Monitoring Strategies & Solutions for Flue Gas Pollutants (CEMS)

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CEM India

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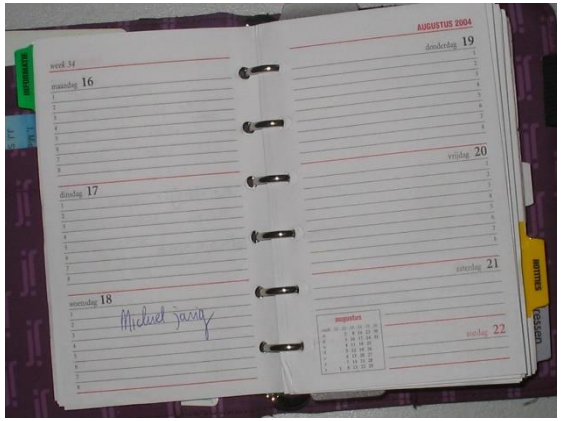
Agenda



- Where do we measure?
- What do we measure?
- Regulations
- Analysers / Detection Technologies
  - In-situ
  - Conventional extractive
  - Dilution extractive
- Quality Assurance
- PEMS ?
- Conclusions

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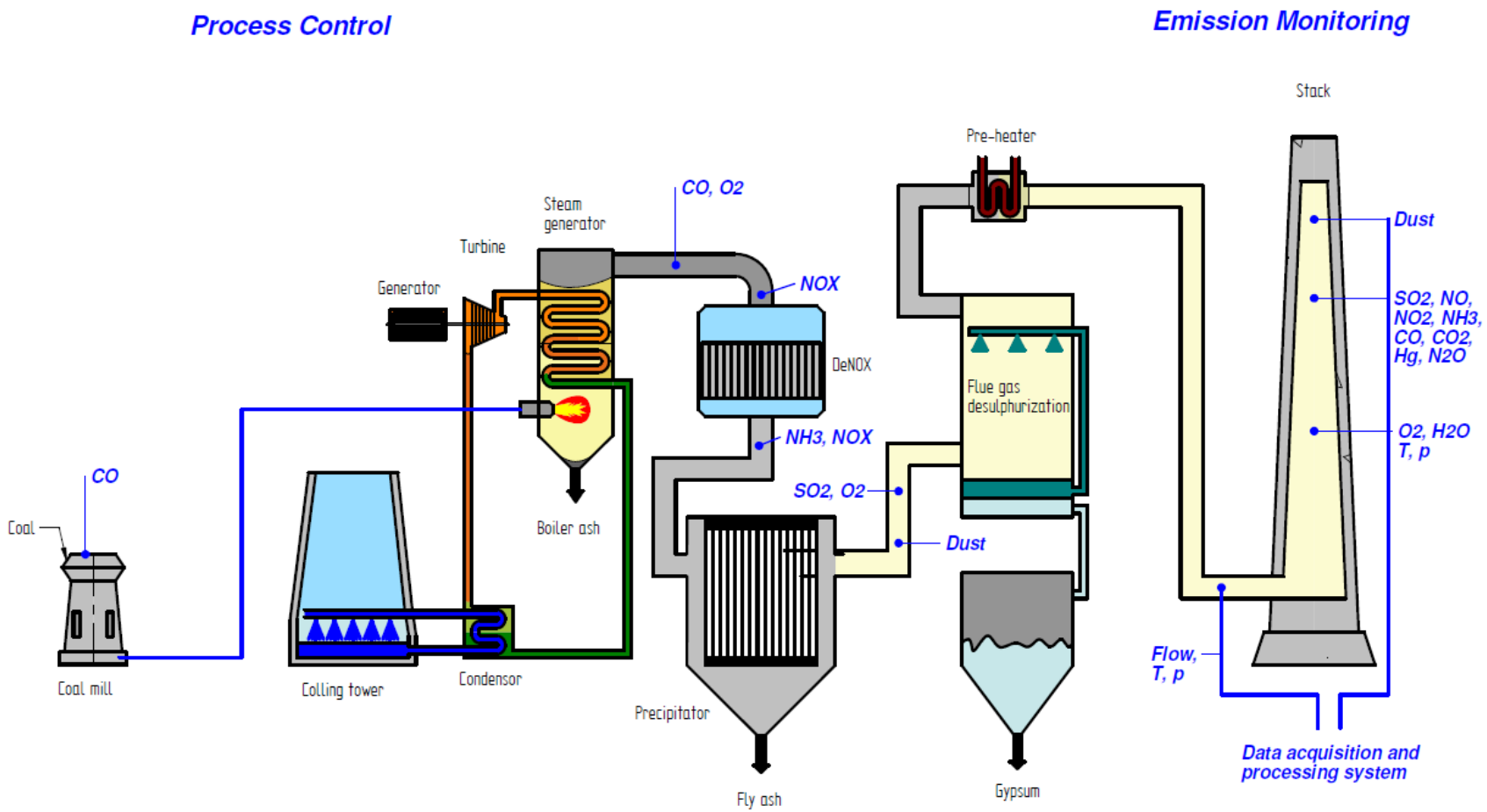
What needs to be measured where in a Thermal Power Plant?



