Mercury Technology Bulletin Series: 015

Heating vaporization mercury measuring device for multiple sample matrices

Background

The importance of mercury management

Manufacturing, import and export of certain fluorescent lamps, batteries, and other mercury-added products were prohibited after the Minamata Convention on Mercury entered into force. In addition, used mercury-added products are being collected as waste and being replaced with mercury-free products. Nevertheless, mercury still may be contained in food such as seafoods, underground resources, cosmetics, etc. in trace amounts. There is a need to analyze the concentration of mercury circulating in our surroundings and daily lives in order to manage it appropriately, thereby maintaining and managing a safe lifestyle.

Various methods of mercury analysis are available, but mostly require sample chemical-pretreatment. It is best to have a technique that is versatile enough to simply measure directly samples of different matrices (solid, liquid, gaseous and oil) with ease and accuracy.

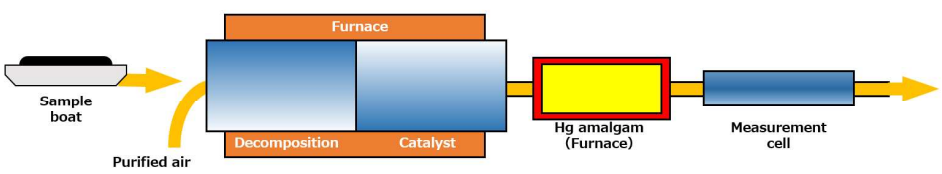
Overview of the technology

Heating vaporization mercury measurement technology

Mercury species contained in various types of sample media can be extracted into mercury gas by heating to high temperatures. The extracted mercury gas is selectively collected and concentrated as gold amalgam, with an adsorbent which is coated in gold. The mercury gas can be separated by heating on the amalgam. The released concentrated mercury gas is transferred to a suitable detector for measurement.

Taking advantage of amalgamation properties, it can be deployed to collect and concentrate mercury gas in ambient air. Atmospheric mercury is concentrated by flowing the air stream passed the gold-coated adsorbent at a fixed flow rate for a preset period of time. The gold-coat absorbent is then heated to vaporize the concentrated mercury gas out for measurement.

Schematic diagram of heating vaporization measurement



Features and benefits of heating vaporization mercury measuring device:

- Measurement is completed in about 10 minutes
- Almost no chemical agents such as acids required
- No wastes such as waste liquid produced after measurement
- High sensitivity due to single measurement of concentrated mercury gas extracted from each sample

Typically, trace amounts of heavy metals in water, soil, food, hair, etc. are measured conventionally by breaking down the sample using chemical agents such as acids.

These chemicals used in analysis are often toxic and/or harmful, handling and managing them requires knowledge and qualifications in chemistry. Moreover, waste liquid produced after measuring is also toxic and requires careful waste management.

In addition, toxic gases may be generated during the sample's wet-chemical decomposition process, making safety and cautiousness of the work environment important.

Heating vaporization technique is an analytical method that decreases the challenges associated with typical analysis while achieving highly accurate measurements of the samples. Although it has long been established as an analytical technique, the recent development of compact, portable heating vaporization mercury measurement device gives and improves the convenience and ease of analyzing mercury in samples directly.

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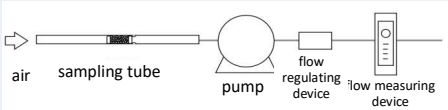
Advantages / Benefits

Measurement of mercury in various matrices (solid, liquid, gas, oil, etc.)

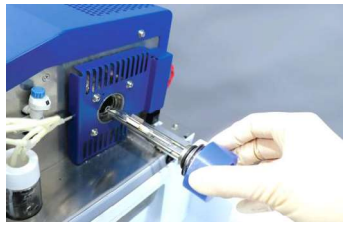
The device is compact, portable, and easy to setup which makes it adaptable to any analysis location. In addition to solids and oils, gases and liquids can also be measured.

1. Measurement of mercury in the air

Samples collected in the air sampling tubes described in the Manual of Measurement Methods for Hazardous Air Pollutants which is commonly used in Japan, can be measured with the heating vaporization measurement device.



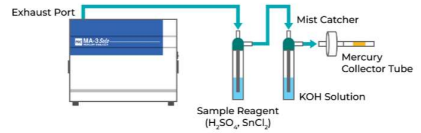
Source: Manual of Measurement Methods for Hazardous Air Pollutants (MOEJ)



Source: Nippon Instruments Corporation

2. High sensitivity due to concentration via gold amalgam

Reducing vaporization-gold amalgam collection measurement of liquid sample is possible by using the carrier gas of the instrument. The concentration of mercury in ambient waters such as rivers and lakes is extremely low, so the sensitivity of ordinary heating vaporization measurement may be insufficient. By using reducing vaporization gold-amalgam collection measurement, environmental assessment of extremely low concentrations is possible. The table on the right shows the measurement results of a standard solution of mercury chloride at extremely low concentrations to simulate ambient water. The variation coefficient is low around 5%, indicating that this method is highly accurate.



Source: Nippon Instruments Corporation

	n	Average concentration (ng/L)	Coefficient of variation (%)
5ng/L Mercury chloride standard solution	5	4.89	5.3
10ng/L Mercury chloride standard solution	5	9.88	3.9

Applicability

Application to other measurement methods

The heating vaporization method is applied to various measurement methods both within and outside of Japan.

Examples: JIS K0102, JIS M8821, JIS K0222, MOEJ Notification No.94, Manual of Measurement Methods for Hazardous Air Pollutants, USEPA 7473, ASTM D 6722-19, ASTM D 7623-20, UOP 938-20, UOP 1009-15, ISO 15411, ASTM D 5954, ISO 6978, ISO 20552, JLPGA-S-07 and others.

Reduction of running costs for analysis

This measurement method is economical, as the analysis can be done without using high purity compressed gases and the sample holder can be reused. In addition, because it can be used in any location and on any sample media, a single instrument is sufficient to satisfy for a wide variety of situations and application needs.

Further Reading

The Ministry of the Environment Japan "Manual of Measurement Methods for Hazardous Air Pollutants: Manual of measurement methods for restricted pollutants in exhaust gases" (Japanese only) Chapter 2 Mercury in air

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