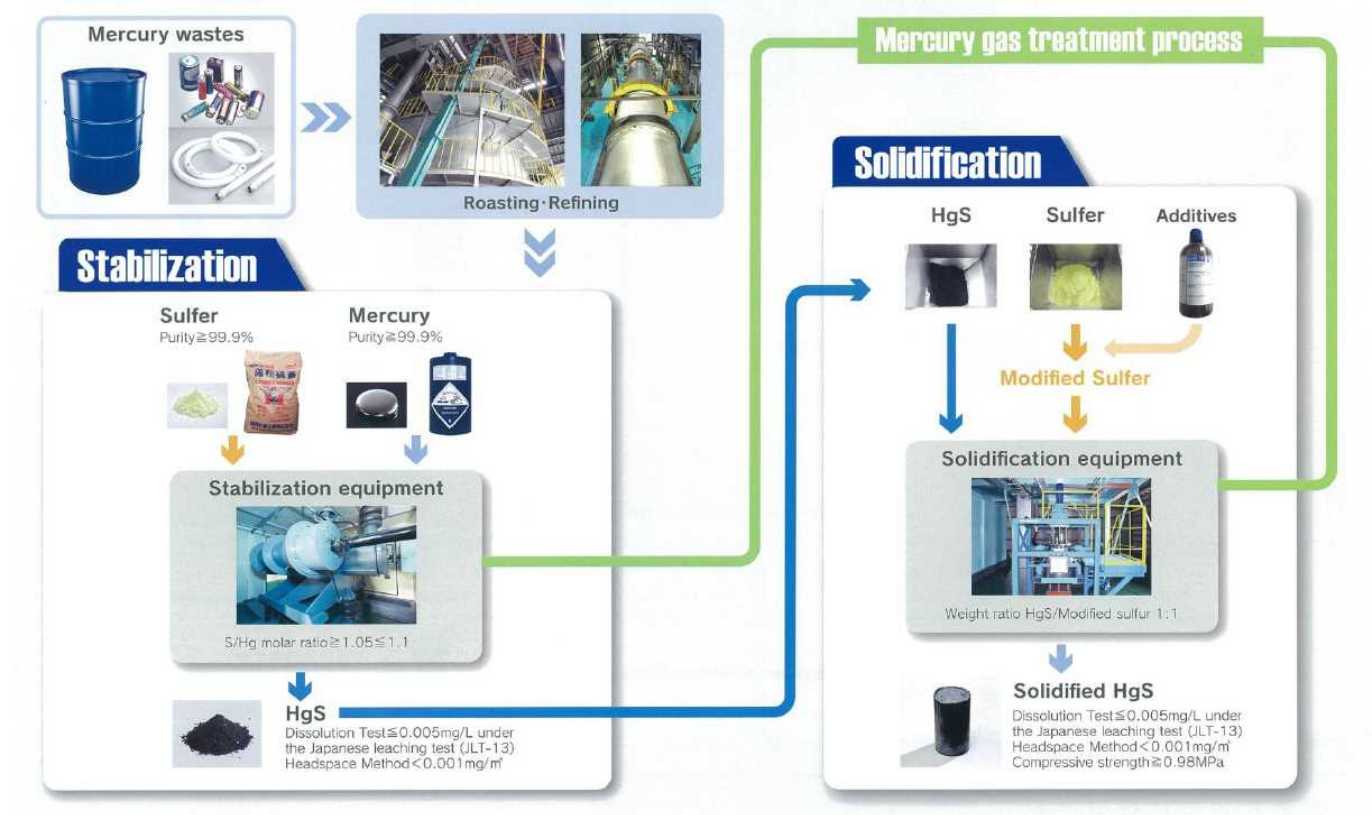
Overview of the Technology

Technology includes the process of stabilization using sulfur and subsequent solidification of the stabilized product.

Stabilization of elemental mercury is carried out by mixing mercury with pure sulfur (purity >99.9%) and treatment in a specialized equipment. The end product is Mercury Sulfide (HgS).

The stabilized mercury can also be treated through a solidification process if required by national regulations. This involves the mixing of the treated HgS with sulfur and special additive in a fixed ratio in a controlled environment of a specialized device. The end product is solidified HgS that can be safely disposed in a landfill or in an underground mine (Dissolution test =< 0.005mg/L, Headspace method < 0.001mg/m^3, Compressive strength >= 0.98 Mpa).