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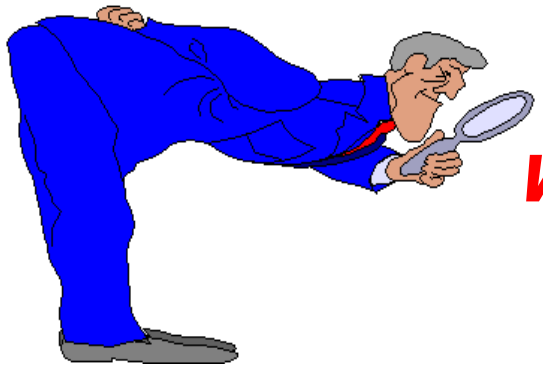

WHY MONITORING AT ALL??

If we don't know "what and how much", we don't know "how to reduce it"

Emission Monitoring documents the efficiency of Emission Control Activities

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REGULATIONS

There are basically two ways of the regulatory approach:

- ***U.S.A.***
  - **US-EPA regulations are laid down in 40CFR60 and ASTM's**
  - **Instruments cannot get type-approval – there is no scheme like that in USA**
  - **Extensive site testing after installation is required**

- ***EUROPE***
  - **European regulations are laid down in EN's as well as country-specific laws and regulations, f.e. in Germany: TA-Luft, BImSchG, and BImSchV 1 – 45**
  - **Instruments have to successfully complete type-approval ("TUEV-Test, MCERTS") = QAL 1**
  - **Extensive site testing after installation is required = QAL 2**

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What is it we are interested in?

There are plenty of pollutants we can / have to measure:

- **Particulates:**
  - **Total Dust or Opacity, Heavy Metals**
- **Inorganic Compounds:**
- **CO, CO_2, SO_2, $NO/NO_2/NO_x$, NH_3, HCl, HF, Total Hg**
- **Organic Compounds:**
- **THC, Dioxins & Furans**

- **Reference Values:**
  - **O_2, H_2O, Temperature, Pressure, Gas Velocity / Flow**

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CEMS DESIGN

- **CEMS (Continuous Emission Monitoring System) can be designed in three principle ways (or a combination between them):**

Direct In-Situ Analyzers

- Dust/Opacity, O_2, H_2O, CO, CO_2, SO_2, NO, NO_2 , NH_3, HCl, HF
- Hg (elemental only)

Conventional Extractive Analyzers

- Dust, CO, CO_2, SO_2, NO, NO_2 , NO_x, NH_3, HCl, HF, Total Hg, THC, Dioxins & Furans (Samplers only), O_2, H_2O

