Mercury: measure and control

Following the new EU BREF document for waste incineration, European cement plants have to implement the requirement to continuously monitor and abate mercury emissions. To enable this they will need to apply technologies that measure mercury in the raw gas and optimise sorbent use.

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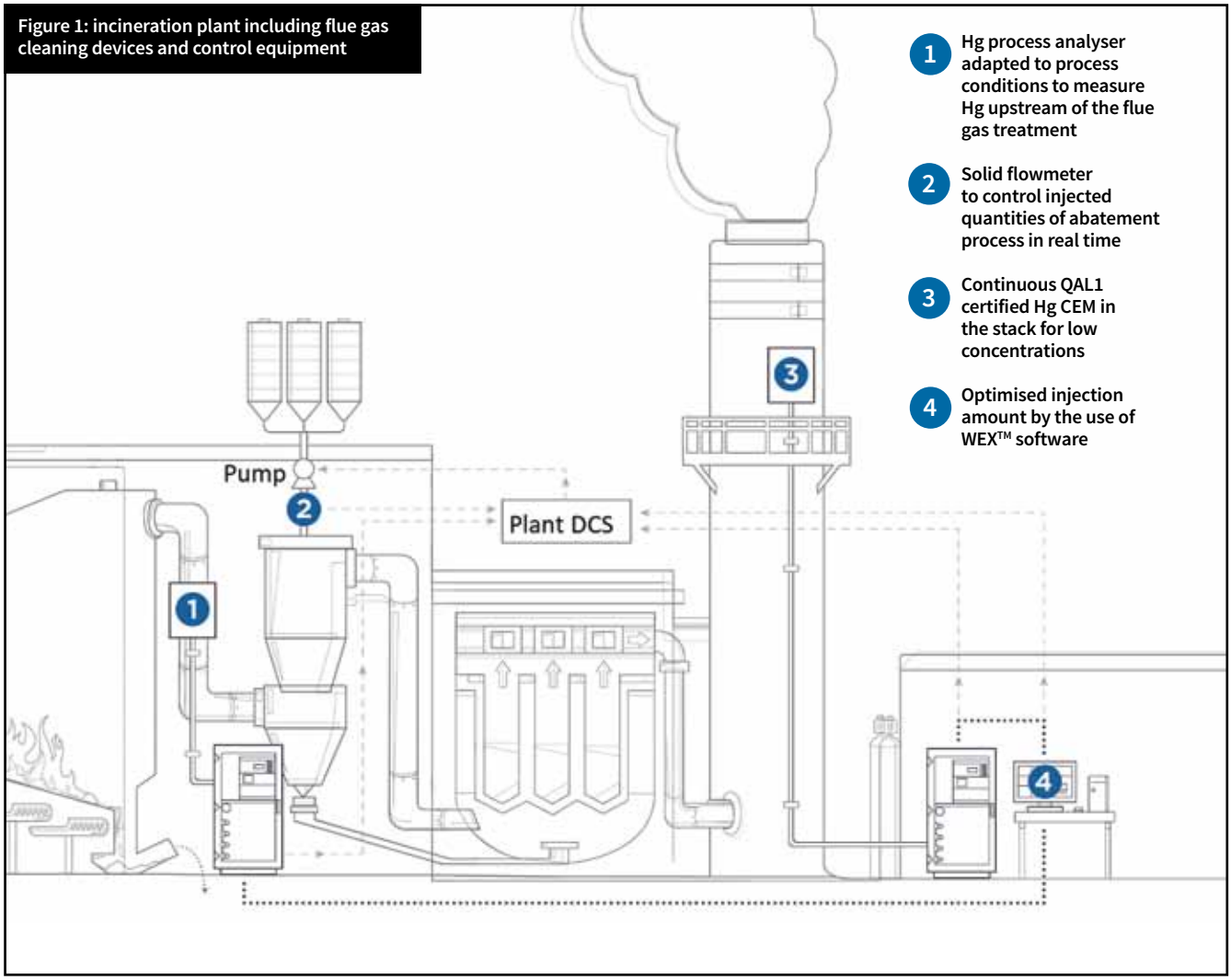
Figure 1: incineration plant including flue gas cleaning devices and control equipment



In December 2019 the new BREF (Best Available Technology Reference) document for waste incineration was published in the EU. One important topic in the Best Available Technology (BAT) conclusions is the request for continuous monitoring of mercury (Hg) emissions. In the BAT conclusions are mentioned so-called BAT-Annual Emission Levels (AELs) for daily averages, with Hg concentrations in the range of 5-20µg/Nm³. Now, EU member countries are required to implement the BAT conclusions into their national regulations by December 2023.

Normally cement kilns have to fulfil the requirements of large combustion plants. However, many cement kilns burn waste as a substitute for standard fuels and therefore, need to follow the requirements for waste incineration. As waste is an unknown mixture of inhomogeneous material, it is more difficult to prevent any Hg-emission peak, in comparison to burning coal. If only a Hg continuous emission monitor (CEM) is installed at the stack, then it is already too late for the process to react when a peak is detected. In this case, the complete flue gas cleaning device is already contaminated and it can take a long time until the Hg-concentration in the stack reaches a normal level.

A range of technologies to ensure low Hg emissions

To improve ensuring low Hg emissions by incineration and co-incineration of waste, ENVEA offers a global solution by using different technologies of its product range.