Overview of Stabilization and Solidification process



Source: Nomura Kohsan Co., Ltd

Mercury Technology Bulletin Series:

Advantages/Strengths

Environmentally Sound Treatment

Majority of mercury in nature exists in the form of mercury sulfide (HgS) and hence this form of mercury is very stable with very little risk of volatilization and elution of mercury. Dissolution tests conducted on Mercury Sulfide produced using this method have shown mercury concentrations to be less than 0.005mg/L

Black Mercury Sulfide after stabilization

Photo provided by Nomura Kohsan Co., Ltd

Reliable method for Stabilization

Other methods of stabilization like Vapor-Phase synthesis method require sophisticated equipment and have a risk of leakage/release of mercury. Mechano-chemical method controls physical reaction of mercury and sulfur and does not use any chemical. It results in a low risk of leakage/release of mercury as mercury is not vaporized.

Solidified Sulfur Polymer

Photo provided by Nomura Kohsan Co., Ltd

Improved method of Solidification

Using sulfur for solidification produces a product that is of higher density, higher strength, higher salinity tolerance and higher acid resistivity than using traditional method of concrete solidification.

Applicability

The requirement of the degree to which excess mercury needs to be treated depends on the legal requirement as described in the standards or guidelines developed in each country. Countries that do not yet have legal stipulations need to develop guidelines , taking into account the country`s existing environmental and safety laws and regulations.

The legal requirement will determine whether stabilization of mercury alone is sufficient , or whether a further step of solidification may be required after stabilization. Package units for stabilization of waste mercury that can be installed and used onsite is now under development. Export of these mobile units from Japan are planned which can then be set up in the countries where ESM of the waste mercury presents significant challenges.

Stabilization and Solidification plant

Photo provided by Nomura Kohsan Co., Ltd

Final storage in controlled landfills

Source: Nomura Kohsan Co., Ltd

Further Reading

Nomura Kohsan Co., Ltd, Development of Stabilization and Solidification Technology
(http://nkcl.jp/research/stabilization-solidification-processes/)

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環境省
Ministry of the Environment

Monitoring of Mercury in Ambient Air

Background

Mercury is emitted to the atmosphere from both natural and anthropogenic sources. In order to make the necessary policy decisions and develop specific strategies for the reduction of anthropogenic emission of mercury from various sources, the information on the level of mercury in the ambient air is necessary. Article 19 of the Minamata Convention also calls on the Parties to endeavor to cooperate with each other and to develop and improve the monitoring of levels of mercury and its compounds.

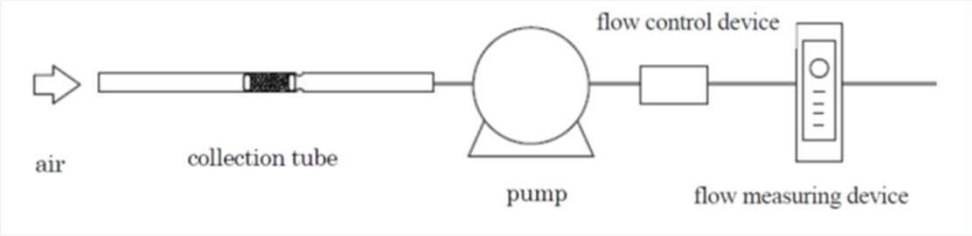
Japan has developed a reliable method for the measurement of mercury in the ambient air and published it as a part of the *"Manual of Measurement Method of Hazardous Air Pollutants".* This manual will be a useful tool for countries to prepare a monitoring system for atmospheric mercury.

Overview of the Technology

The measurement method for mercury in the ambient air, as described in the *"Manual of Measurement Method of Hazardous Air Pollutants"* comprises of Gold Amalgamation Trap, Thermal Desorption and Cold Vapor Atomic Absorption Spectrometry.

Mercury in the ambient air is collected at a constant flow rate by using a collection tube (inner diameter 4mm) filled with mercury trap particles (80 mg of particles capped on both sides with quartz wool) . The particles are composed of diatomaceous earth particles (thermostable earth particles of 500 – 600 µm in diameter) with gold bake-coated on their surfaces.