Dilution-based Extractive Analyzers

- Dust, SO_2, NO, NO_2 , NO_x, Total Hg

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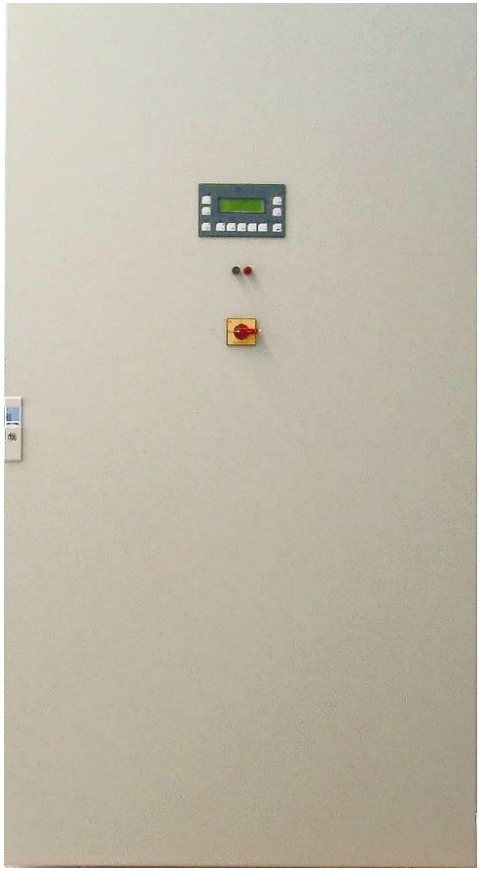
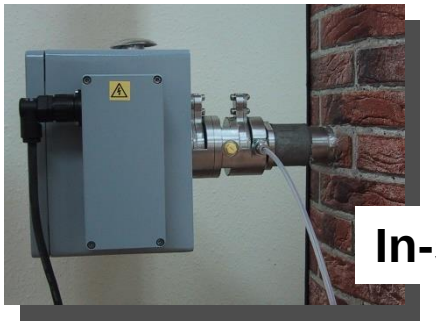
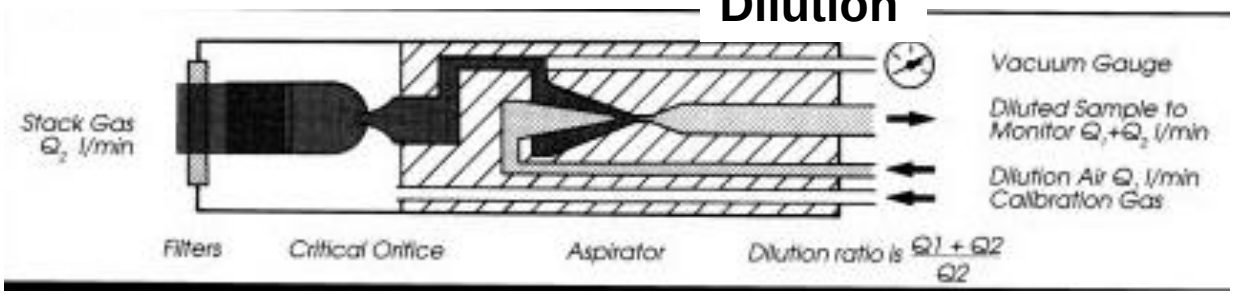




