CONTINUOUS EMISSION MONITORING SYSTEM

SOLUTIONS FOR GREEN ENVIRONMENT
WHAT IS CEMS?

A continuous emission monitoring system (CEMS) is the total equipment necessary for the determination of a gas or particulate matter concentration or emission rate using pollutant analyser measurements and a conversion equation, graph, or computer program to produce results in units of the applicable emission limitation or standard.
TYPE OF EMISSION

Emission Monitoring of Stationary Source

- AAQMS - AMBIENT AIR QUALITY MONITORING SYSTEM
- STACK
- FUGITIVE EMISSION
- EFFLUENT
A COMPLETE CEMS Solution

SOx/NOx/CO/CO2/THC/O2

NH3/HF/HCl

SPM

Mercury

Pressure/Temperature

Volume Flow
Overview

- CEMS Methodologies
  - Extractive, In-Situ etc
- Common measurements and analytical approaches
- Common Problems in the different methodologies
CEMS Technologies

- Continuous emission monitoring or automated measuring systems can be categorised into two types:
  - Type 1: Extractive systems
  - Type 2: *In situ* systems

- Extractive systems withdraw flue gas continuously from stack and transport it to the analyser.

- *In situ* systems carry out most of their operations in the stack.
  - Point in situ carry out analysis at a single point in the stack.
  - Path monitors carry out analysis usually over the entire stack.
TYPE OF CEMS TECHNIQUE

CEMS

EXTRACTIVE

DILUTION EXTRACTIVE
IN STACK DILUTION
OUT OF STACK

EXTRACTIVE

HOT METHOD
COLD DRY METHOD

AT POINT
HOT WET METHOD

CROSS STACK
LOW PRESSURE SAMPLING

INSITU
EXTRACTIVE ....HOT EXTRACTION METHOD OF SAMPLING

Stack

Extraction probe

Heated line

Gas

Analyzer

Gas

Sample conditioning system

Vent
Typical Sample Conditioning System Design for HOT EXTRACTION METHOD CEMS

- Sample Gas Cooler
- Filter
- Coalescing Filter
- Analyzer
- Auto Drain Pump
- Condensate Barrier
- Sample Gas Pump
- Pressure Reducer
Typical SHS Design for Hot Extractive CEMS
MAIN POINTS IN A HOT EXTRACTION METHOD

a. The Heated Probe should be located as per the guidelines. Which should 2 times the stack diameter downstream and 1/2 times stack diameter upstream. However the Probe is to be located at a location where maintenance can done and there is proper approach to the Probe.

b. The Heated Tune is to start from the Probe and continue till the Analyser Panel. There should be no Cold Spots.

c. The Gradient of the Heated line should be downwards.

d. Line should be checked and Leakage free Line should be ensured
The Probe Head

The picture along side shows the Probe Head. The Tube Assembly (Picture shown below) is to be screwed on to the Probe Head.

The Assembled Probe Head along with the Tube Assembly is to be inserted through the Bushing Tube. Please note the angle of the Probe should be towards the ground.
Cool-Dry Extractive Systems

Sample gas is extracted and conditioned to remove moisture prior to analysis. Options:

- Conditioning at the CEM shelter
  Heated sample line is required to keep the wet sample above its dew point until it reaches the water removal system
- Conditioning at the stack
  Water is removed at the stack - no heated line - commonly used by source testers for short-term sampling
Nafion Dryer based Measurements

- Tube-in-shell, heat and moisture exchanger

- To increase drying capacity, simply increase the surface area (wider, longer or more tubes)
Extractive based on COLD DRY METHOD
Typical SHS Design for COLD DRY METHOD
**MAIN POINTS IN A COLD DRY EXTRACTION METHOD**

a. The Heated Probe should be located as per the guidelines. Which should 2 times the stack diameter downstream and 1/2 times stack diameter upstream. However, the Probe is to be located at a location where maintenance can be done and there is proper approach to the Probe.

b. The Heated Tube is to start from the Probe and continue till the Nafion Dryer. There should be no Cold Spots.

c. Air to Nafion Drier should be moisture free – Dry.

d. Line should be checked and Leakage free Line should be ensured.
Hot-Wet Extractive Systems

No moisture removal - Moisture remains in the system throughout the sampling and measurement process.