Overview of mercury sampling device

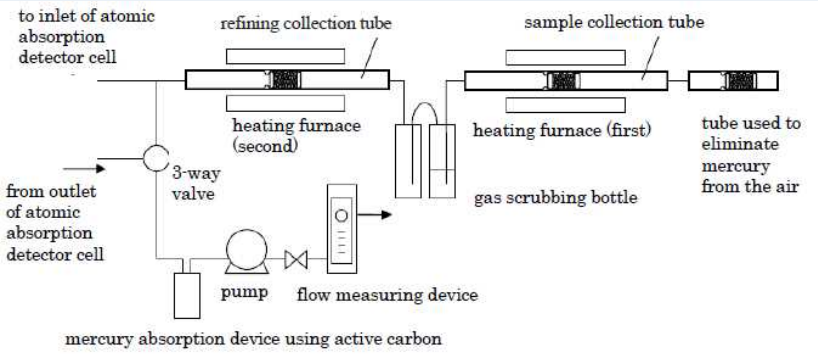


Source : Manual of measurement method of hazardous air pollutants

Generally, the flow rate of air sample collection is 0.5-1 mL per minute and sample is collected for 24 hours for ambient monitoring. As the flow rate is not very high, the collection of air sample can be done by a small pump. The necessary electrical power is also small.

During sampling, the surfaces of the particles may adsorb interfering gas other than mercury vapor that could compromise the measured values of mercury. The collected air sample tube is sealed and sent to the laboratory for measurement. On measurement of the CVAAS (Cold Vapor Atomic Absorption Spectrometry), in order to eliminate the influence of interfering gas, the collection tube is connected to a thermal desorption device whereby the generated mercury vapor is re-trapped by a refining collection tube. Then desorbed atomic mercury from secondary collection tube is led to the absorption detector cell of the atomic absorption spectrometer to determine the quantity of mercury by measuring the atomic absorption at a wavelength of 253.7nm. Measuring instruments specific to this type of collection tube are commercially available, but generic Atomic Absorption Spectrometer can be used for measurement by setting up the device to introduce mercury into the spectrometer from heater or pump.

Thermal Desorption Device



Source : Manual of measurement method of hazardous air pollutants

Mercury Technology Bulletin Series:

Advantages/Strengths

Data accuracy

This method of measuring the concentration of mercury in the ambient air using Gold Amalgamation Trap, Thermal Desorption and Cold Vapor Atomic Absorption Spectrometry is the official method for atmospheric mercury monitoring in Japan.

It is a proven method commonly used in Japan and is widely considered to provide accurate and reliable data. If the clearly defined procedures for measurement are followed, very little difference in measured value, irrespective of which entity is carrying out the measurement, is observed. This ensures comparability of various different data sets obtained through measurement using this technique.

Decent tool for policy making and concrete action

Measurement of ambient air concentration of mercury can be a useful tool to help decision makers to formulate policies, and take concrete actions to protect the population from mercury exposure. The method can be used for formulation of monitoring system by policy makers. As the device used for sample collection is small and inexpensive, this method can be applied for the monitoring of local mercury usage and emission.

Example of sampling setup

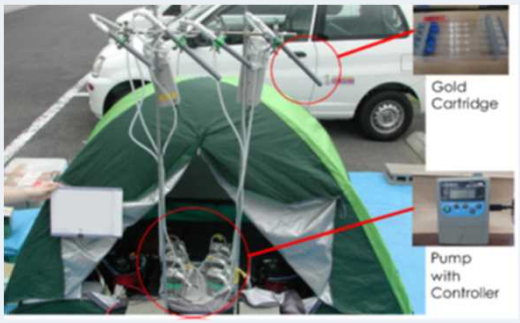


Photo provided by IDEA Consultants, Inc.

Applicability

With this method, analysis and collection of gaseous elemental mercury in the ambient air is possible. Measurement accuracy and sampling efficiency of the other chemical forms of mercury is partly uncertain. However, as the majority of mercury in ambient air exists as gaseous elemental form, the measured value determined by this method is considered as measured value for mercury concentration in the ambient air.

In order to ensure the reliability of the measured value, it is necessary to implement a strict measurement quality control. The Japanese government, through Japan International Cooperation Agency (JICA), has started a training programme since 2017 entitled “Capacity strengthening for multi-media mercury monitoring (4M) ” aimed at laboratory technicians from developing countries on monitoring of mercury. The goal of this program is to enhance the capacity of analytical techniques and laboratory management necessary for more functional mercury monitoring.

Training of participants from developing countries

Further Reading

MOEJ, Manual of measurement method of hazardous air pollutants – Monitoring of mercury in the Ambient Air (Japanese only)
(http://www.env.go.jp/air/osen/manual2/pdf/01_chpt6.pdf)

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