In-situ

⬅ Extractive ➡

Dilution



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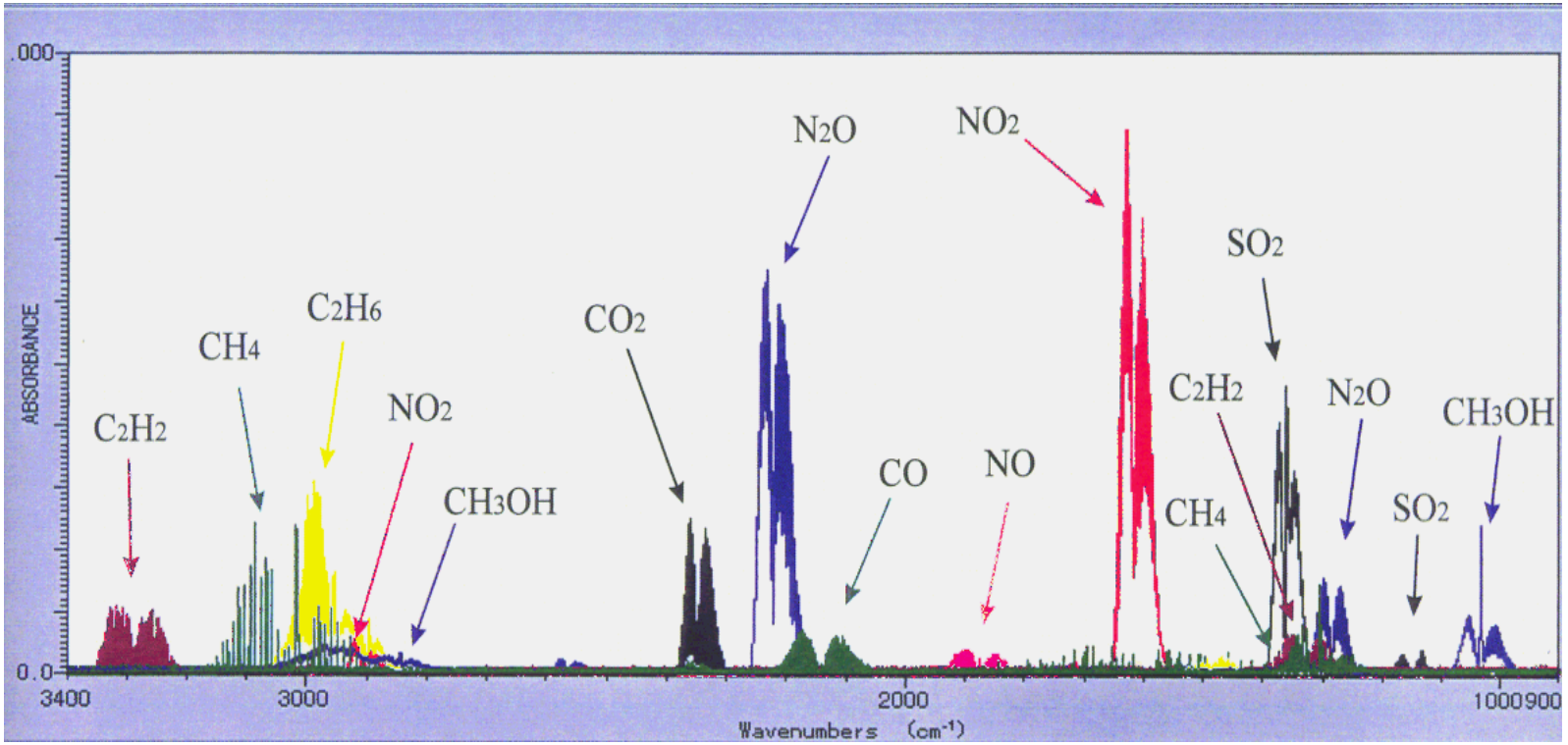

Many gaseous pollutants show absorption band(s) in the infrared wavelength band

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OTHER DETECTION TECHNOLOGIES for gas measurement

- **UV-Absorption is used for a number of pollutants like NO and NO_2**
- **Chemiluminescence is used for NO, NO_2, NO_x**
- **FTIR Spectrometry is used as Multicomponent Analyzer**
- **Flame Ionization Detector (FID) is used for Total Hydrocarbons (THC)**
- **UV-Photometrie or CVAFS, together with sample preparation, are used for Total Mercury**
- **ZrO_2 probes are used for O_2**

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DETECTION TECHNOLOGIES
for dust measurement

- **Light Transmission** for %-Opacity and Extinction (= calibrated into dust concentration [mg/m³])
- Generally only accepted principle: Autocollimation (= double path light beam from one light emitter); single path light beam not for statutory measurements
- **Light Scattering** for dust concentration [mg/m³] and low concentration (0.5 – 250 mg/m³); either backward or forward scattering
- **Extractive Beta-Gauge** instruments mainly for applications, where optical principles cannot be used (= stack gas below dewpoint; varying particle colors and/or particle size and density)
- **Triboelectric** mainly as broken bag filter detector – qualitative measurement; or **Electro-Dynamic** calibrated for dust concentration

