AIR & WASTE MANAGEMENT ASSOCIATION

Ontario Section

The Air and Acoustic Monitoring Conference
October 26, 2016

Introduction to CEM's
Continuous Emissions Monitoring

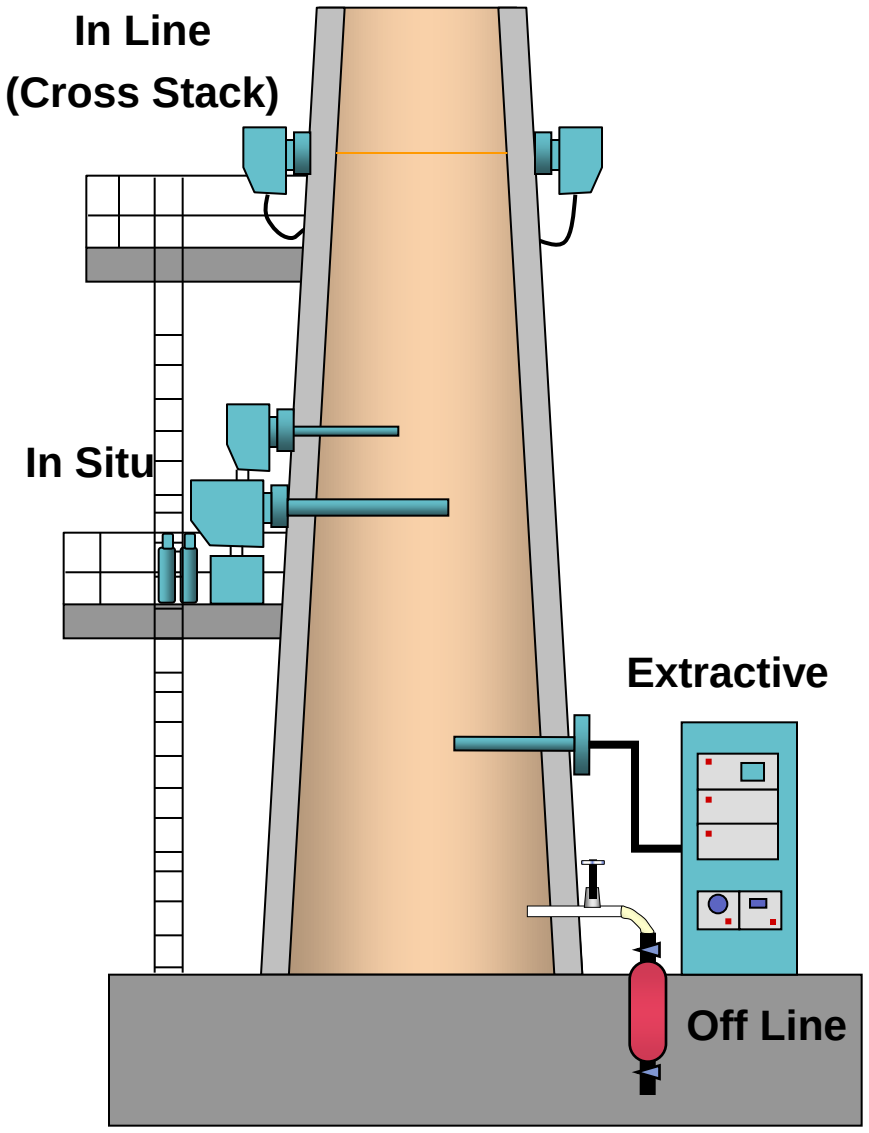
14-04-09

CEMSpecialties Inc
Process and Emission Monitoring Specialists
Website: www.cemsi.on.ca

What is a CEM?

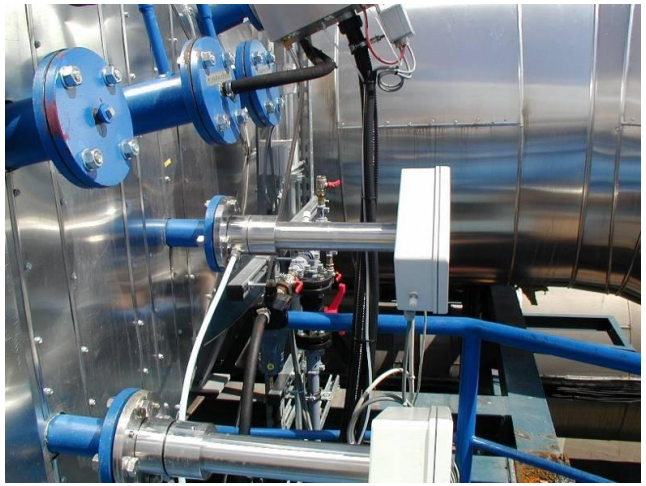
- **CEM** is an acronym for Continuous Emissions Monitoring
- Contrary to popular belief, it does not stand for “Career Ending Move”
- *It is an Analytical device used to continuously monitor the emissions from a process*

