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HCl CEM: “Best Practices” and Technology Overview

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Experience

- There is over 30 Years experience in measuring HCl in CEM applications
  - Cement
  - Power
  - Waste Incineration
  - Pharmaceutical

- Typical spans are in the 0 - 5/10ppm range

Best Practice

- Fast and correct measurement of HCl in ppm concentrations can only be made when you measure wet.
  - This prevents errors due to absorption, desorption effects from HCl on the wetted parts.

- Keep the entire sample train hot/insulated to prevent cold spots
  - System components should be kept at a minimum of 185° C to prevent cold spots
    - Swagelok fitting on inlet/outlet pump
    - Sample pump
    - Flange and tube at the sample probe
    - Ends of sample line extending from heated line (insulated)
    - Vent tube from photometer (avoid salt formation)
    - Sample probe tube (if flue gas below acid dewpoint)

- Sample at high temperature and high flow rate.
  - Shortens the time the sample is in contact with the system components, minimizing memory effects.

Best Practices - Calibration

- HCl is not CO. Calibration gas injection is the most troublesome part of HCl monitoring.
  - Cylinder values can be effected by dirty pressure regulators, improper handling of the regulators or incompatible materials used in the sample system
  - Cylinders < 100ppm need to be tested for long term stability
    - HCl/N2 mixtures down to 1 ppm show stability in passivated Luxfer aluminum cylinders
    - HCl/N2 mixtures down to 25 ppm show stability in nickel plated steel cylinders.
  - Dry calibration gas injection at the probe leads to issues with absorption/desorption
    - Measurement stability time of the system can be very long (>35-40 min at <10ppm); if the measurement range is low, this uses a lot of expensive cal gas
    - This issue is not specific to any measurement technology (NDIR, TDLS, FTIR)
  - Options
    - Automated wet calibrator can be integrated into the system.
      - NIST Tracable, easy to use
    - Humidification of dry gas increases response time.

PS18 – Brief Overview

- Will be inclusive of all technologies; extractive, dilution, in-situ

- Will include provisions for:
  - Linearity
  - Interference Tests
  - Limit of Detection (LOD)
  - Response Time
  - Cal Error
  - RATA and/or Dynamic Spiking
    - Reference methods may include EPA Method 320/321, ASTM D-6348-12.
    - EPA Method 26A may also be used, but not for Portland Cement kilns

  - One of the major parameters to be addressed is the definition of standards (dry cylinders, wet gas generators)
    - Both will likely be allowed

NDIR Monitoring Technique

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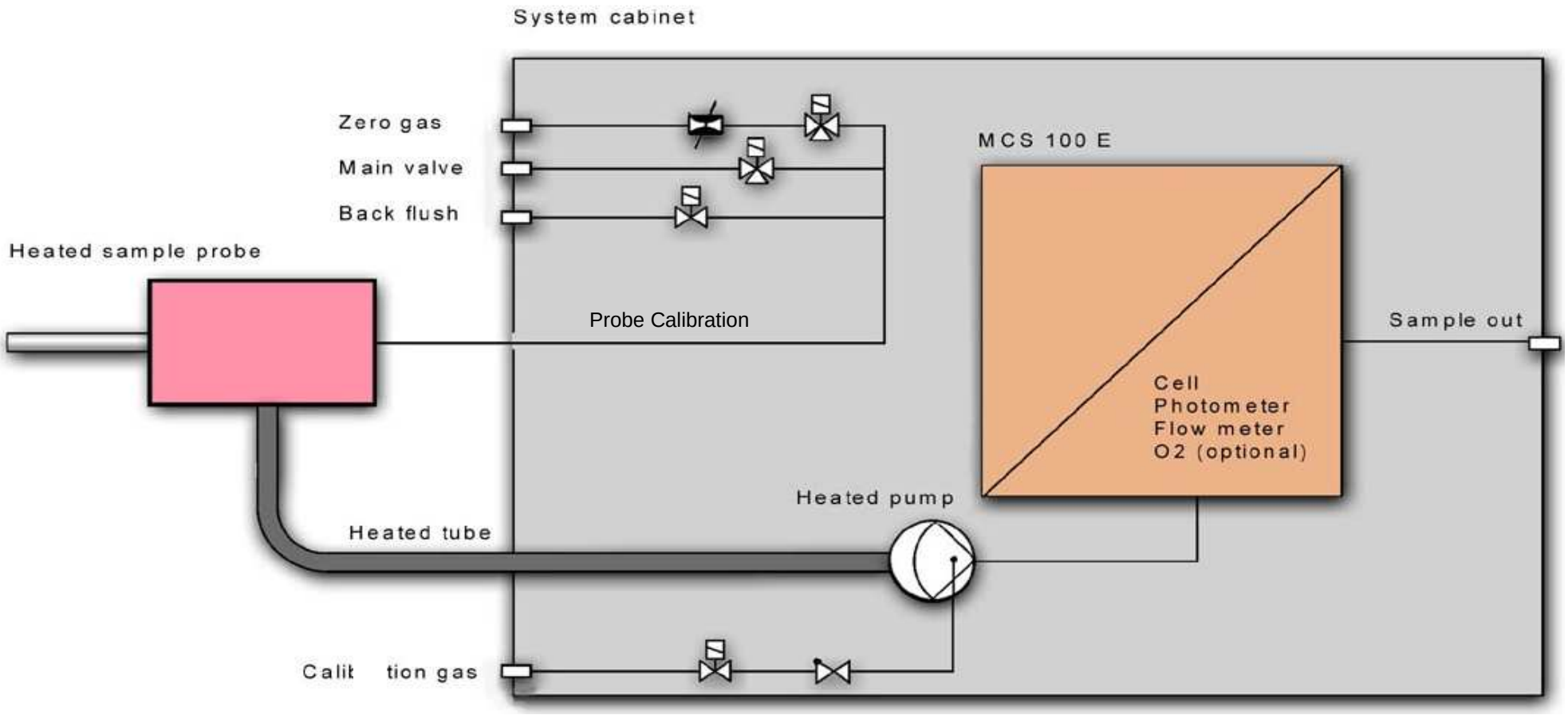
- Multi-component
- Undiluted Hot Wet Extractive
- Utilizes Gas Filter Correlation Technique for HCl
- Simple and reliable sample system
- Long path cell for low ranges
- > 3000 installations worldwide