Sampling line, pump, and analytical chamber are heated to keep wet sample gas above its dew point. Sample is analyzed hot and wet.
In-Stack Dilution Systems

Flue gas sample is diluted with clean/dry air using a "dilution probe" inside the stack

- Sample gas is diluted (typically at ratios of 15 to 300 to 1) with dry gas at dew points

- Dilution ratio controlled by using a critical orifice in the probe - critical flow maintained by achieving a set pressure drop across orifice

- Flow through orifice is dependent on Ts, Ps, Ms, and dilution air pressure and temperature.

- A "wet" gas measurement is made
Out-of-Stack Dilution Systems

Flue gas sample is diluted with clean/dry air using dilution "box" close-coupled or otherwise outside of the stack

- Dilution ratio controlled by using a critical orifice in the box - critical flow maintained by achieving a set pressure drop across orifice
- Sample gas is diluted (typically at ratios of 15 to 300 to 1) with dry gas at dew points typically at - 40° C
- Flow through orifice is dependent on Ps, Ms, and dilution air pressure and temperature.

A "wet" gas measurement is made
MEASUREMENT BASED ON DILUTION TECHNIQUE
Typical SHS Design for Dilution based CEMS
Low Pressure Sampling

- The measuring principle works on a low pressure sample (LPS). The sampling system consists of a SONIC NOZZLE. It is an original system which can collect and convey the sample from 50 to 200 mbar abs from the sampling point to the analyzer.

- The sample is taken at a very low pressure (50 to 200 mbar absolute). This feature enables us to reduce the vapor pressure of the sample at the level of the sampling point. At the pressure of the sampling, the ambient temperature is almost always above the dew point. There is no risk of condensation, which eliminates the need for a heated line and a cooler. Thanks to this technique, we do not distort the sample.

- The sample is taken with a flow rate of 1 to 24 l/h. However, since the pressure of the sample in the duct is 10 times lower than the atmospheric pressure (100 mbar abs), the transfer speed is multiplied by 10. The transfer rate of the sample ranges therefore between 10 to 240 l/h.

- Since only a little flow amount is collected, the system hardly gets dirty, requiring limited maintenance of the analysis chain.
MEASUREMENT BASED ON LOW PRESSURE SAMPLING

LAYOUT FROM SONIC NOZZLE TO ProCeas ANALYZER

Sonic nozzle 3 - 9 L/h
2μm filter passivated rock wool
GAS PROCESS

Polytube 2 PFA 1/4" cores
Heated line option
Sample 30 to 90 L/h @100 mbar
Standardized gas + Backflush
Remote analog / digital I/O’s option

Standardized gases 1 regulated bar

Oil / dust free dry air (6 bar ± 0.5)
-200 L/h
110/220V 50/60 Hz 3A

ProCeas
2.45 ppm
Air conditioned room

Jbus - Modbus RS232/ 485/ ETH outputs
USB ports (keyboard, mouse, data...)

Exhaust
Pump 3-9 L/h @P° Atm.
In-Situ Systems

Measure gases, flow, or particulate matter in the duct or stack without gas extraction

- **Path Systems**
  Transmit light or sound across the duct or stack to make the measurement.

- **Point Systems**
  Make measurements at a point or short sensing volume (cm to m) in the stack or duct.
OVERVIEW OF INSITU CEMS:

**CEMS:**
(Analyzer Used: IR/UV Based)

**CEMS:**
(Analyzer Used: DOAS)

**CEMS:**
(Analyzer Used: TDLS)

**POINT SYSTEM**

**PATH SYSTEM**

SO₂/NOₓ/CO/CO₂/O₂

SO₂/NOₓ/CO/CO₂/NH₃

NH₃/HCL/HF/CO/CO₂
PROBE TYPE INSITU CEMS:

An infra-red (IR) or UV, duct or stack-mounted gas analyser designed to provide in-stack analysis of gas-phase emission components.

A typical system comprises an in-situ mounted analyser, an integral calibration function and a Control Unit with options which include a powerful in-situ Heater and calibration gas cylinders.
CEM systems measure multiple emissions or process gases in real time in situ. Using the UV / FTIR DOAS (Differential Optical Absorption Spectroscopy) technique, the system is non-contact, with fast response.