CEM Installation Options



- **In-line – Cross Stack**
  - Continuous measurement directly in the stack/process
- **In-line – Insitu (point)**
  - Continuous measurement directly in the stack/process
  - Measuring a point within the stack
- **On-line – Extractive measurement**
  - Continuous measurement,
  - **Cold/Dry** Sampling and conditioning of the sample gas feeding to the analyzer
  - **Hot/Wet** sample temperature controlled

Process Gas Conditions to Consider



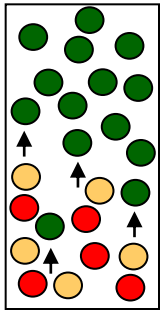
- Harsh conditions
- High temperature
- High pressure
- High dust load
- Corrosive Gas
- Hazardous area
- Condensing Gas

Determining the Right Sample Point – I

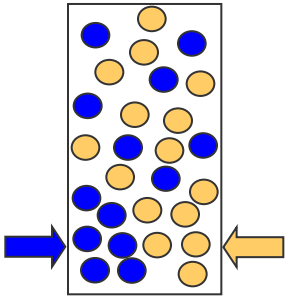
Practical aspects of the sample location

- Easy accessibility for installation and maintenance
- Weatherproof installation
- Protection against process and plant influences

Determining the Right Sample Point– II

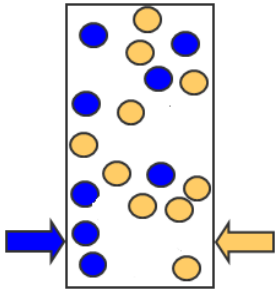


- All chemical reactions are completed at the sample location

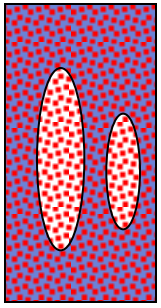


- Sample gas is well mixed, with no signs of stratification

Determining the Right Sample Point– III

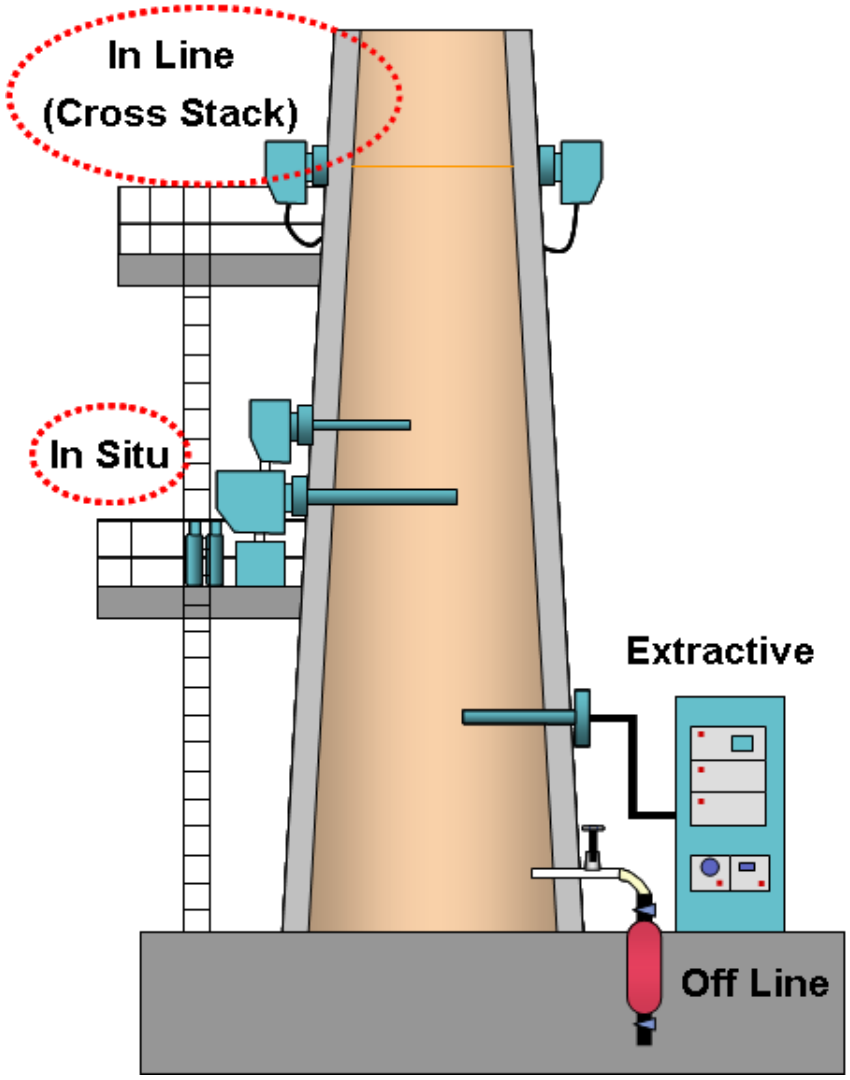


- Temperature and pressure: condensable, over pressuring



- Dust / Aerosols, Adsorption, desorption

In-line (In-situ) principle



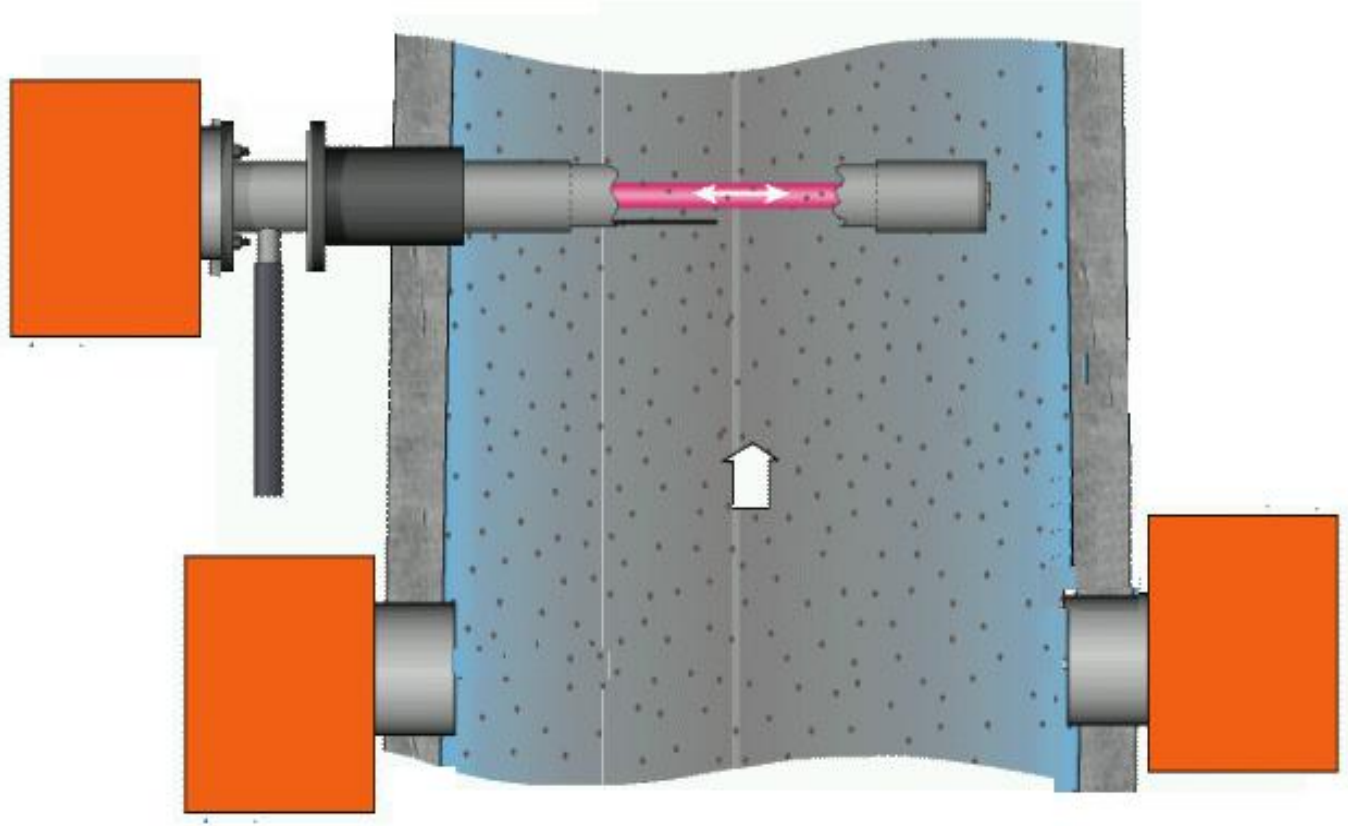
- **Advantages**
- Direct installation into the process
- Direct detection of changing concentrations
- No delay in measurement

- **Disadvantages**
- Detector exposed directly to temperature and pressure
- Little, or no protection to dust and high temperatures
- Difficult installation, e.g. at the top of a stack etc.

