

Solutions for Mercury Analysis in Ambient Air

Mercury emissions has no boundaries. Emitted mercury can travel relatively hundreds of miles away from its source of emission. Thus, reduction of mercury in the atmosphere requires transboundary effort. There are two main sources of mercury emissions, namely natural and anthropogenic emissions. Anthropogenic emissions account for most of the mercury emissions which made up about 2200 metric tons per year.

Types of Anthropogenic Emissions				
Artisanal and Small Scale Mining 837,658 kg	Stationary Combustion of Coal 473,777 kg	Nonferrous Metals Production 326,657 kg	Cement Production 233,168 kg	Waste from Products 146,938 kg
Vinyl Chlorine Monomer 58,268 kg	Biomass Burning 51,860 kg	Ferrous Metals Production 39,903 kg	Chlor-alkali Production 15,146 kg	Waste Incineration 14,944 kg
Oil Refining 14,377 kg	Stationary Combustion of Oil and Gas 7,130 kg	Cremation 3,768 kg		

Global sources of mercury. See table for full details.
Source: [Technical Background Report of the Global Mercury Assessment, 2018.](#)



Types of mercury

Gaseous Elemental Mercury (GEM)

GEM is described as the most abundant (~95%) and enduring species in the atmosphere. As the GEM's reactivity with other pollutants is very low, its lifespan can last up to 2 years. With its high volatility, GEM tends to travel hundreds of miles away from point of emission. After some weathering and reaction with atmosphere oxidants, some of the GEM might form dry or wet deposits in our ecosystem, directly infiltrate into our ecosystem.

Solutions for the analysis of GEM

Depending on each laboratory's needs and capabilities, solutions for measuring mercury in ambient air can be divided into 3 categories which are:

1 Continuous, Unattended, and Fully Automated Monitoring with AM-6F

NIC AM-6F, a fully automated continuous mercury monitor, is designed for automated and continuous monitoring of Gaseous Elemental Mercury (GEM), especially in ambient air.

Technique in AM-6F:	Direct Gold-Amalgamation Sampling CVAFS (Fluorescence technology) Detection
Recommended usage:	24/7 Remote Monitoring of GEM in Ambient Air
Detection limit:	0.1ng/m3 (4.2 Liters of the sample)



AM-6F is designed with the **NICares** principle to save energy, save resources with less waste generation. It is a great tool for laboratories who wanted to understand the background of the region and data can be served as a reference for ambient air quality monitoring. The data will be useful in trend studies, transboundary effects of mercury pollution, and geochemical cycling of mercury.

Particulate Bound Mercury (PBM)

Emitted mercury tends to bind to particles in the dusty area such as industries. It plays an important role in the geochemical cycling of mercury in the atmosphere. The amount of PBM is very small though compared to GEM though it is frequently associated with the abundance of emission sources.

Solutions for the analysis of PBM

Multiple techniques are used in the sampling of PBM, which includes quartz filter sampling where continuous stream of air is pulled through the quartz sampling paper to trap the particulate matters.

Conventionally, the quartz sampling paper must be digested by a series of wet chemical sample preparation. This procedure is time-consuming. Moreover, since mercury content in this application is usually in the ultra-trace level, the tedious wet-chemical preparation is highly prone to error due to handling and external contamination.

NIC MA-series offers a solution to analyze the quartz sampling paper directly without going through the wet chemical sample preparation.