HW Sample System



NDIR Monitoring Technique

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Relevant Measuring Ranges

HCl	0	-	10	ppm
NH_3	0	-	15	ppm
SO_2	0	-	25	ppm
CO	0	-	40	ppm
NO	0	-	80	ppm
CO_2	0	-	25	Vol.-%
H_2O	0	-	40	Vol.-%
O_2	0	-	21	Vol.-%
NO_2	0	-	50	ppm
N_2O	0	-	50	ppm
CH_4	0	-	70	ppm

Smallest ranges @ standard conditions dry (H_2O, O_2: wet)

TDL Monitoring Technique

- Tunable Diode Laser Spectrocopy uses a laser light scanning over a specific absorption wavelength area of desired measurement component.
- Laser selectivity means high sensitivity and minimal cross-interference effects
- “Line locking” technique eliminates measurement drift
- Inline gas cell can be used for daily validation
- Available in in-situ and extractive configurations
  - In-situ: Cross stack and probe
  - Extractive: Hot wet

TDL Monitoring Technique

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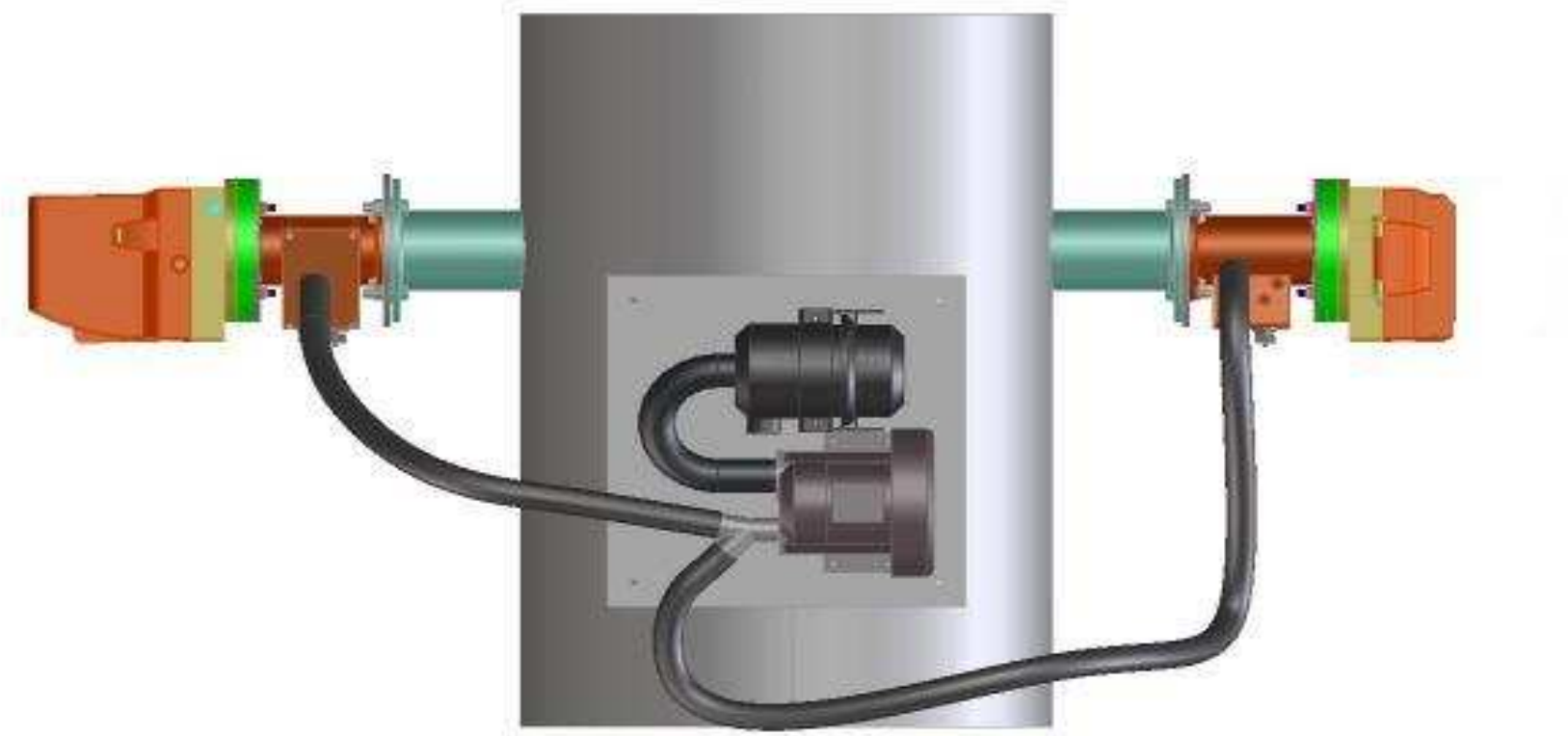
TDLS Cross Stack Versions – Min Range: 0-10ppm