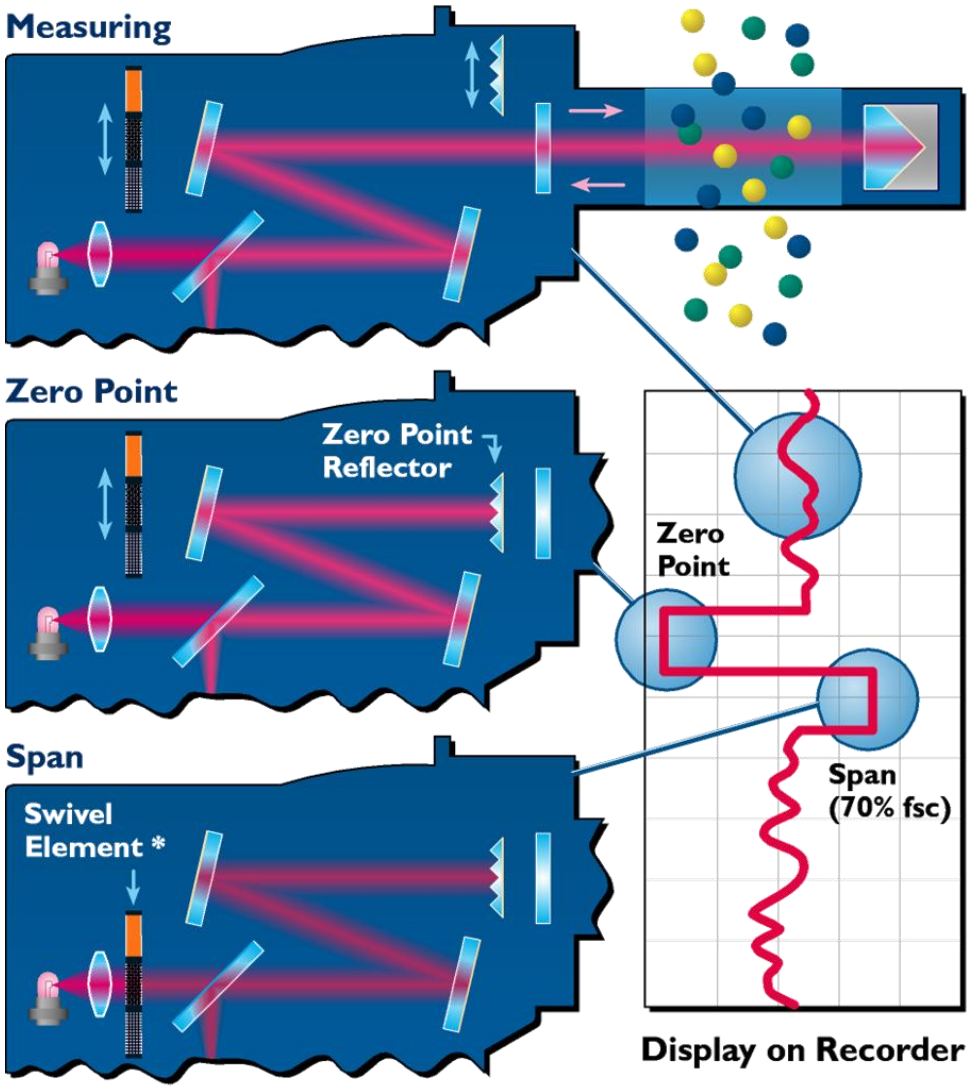
Insitu Gas Analyzers

Lambert - Beer´s Law

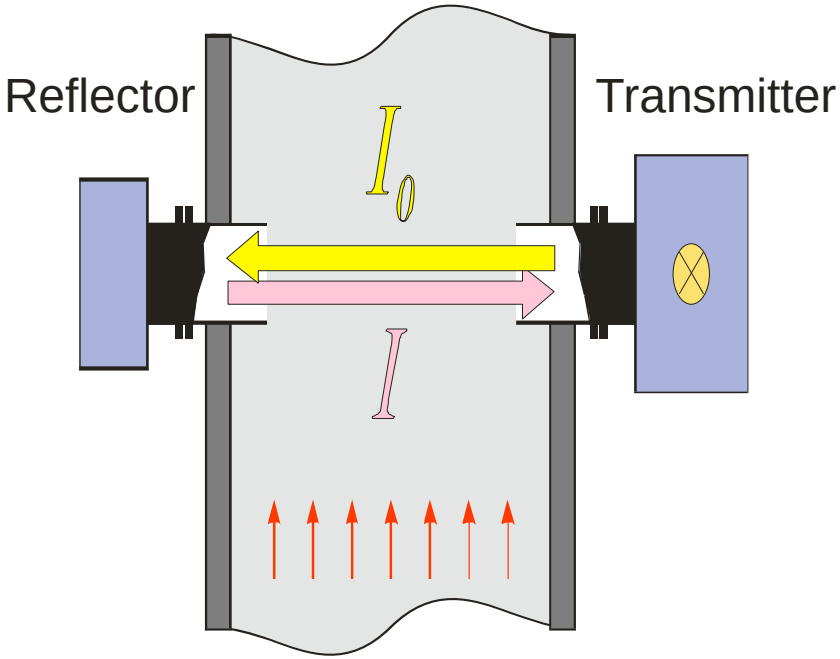
$$I_1 = I_0 * e^{-E* c *L}$$



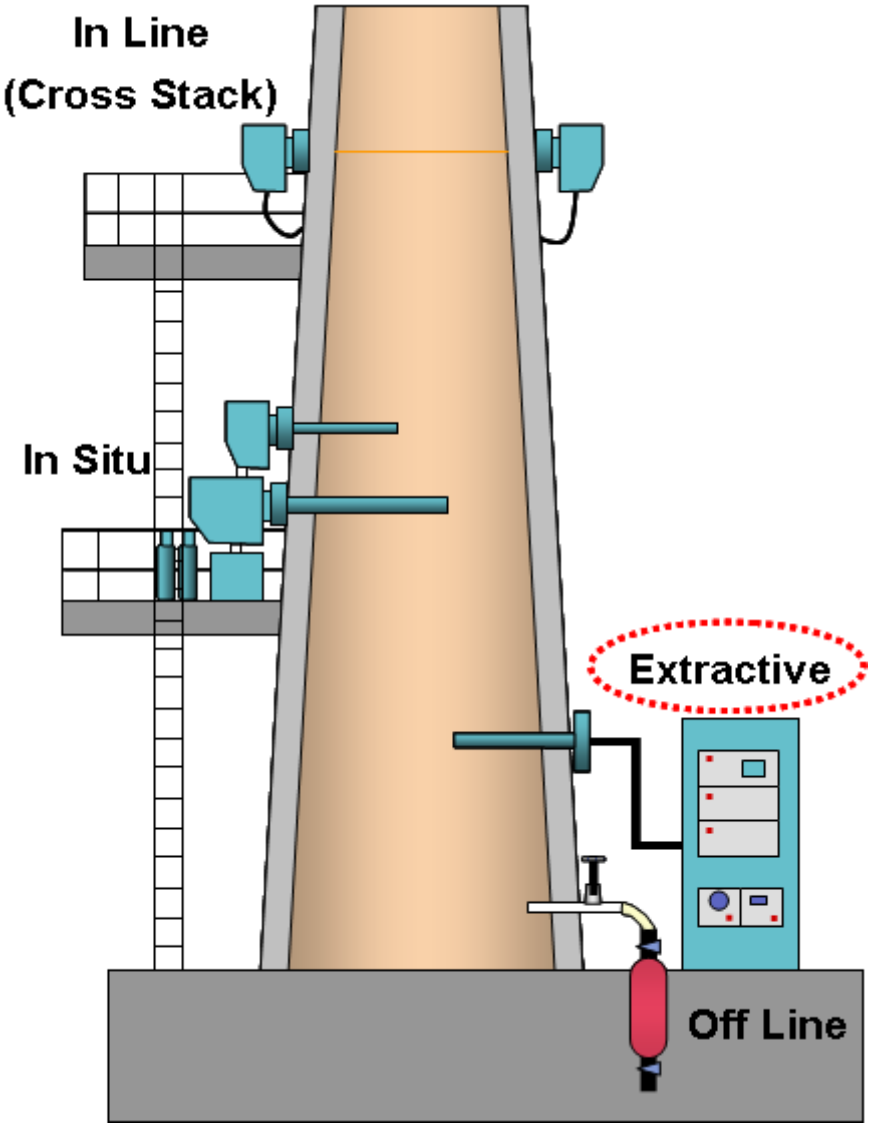
Insitu Measure and Calibration Routine



