Mercury CEM Overview

Mercury CEMS have been widely used in Europe where there are strict regulations regarding total mercury emissions from Municipal and Hazardous waste combustors. The mercury that resides in the flue gas stream primarily consists of elemental Mercury (Hg0) and Mercuric Chloride (HgCl2). First generation Mercury CEMS used wet chemical reactions to convert Mercuric Chloride to elemental Mercury. Commonly used reagents to accomplish that were Stannous Chloride, Sodium Tetrahydroborate and Ascorbic Acid. Due to the presence of reactors and tubings associated with wet chemistry the first generation Mercury CEMS suffered problems related to tubing pluggage, corrosion and inefficient conversion of mercuric chloride to mercury.

Seefelder Messtechnik was the pioneer in introducing commercial Mercury CEMS in the US and has worked with the first generation systems since the early nineties. Seefelder Messtechnik has extensive experience operating and trouble-shooting the Seefelder Messtechnik HG-MAT2 systems. We participated in several evaluations of mercury CEMS conducted by the agencies like the US EPA and DOE. Some of the tests include those conducted by the US EPA at a test incinerator in Jefferson, AK; the USEPA/DOE evaluation in Holly Hill, NC at a hazardous waste incinerator; and DOE evaluation at Oak Ridge, TN.)

As a result of the experience gained by running the first-generation Mercury CEMS, Seefelder Messtechnik is now proud to introduce the second generation Mercury CEMS – the SMT HG-CEM. All the experience gained by operating and trouble-shooting the first-generation Mercury CEMS has now been incorporated in the design of this new system. The HG-CEM represents a considerable simplification in design and totally eliminates wet chemistry in favour of dry catalytic reduction. In addition, by incorporating a gold trap amalgamation unit the interference problems associated with SO2 and NOx have been totally eliminated.

Method of Detection

The SMT HG-CEM uses a well-proven and highly accurate cold vapour atomic absorption UV photometer, at the 253.7 nm wavelength, to detect elemental mercury in the gaseous phase. In order to measure total mercury, which includes mercuric chloride, the HG-CEM uses a patented dry thermocatalytic device to convert those compounds to elemental Mercury. No wet chemical reactors are used and this greatly decreases complexity and maintenance requirements. The sample stream is then passed through a gold trap amalgamation unit where elemental mercury is absorbed. Subsequently, the mercury is desorbed from the gold trap into a stream of pure nitrogen and measured in a UV atomic absorption photometer operating at 253.7 nm.

Advantages of the HG-CEM

No Interference and No Cross Sensitivities

It is well known that one of the simplest, most accurate, and cost effective way to measure gaseous mercury is with the cold vapour atomic absorption UV photometer technique. Unfortunately, many other compounds commonly found in flue gases, cause dramatic interference to that measurement. The SMT HG-CEM uses a Gold Trap Amalgamation unit to capture the mercury present in flue gas, then transfer that mercury into a stream of pure nitrogen. Then when presented to the UV photometer, the measurement can be performed very accurately…with interference completely eliminated.

Flexible Ranges with Extremely Low Detection Threshold

As discussed previously the SMT HG-CEM use a gold trap to collect mercury and eliminate interference problems. By varying the collection time associated with the gold trap it is possible to change the measuring ranges of the instrument. Thus for a hazardous or municipal waste incinerator the SMT HG-CEM can operate in the range of 0 to 50 microgm/m3 while for a coal-fired utility application the collection time can be increased and the measuring range may be 0 to 10 microgm/m3 or even 0 to 1 microgm/m3.

Optimum Materials of Construction to Minimise Memory and Hysteresis Effects

Since mercury tends to “stick” to many materials, especially metals, those used for construction in a mercury analyser system are crucial. Thus the SMT HG-CEM is designed from the ground up to minimise contact with metallic surfaces. In the few instances where it is strictly unavoidable, heated special alloys are used. All fittings and tubings are made of Teflon, and other materials are Quartz and glass. All surfaces coming in contact with ionic mercury are held at elevated temperatures.