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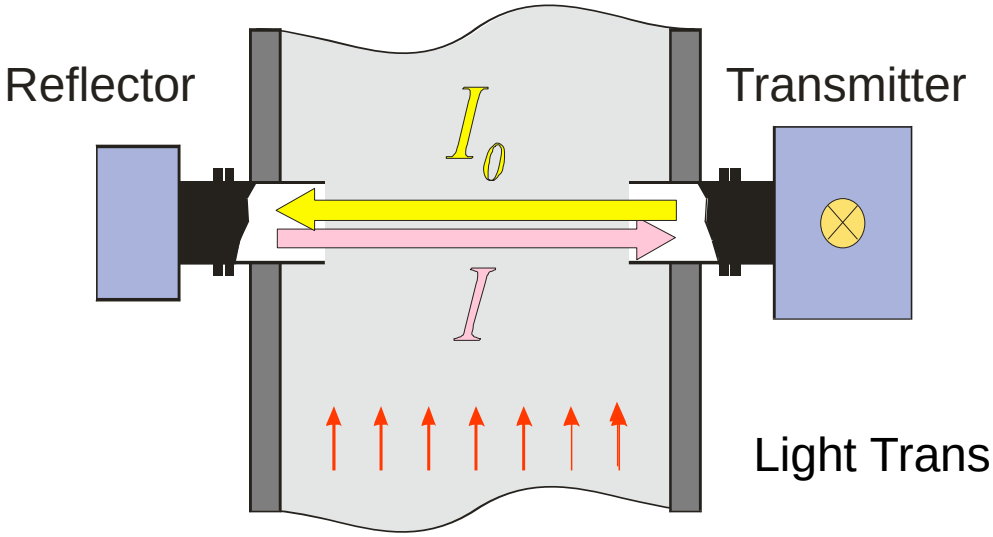
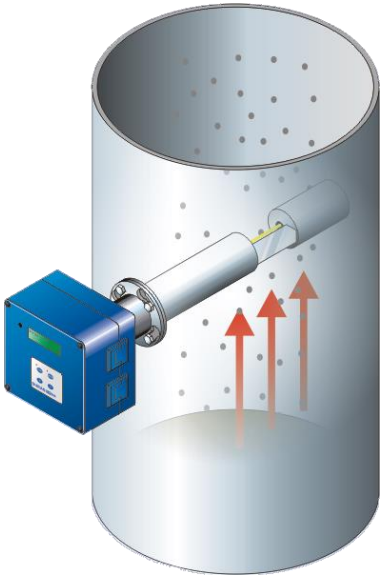
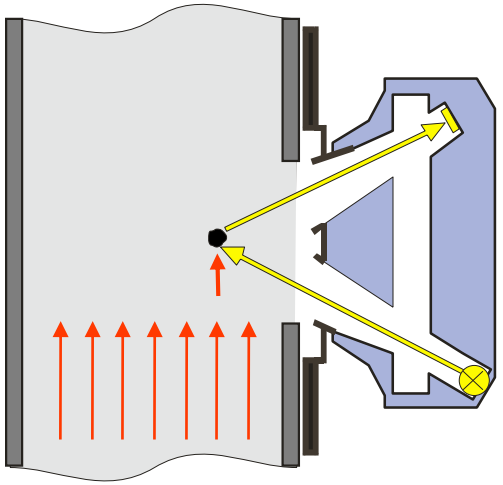