In-Line (Cross Stack)



On-line (extractive) principle

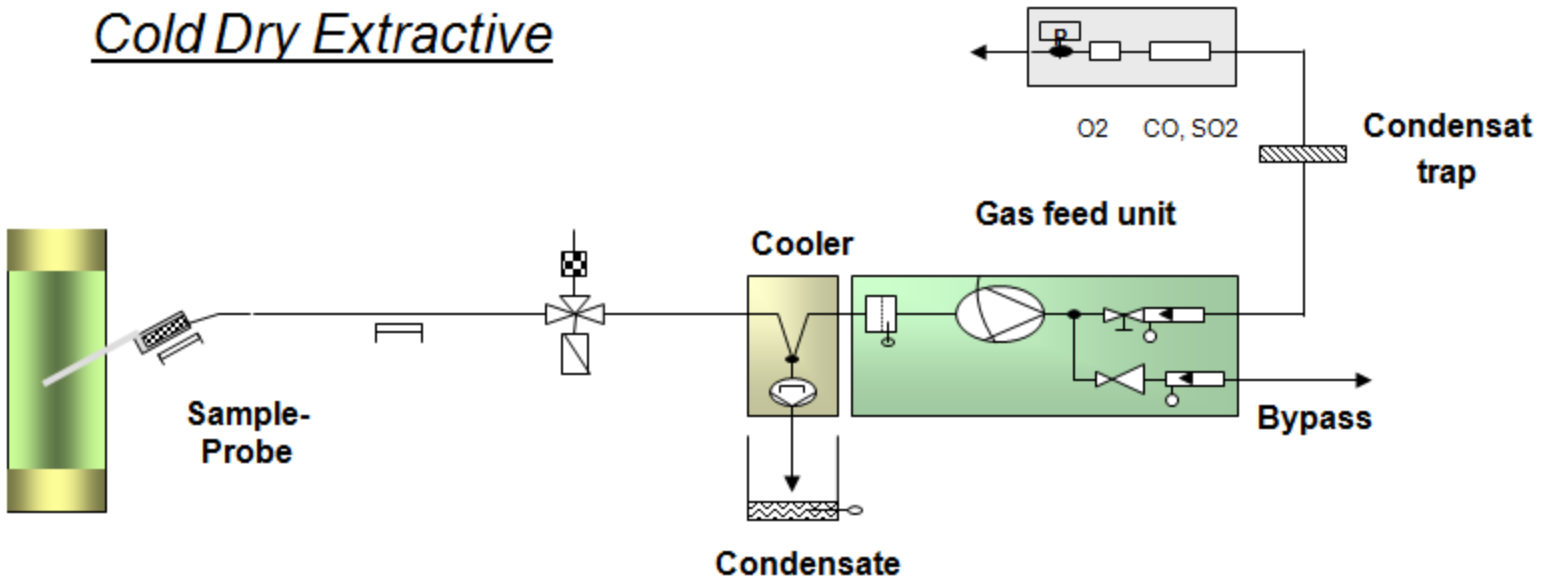


- **Advantages**
- Easy maintenance at the analyzer
- Multi component measurement possible
- Easy calibration