Technique:

Sampling:

Quartz Filter Paper (47mm),
~5L/min Flow rate

Measurement:

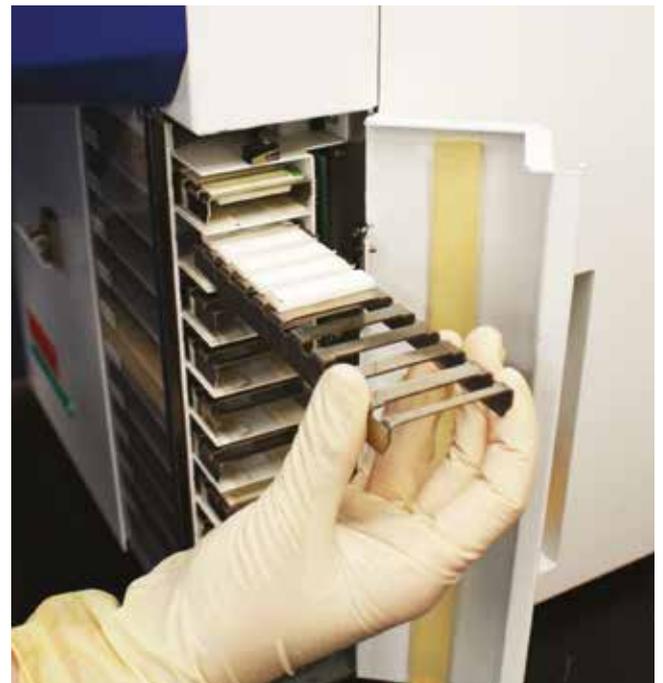
Thermal Decomposition / Gold
Amalgamation / CVAAS Detection

Recommended usage:

Dust and Particulates in Ambient Air

Detection limit:

0.001ng (MA-3000); 0.01ng
(MA-3 Solo)



2.1 Manual Active Sampling and Measurement with:

SK-1000A + WA-5 Series

NIC offers Ambient Air Sampling Kit, SK-1000A as a solution for researchers and laboratories that needs to conduct field samplings of mercury in ambient air. SK-1000A kit comes complete with apparatus to setup for manual active sampling using NIC mercury collector tube (also known as the gold amalgamation tube), which can later directly analyze in NIC WA-series Mercury Analyzer or other series with Thermal Tube Desorption (RH-module). Choices of CVAAS and CVAFS detector are available on NIC WA-series. **This Manual Active Sampling Technique is validated by the Ministry of Environment Japan (MOEJ) documented in the Manual of Measurement Method of Hazardous Air Pollutants.**

Technique:

Sampling: Direct Gold Amalgamation Sampling using NIC Mercury Collector Tube and Pump

Measurement (In the lab): Thermal Tube Desorption / Gold Amalgamation / CVAAS or CVAFS Detection

Recommended usage: Targeted site ambient air monitoring and other gaseous matrices

Detection limit: 1pg (CVAAS); 0.1pg (CVAFS)



2.2 Active Sampling and Measurement with:

EMP-Gold+ Field-Portable Mercury Monitor



EMP-Gold+ is engineered for on-site continuous, **in-situ** sampling of GEM in ambient air and measurement down to ultra-trace levels. To enhance our user's experience to field application, EMP-Gold+ is powered by re-chargeable batteries to ensure its portability at its best without the need for a plug, offering a truly **grab-and-go** mercury monitor. Nevertheless, AC power operation is still available with AC adapters, if required.

Technique:

Sampling: Automatic Direct Gold Amalgamation Sampling with onboard Mercury Collector Tube and Pump

Measurement (On-site): CVAAS Detection (within EMP-3)

Recommended usage: Targeted site ambient air monitoring, soil gas, and other gaseous samples

Detection Limit: 2pg



3 Passive Sampling (with Sulfur-based Diffuser) and Measurement with:

Passive sampler is an alternative sampling to conventional active samplers. Especially with sampling sites that are difficult to access to, and or lack of utilities for setting up of active sampler, passive sampler can be deployed instead. After the sampling is done, the sorbent in the passive air sampler (PAS) will be processed by wet chemical sample preparation or direct thermal decomposition procedure prior to measurement. The direct thermal decomposition technique is simpler as it avoids the use of any wet reagents, which is usually tedious, labor-intensive, time-consuming and prone to handling error. NIC MA-Series offer ease of use, quick and direct analysis of passive air sampler with result in a few minutes.