Light Transmission





Light Scattering

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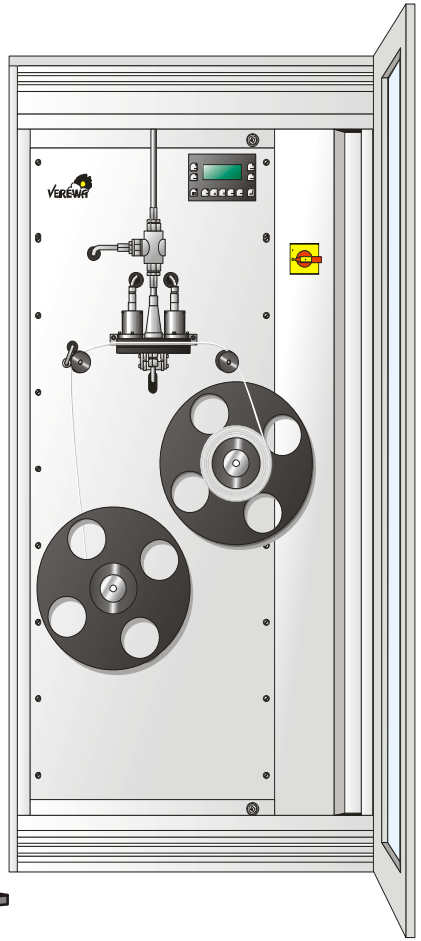
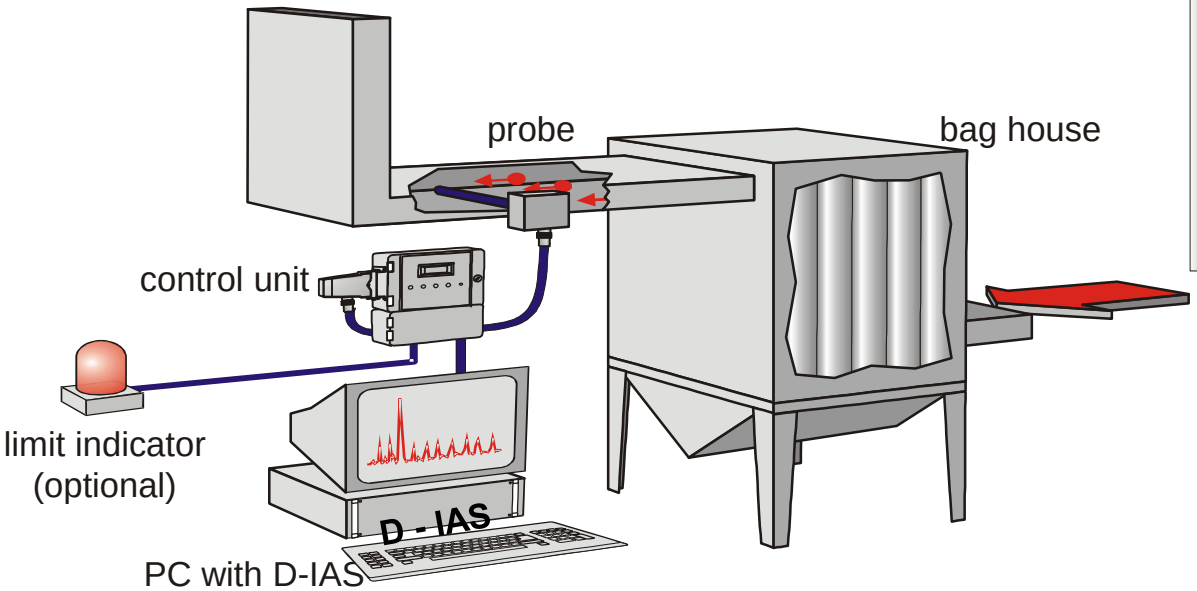
Extractive Beta-Gauge





Triboelectric

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ADVANTAGE / *DIS-ADVANTAGE*
IN-SITU

- No sample transport – gases / dust are analyzed in their stack environment
- Typically Multicomponent Analyzers – reduction on space and accessories
- Unknown / Unexpected interferences possible – difficult to consider during calibration
- If a key component fails, the whole Multicomponent Analyzer is down
- Sensitivity might be depending on available pathlength (stack diameter)