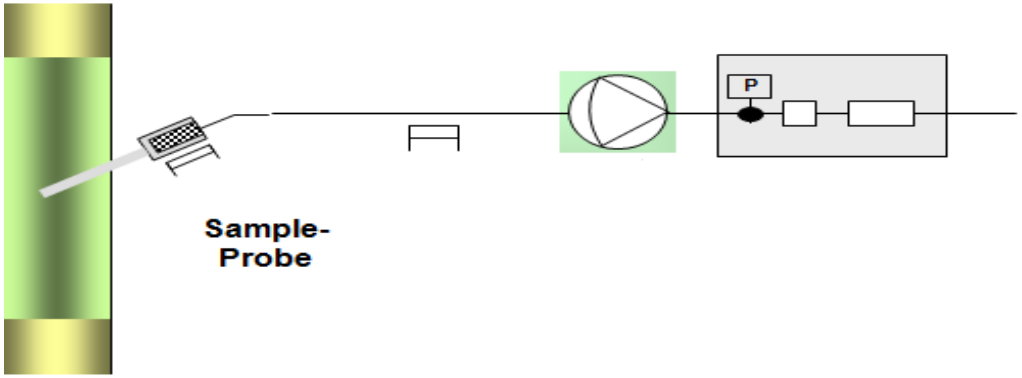
- **Disadvantages**
- Additional effort for sampling and conditioning
- Dispose of the sample gas
- Leakage in sample system (misreading)
- Sometimes long response times

Extractive Gas Path

Cold Dry Extractive



Hot Wet Extractive



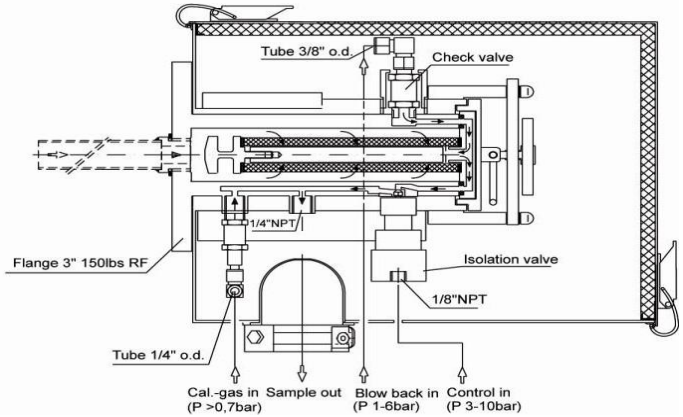
Extractive Sample Probe Tube

- Material of Construction: carbon steel, stainless steel, hastelloy, PTFE
- Operating temperature: heated or unheated
- Filtration: filter or no filter, what porosity
- Mounting: flange size and material

Extractive Sample Probe

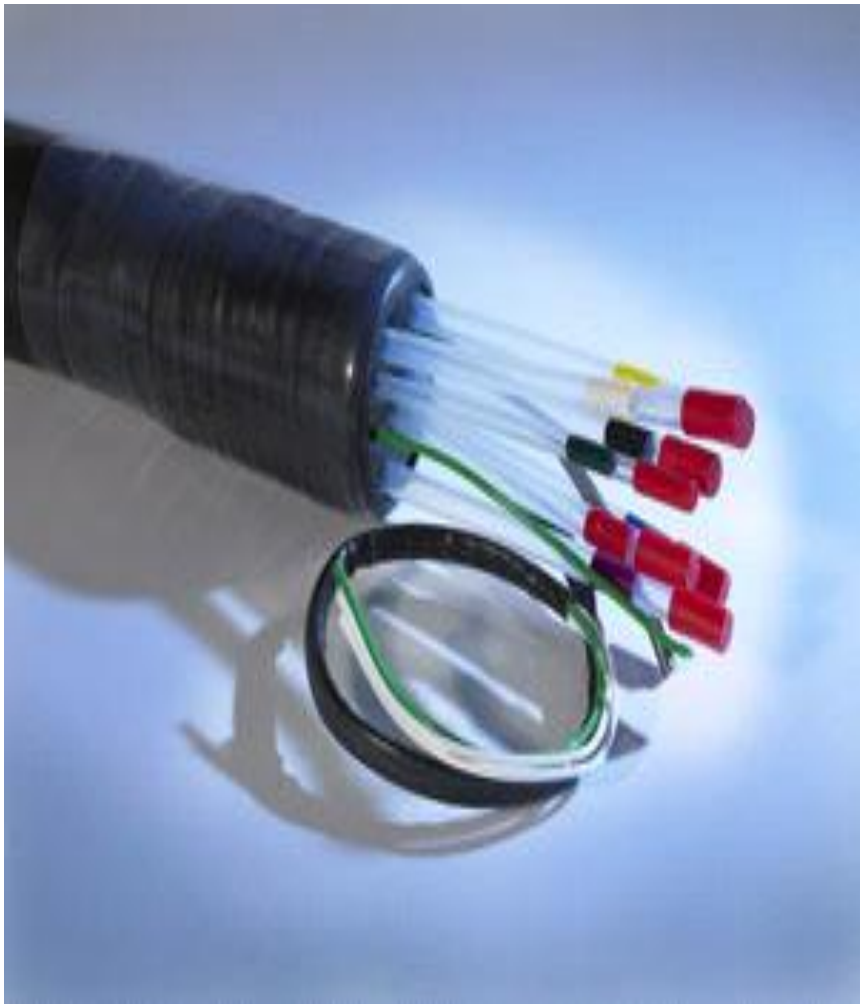
- Material of Construction: carbon steel, stainless steel, hastelloy, PTFE
- Operating temperature: heated or unheated
- Filtration: filter or no filter, what porosity
- Mounting: flange size and material