Technique:	
Sampling:	Passive Air Sampling Deployment (week / month)
Measurement:	Thermal Decomposition / Gold Amalgamation / CVAAS Detection
Recommended usage:	Ambient Air Monitoring
Detection limit:	0.001ng (MA-3000) 0.01ng (MA-3 Solo)

Reactive Gaseous Mercury (RGM)

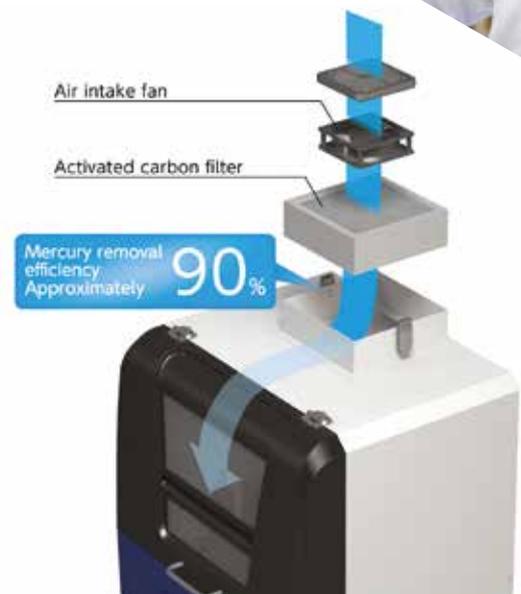
RGM is also referred to as GOM (Gaseous Oxidized Mercury). These species made up a small fraction of the atmospheric mercury, but it is prudent to be included in the assessment of environmental impact. RGM has much higher water solubility. It usually reaches the ground via rain or snow. The accumulation of RGM in the eco water systems will eventually lead to water contamination, which impacts human health directly through contaminated food and water intake.

Solutions for the analysis of RGM

Although RGM is usually deposited as rain or snow, it will be discussed here as part of the ambient air monitoring solutions. The amount of RGM or GOM is very low compared to GEM and thus its concentration in rain or snow precipitation is usually found at the ultra-trace level. Suitable rain samples or snow condensates are collected and analyzed as water samples.

RGM's lifespan is merely approximately a few hours, it possesses a much higher adsorption rate and forms an irreversible bond with hair (Abdelkarem A. S. Elgazali, 2018) which can cause devastating impacts such as mercury poisoning to the exposed group.

To analyze the ultra-trace level of mercury in rain deposits or snow precipitation, RA-4300FG+ from NIC is designed to combat a few challenges in ultra-trace level mercury analysis, following and complying with the stringent QC criteria defined in USEPA 1631e methodology.



Discrete Direct Purge (DDP) Technique

Reduce memory effect caused by the mercury

Japanese state-of-the-art CVAFS Detector

Highly Stable for Ultra-Trace Mercury measurement (Detection limit down to 0.1pg)

Built-in "Clean Chamber"

Providing an ultra-clean environment for CVAFS measurement

Technique:	Discrete Direct Purge (DDP) – Reducing Vaporization – Gold-Amalgamation – CVAFS
Method:	USEPA 1631e
Recommended usage:	Rainwater, Snow, Sea Water, and other clean water matrices
Detection limit:	0.05ppt (5mL sample size)



NIPPON INSTRUMENTS CORPORATION

Leading In Innovation



Nippon Instruments Corporation (NIC), the global leader in Mercury Analyzer automation and instrumentation, commercialized the world's first direct thermal decomposition Mercury Analyzer back in the 1970s'. Since that time, we have continued to develop, sell and install a vast range of Mercury Analyzers and customized solutions around the world for regulatory agencies and institutions, universities, research groups, oil and gas refineries, petrochemical industries, food providers, biology and toxicology science groups and more.

Thanks to our strong R&D capacities and technological innovations, NIC is the driving force in the Mercury Analyzer market, setting the standards for functional scope and user-friendliness. With a dense network of knowledgeable sales partners and qualified service partners, we provide scientifically sound and environmentally responsible solutions for our customers around the globe.



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