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ADVANTAGE / *DIS-ADVANTAGE*
CONVENTIONAL EXTRACTIVE

- Relatively simple way of calibrating the entire CEMS
- With individual analyzers: typically no common breakdown possible; Multicomponent Analyzers – reduction on space and accessories
- Requirement of A/C instrument shelter
- With Sample Gas Chillers: probability of loss of components; with High Temperature Systems: probability for higher maintenance and service
- Accuracy of measurement depending on quality of sample handling/ sample transport/sample conditioning
- ***SAMPLE HANDLING SYSTEM OFTEN IS NOT PROFESSIONALLY DESIGNED!***

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ADVANTAGE / *DIS-ADVANTAGE*
DILUTION EXTRACTIVE

- Relatively simple way of calibrating the entire CEMS
- Dilution reduces interferences from inappropriate sample handling
- With individual analyzers: typically no common breakdown possible
- Requirement of A/C instrument shelter
- Ambient Air Analyzers with lower LDL required = typically more expensive
- Accuracy of measurement depending on stability of dilution; Critical Orifices are sensitive to inlet-pressure changes
- Typically not possible to perform dry-basis-measurement, complex to report dry-basis values

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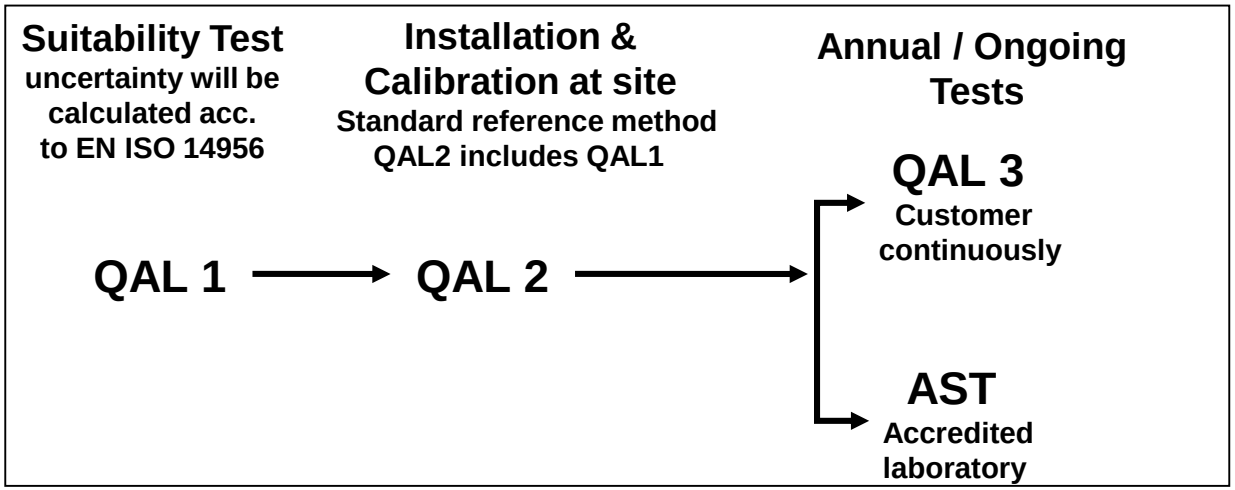
QUALITY ASSURANCE 1

USA:

– Quality and Accuracy of CEMS measurements are assured by extensive site acceptance tests after installation and by annual reference calibrations from accredited laboratories

EUROPE:

– Quality Assurance of any CEMS is acc. to EN 14181 and following the QAL-scheme:



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QUALITY ASSURANCE 2
EUROPE

QAL 1 is the „TUEV-Test“ (Germany) or MCERTS (UK) – an *instrument type approval*. In Europe only instruments having successfully passed QAL 1 are allowed to be used for statutory monitoring. Approvals can expire or be revoked. Online information: www.qal1.de/en

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QAL 2 is an extensive site acceptance test after installation, performed by an ***accredited laboratory or agency***. Testing is for quality of the installation, sample handling, as well as accuracy of the instrumentation. Only QAL 1 approved instrumentation is allowed. QAL 2 to be repeated every five years.

QAL 3 is the ongoing daily quality assurance (zero & span checks, regular maintenance), performed by the ***user***.

