Introduction to Emissions Monitoring

The monitoring of industrial emissions is undertaken for a variety of reasons. These can be for instance:

- To ensure compliance with legislation – Industrial Emissions Directive, Climate Change legislation, regulator environmental permit conditions
- To control the process – with direct feedback into the control systems
- To comply with corporate environmental policy – influence of investors and other stakeholders on the environmental performance of a company
- As part of an environmental impact assessment – to assess future developments and the options for abatement
- Commissioning of new plant – to comply against contract conditions

The monitoring is undertaken either by taking a sample of gas and analysing it directly to sending it to a laboratory for analysis (Periodic Sampling) or by continuously analysing the stack gas using a system inside the stack or extracting the stack gas and analysing it in a gas analyser (Continuous Emissions Monitoring or CEMS).

For each of these scenarios there are a set of standards to follow and comply with. In Europe these are the European Standards. In many cases staff and laboratories are required to show continued compliance by being accredited to do the tests by an accreditation organisation for instance UK accreditation service (UKAS).

Additional requirements maybe placed on the testing by the environmental regulators, such as the MCERTS scheme in the UK.

For periodic sampling it is often a requirement of the standards that the sample of gas taken form the stack is extracted at the same flowrate as the gas is travelling up the stack. This is referred to as isokinetic sampling as the energy

in the sample gas is the same as the stack gas. The reason for this is to ensure a representative sample is collected. To achieve isokinetic sampling it is necessary to sample at a location where the stack gas flow is undisturbed and uniform as the sample equipment is not able to match the stack gas flowrate when the stack gas swirling and flowing at an angle to the stack.. For this reason it is often necessary to locate the sampling ports some distance up the stack rather than at the bottom.

Testing for any parameter with particles in is required to be isokinetically sampled. These include:

- Total particulate matter – including particles with a diameter of 10 microns (PM10) and particles with a diameter of 2.5 microns (PM2.5)
- Trace Metals such as lead, nickel, vanadium, arsenic and chromium
- Complex organic compounds such as dioxins, PCBs and PAHs
- Other species such as hydrogen chloride

Parameters that are gases at ambient temperatures and do not form as particles and so do not require isokinetic sampling are:

- Nitrogen oxides
- Carbon monoxide, carbon dioxide and oxygen
- Sulphur dioxide

Where samples are taken for analysis in the laboratory then careful sample handling is essential to ensure the samples do not change before reaching the laboratory. The analysis undertaken in the laboratory could include:

- Gravimetric – many samples are accurately weighed to measure the quantity of particulates collected

- ICP-MS – Inductively Coupled Plasma Mass Spectrophotometry is used to accurately measure metal concentrations in dust samples
- GC-MS – Gas chromatography mass spectrometry is used to measure very small quantities of dioxins, PCBs and PAHs
- Ion exchange chromatography is used to determine the concentrations of chlorides and sulphates.

Where gas is analysed directly on site then gas analysers using the following techniques maybe employed:

- NDIR – Non-dispersive infra red analysis for carbon monoxide and carbon dioxide.
- Chemiluminescence analysers for nitrogen oxides
- Paramagnetic analysers used to determine oxygen concentrations

FTIR – Fourier transform infra red used for a wide range of parameters including CO, CO_2, SO_2, NO, NO_2, O_2.

When CEMS are used to measure stack gases they may use the instruments above in a similar way to periodic sampling or they may use analysers that are installed directly onto the stack. These pass a beam of infra red or visible light through the stack gas and determine the gas composition by analysing the light adsorption across the stack. These are referred to as cross stack analysers.
Where CEMS are used to comply with environmental permit conditions then they are often required to be calibrated against a periodic sampling method to ensure the data produced is correct and its results can be traced back to the national standards for that parameter. The European standard used for this calibration is BS EN 14181.

A fundamental element of stack gas monitoring whether periodic or CEMS is the safe location of the equipment and the safety training of the staff undertaking the work. The available guidance on these issues must be followed at all times.

The results of the monitoring of emissions will be presented in a format to allow direct comparison with the permit conditions or the figures specified in the environmental policy or environmental impact statement. These will either be as a concentration of that parameter expressed as a weight of the parameter in a volume of gas or as a mass emissions expressed as a weight of the parameter emitted over time.

The report should state the accuracy of the test and if any problems were encountered during the testing that may have affected the test. The operation of the plant at the time of the test should also be reported to allow a meaningful comparison with other tests.

Emissions monitoring is a time consuming and complex process and all effort should be made to ensure the data produced is of as much value as possible to the plant operator and other interested parties.

References:

GOV.UK (2014) Technical Guidance Note (Monitoring) Monitoring of stack emissions to air Version 10 October 2013 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/301145/TGN_M2_Monitoring_of_Stack_Emissions_to_Air.pdf