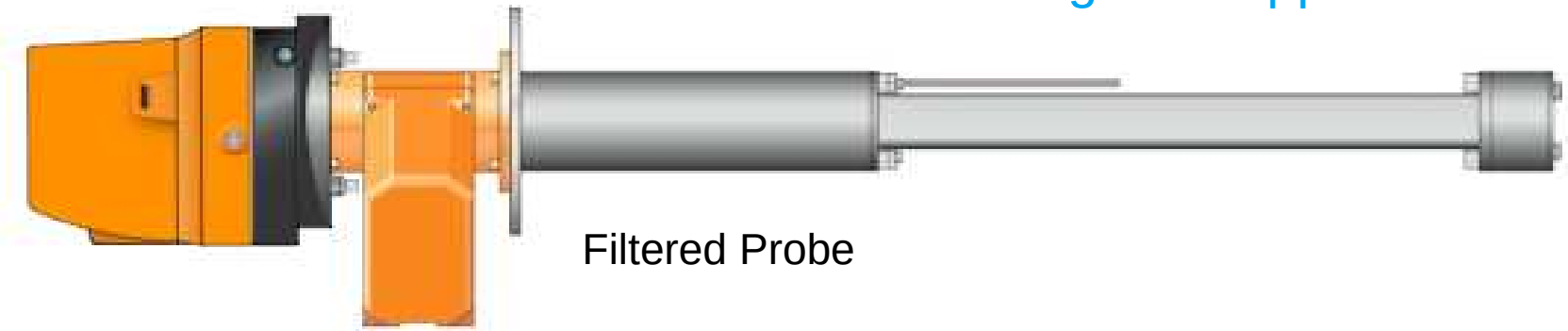
Cross stack version

: Daily validation via gas cell

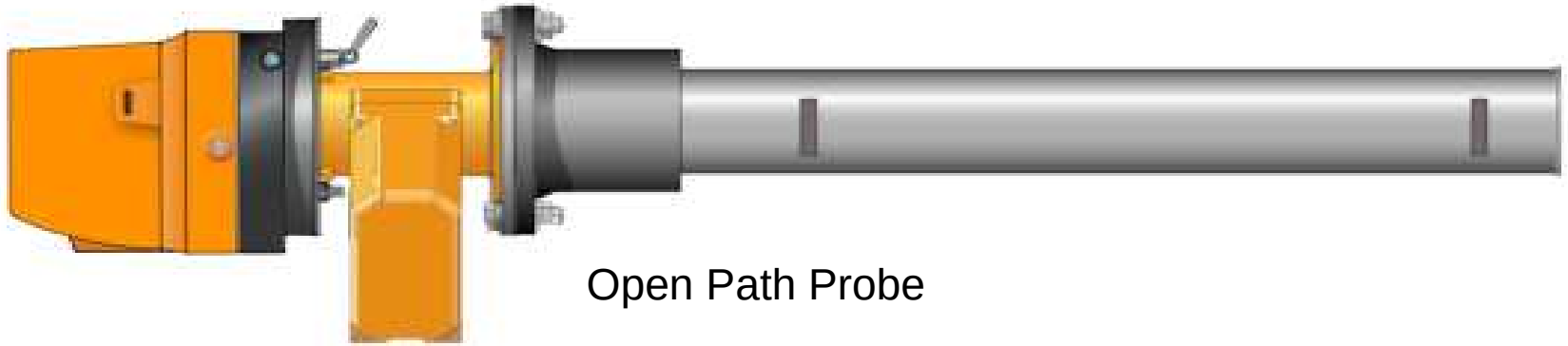
: Spiking difficult

TDL Monitoring Technique

TDLS Probe Versions – Min Range: 0-10ppm



Filtered Probe



Open Path Probe

TDL Monitoring Technique

- A complete TDLS system in one housing
- Minimum Range: 0-5 ppm HCl
- Extractive „hot-wet“ measurement
- Heated, volume- and flow- optimized multi-pass gas cell, 290ml
- 19“-rack for control cabinet installation

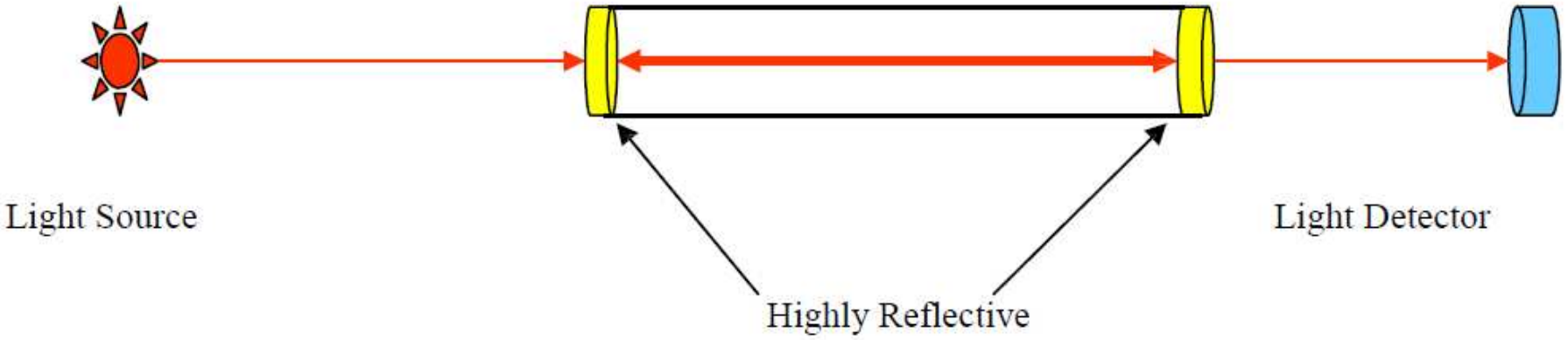
GME700

FTIR Monitoring Technique

- Fourier Transform IR Technique utilizes a moving mirror in an interferometer to generate a “interferogram” of the sample absorption spectrum.
- Performing a mathematical Fourier transform on the “interferogram” generates an absorption spectrum of the entire used spectral range.
- FTIR can generate multi-component measurement results, including HCl.
- Hot wet sample system
- Typical minimum range of HCl: 0-10ppm

Cavity Ringdown

- Cavity ringdown measures by attuning light rays from a laser in the IR spectrum where the component to be measured is absorbed.
- Measuring the time it takes for the light to fade, or “ringdown” gives an accurate molecule count.
- Dilution extractive measurement technique
- Range: 0-5ppm (+/- 1 ppb)



Summary

- There are many, well known and used measurement techniques for monitoring of HCl
- Minimum range and detection limits meet current requirements
- NDIR and FTIR offer multi-component options
- TDLS and Cavity Ringdown offers single component option
- Sample handling is key
  - Keep Sample Hot
  - Move Sample fast
- Calibration is the difficult part
  - Accuracy and handling of dry gas cylinders
  - Absorption/Desorption for dry gases
  - Wet Calibration

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Thank you for your attention.