SP2020-H/C/I/BB/F

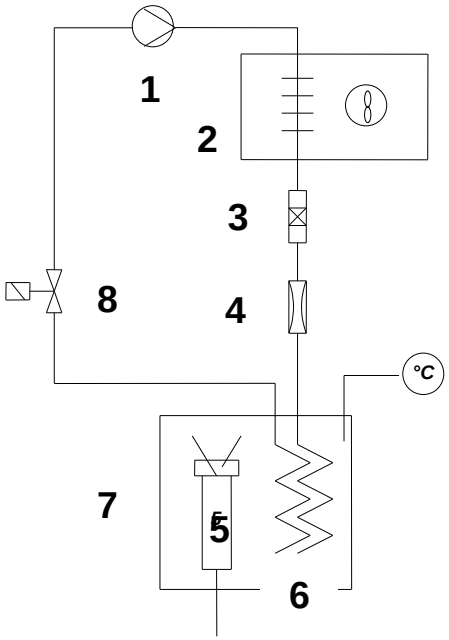


Sample Gas Transport

- Material of Construction: stainless steel, PTFE, Polyethylene
- Operating temperature: heated or unheated
- How many tubes, what diameter of tubes
- Length of line needed



Sample Gas Conditioner

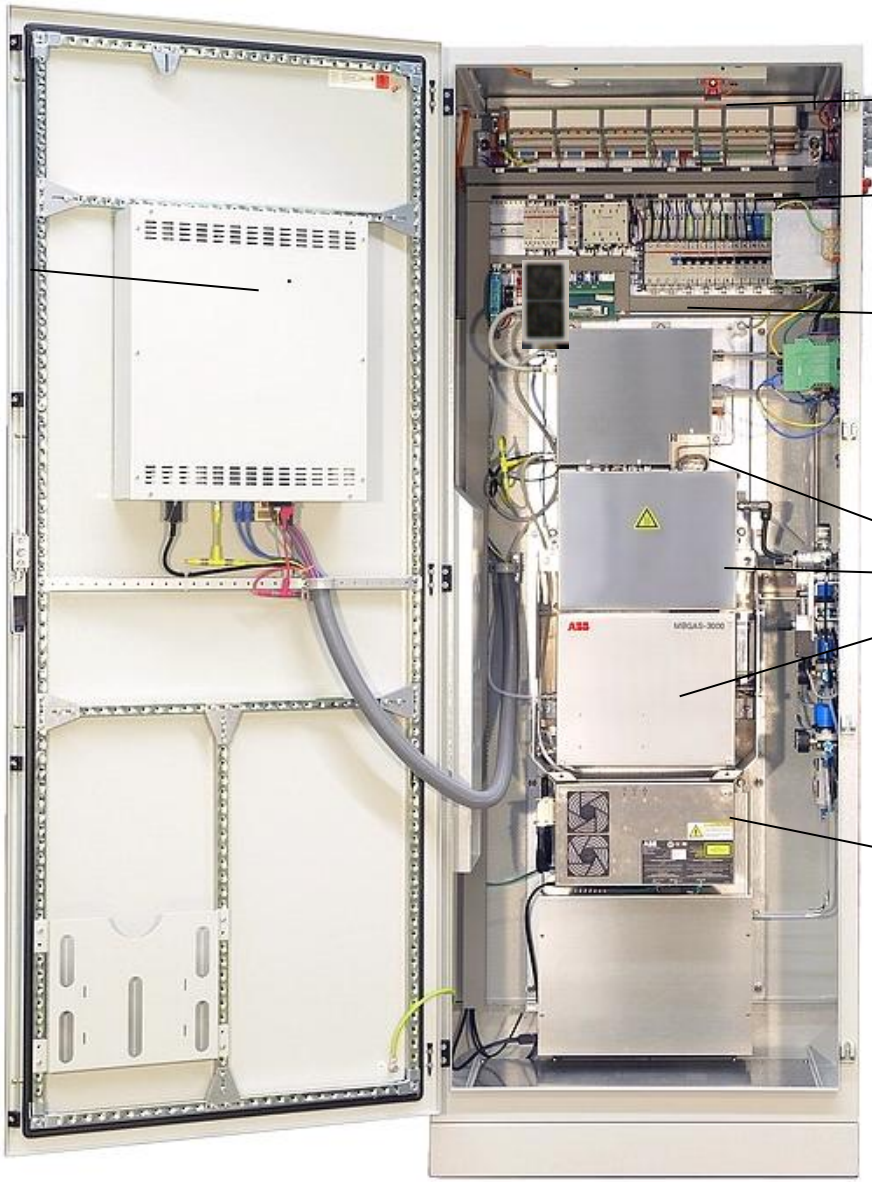


Cool circular flow

1 Compressor
2 Condensator
3 Dryer
4 Capillary
5 Heat exchanger
6 Vaporizer
7 Cool block with Temperature Sensor
8 Control valve