A basic system includes an analyser spectrometer, an emitter/receiver set, and an optical fibre cable & calibration gas cylinders.
PATH TYPE INSITU CEMS:

TDLS System Design for NH3, HF, HCL
A basic system includes an analyser spectrometer, an emitter/receiver set, and an optical fibre cable.

- Insitu Single-line molecular absorption spectroscopy
- Absorption Technology – Wavelength Modulation Spectroscopy
- Fast Response time
- Zero Drift – No Calibration
In-Situ Single Line Absorption Spectroscopy

Typical optical pass band filter

Scan width of the TDLAS

Absorption line

Laser line
CERTIFICATION OF ANALYZERS

- Analyzers should be Certified according to EN 14181/ EN 15267 by TUV.
- Analyzers should be Certified according to MCERTS, UK
- Analyzers should be compliant to US EPA
Analytical Methods

- Common Species
  - SO2
  - NOx
  - CO
  - Oxygen
  - Ammonia / HF / HCL
  - Mercury
  - H2S
  - CO2
  - VOC’s/THC
## Overview of Technologies

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THE BEST SOLUTION

AIM :-
We are to measure Pollutants which are emitted out from the Stacks.

Points to Note :

1. All Stacks are different, as the nature of the industries are different.

2. Some Stacks are of Steel, some Cement, Power Plants, Petrochemicals, Fertilizers etc.

3. Though the ultimate measurement components are the same, the background gas composition are different.

4. Technology should be chosen keeping the Application and the Gas components in mind.
1. The Temperature of the Stack.
2. The Moisture Content in the Stack.
3. Dew Point Of Sample Gas
4. The Dust Content in the Stack.
5. The Presence of Corrosive Components in the Gas.
6. The Range of the Analyser.
7. The Area Classification, (Safe Area or in Zone)
8. What is the maintenance requirement of the Analyser.
Calibration Of an Analyser ensures that the Analyser is reading the Certified Gas Correctly. Hence it can be concluded when the Stack gas is fed in the Analyser after calibration the concentration displayed would be correct.
WHAT ARE THE MAJOR ITEMS NEEDED FOR CALIBRATION


2. The Calibration Cylinders should have a valid Certificate. In case dates have expired the Cylinder needs to be refilled and revalidated.

3. There should be a Zero Gas Cylinder.

4. There Should be a Span Gas Cylinder. (The Value of the Span Gas Cylinder should be around 80% of the measuring Range of the Analyser.)

5. The Gas Analysis System should have facility to allow the possibility of passing Calibration Gas in the Analyser and performing calibration.
TYPES OF CALIBRATION

Manual Calibration :-

This means that a person is in front of the Analyser System, he opens the Calibration Cylinders and lets the gasses pass through the Analyser, and once the readings in the Analyser has stabilised, He performs calibration.

Automatic Calibration :-

This is termed so that the calibration is performed by the Analyser Automatically.

Now this Automatic Calibration can be triggered in Two ways :

1. The Calibration can be time based
2. The Calibration can be triggered by external input.
AUTOMATIC CALIBRATION

Some Analysers are equipped with calibration Cuvette.

These Cuvettes are pre filled in the Factory with the zero and Span Gases.

During Automatic Calibration, these cuvette come in line with the IR beam. The Analyser Response in the Zero Gas and Span gas in measured, and in case there is drift the Analyser Automatically corrects the drift.
Typical Analyzer with Calibration System
AUTOMATIC CALIBRATION

In Analysers which don’t have the Calibration Cuvette, the Analyser Goes into the Automatic Calibration Mode. And Goes to Zero Cal.

During Zero Cal the Analyser Activates a Relay. With the help of this relay a solenoid valve is energised, which allows zero Gas t flow in the Analyser. The Analyser then calibrates itself for Zero.

Then The Analyser Goes to Span Cal. During Span Cal another Relay is energised. This Relay allows the Span Gas to enter the Analyser. The Analyser then calibrates itself for Span.
HOW DO WE DETERMINE THE FREQUENCY OF CALIBRATION FOR ANALYSERS

1. The Analyser will have a drift value as mentioned in the Data Sheet.

2. Calibration Gas is to be passed in the Analyser every month and drift to be noted. If the Drift is within the limits the Analyser is to be calibrated once in three months.

3. In case the drift is outside the limits, the frequency of calibration is to be increased and drift checking Frequency is also to be increased.
Thank you for your attention