Excellent Price to Performance Ratio, Low Maintenance and Operating Costs

The SMT HG-CEM uses a new and extremely clean mechanical design that is made possible by recent advances in materials and computer electronics. That means it can be manufactured with less material costs and labour, making it much more affordable than ever before—and the ongoing cost of operation is dramatically. The design is modular so that individual components can be exchanged easily.

Easy to Service and Repair

The entire system is functionally controlled by a microprocessor. All input is made through a water-resistant front panel keyboard with user-programmable keys (“soft keys”). A large TFT colour screen vividly displays all system variables and measured values. The system components are used in a “swing design” compartment and can be very easily accessed. The most important components are housed in two 19” rack-mounted units each 3 units high. Other components can be accessed from the back plate of the housing.

Automatic Operation with Minimum Supervision and Remote Monitoring

The SMT HG-CEM executes an automatic zero point and a reference point procedure at pre-set intervals. Important process variables like flow rate, temperature and instrument drift are continuously monitored. In case of excessive deviations from set values, a status signal is activated to alarm the operator.

Basic Components of the HG-CEM

Sampling System (Probe and Heated Line)

The sample probe extracts 2 to 3 litres per minute and transports it through a heated sampling line at 200 ºC. In order to prevent loss of mercury in the sampling line it is recommended that the line not exceed 150 feet.

Thermocatalytic Converter

This thermal catalyst causes the reduction of mercury compounds to elemental mercury vapour. The thermocatalytic converter unit is
easily accessible for maintenance. After the catalytic converter, Mercury exists only in the elemental form and hence drastically
reducing MEMORY effects.

Gold Trap Amalgamation Unit

This amalgamation unit consists of an integrated valve assembly, a gold trap and a calibration source for elemental mercury vapour. The valve assembly can be switched to a “continuous mode operation” in case of high mercury concentrations. Also the presence of the gold trap amalgamation unit offers the flexibility of reducing the detection threshold for the system. By modifying the collection time associated with the Gold Amalgamation unit it is possible to lower the detection threshold of the system.

UV Photometer

The UV Photometer used by the HG-CEM system is a time-tested instrument that has been ruggedized and field-proven. It consists of a fixed wavelength atomic absorption spectrometer at 253.7 nm wavelength. The photometer has a reference beam for lamp control and an electrodeless low-pressure lamp with long service life (>20000 hours).

Technical Specifications

- Mercury Detector: Atomic absorption spectrometer with fixed wavelength at 253.7nm. UV photometer with reference beam for lamp control and electrodeless low-pressure lamp with long service life (>20000 hrs).
- Measuring Method: Thermocatalytic conversion of mercury compounds to elemental mercury followed by gold trap amalgamation to remove interference from other species. No wet chemistry is involved in the process
- Measuring Ranges
- Variable depending upon the collection times. Some possibilities are 0 to 10 microgm/m3, 0 to 45 microgm/m3 and 0 to 75 microgm/m3
- Resolution: 0.1 microgm/m3
- Response Delay: Adjustable depending upon gold trap amalgamation cycle time (minimum 90 seconds)
- Start-up Time: 30 minutes
- Status Display
- Relay: Operative, Maintenance, Malfunction --- remote monitoring possible through PC software
- Output: Analogue: 4…20mA at 500 ohm load Digital: RS-232
- Sample Gas Connection: Matched to customer needs (3/8" gas connector or PF36 thread connection - diameter 47mm) Supply Line: Heated sample line with Teflon tubing 3/8" OD, ¼" ID and temperature approximately 200 ºC. Maximum length of 150'. Flow Rate: 120 to 180 litres per hour
- Sampling Probe: Heated sampling probe
- Power Supply: 110 / 220 V, 50 / 60 Hz, 500 VA for Mercury CEM, 100 watts per meter of sampling line
- Dimensions: 600 x 750 x 500 (Width x Height x Depth in mm)
- Weight: 80 kg
- Interference: No interference from SO2, NO x, VOC and other compounds through the use of the gold trap
- Zero Point: Automatic control and correction of zero point --- manual correction possible
- Calibration: Automatic and manual calibration using permeation device
- Operating temperature: 5 to 35 ºC
- Utilities Required: Nitrogen at flow rate of 6 litres per hour