Sample Gas Transport

Extractive Hot Wet Gas Analyzer



Extractive Cold Dry Gas Analyzer

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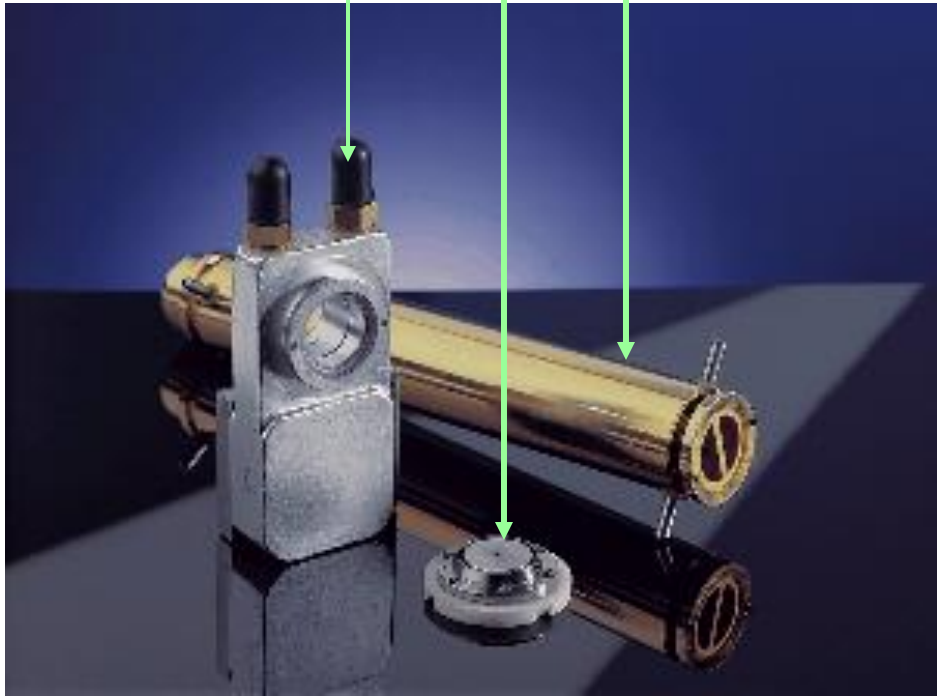
Internal Calibration Cells

Membrane condensator

Detector

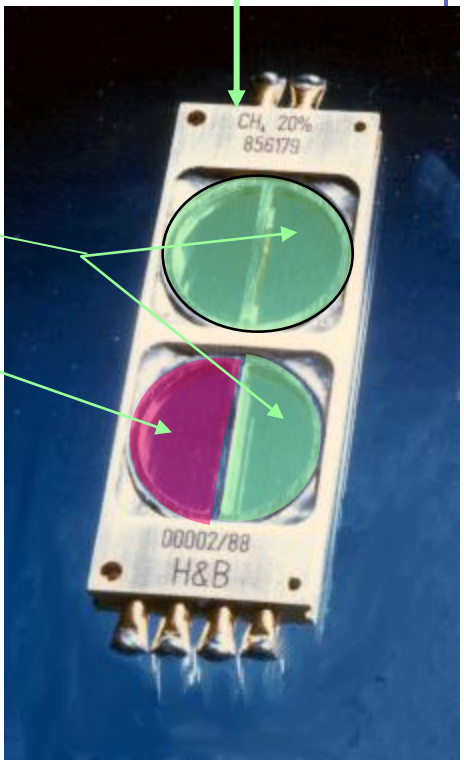
Sample cell

Calibration cell



N_2- Filling

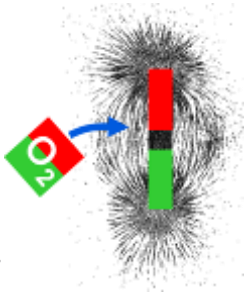
Sample gas



Different gas species – Different measuring methods needed

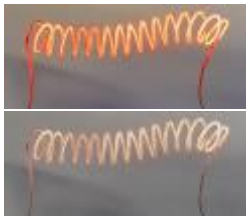
- **Infrared spectroscopy**
- Selective absorption of IR light
- Typical gases: CO_2, CO, NO, SO_2, C_2H_4

- **Ultraviolet spectroscopy**
- Selective absorption of UV light
- Typical gases: NO, NO_2, SO_2, Cl_2



- **Magnetic susceptibility**
- Measurement of paramagnetic O_2

- **Thermal conductivity**
- Measurement of differences in thermal conductivities
- Typical gases: H_2, He



- **Flame ionization**
- Ionization of organic compounds in a hydrogen flame
- Typical gases: all kind of organic compounds, e.g. CH_4, C_3H_8