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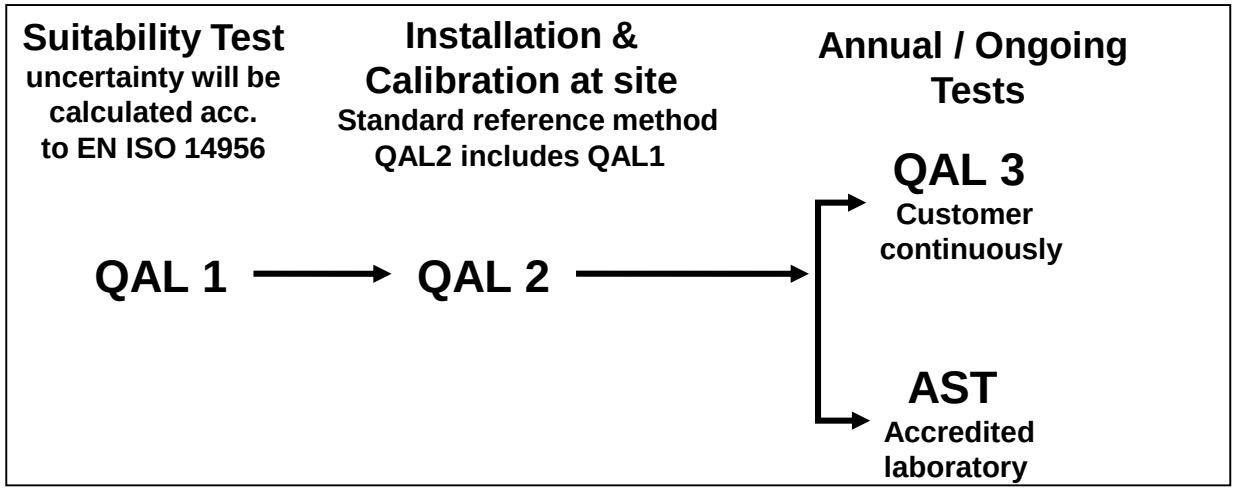
AST – Annual Surveillance Test - is a short QAL 2 test to be performed annually by an *accredited laboratory or agency*. If AST fails, the instrumentation has to be rectified and immediately a complete QAL 2 test is required.



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WHY MONITORING AT ALL?

Predictive Emission Monitoring Systems (PEMS) offer an alternative to CEMS:

A PEMS is a software based data acquisition system (Software-CEMS) that is interfaced with the process control system and inputs from the combustion or pollution control process.
It utilizes these inputs to determine the emission rates of the various **gaseous** pollutants that are regulated.
The predictive emissions monitoring system has no gas analyzers, but requires dust / opacity monitors.
An Annual Surveillance Test or RATA is required by using e.g. mobile CEMS.
The main factor defining the possibility for using a PEMS is the fuel used in the process. PEMS requires fuels with very constant conditions. Plants using solid fuels (coal, waste, biomass, etc.) cannot utilize PEMS and require instrumental CEMS.

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FINAL CONCLUSION

Big Question:

WHAT IS THE RIGHT INSTRUMENT FOR ME???

Simple Answers:

- All types of QAL-1 approved Analyzers are mature instruments.
- Correct Sample Handling & Conditioning for extractive Emission Monitors is essential for an accurate analysis.
- In-situ instruments are not always the better way to go!
- Not monitoring but Predicting might provide less headaches.

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FINAL CONCLUSION 2

The purchasing process takes little time in comparison to the time you or your customer have to life with the instrumentation. Therefore:

- **Select instruments which are Internationally approved.**
- **Support and Service, AMC's and Spare Parts Inventory, Manufacturer's Service Personnel in the country or Manufacturer-trained personnel are essential for a hassle-free operation.**
- **Purchasing requirement must always include at least 2 years of consumables, spare parts, and AMC – this way it is ensured that quality instrumentation is offered.**
- **Try to avoid purchase only based on "L1", base it on technology!**
- **For larger installations a BOT scheme could be of interest.**

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