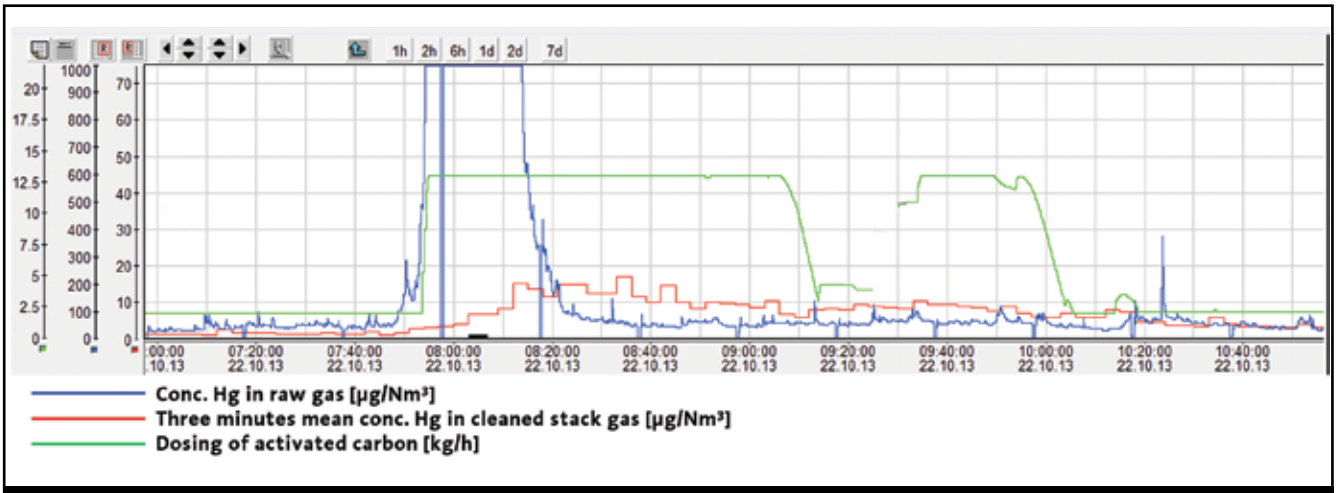


Figure 2: relationship of measured Hg concentrations in uncleaned raw gas, clean gas and the dosing of activated carbon

As shown in Figure 1, four devices are required in this global solution:

1. continuous measurement of Hg upstream of the flue gas treatment, by a specific Hg process analyser (SM-4Raw gas) adapted to the process conditions, allowing a very fast response over a wide concentration range of Hg.
2. continuous monitoring of abatement product injection rates with the SolidFlow 2.0 solid flowmeter, to control the injected quantities of abatement products in real time.
3. continuous QAL1 certified Hg-CEM (SM-4) in the stack for low concentrations.
4. optimisation of the injection amount, by the use of the WEX™ software, which calculates averages, trends and predictive averages.

These four key points allow a real optimisation of the flue gas cleaning process and therefore, generate high security for the control of atmospheric Hg-emissions. Additionally, the system has a strong environmental and economic impact by limiting the required quantity of the adsorbent.

"Depending on the used Hg abatement technology, the cement plant could also require a speciation measurement of Hg^0 and Hg^{2+}, and Hg^{total}. A modified version of the Hg monitor would enable such a speciation."

Continuous measurement of Hg upstream of the flue gas treatment

The ENVEA SM-4R Hg process analyser is based on atomic absorption. It features a dilution probe that allows a wide range of measurement and elimination of interference from matrix gases. The sampling system (which consists of the probe, dilution module and thermo-catalytic reactor), is heated to avoid the retention of Hg in the probe. In the thermo-catalytic reactor, the ionic Hg is converted into elemental Hg. In comparison to ionic Hg, elemental Hg is quite less reactive. Therefore, no heated sampling line is needed between the sampling probe and the analyser.

Due to this design, the Hg process analyser SM-4R has a short reaction time, which is necessary for dynamic Hg abatement control.

Continuous certified Hg CEM in the stack

The QAL1 certified Hg-CEM SM-4 has almost the same design as the SM-4R Hg process analyser. Additionally, it includes a Gold Trap inside the atomic absorption analyser, which allows a precise Hg measurement in the range of a few µg/Nm³. Therefore, this analyser is used for legal emission monitoring at the stack.

Optimising the quantity of injected abatement product

The quantity of the injected abatement product is determined by the measurement of its solid flow by the use of the SolidFlow 2.0 monitor. All signals of the Hg analysers SM-4 and SM-4R as well as those from the SolidFlow 2.0 are transferred to the data acquisition system WEX.

Depending on the momentarily measured Hg-concentration in the raw gas, more or less sorbent can be added to effectively reduce Hg-concentration in the cleaned stack gas. For this process, the WEX system uses the solid flow of the adsorbent, which is measured by the SolidFlow 2.0 flow monitor, to control the pump of the adsorber material.

Figure 2 shows the results of a test carried out in a hazardous waste incinerator. After a strong increase of the Hg concentration in the raw gas over 1mg/Nm³, the quantity of activated carbon was increased to its maximum of 12.5kg/h. Due to this action, the Hg concentration in the stack was kept below 20µg/Nm³ and therefore, below the applied emission limit value. The reaction of the SM-4R Hg process analyser was very dynamic during this event.

With its fast reaction to changing Hg-concentration, the SM-4R is able to control the quantity of added activated carbon adsorbent, therefore, drastically reducing the running costs of operation.

Use in coprocessing kiln line

These results demonstrate the efficiencies of ENVEA's global solution for Hg-emission control. The principle of operation and Hg emission control can be also used in cement kilns that co-process waste.

Depending on the used Hg abatement technology, the cement plant could also require a speciation measurement of Hg^0 and Hg^{2+}, and Hg^{total}. A modified version of the Hg monitor would enable such a speciation. ■